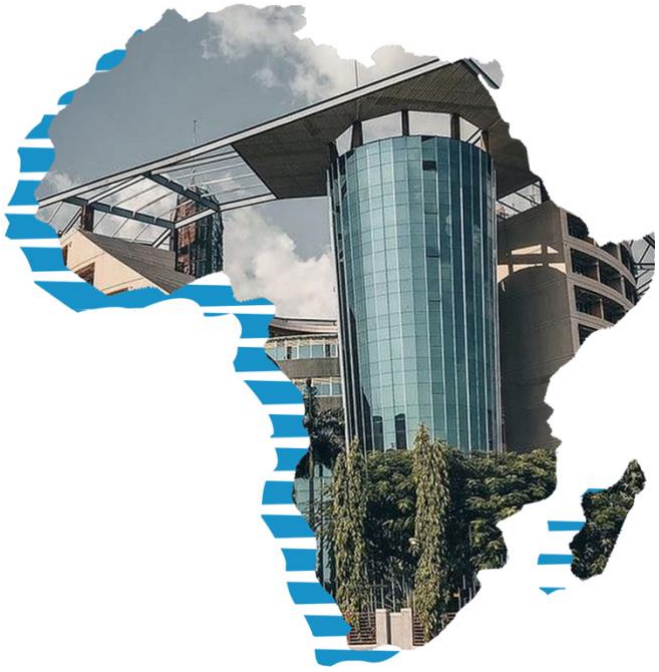
INTERNATIONAL TELECOMMUNICATION UNION

ITU POLICY ANALYSIS
Strengthening National Broadband Mapping Systems in Nigeria



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List of Acronyms and Abbreviations

API — Application Programming Interface
ATC — American Tower Corporation, (ATC Nigeria)
BCO — Broadband Competence Office
BCRD — Broadband Cost Reduction Directive
BDT — ITU Telecommunication Development Bureau
BEREC — Body of European Regulators for Electronic Communications
CAPEX — Capital Expenditure
CBN — Central Bank of Nigeria
CER — Critical Entities Resilience (EU)
CNII — Critical National Information Infrastructure
DCM — Digital Cadastral Map
DESI — Digital Economy and Society Index
DGA — Data Governance Act
DGU — State Geodetic Administration (Croatia)
DPIA — Data Protection Impact Assessment
DTM — Digital Terrain Model
ECOWAS — Economic Community of West African States
EECC — European Electronic Communications Code
ESF — Environmental and Social Framework (World Bank)
EU — European Union
FCT — Federal Capital Territory (Abuja)
FEC — Federal Executive Council
FMCDE — Federal Ministry of Communications, Innovation and Digital Economy
FMW — Federal Ministry of Works
GIA — Gigabit Infrastructure Act
GDP - Gross Domestic Product
GIS — Geographic Information System
HAKOM — Croatian Regulatory Authority for Network Industries
IFC — International Finance Corporation
INEC — Independent National Electoral Commission
ITU — International Telecommunication Union
JIT — Single Information Point (Croatia)

KPI — Key Performance Indicator
KPO — National Recovery Plan (Poland)
MoU — Memorandum of Understanding
NASRDA — National Space Research and Development Agency
NBP — National Broadband Plan
NBS — National Bureau of Statistics
NCA — Nigerian Communications Act
NCC — Nigerian Communications Commission
NDEPS — National Digital Economy Policy and Strategy
NDP — National Development Plan
NDPA — Nigeria Data Protection Act
NGDI — National Geospatial Data Infrastructure
NGF — Nigeria Governors' Forum
NICTIB — National ICT Infrastructure Backbone
NIS2 — Network and Information Security Directive (EU)
NPC — National Population Commission
NRA – National Regulatory Auuthority
OGC — Open Geospatial Consortium
OMS — Obligation Management System
OPEX — Operating Expenditure
OSGoF — Office of the SurveyorGeneral of the Federation
PoP — Point of Presence
POPC - Operational Programme Digital Poland (Poland)
QoE — Quality of Experience
QoS — Quality of Service
RAN — Radio Access Network
REA — Rural Electrification Agency
RoW — Right of Way
SKI — Infrastructure Cadastre System (Croatia)
SOC — Security Operations Center
VHCN — Very HighCapacity Network
WATRA — West Africa Telecommunications Regulators Association
WFS - Web Feature Service
WMS - Web Map Service

Figures and Tables

1. Introduction

Reliable broadband infrastructure has become essential for economic development, social inclusion and the functioning of modern public services. Yet many countries continue to face significant challenges in understanding the true extent, quality and distribution of their digital networks due to fragmented data, limited mapping capabilities and inconsistent reporting frameworks.
This introductory chapter sets the scene for the work presented in the report by outlining the broader context, explaining the purpose and objectives of the assessment, and describing the methodological approach that guides the analysis in the sections that follow.

1.1. Purpose and objectives of the project

Africa remains the region with the lowest level of digital connectivity globally. According to ITU data, in 2024 approximately 38% of the population in Africa used the Internet, compared to a global average of around 68%. At the same time, Africa is experiencing one of the fastest rates of growth in Internet usage worldwide, which translates into increasing demand for reliable, affordable and good-quality broadband connectivity across all sectors of the economy and areas of social life.

In response to these challenges, the Africa Broadband Maps (Africa BB Maps) initiative is being implemented by the International Telecommunication Union (ITU) with financial support from the European Union. The initiative is designed as a multi-year, phased programme, with activities intensifying from 2025 onwards. Its overall objective is to support the establishment or strengthening of national broadband mapping capacities in a group of selected Sub-Saharan African countries, including Benin, Botswana, Burundi, Côte d'Ivoire, Ethiopia, Kenya, Malawi, Nigeria, Uganda, Zambia and Zimbabwe.

Africa BB Maps combines strategic and operational elements. It forms part of the broader Africa-Europe Digital Regulators Partnership and contributes to the objectives of the European Union's Global Gateway strategy, in particular with regard to evidence-based policy-making and inclusive digital transformation. Rather than creating a single centralized system, the initiative supports NRAs in developing or improving country-specific broadband mapping tools that are aligned with internationally recognised good practices and adapted to local legal, institutional and market conditions.

A core objective of Africa BB Maps is to improve the availability, consistency and usability of georeferenced data related to broadband networks and services. The initiative focuses primarily on data concerning network infrastructure and coverage, such as backbone and access networks, transmission routes, and the geographic extent of mobile and fixed broadband services. Where feasible and in line with national regulations, additional data layers may be incorporated over time. The availability and level of detail of such data depend on national data-sharing frameworks, the participation of operators and infrastructure providers, and the technical capacity of the responsible institutions.

By supporting the development of broadband mapping systems, Africa BB Maps aims to enable regulators and policy-makers to better identify underserved and unserved areas, assess investment needs, and design targeted interventions. The initiative also seeks to improve transparency and facilitate coordination among public authorities and market players, including in areas such as infrastructure sharing and the avoidance of unnecessary duplication of civil works. In this way, the project contributes to more efficient use of public and private resources and to the long-term resilience of digital infrastructure.

An important characteristic of Africa BB Maps is its collaborative approach. The initiative provides a framework for structured cooperation and knowledge exchange between African NRAs, European regulatory institutions, telecom operators, infrastructure providers and entities responsible for geospatial data. European experience in broadband mapping, data governance and regulatory practice - including lessons learned from BEREC and EU broadband mapping initiatives - is used as a reference point, while solutions are adapted to the specific circumstances of participating African countries. The aim is not to replicate European regulatory models, but to support gradual convergence towards interoperable and methodologically consistent approaches that can enhance comparability over time.

Nigeria represents a particularly relevant case within the Africa BB Maps initiative. As one of the largest and most dynamic telecommunications markets in Africa, Nigeria faces significant challenges related to the fragmentation of data on infrastructure, coverage and services. Geographic diversity, uneven population distribution, energy and security constraints, and rapid network expansion all increase the need for reliable spatial data to support regulatory oversight and investment planning. Africa BB Maps seeks to assist Nigeria in strengthening its broadband mapping capabilities by supporting the development of interoperable tools and by promoting clearer processes for data collection, validation and use, within the existing national legal and institutional framework.

The initiative is implemented in phases. Initial activities focus on baseline assessments, analysis of regulatory and institutional frameworks, and stakeholder engagement at national and sub-regional level. This report for Nigeria forms part of this preparatory phase, providing an overview of the current context, identifying gaps and challenges, and outlining areas for further action. Subsequent phases focus on the gradual implementation or enhancement of national broadband mapping tools, capacity-building and training, and post-implementation support aimed at ensuring operational continuity and sustainability.

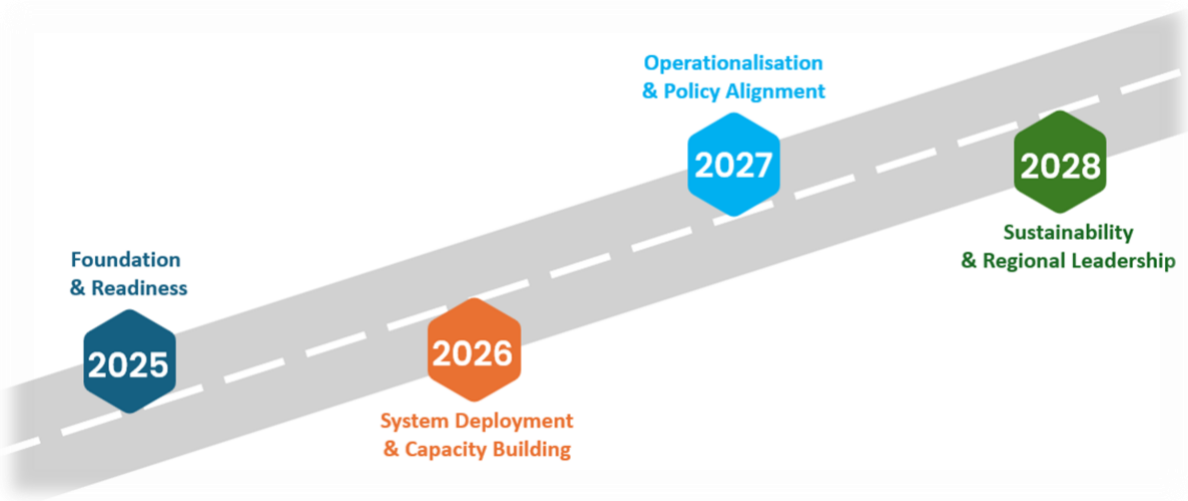


Figure 1 *Africa BB-maps project timeline*

Implementation in Nigeria is based on close cooperation with the Nigerian Communications Commission (NCC), relevant government bodies responsible for planning and geospatial data, as well as telecom operators and infrastructure providers. Workshops, technical meetings and consultations are used to facilitate data exchange, build institutional capacity and align expectations among stakeholders.

The purpose of this report is therefore to assess the existing regulatory and institutional environment, identify gaps in data availability and processes, and formulate strategic and

technical recommendations consistent with ITU methodologies and Africa BB Maps objectives. The document serves as a foundation for subsequent stages of the initiative, including the development of technical specifications, capacity-building activities and measures aimed at ensuring the long-term sustainability of broadband mapping solutions in Nigeria.

1.2. Methodology and approach

The preparation of this report was based on a multi-stage process aimed at ensuring reliability, transparency, and broad stakeholder engagement. The methodology combined document analysis, consultations with key entities, and technical-political workshops, enabling data collection, validation of assumptions, and joint development of recommendations.

The first step was a workshop held in Abuja on August 5-7, 2025, which brought together representatives of the Nigerian Communications Commission, government institutions, telecommunications operators, infrastructure providers, international organizations, and ITU experts. The meeting was interactive and included three main components: political and strategic dialogue, in-depth technical sessions on system architecture and data standards, and work on the implementation roadmap. The discussions helped identify key data sources, regulatory and technical barriers, and priority actions.

The next stage involved bilateral meetings with public institutions, held in November 2025, including the National Population Commission (NPC), Nigerian Postal Service (NIPOST), Office of the Surveyor General of the Federation (OSGoF), National Geospatial Data Infrastructure (NGDI), the technical arm of the Nigerian Governors Forum (NGF), GRID-3 project domiciled in National Space Research and Development Agency (NASRDA), Rural Electrification Agency (REA) and the Federal Ministry of Works (FMW). These meetings aimed to obtain reference data, discuss mechanisms for data sharing, and verify the feasibility of integration with the planned mapping system.

In parallel, consultations were conducted with the private sector, including mobile operators (MTN, Airtel, Globacom, T2), internet and fiber service providers (IPNX, MainOne/Equinix, Spectranet, Layer3, Phase3 Telecom, Smile, FibreOne, Galaxy Backbone (GBB), and tower companies (IHS, ATC, Africa Mobile Networks (AMN)). The dialogue with the market made it possible to assess the availability of data on infrastructure, coverage, and service quality, as well as the readiness to share such data in standardized formats.

The report preparation process also included questionnaires and follow-up inquiries sent to operators and institutions to obtain missing information. The collected data were analyzed for consistency, completeness, and compliance with ITU technical requirements.

The final stage involved the review of strategic documents and legal acts, including the Nigerian National Broadband Plan 2020-2025, Nigerian Communications Act 2003 and relevant NCC regulations and guidelines, NGDI policy, and regulations on data protection and cybersecurity. Based on the gathered information, a diagnosis of the current state was developed, regulatory and technical gaps were identified, and strategic and technical recommendations were formulated, forming the foundation for implementing the national broadband mapping system.

Importantly, the methodology was anchored in international best practices and guidance documents, including ITU's "Guidelines for Establishing or Strengthening National Broadband Mapping Systems" (2022) and Recommendation ITU-T E.813 on mapping and visualization strategies (2024). European experience was also leveraged through reference to the EU Electronic Communications Code (Directive 2018/1972), the Gigabit Infrastructure Act (2024), and BEREC guidelines on geographical surveys and data validation. These frameworks provided a benchmark for regulatory design, interoperability standards, and governance

models, ensuring that Nigeria's approach aligns with globally recognized principles while remaining adapted to local conditions

The methodology is based on the principles of evidence-based policy, multi-stakeholder engagement, and alignment with international ITU and EU standards, ensuring coherence, transparency, and the ability to replicate best practices across the region.

This approach guarantees the report's high substantive quality, its compliance with international best practices, and broad stakeholder acceptance. As a result, the document can serve as a reliable tool to support strategic and operational decisions regarding broadband infrastructure development in Nigeria.

1.3. Structure of the report

The structure of this report has been designed to provide a comprehensive presentation of the Africa-BB-Maps project context, an assessment of the current situation in Nigeria, and recommendations for implementing a national broadband mapping system. The arrangement of chapters reflects a logical sequence of actions-from strategic analysis to an implementation roadmap-ensuring clarity and coherence throughout.

Chapter 1 - Introduction outlines the background of the project, its objectives and relevance for Nigeria, the applied methodology, and the structure of the document. It also highlights the role of this report as a key deliverable of the first year of the Africa-BB-Maps project, serving as a starting point for subsequent implementation phases.

Chapter 2 - Policy and Strategic Context discusses international regulatory frameworks (ITU, EU) and national strategies and documents that define the direction of broadband infrastructure development. This analysis explains how the project aligns with broader digital initiatives and public policies, and how harmonization of approaches can support Nigeria's development goals.

Chapter 3 - Current State Assessment and Justification for Mapping provides a geographic, demographic, and market analysis, a review of existing mapping initiatives, and identification of critical gaps in service availability. This chapter forms the basis for defining intervention priorities and highlights areas where data deficiencies hinder investment planning.

Chapter 4 - Regulatory and Institutional Framework Assessment examines existing legislation, inter-institutional cooperation mechanisms, and legal and organizational barriers that may affect the implementation of the mapping system. It identifies areas requiring legislative and procedural adjustments to ensure system effectiveness and sustainability.

Chapter 5 - Data Governance and Interoperability presents the legal and technical foundations for data collection, exchange, and publication, including standards, protocols, and multi-stakeholder collaboration models. It also addresses issues related to open data, information security, and system interoperability, which are essential for integrating data from diverse sources.

Chapter 6 - Institutional Capacity evaluates the organizational and technical capabilities of key stakeholders, including the regulator, government institutions, and operators. This analysis helps define needs for capacity building, technical resources, and coordination mechanisms.

Chapter 7 - Recommendations and Implementation Roadmap formulates strategic and technical recommendations, sets priorities for action, and outlines the timeline for implementing the national broadband mapping system in subsequent project phases. It also includes proposals for monitoring progress and evaluating outcomes.

Chapter 8 - Risk Analysis and Mitigation Strategies identifies potential risks associated with system implementation and proposes measures to minimize their impact, including technical, organizational, and financial risks.

Chapter 9 - Financing and Resource Mobilization indicates possible funding sources and models for ensuring system sustainability, including mechanisms for collaboration with public and private partners and leveraging international funds.

Chapter 10 - Sustainability and Long-Term Vision defines mechanisms for maintaining the system, its future development, and integration with upcoming digital initiatives to ensure adaptability in a changing technological and regulatory environment.

Chapter 11 - Conclusion provides a synthesis of findings and key recommendations that form the basis for further implementation actions.

This structure enables a gradual transition from the general context and strategic analysis to detailed recommendations and an implementation plan. It ensures that the document serves not only as an information source but also as a decision-support tool, allowing stakeholders-both national and international-to understand the project's logic, priorities, and implementation pathway. The structure also guarantees transparency and facilitates tracking the links between diagnosis, risk analysis, recommendations, and action plans, which is critical for the successful deployment of Nigeria's broadband mapping system.

2. Policy and strategic context

This chapter will present the current strategic and legislative framework, with an emphasis on mapping and its impact on mapping processes within the EU, which is regarded as one of the key global actors in this domain. The chapter will help clarify the original context of the document.

2.1 International framework: ITU policy directions

The International Telecommunication Union (ITU) plays a key role in defining policy, regulatory, and technical directions for countries building or strengthening national broadband mapping systems. Broadband mapping, understood as the systematic collection and visualization of geo, referenced data on infrastructure, service quality, planned investments, and demand, is a cornerstone of evidence, based digital policy. It helps identify underserved areas, improve coordination between public and private investments, reduce deployment costs, and accelerate digital inclusion. By revealing gaps in coverage and affordability, mapping also enhances market transparency and provides investors with clearer deployment plans, reducing uncertainty and supporting targeted interventions where market incentives fall short.

The importance of broadband mapping from ITU's perspective is reflected in the resources presented on the ITU page[1]. ITU provides an interactive map of global transmission infrastructure that enables visualization of fiber routes, microwave links, and satellite stations at both national and international levels. The platform also includes a database with key indicators on network capacity and coverage, data quality validation mechanisms, and tools supporting geospatial analysis. In addition, the site offers user guides, training materials, and access to supplementary resources such as data catalogues and open, source tools within the BBmaps Toolkit. This makes it not just a visualization tool but part of ITU's comprehensive ecosystem that helps countries design data, driven digital policies and plan investments in broadband infrastructure.

In its Guidelines on Establishing or Strengthening National Broadband Mapping Systems (2022)[2] ITU provides a detailed roadmap for creating mapping systems that are legally sound, technically robust, and operationally sustainable. The Guidelines define broadband mapping as a digitized system for collecting, structuring, and representing geo-referenced data on infrastructure, service availability and quality, planned investments, and demand. They stress that mapping should be embedded in a continuous policy cycle, planning, intervention, monitoring, and evaluation, rather than treated as a one-off exercise.

The document sets out three pillars: regulatory framework, technical requirements, and project management. From a regulatory perspective, ITU recommends establishing a clear legal mandate for mapping, including obligations for operators to provide data, rules for confidentiality, and mechanisms for dispute resolution. It emphasizes that without such a mandate, mapping systems risk fragmentation and lack of compliance. The Guidelines draw on European best practices, showing how harmonized frameworks such as the EU State Aid Guidelines and the Broadband Cost Reduction Directive have made mapping a cornerstone of digital policy.

On the technical side, ITU advises building systems that integrate four layers: infrastructure, service, investment, and demand. Each layer serves a distinct purpose, tracking physical assets, monitoring service availability and quality, identifying planned deployments, and capturing user needs. The Guidelines recommend using GIS-based platforms, open

[1] https://www.itu.int/en/ITU, D/Technology/Pages/InteractiveTransmissionMaps.aspx

[2] Guidelines on Establishing or Strenghteninng National Broadband Mapping Systems

standards, and interoperable solutions to ensure scalability and cost efficiency. They also specify requirements for data formats, granularity (address-level or grid-based), and validation processes, highlighting the need for strict quality checks and transparent methodologies. Visualization tools are another critical component. ITU suggests interactive maps, APIs, and downloadable datasets, complemented by advanced techniques such as choropleth maps, hexagonal grids, heatmaps, and temporal animated maps to analyse connectivity patterns and trends over time.

Project management guidance includes stakeholder analysis, governance structures, roadmap development, budgeting, and risk management. ITU stresses the importance of internal sponsorship, efficient reporting tools, and long-term sustainability measures such as continuous updates, adaptability of collection tools, and investment in visualization platforms. Talent management and capacity building are highlighted as critical success factors, ensuring that teams have the technical and analytical skills needed to maintain and evolve the system. The Guidelines also provide practical advice on implementation models, outsourced, in-house, or hybrid, and outline the pros and cons of each approach. Budgeting considerations are discussed in detail, including cost estimation methods and factors influencing system complexity.

Finally, the Guidelines include appendices with practical tools such as a cost calculator for estimating system development and maintenance expenses, as well as checklists for minimum regulatory, technical, and project requirements. These resources make the document not only a policy reference but also a practical manual for implementation.

ITU's commitment to broadband mapping is further reinforced by its latest standardization work, notably Recommendation ITU-T E.813 "Mapping and visualization strategies for the assessment of connectivity" (approved in May 2024). This Recommendation provides a structured framework for mapping and visualization strategies aimed at assessing connectivity and begins by defining connectivity in a broader sense than traditional telecom definitions. Connectivity is not limited to the mere presence of service but encompasses technical and non-technical dimensions, including network performance, device capability, affordability, and socio-economic factors. This holistic approach ensures that connectivity assessment reflects real user experience and market conditions.

A central concept introduced in E.813 is the Connectivity Index, a composite indicator that aggregates multiple parameters into a single value to simplify analysis and support targeted interventions. ITU outlines guidelines for constructing such an index, including the selection of relevant KPIs, normalization of data, weighting schemes, and the use of multivariate methods such as cluster analysis or principal component analysis. Transparency in methodology is emphasized to ensure that results are verifiable and actionable.

The Recommendation dedicates a significant section to data tools, organized into thematic toolboxes. These include performance metrics (throughput, latency, MOS), market trends (penetration rates, pricing, churn), coverage indicators (signal strength, line-of-sight, wired and satellite availability), infrastructure data (fiber routes, towers, backhaul), consumer behavior factors (device penetration, digital habits), socio-economic parameters (income, education, demographics), and GIS layers (terrain, topography, regulatory constraints). Each toolbox contributes to building a multi-dimensional picture of connectivity, which can then be visualized geographically.

Mapping and visualization strategies form another core chapter. ITU recommends using GIS-based tools to represent connectivity levels clearly and effectively. Various map styles are discussed, including choropleth maps for administrative comparisons, hexagonal grids for pattern detection, heatmaps for continuous data representation, and temporal animated maps

to show changes over time. These visualization techniques help communicate complex data to diverse audiences, from technical experts to end users, and support decision-making for infrastructure deployment and policy interventions.

The Recommendation also addresses interface design for connectivity assessment. For regulators and organizations, interfaces should allow detailed filtering, integration of multiple data sources, and advanced analytics to guide investment priorities and regulatory actions. For end users, simplicity and clarity are key, with features that display coverage, technology availability, and basic performance indicators in an accessible format.

Finally, E.813 includes practical use cases illustrating how connectivity mapping supports accelerating infrastructure deployment, resolving quality of service issues, empowering consumer choice, and improving transparency and governance. Appendices provide guidance on data source characteristics, granularity, periodicity, and methodologies for constructing single-number indicators.

2.2 European Union policy directions on broadband mapping

Within the European Union, broadband mapping is embedded in a wider connectivity and data policy framework that has evolved over more than a decade.

From early monitoring to systematic indicators

In the early 2010s, the Digital Agenda for Europe (launched in 2010) and the emerging Digital Economy and Society Index (DESI) began to track broadband availability and take, up using indicators reported by national authorities and operators. Around the same time, the Commission started publishing the recurring “Broadband Coverage in Europe” studies, which report coverage by technology, speed tiers and territorial typology (e.g. rural vs urban) based on standard surveys primarily to NRAs and operators.

These outputs are statistical, but the underlying data collections are derived from broadband mapping at national level. The policy motivation in this phase was to measure progress and reveal the “digital divide”, especially between rural and urban areas and between Member States.

From NGA towards VHCN and 5G preparing for the Digital Decade

As the focus shifted from basic broadband to Next Generation Access (NGA) and Very High, Capacity Networks (VHCN), the Union refined its targets (e.g. the 2016 Gigabit Society Communication) and upgraded its monitoring tools within DESI and the coverage studies.

These refinements responded to two needs: (i) to understand where high, speed networks were available and (ii) to support the planning of public interventions (State aid, structural funds) based on reliable information about NGA and, later VHCN gaps.

Digital Decade Policy Programme 2030

This next step in the evolution, was consolidated with the adoption of the Digital Decade Policy Programme 2030, Decision (EU) 2022/2481, which entered into force in 2022.

It sets Union, level connectivity targets: *gigabit networks for all end users at a fixed location and 5G, equivalent high, speed wireless coverage in all populated areas by 2030* and establishes a governance system built on National digital decade strategic Roadmaps and an annual Report on the State of the Digital Decade.

The explicit purpose is to turn political ambitions into measurable, trackable commitments. In this framework, broadband mapping, although it started much earlier now supplies key input

data for the connectivity indicators and dashboards that the European Commission uses to monitor progress towards these 2030 targets.

European Electronic Communications Code (EECC) is making mapping a legal obligation

The principal sector, specific legal basis for broadband mapping is the European Electronic Communications Code , Directive (EU) 2018/1972, adopted in December 2018 and to be transposed by end, 2020.

- Article 22 requires national regulatory and/or other competent authorities to conduct geographical survey of the reach of electronic communications networks capable of delivering broadband, to complete the first survey by 21 December 2023 and to update it at least every three years thereafter.
- The survey must cover both existing and planned broadband networks, at a level of geographic granularity sufficient for regulatory and policy tasks.

Its results must be made available, in appropriate form, to authorities responsible for electronic communications regulation, State aid, universal service and digital strategies, so that all interventions rely on consistent, map, based evidence rather than ad hoc information. The purpose behind Article 22 was twofold: (i) support better, targeted public funding and regulatory obligations by knowing where networks exist or are planned, and (ii) harmonise the methodological approach to mapping across the internal market. Under Article 22(7), the BEREC was mandated to issue Guidelines on geographical surveys of network deployments.

BEREC adopted its first guidelines and then a more detailed handbook in 2020, 2021, providing:

- common definitions (including for very high, capacity networks),
- recommendations on address or grid, level mapping, and
- good practices for verification of operator data and public consultation.

The aim was to ensure that, by the 2023 deadline, all Member States would carry out broadly comparable surveys that could underpin both national decisions and EU, level assessments.

From the Broadband Cost Reduction Directive to the Gigabit Infrastructure Act

A second pillar is the EU framework on cost, efficient deployment and infrastructure sharing, which closely interacts with broadband mapping.

In 2014, the EU adopted the Broadband Cost Reduction Directive, Directive2014/61/EU.
It required Member States to:

- facilitate access to existing physical infrastructure (ducts, masts, manholes, buildings, etc.),
- coordinate civil works across sectors, and
- set up single information points (SIP) where operators could obtain information on existing useful infrastructure and planned civil works.

The policy motivation was clear: civil works are the largest cost item in broadband deployment; by making information on ducts and works visible and shareable, the EU sought to reduce deployment costs and accelerate roll, out, especially in challenging areas.

After several years of implementation, the Commission concluded that more stringent and harmonised rules were needed to reach gigabit, level ambitions. This led to the Gigabit Infrastructure Act (GIA), Regulation (EU) 2024/1309, adopted in 2024.

The GIA repeals the BCRD and becomes fully applicable from November 2025 (with some provisions applying later).

As a directly applicable Regulation across the Union, it sets more detailed and binding rules on:

- digital single information points,
- streamlined and time, limited permit and rights, of, way procedures, and
- the right to access and reuse physical infrastructure owned by public bodies and utilities.

In practice, the information systems and registries created or upgraded under the BCRD and then the GIA, containing georeferenced data on existing useful infrastructure and planned civil works, become critical layers of national broadband mapping systems.

The underlying premise is to use mapping as a planning tool that helps operators and authorities at all levels to co, invest, avoid duplication of infrastructure (overbuild) and to coordinate works across sectors.

State aid rules and the white, grey and black areas (2013, 2023)

Investment support for broadband is governed by EU State aid rules, which explicitly rely on robust mapping.

The Commission adopted its first dedicated Guidelines on State aid for broadband networks in 2009, updated them in 2013, and then replaced them with the current version 2023/C 36/01 in 2023.

These Guidelines set out how the Commission applies Articles 107(2)(a) and 107(3)(c) TFEU when assessing broadband aid. Across these iterations, the core logic has remained:

- Depending on the aimed characteristics of network to be subsidized, applying principles of technological neutrality, Member States must prepare detailed coverage maps distinguishing:
  - “white” areas (no network with aimed characteristics),
  - “grey” areas (one network with aimed characteristics),
  - “black” areas (at least two competing networks with aimed characteristics).
- Maps must consider not only existing coverage but also credible investment plans over a defined forward, looking period (not longer than 3 years), based on consultation with operators.
- Aid may only be granted in white, and under stricter conditions, grey areas where there exist clear market failure and low risk of distorting competition or crowding out private investment.

The policy reasoning is to ensure that public funds go where markets failed without subsidising competitive areas. By tying eligibility and proportionality assessments to the existence of transparent, consulted mapping State aid control effectively makes broadband mapping a precondition for using EU, compatible subsidies.

INSPIRE, Open Data and high, value datasets

A further building block is the EU’s spatial data and open data framework, which provides the technical and legal environment for reusing broadband, related datasets.

In 2007, the EU adopted the INSPIRE Directive, Directive 2007/2/EC, to establish an infrastructure for spatial information in Europe. It introduced harmonised metadata, data models and network services (e.g. interoperable web services) for environmental and related public tasks.

Over time, Member States have used INSPIRE infrastructures as the backbone for many national geospatial portals, and broadband infrastructure/coverage layers can be embedded alongside reference datasets such as administrative boundaries, transport networks, land use and population grids.

In 2019, the EU modernised its open data framework by adopting the Open Data Directive, Directive (EU) 2019/1024, recasting the former PSI Directive.

In 2023, the Commission adopted Implementing Regulation (EU) 2023/138, which defines a list of high, value datasets and rules for their publication and re, use, including a thematic category for geospatial data that must be made available free of charge, in machine, readable formats and via APIs.

The motivation over this 2007, 2023 period has been to make public geospatial data interoperable and widely reusable, reducing fragmentation between countries and sectors. While broadband network layers are not automatically labelled as “high, value datasets”, the combination of INSPIRE and the Open Data framework strongly encourages the publication of at least aggregated broadband coverage and infrastructure information as open data, within security and confidentiality limits.

Horizontal data, sharing rules and security (DGA, Data Act, NIS2, CER)

Recent horizontal data legislation and security rules further shape how broadband, relevant data can be accessed and shared.

The Data Governance Act (DGA), Regulation (EU) 2022/868, adopted in 2022, complements open data rules by creating mechanisms for the reuse of public sector data that cannot be fully open (for example, commercially sensitive or security, relevant datasets).

It introduces:

- requirements for secure processing environments, and
- a framework for data intermediaries to support trustworthy data sharing.

The underlying aim is to unlock more public, sector data for reuse (including for research and innovation) while respecting legitimate restrictions.

The Data Act, Regulation (EU) 2023/2854, adopted in 2023, establishes harmonised rules on fair access to and use of data across the internal market. It includes provisions on business, to government data sharing for specified public, interest purposes, allowing public bodies to request data held by private entities under defined conditions.

Together, these instruments provide a horizontal legal basis that regulators and other public authorities can invoke when they need datasets from operators or other sectors (energy, transport, buildings) to improve broadband mapping, while respecting confidentiality and cybersecurity.
In parallel:

- The NIS2 Directive, Directive (EU) 2022/2555, and
- the Critical Entities Resilience Directive, Directive (EU) 2022/2557

were adopted in 2022 to strengthen cybersecurity and the resilience of critical entities, including digital infrastructure operators.
They influence how detailed infrastructure information is handled, pushing many Member States towards tiered access models for their broadband maps (public, governmental, confidential layers) so that security, sensitive information is not exposed.

2.3 National context: Poland and Croatian experience and best practices

Broadband Infrastructure Mapping in Poland

Poland’s broadband mapping initiative started in 2010 with the launch of the System for Inventory of Infrastructure and Services (SIIS), managed by the Office of Electronic Communications (UKE). The system was designed to provide a single, reliable source of

information about telecommunications infrastructure and broadband service availability, supporting strategic planning and investment decisions.

SIIS collected detailed data on backbone, distribution, and access networks, including fiber routes, radio links, nodes, and co-location facilities. Operators submitted this information through standardized formats, CSV or XML, validated against XSD schemas. Smaller entities used web forms, while larger operators relied on automated uploads. To facilitate reporting, UKE provided a dedicated application called MiniSIIS, which supported data import, automated checks, and geocoding.

The platform integrated multiple national reference datasets such as the National Register of Boundaries (PRG), Topographic Database (BDOT10k), and TERYT territorial register, ensuring spatial accuracy and enabling linkage of infrastructure records to administrative units and even individual buildings. This integration allowed SIIS to enrich technical data with demographic and economic indicators, which were essential for identifying areas at risk of digital exclusion.

Data validation was a critical component of SIIS. The process combined automated and manual checks:

- addresses were normalized and standardized to official formats.
- missing attributes were supplemented from reference databases, and duplicates were removed.
- geocoding converted addresses into precise coordinates, with accuracy levels ranging from building centroids to municipal centers.
- logical and spatial rules verified that fiber routes connected valid nodes, radio sectors matched licensed frequency ranges, and coordinates fell within correct administrative boundaries.
- business rules flagged anomalies such as invalid house numbers, missing cable segments, incorrect sector radii, or inconsistencies between node addresses and coordinates.

SIIS enabled Poland to identify gaps in broadband coverage, reduce duplication of infrastructure, and prepare for the next stage of integration under the EU Cost Reduction Directive, a transition that led to the creation of the broader Single Information Point (PIT) system[3].

PIT, Expanded Scope and Architecture

The first version of PIT was launched on January 1, 2017, and the second, enhanced version became available to external users on April 15, 2019. This upgrade was driven by the need to comply with the EU Cost Reduction Directive (2014/61/EU), which introduced obligations to facilitate infrastructure sharing and reduce deployment costs for high, speed networks.

Unlike SIIS, which focused exclusively on telecommunications, PIT broadened its scope to include multiple sectors. Data submission obligations now cover telecommunication operators, energy and gas companies, water utilities, road authorities, railway and transport entities, and local governments. This cross, sector approach enables comprehensive planning and fosters co, investment opportunities.

The range of data collected in PIT is extensive and includes:

- ducts, pipelines, cable trays, manholes, towers, poles, cabinets, antenna installations,

[3] https://pitmap.uke.gov.pl/

- technological channels and conditions for access,
- nodes and connection points,
- investment plans for planned infrastructure (linear, point, and surface elements),
- fees for occupying road lanes and conditions for property access,
- contact details of entities responsible for granting access,
- information on usage possibilities for infrastructure elements.

PIT introduced a modern architecture based on open-source technologies such as PostgreSQL, GeoServer, and QGIS, combined with Python scripts for automation. The system supports 15 data formats, including CSV, XML, XLS, DXF, GML, SHP, TXT, GeoJSON, KML, GeoPackage, and other engineering and geospatial standards.

Data can be submitted in three ways:

- manual input via web forms for smaller datasets,
- file import for structured submissions,
- mass uploads for large, scale transfers.

Validation in PIT is rigorous and multi-layered, combining automated checks, business rules, and manual reviews. The system applies:

- syntax and format checks to verify compliance with schema definitions and mandatory fields,
- logical consistency rules to ensure relationships between elements are correct (e.g., ducts linked to valid nodes, investment plans aligned with existing infrastructure),
- spatial checks confirming that coordinates fall within correct administrative boundaries and match reference datasets,
- business rules to detect anomalies such as:
    - missing or invalid identifiers,
    - incomplete attributes,
    - discrepancies between planned and existing infrastructure,
    - technical errors like sector radii exceeding permitted ranges or cable endpoints located in the same position.

Errors detected during import are listed for correction before publication, and operators receive detailed feedback reports. This process guarantees that the information stored in PIT is accurate, reliable, and suitable for strategic planning.

Transparent Access to Data and Visualization Tools

PIT provides access to data through an interactive mapping portal and web services compliant with OGC standards (WMS, WFS), enabling visualization of infrastructure layers and investment plans. Publicly available layers include technological ducts, manholes, cabinets, towers, nodes, and conditions for road lane occupation and related fees. Data can be downloaded in open formats (GeoJSON, SHP, GML) or accessed via API for integrators.

Although PIT does not offer citizen, facing features, Poland provides the internet.gov.pl portal, managed by the Ministry of Digital Affairs, which allows users to check broadband availability at a specific address and submit requests for high speed internet. This tool enhances transparency and public engagement in the digitalization process.

It enables:

- checking broadband service availability at a specific address,

- submitting requests for high, speed internet,
- viewing planned investments under Operational Programme Digital Poland (POPC) and National Recovery Plan (KPO).

This portal increases transparency and supports public participation in planning digital infrastructure.

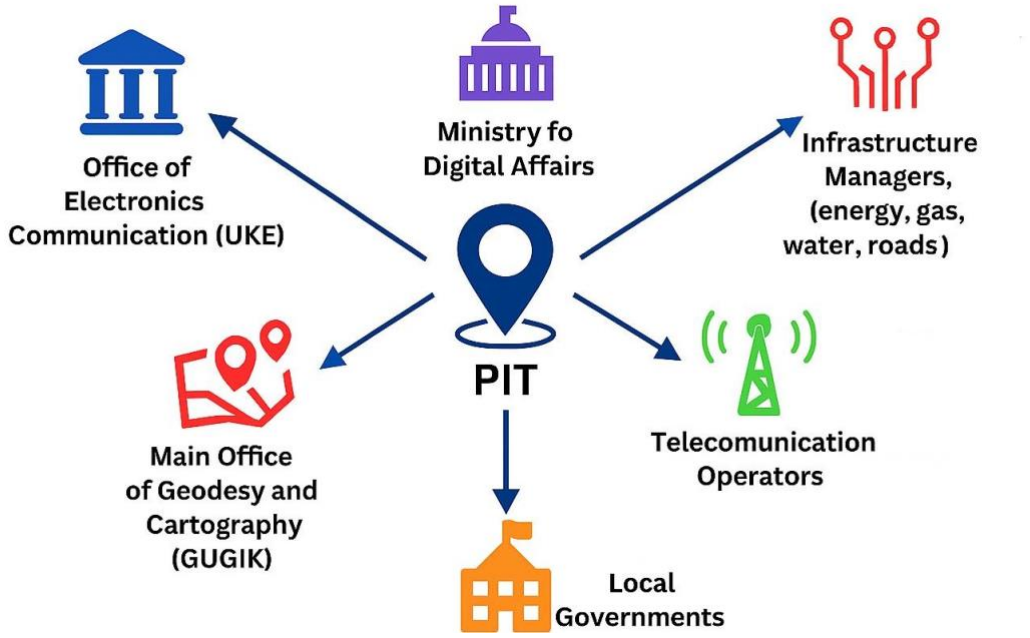


Figure 2 Institutions and Their Roles in the Mapping Ecosystem in Poland

Effective mapping of telecommunications infrastructure in Poland relies on the collaboration of multiple institutions, each performing complementary functions. Every entity brings unique competencies, from market regulation and spatial data management to public policy implementation and citizen support. Their activities are closely interconnected, forming a coherent data governance ecosystem.

The Office of Electronic Communications (UKE) acts as the national regulator and coordinator for collecting infrastructure data. It is responsible for validating information submitted by operators and ensuring its accuracy and consistency.

The Ministry of Digital Affairs defines strategic objectives for broadband development, oversees intervention programs (such as POPC and KPO), and provides tools for citizens, including the internet.gov.pl portal, which allows users to check broadband availability and report demand for high, speed internet.

The Head Office of Geodesy and Cartography (GUGiK) supplies reference geospatial datasets (PRG, BDOT10k, TERYT), which are essential for precise infrastructure mapping within the PIT system.

Telecommunications operators and infrastructure managers (energy, gas, water, roads, rail) report data on existing assets and planned investments, enabling coordination and cost reduction in network deployment.

Local government units (LGUs) contribute information on property access conditions, fees, and local development plans, which are critical for planning investments at the municipal level.

This collaborative model integrates technical, spatial, and administrative data into a unified information system. It enables not only monitoring the state of infrastructure but also identifying "white spots," planning public interventions, and supporting the rollout of very high, capacity networks in an efficient and transparent manner.

Use of Mapping

Data from SIIS and PIT were critical for defining intervention areas under the Operational Programme Digital Poland (POPC) and the KPO. They enabled:

- precise identification of "white spots" and packaging of addresses for tenders,
- optimization of network routes using existing infrastructure (ducts, manholes, nodes),
- cost reduction through resource sharing,
- elimination of duplicate commercial investments.

As a result, gigabit connectivity deployment accelerated in municipalities with the lowest availability, improving efficiency in public spending.

In Poland, "white spots" are identified at the address and network termination point level. An area is considered white if:

- there is no availability of NGA/VHCN services (FTTH, Docsis 3.1, 5G),
- there are no credible commercial plans within a 3, year horizon.

The process includes rounds of market interest inquiries, where operators submit investment declarations. These declarations are verified against PIT data, reference geospatial databases, and construction schedules. Priority is given to areas with low population density, high risk of digital exclusion, and low-income levels.

Conclusion

Poland has established a robust and evolving broadband mapping ecosystem that aligns with EU requirements and supports national digital transformation goals. Starting with SIIS and progressing to the comprehensive PIT platform, Poland has combined regulatory oversight, multi, sector data integration, and open, source technologies to create a reliable foundation for strategic planning and cost, efficient network deployment. The inclusion of reference geospatial datasets, rigorous validation processes, and tools for both operators and public administration ensure high data quality and interoperability.

By linking mapping efforts with intervention programs such as POPC and KPO, Poland demonstrates how broadband mapping can directly accelerate gigabit connectivity and reduce digital exclusion. While PIT primarily serves institutional and industry stakeholders, complementary tools like internet.gov.pl enhance transparency and empower citizens to participate in shaping broadband development.

Poland's approach illustrates how a large and diverse country can successfully implement a forward, looking, integrated system that not only meets regulatory obligations but also fosters collaboration, infrastructure sharing, and efficient investment planning, positioning Poland as a strong reference model within the EU.

Broadband infrastructure mapping in Croatia

Croatia's broadband mapping and infrastructure data environment sits at the intersection of electronic communications regulation, geospatial information and official statistics. The system is led by the Croatian Regulatory Authority for Network Industries (HAKOM) `and closely linked to the State Geodetic Administration (DGU) and the Croatian Bureau of Statistics (DZS), so

that infrastructure, coverage and socio, economic data can be combined for planning, regulation and funding decisions.

Regulatory and strategic framework

Croatia's broadband mapping is anchored in a coherent set of legal and strategic instruments:

- The Electronic Communications Act (ZEK) transposes the EECC, designates HAKOM as the national regulatory authority, and empowers it to request detailed data from operators, conduct geographical surveys of network deployments and support broadband policy and State aid implementation.
- The National Plan for the Development of Broadband Access in the Republic of Croatia for the Period from 2021 to 2027 (*National Plan for Broadband Development 2021, 2027*) operationalises EU Gigabit Society and Digital Decade objectives. It sets national coverage and take-up targets and formally assigns HAKOM the role of BCO, coordinating national and EU, funded broadband projects.
- The National Framework Programme for the Development of Broadband Access Infrastructure (ONP) and the National Programme for the Development of Broadband Aggregation Infrastructure in Areas Lacking Sufficient Commercial Interest for Investment (NP, BBI) are State aid schemes approved by the European Commission. They rely on detailed broadband mapping to identify white and grey areas and to monitor roll, out of NGA and very high, capacity (VHCN) networks.
- The earlier Strategy for the Development of Broadband Access 2016, 2020 laid the groundwork for NGA/VHCN deployment and has been followed by the Digital Croatia Strategy for the Period until 2032 (Digital Croatia Strategy 2032), which embeds connectivity and broadband mapping into wider digital, transformation goals.
- The Act on State Survey and Real Estate Cadastre establishes the DGU, the Digital Cadastral Map DCM which form the geospatial backbone on which broadband mapping is built.

In line with Article 22 EECC, as transposed through the Electronic Communications Act, Croatia must carry out geographical surveys of broadband networks and update them at least every three years, but it is done on quarterly, except for the planned infrastructure. This obligation underpins the systematic collection of coverage and infrastructure data used for market analysis, Digital Decade reporting, State aid "white, grey, black" classification and public transparency.

Broadband Mapping

Croatia distinguishes clearly between two core dimensions of broadband mapping:

1. Physical infrastructure mapping
2. Broadband coverage and take up mapping

both built on a shared geospatial backbone provided by the high, resolution (1:500) aerial DCM.

Physical infrastructure mapping

The DCM is the authoritative graphical representation of cadastral data, maintained within the Joint Information System of Land Registry and Cadastre (ZIS). It provides parcel boundaries, building footprints, addresses, land, use segments and special legal regimes. The DCM is served as INSPIRE, aligned map and feature services in the national spatial data infrastructure, using the national reference system HTRS96/TM. It is the basic spatial reference for address and parcel level broadband mapping.

The Infrastructure Cadastre System (Sustav katastra infrastrukture, SKI) is the national infrastructure cadastre operated by DGU. It was established through the EU, funded project

"Establishment of the Information System in Function of the Single Information Point and Infrastructure Cadastre", co-financed by the European Regional Development Fund. The project created the HR, SKI information system and the Single Information Point (JIT) as the public front end.

In June 2024 SKI was declared operational for the entire territory of Croatia, so all types of linear and point infrastructure (telecommunications, energy, water, transport, gas, etc.) can be recorded, maintained and accessed in one system.

SKI has a dual structure:

- a non-public part used by DGU and authorised professional users to maintain the official utility cadastre; and
- a public Single Information Point accessible via the e-Građani platform or directly via the SKI portal, allowing users to visualise infrastructure, obtain web, service feeds, submit and view notifications on planned works, and lodge digital geodetic infrastructure surveys.

For broadband policy, this means that ducts, cables, masts, nodes and other elements of electronic communications networks are mapped explicitly and can be overlaid with parcels, buildings and other utilities. Operators and public authorities thus share a common, authoritative view of physical infrastructure when planning new networks, coordinating civil works or designing publicly funded projects.

Broadband coverage and take up mapping

On top of Joint Information System of Land Registry and Cadastre, HAKOM maintains detailed coverage and take up data for fixed and mobile broadband, based on operators' legal reporting obligations.

For fixed broadband, operators report on address level:

- the geographical reach of access networks at fine spatial level (down to building or address), indicating which technologies (xDSL, cable, FTTx, fixed wireless) are available at each location;
- the maximum advertised downstream and upstream speeds and whether the access qualifies as NGA or VHCN;
- subscription (take, up) by technology and speed tier, which HAKOM aggregates to suitable spatial units (e.g. municipalities, settlements or grid cells) for analysis of usage versus availability.

For mobile broadband, operators provide radio, network data and propagation parameters. HAKOM uses these to generate polygon based coverage layers for 3G, 4G and 5G, which are published through its interactive portal so citizens and local authorities can see the claimed outdoor coverage of each technology and compare operators.

HAKOM's interactive GIS portal ("HAKOM maps") combines datasets into several thematic views:

- Broadband Accessibility Map (including VHCN availability),
- Consolidated Mobile Network Plan (existing antenna sites and planned coverage),
- an Intention, to, Deploy Map (areas where operators plan fibre roll, out), and
- quality-of-service crowdsourced maps based on HAKOMetar (fixed) and HAKOMetar Plus (mobile) measurements.

By combining physical infrastructure mapping (DCM + SKI) with coverage and take, up mapping, citizens can see not only where networks and ducts are, but also which buildings and people are served, at what quality, and with what level of subscription.

Role of official statistics and the Croatian Bureau of Statistics (DZS)

The Croatian Bureau of Statistics (Državni zavod za statistiku, DZS) complements broadband mapping by providing authoritative demographic and socio, economic data in geospatial form.

Through projects such as the "Development of the Geographical Information System (GIS)" and the 2021 Census, DZS has georeferenced population, households, dwellings, business entities and tourist accommodation capacities to spatial units such as municipalities, settlements and 1×1 km grid cells, and in some cases to address level.

Methodological reports describe how census and administrative records are linked to geocoded addresses and grid cells.

Cooperation agreements between DZS and DGU allow DZS to use cadastral and address data in official statistics, while agreements between DZS and HAKOM cover the exchange of electronic communications data for statistical purposes.

In broadband policy practice, this enables overlaying broadband coverage and infrastructure (HAKOM + SKI) with population and household distributions (DZS) so that unserved and underserved people and households can be identified precisely and interventions targeted where connectivity gaps coincide with significant demand or economic activity.

Technical solutions

From a technical perspective, Croatia's broadband mapping relies on standardised operator reporting, relational databases and GIS tools, integrated with the national spatial data infrastructure:

- Operators submit coverage and infrastructure data in agreed electronic formats (e.g. CSV, XLS) with spatial attributes (coordinates).
- HAKOM imports these into relational databases, applies automatic checks and converts them into GIS layers.
- Geospatial processing and visualisation are carried out using GIS tools (ESRI), and web services (WMS, WFS) feed both the public portal and internal dashboards.
- HAKOMetar and HAKOMetar Plus provide georeferenced speed, test data that are plotted on maps and used as an independent reference for quality of service.
- SKI and the Digital Cadastral Map are exposed as INSPIRE, compliant spatial services, ensuring that broadband layers can be overlaid with cadastral parcels, administrative units and other reference data without ad hoc transformations.

This architecture allows Croatia to maintain address, level mapping while preserving consistency with national and EU geospatial standards.

Organisational arrangements

Several institutions share responsibilities within Croatia's broadband mapping ecosystem:

- Croatian Regulatory Authority for Network Industries (HAKOM)

  Implements the Electronic Communications Act; defines data models and templates for operator reporting; collects and validates coverage, infrastructure and QoS data; maintains the public broadband GIS portal; acts as Broadband Competence Office; and advises line ministries on State aid and Recovery and Resilience Facility (RRF) projects.

- State Geodetic Administration

  Implements the Act on State Survey and Real Estate Cadastre; operates the Digital Cadastral Map and Real Estate Cadastre; runs the SKI and itsJIT; and manages the national spatial data infrastructure, ensuring that cadastral, address and infrastructure layers are available as reference data.

- Croatian Bureau of Statistics (DZS)

  Produces official statistics, including census based population and household data and geostatistical grids; cooperates with HAKOM and DGU on the use of administrative and geospatial data; and provides the demographic and socio economic context needed to monitor the digital divide.

- Line ministries and regional/local authorities

  Adopt and implement the National Plan for Broadband Development and related digital policies; use broadband maps and SKI data to design and select intervention areas for State aid and RRF projects; and integrate broadband planning into local and regional development strategies.

This institutional set-up ensures that broadband mapping is not a standalone technical exercise but a shared, cross, sectoral function.

Approach to data validation and data sharing

Croatia combines legal obligations, technical checks and cross, sector data sharing to ensure the quality and usefulness of broadband mapping data.

Data validation

- Legal obligations in the Electronic Communications Act give HAKOM powers to request accurate data from operators, require corrections and apply enforcement measures if necessary.
- Technical consistency checks compare operator, reported geometries and coverage against the Digital Cadastral Map and SKI, ensuring that network elements and coverage polygons are plausible and correctly aligned with parcels and buildings.
- Statistical plausibility checks use population and household data from DZS to detect anomalies (e.g. areas claimed to be fully covered but with almost no inhabitants, or highly populated areas with unexpectedly low reported coverage or take, up).
- Measurement based verification uses HAKOMetar and HAKOMetar Plus as independent indicators of quality of service. Systematic discrepancies between declared and measured performance, especially where user complaints accumulate, can trigger further investigation or regulatory follow, up.

Data sharing and access

Croatia applies a tiered access model for broadband and infrastructure data:

- At public level, HAKOM's interactive portal provides open access to broadband coverage maps, mobile coverage, planned fibre deployments and QoS results from HAKOMetar. Aggregated statistics and reports are published on HAKOM's website and feed into EU, level indicators (DESI and the Digital Decade scoreboard).
- At controlled level, detailed infrastructure data from SKI (routes of ducts and cables, technical attributes) are accessible via the Single Information Point to authorised users

such as public authorities, licensed surveyors and utilities. For State aid and RRF projects, ministries and implementing bodies can receive detailed coverage and infrastructure extracts under confidentiality obligations to define intervention areas and verify white, grey or black status.

- At restricted/confidential level, highly detailed network elements of critical importance (e.g. exact backbone routes and key nodes) are treated as sensitive and not published openly, in line with national security and EU, level cybersecurity and critical, entities resilience rules.

To conclude, Croatia combines precise geospatial referencing, robust sectoral data and rich demographic and socio, economic context, making it a relevant reference model for countries that are designing or upgrading their own national broadband mapping systems.

3. Countrywide assessment and justification for broadband mapping

3.1. Geographic and institutional overview

Nigeria is the largest country in Africa by population and one of the most geographically and institutionally diverse nations on the continent. With a landmass of approximately 923,768 square kilometres, Nigeria is the 14th largest country in Africa and is bordered by Niger to the north, Chad and Cameroon to the east, Benin to the west, and the Atlantic Ocean to the south. The country is divided into six geopolitical zones: North Central, North East, North West, South East, South South, and South West. These zones are further subdivided into 36 states and the Federal Capital Territory (FCT), Abuja, which serves as the nation's political capital.

Nigeria's geography is marked by diverse landscapes, ranging from the arid savannahs of the north to the tropical rainforests of the south. The terrain also includes highlands, plateaus, and major rivers such as the Niger and Benue, which converge to form the Niger Delta-one of the largest river deltas in the world. This geographic diversity significantly impacts broadband infrastructure deployment. The northern regions, such as Borno, Yobe, and Zamfara, are characterized by vast and sparsely populated areas, which pose significant challenges for broadband rollout. The high costs of infrastructure development in these regions, combined with security concerns and limited economic activity, make it difficult to justify private sector investments. Targeted public-private partnerships and government intervention are required to bridge this gap. Conversely, the southern regions, with higher population densities and urbanization rates, present more favourable conditions for broadband expansion. Urban centers such as Lagos, Abuja, and Port Harcourt are hubs of economic activity and innovation, making them focal points for broadband deployment. Lagos as Nigeria's commercial capital, hosts a growing number of tech startups and innovation hubs, further driving the demand for broadband connectivity. However, rural areas, which account for over half of Nigeria's population, remain significantly underserved and face a persistent digital divide due to limited infrastructure and affordability challenges. Bridging this gap is essential for achieving universal broadband access and fostering inclusive economic development.

The institutional landscape in Nigeria is equally complex, with multiple organizations playing critical roles in broadband mapping. The Nigerian Communications Commission is the primary regulatory authority for the telecommunications sector and serves as the central institution for broadband mapping. The NCC regulates and licenses telecom operators and internet service providers (ISPs), ensures compliance with the targets set by the National Broadband Plan, oversees spectrum assignment for wireless broadband, and coordinates data collection, integration, and dissemination for broadband mapping. Its leadership is essential for ensuring that broadband mapping data is accurate, up-to-date, and aligned with national development objectives. The NCC also collaborates with international organizations such as the International Telecommunication Union to adopt global best practices.

Another critical institution is the National Population Commission, which oversees demographic data collection and management. The NPC provides essential datasets, including population distribution, household information, and demographic trends, which are crucial for identifying underserved areas, prioritizing infrastructure deployment, and ensuring equitable broadband access. The ongoing digitization of NPC's data collection processes further enhances its potential contribution to broadband mapping initiatives.

The Nigerian Postal Service is another key player, particularly in the management of address data. Its National Addressing System provides a framework for identifying and mapping physical locations across Nigeria. This data is vital for geospatial analysis, infrastructure

planning, and ensuring that broadband services reach all areas, including rural and remote regions. NIPOST's collaboration with the National Addressing Council has further strengthened its capacity to support broadband mapping efforts.

The National Geospatial Data Infrastructure is responsible for developing and managing geospatial data for Nigeria. Despite its limited role in broadband mapping thus far, NGDI has the potential to contribute important datasets such as administrative boundaries, land use data, and topographical maps. To fully realize its potential, NGDI requires enhanced capacity through partnerships with international organizations, technical training, and increased funding to develop its infrastructure and human capital. However, to fully realize this potential, NGDI requires enhanced engagement and collaboration with other stakeholders.

The Rural Electrification Agency (REA) is responsible for expanding access to electricity in rural and underserved areas. Its role in broadband mapping lies in its ability to identify regions with limited energy access, which often overlap with areas lacking broadband connectivity. By aligning broadband deployment with electrification projects, the REA can help reduce costs and improve service delivery in underserved regions.

The Ministry of Communications, Innovation, and Digital Economy provide strategic oversight and policy direction for the ICT sector in Nigeria. It plays a vital role in ensuring that broadband mapping aligns with national development goals, particularly those outlined in the National Digital Economy Policy and Strategy (2020-2030). The ministry's leadership is critical for fostering collaboration among stakeholders and driving the implementation of broadband initiatives.

State and local governments also play an essential role in broadband mapping. They have direct access to local communities and are responsible for infrastructure development within their jurisdictions. Their responsibilities include facilitating right-of-way approvals for broadband infrastructure, providing local data on population and infrastructure, and coordinating with federal agencies to implement broadband initiatives at the local level. Their involvement is critical for ensuring that broadband mapping efforts are inclusive and responsive to local needs.

The private sector, including telecom operators, internet service providers, and technology companies, is a key driver of broadband infrastructure development. These stakeholders provide the financial resources, technical expertise, and operational capacity needed for broadband deployment. Their participation in broadband mapping ensures that infrastructure investments are data-driven and aligned with market demand. Collaboration between the private sector and government institutions is essential for achieving the goals of the National Broadband Plan and bridging the digital divide.

International development partners such as the International Telecommunication Union, the World Bank, and the African Development Bank (AfDB) also play a vital role in Nigeria's broadband mapping efforts. These organizations provide technical assistance, funding, and capacity-building support, helping to align Nigeria's broadband initiatives with global standards and best practices.

Despite the robust institutional framework for broadband mapping in Nigeria, several challenges persist. The effectiveness of broadband mapping efforts is hindered by limited coordination among stakeholders, insufficient technical capacity, and significant gaps in data availability and quality. Specifically, challenges include the lack of standardized data formats, outdated infrastructure records, and limited access to high-resolution geospatial data. Addressing these challenges requires a more collaborative approach, with clearly defined roles and responsibilities for each institution involved in broadband mapping. Enhanced capacity building and the adoption of advanced technologies for data collection and analysis are also critical for overcoming these barriers.

Opportunities for improvement include leveraging existing partnerships with international development organizations, such as the International Telecommunication Union (ITU) and the World Bank, to access funding, technical expertise, and capacity-building programs. These partnerships can support the development of standardized broadband mapping frameworks, advanced data collection tools, and training for local stakeholders. Strengthening collaboration between federal, state, and local governments can enhance the effectiveness of broadband mapping initiatives, particularly in reaching rural and underserved areas. By addressing these challenges and capitalizing on available opportunities, Nigeria can make significant progress in its broadband mapping efforts and move closer to achieving universal broadband access.

In conclusion, Nigeria's geographic diversity and institutional framework provide a strong foundation for broadband mapping but also present unique challenges that require coordinated efforts to address. Institutions such as the NCC, NPC, NIPOST, and REA are well-positioned to lead these efforts, supported by state and local governments, private sector stakeholders, and international development partners. By fostering collaboration, improving data quality, and addressing capacity gaps, Nigeria can ensure that its broadband mapping initiatives support the country's broader goals of digital transformation and inclusive economic growth.

3.2. Economic and Telecom Market Overview

Nigeria, often referred to as the "Giant of Africa," is the most populous country on the continent and one of its largest economies. With a population exceeding 220 million people in 2026, Nigeria represents a significant market for economic activities, particularly in the telecommunications sector. Over the last two decades, the country has experienced remarkable growth in its ICT sector, which has become a cornerstone of Nigeria's economic transformation. Telecommunications have emerged as a critical enabler of digitalization, fostering innovation, improving connectivity, and driving socio-economic development across various domains.

The economy is highly diverse, with key contributions from oil and gas, agriculture, trade, and telecommunications. However, the country remains heavily reliant on oil exports, which account for over 80% of government revenue, making it highly susceptible to fluctuations in global oil prices. Despite these challenges, the Nigerian economy has demonstrated resilience, achieving a GDP growth rate of 3.5% in 2025, driven by non-oil sectors such as ICT, agriculture, and services. The telecommunications sector alone contributes approximately 9,4% to the national GDP, underscoring its importance as a driver of economic growth.

Nigeria's population is growing rapidly, with an annual growth rate of 2.6%. The country is expected to become the third most populous nation in the world by 2050, with a projected population of 400 million. This rapid population growth, combined with increasing urbanization-over 50% of the population now resides in urban areas-has created a robust demand for digital infrastructure and connectivity. However, this growth has also presented significant challenges, including high unemployment rates, and persistent inflation, which reached 22% in the same year. These economic pressures have impacted consumer spending power, including affordability for telecommunications services.

Infrastructure development remains a critical challenge for Nigeria's economic growth. Despite being one of the world's largest oil producers, only 55% of Nigeria's population has access to electricity, which limits the expansion of digital services, particularly in rural and underserved areas. However, recent investments in transport infrastructure, including roads, railways, and ports, have improved logistics and connectivity, creating new opportunities for economic activities such as e-commerce and digital trade.

The Nigerian telecommunications market is the largest in Africa, with over 220 million mobile subscribers and a penetration rate of 102% as of 2025. The market is dominated by four major

operators: MTN Nigeria, Airtel Nigeria, Globacom, and T2mobile. MTN Nigeria leads the market with over 85 million subscribers, followed by Airtel Nigeria, which has focused on data services to capture a significant share of the market. Globacom, as an indigenous operator, has gained popularity through competitive pricing, while T2mobile has carved out a niche in data and enterprise solutions recently entering retail market though national roaming.

Internet penetration in Nigeria reached 47% in 2025, with over 110 million internet users. Mobile broadband dominates the internet landscape, driven by the proliferation of affordable smartphones and competitive data plans. Broadband penetration stands at 51%, with significant growth potential in rural and underserved areas. The government's National Broadband Plan (2020-2025) has set an ambitious target of achieving 70% broadband penetration by 2025, a goal that aligns with Nigeria's broader digital economy strategy.

The ICT sector is a key driver of Nigeria's economic transformation, contributing 14% to the GDP in 2025. This growth is fuelled by the expansion of e-commerce platforms such as Jumia and Konga, which have revolutionized online trade in Nigeria. The country is also a leader in Africa's burgeoning fintech ecosystem, with companies like Flutterwave and Paystack achieving international recognition. Other sectors, such as e-learning, telemedicine, and digital payments, have also witnessed significant growth, further underscoring the role of telecommunications in driving innovation and economic development.

The NCC serves as the primary regulatory authority for the telecommunications sector. The NCC has been instrumental in fostering competition, protecting consumer rights, and enabling infrastructure development. Key regulatory initiatives include spectrum auctions that have facilitated the rollout of 4G and 5G networks, support for the deployment of fiber optic networks and last-mile connectivity, and the implementation of data protection measures in line with global standards. These efforts have created a more competitive and transparent telecom market, encouraging investment and innovation.

Despite its achievements, the Nigerian telecommunications sector faces several challenges. Infrastructure gaps, particularly in rural areas, continue to hinder universal access to broadband. High operating costs, driven by unreliable power supply and multiple taxation, place financial pressure on operators. Additionally, high data costs remain a barrier for low-income households, limiting the accessibility of digital services. Rising cybersecurity threats also pose risks to the sector, necessitating robust security measures to protect users and networks.

Looking ahead, several key trends and opportunities are shaping the future of Nigeria's telecommunications sector. The deployment of 5G networks, which began in 2022, is expected to drive innovation in areas such as the Internet of Things (IoT), smart cities, and industrial automation. For example, 5G-enabled smart city projects in Lagos and Abuja are already exploring applications in traffic management, public safety, and energy efficiency. Bridging the digital divide remains a top priority, with initiatives like the Rural Broadband Initiative aimed at expanding connectivity to underserved areas. Digital inclusion efforts, such as improving digital literacy and making services more affordable, are also crucial to ensuring that all Nigerians can benefit from the digital economy. Furthermore, the sector offers significant investment opportunities, particularly in infrastructure development, fintech, e-commerce, and digital services.

In conclusion, Nigeria's economic and telecommunications landscape is characterized by both challenges and opportunities. While issues such as infrastructure gaps, high operating costs, and affordability barriers persist, the telecommunications sector continues to be a vital driver of economic growth and digital transformation. With strategic investments, regulatory reforms,

and a focus on capacity building, Nigeria is well-positioned to achieve its digital economy goals and ensure that the benefits of connectivity are accessible to all its citizens.

3.3. Broadband Development to Date

The development of broadband internet in Nigeria is a process spanning more than two decades and has gone through several key stages. Its foundation was the liberalization of the market and the GSM license auction in 2001, conducted by the NCC after public consultations and preparation of the documentation package (Digital Mobile Licence). This step opened the market to private operators, which led to a rapid increase in mobile penetration and a shift from a state monopoly to a competitive model with fast scaling of voice and SMS services. In 2007, licenses were granted in the 2 GHz band (3G/UMTS), enabling the transition from voice services to mobile internet. This marked a significant milestone in Nigeria's telecommunications history, as it led to a rapid increase in mobile data usage and laid the foundation for the subsequent rollout of 4G and 5G networks. Subsequent years brought LTE/4G deployments from 2013, 2014, which, along with falling smartphone prices, established mobile broadband as the primary way households and SMEs accessed the internet. In 2022, commercial 5G services were launched, paving the way for applications requiring low latency and high throughput in metropolitan areas.

Over the past decade, the government implemented two successive broadband plans: the National Broadband Plan (NBP) 2013, 2018 and the NBP 2020, 2025. Both emphasized the importance of open access, fiber network expansion, and reducing Right of Way (ROW) costs at the state level.

The National Broadband Plan 2013, 2018 was Nigeria's first structured roadmap for broadband development. Its primary goal was to increase broadband penetration to 30% by 2018, starting from a single, digit baseline. The plan prioritized the rollout of national fiber backbone infrastructure, liberalization of the market to encourage competition, and the creation of an enabling environment for private investment. A key strategic element was the recommendation to harmonize and reduce ROW charges, which had historically been a major barrier to fiber deployment. The plan also promoted the establishment of public access points in schools, libraries, and community centres to bridge the digital divide.

Building on these foundations, the National Broadband Plan 2020-2025 set a more ambitious target of achieving 70% broadband penetration by 2025. As of 2026, Nigeria has achieved approximately 48% broadband penetration, indicated significant progress but also highlighting the need for accelerated efforts to meet the target. It aligned with Nigeria's Digital Economy Policy and Strategy, recognizing broadband as critical for e, government, education, healthcare, and economic growth. The plan emphasized open access principles, ensuring that infrastructure sharing and non, discriminatory access would lower costs and accelerate deployment. It called for aggressive expansion of fiber, to, the, home (FTTx) networks, densification of 4G coverage, and the introduction of 5G services in major urban centers. Another cornerstone was the harmonization of ROW fees across states to a recommended cap of ₦145 per meter, alongside advocacy for "zero ROW" policies to stimulate investment in underserved areas. The plan also encouraged collocation and TowerCo models to reduce CAPEX and improve efficiency, as well as the development of public broadband initiatives to ensure inclusivity.

Together, these plans provided the strategic framework for Nigeria's broadband growth, addressing structural bottlenecks such as high deployment costs, fragmented ROW policies, and limited rural connectivity, while setting clear targets for penetration and infrastructure modernization. On this foundation, Nigeria entered 2024 with very broad mobile coverage and growing network capacity. Population coverage is about 95% for 2G, 89% for 3G, 85% for 4G,

and 5G, though still in its early phase, covers about 13% of the population, concentrated in major urban centers. Broadband penetration (including 3G/4G/5G + ISP + fixed access) rose to 44.43% by the end of 2024, and annual data consumption increased by 34.26% year, on, year, reaching 9.76 million TB. At the same time, due to the implementation of NIN, SIM integration (database cleanup, identity verification) and reporting adjustments by one operator, active mobile internet subscriptions fell by about 15% year, on, year, to 139 million. This decline did not weaken demand for data transfer, traffic continues to grow thanks to widespread 4G availability and the increasing number of devices.

Transmission backbone expansion accelerated: the length of terrestrial fiber reached 110,577 km (2024), representing an increase of about 32% compared to the previous year, and the number of base stations rose to 145,141 (+5.18% YoY). Passive infrastructure includes 39,880 towers, of which about 30,600 belong to specialized TowerCos. Passive market leaders, IHS (approx. 47% share) and ATC (approx. 21%), enable commercially efficient colocation and densification of the 4G/5G radio layer in high, demand areas. The NCC uses coverage maps for joint planning with TowerCos and operators to eliminate white spots.

One of the most important factors influencing the pace of network expansion is the cost of ROW, the right and fees for occupying road corridors or land for laying cables. In Nigeria, this falls under the jurisdiction of state authorities, which historically led to large differences in rates and practices. High ROW fees have long been one of the main barriers to fiber network development, as they significantly increased investment costs. Since 2020, harmonization to ₦145 per meter has been underway, and some states have introduced “zero ROW” (full exemption), which dramatically lowers cost barriers already at the design stage. Where “zero ROW” applies, faster rollout and greater willingness by operators to invest in less urbanized areas are observed. However, the lack of a uniform national policy means that in many regions ROW costs remain high, limiting the pace of backbone expansion outside major corridors.

The second key challenge is energy costs, which in Nigeria are among the highest operational factors in telecommunications. The lack of stable electricity supply in many regions forces the use of diesel generators and backup power systems, significantly increasing OPEX. In 2024, operators indicated that rising fuel and energy prices were one of the main reasons for operating costs increasing by more than 85% year, on, year. High energy costs affect not only day, to, day network maintenance but also investment decisions, especially in rural areas where the absence of power infrastructure means building dedicated energy sources. This means that even with available fiber and tower resources, actual utilization of infrastructure is limited by energy barriers.

Nigeria has high international capacity and wholesale IP resources provided by operators in the ISP and wholesale segments; for example, reported capacities range from hundreds of Gbps to several Tbps. Converting this capacity into real service quality for end users depends on continuous modernization of the domestic network: intercity fiber, metropolitan networks (nodes, redundancy), as well as energy stability and infrastructure security. In this context, the Designation and Protection of Critical National Information Infrastructure (CNII) Order, 2024, published in June in the Official Gazette, is significant, granting telecom infrastructure critical status and criminalizing intentional damage to towers, cables, stations, data centers, and e, government platforms.

ISP data also show the maturity of quality demand: about 80% of customers choose packages with speeds of at least 10 Mbps, confirming growing requirements for video applications, videoconferencing, gaming, and remote work. At the same time, regional asymmetry persists: the South West accounts for about 65% of ISP subscriptions, North Central about 17%, and the North East just 1%. These disparities are driven by factors such as lower population density, security challenges, and limited infrastructure in northern regions. Targeted

investment strategies and incentives for operators are needed to close these gaps. These differences reflect levels of urbanization, purchasing power, and infrastructure access; where "zero ROW" has been implemented, faster closing of gaps is evident.

In summary, Nigeria has an increasingly deep infrastructure base: high mobile coverage, rapid fiber growth, expanding 5G deployments, a strong TowerCo ecosystem, and proactive regulations (NIN, SIM, CNII, ROW facilitation). Full utilization of this potential is still hindered by energy costs, the import, dependent nature of equipment, and varied ROW practices across states, but investment momentum and growing data consumption indicate solid foundations for further broadband development nationwide.

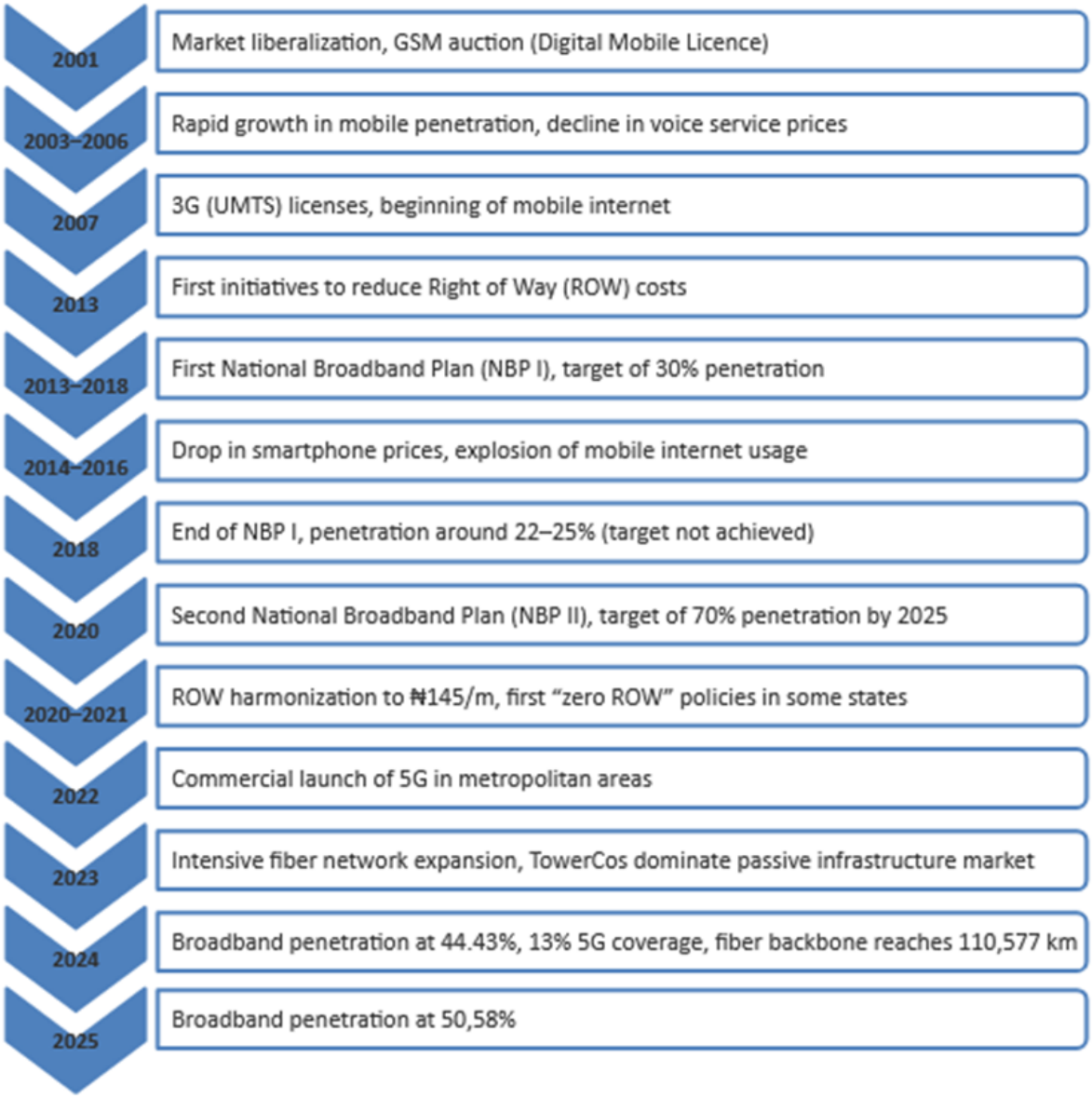


Figure 3 *Key milestones in Nigeria's broadband and mobile connectivity development*

3.4. Short review of existing national broadband mapping initiatives

Broadband mapping is a cornerstone of modern connectivity strategies, enabling regulators and policymakers to understand the geographic distribution of infrastructure and services. It provides the foundation for evidence, based decisions, targeted interventions, and progress monitoring toward universal access goals. Nigeria's experience offers a detailed example of how a national regulator has approached this challenge. The NCC has progressively developed a broadband mapping system that integrates geospatial technologies with regulatory processes. This review examines what has been achieved, identifies existing gaps, and explores the context of data management and collaboration with operators.

The NCC introduced its Geographic Information System (GIS) platform in 2013, initially focusing on improving the quality of network deployment data such as base stations and microwave frequency links. Over time, the scope expanded significantly. By 2017, the Commission began mapping mobile network coverage and fiber optic infrastructure, reflecting the growing importance of broadband in national development. Today, the system supports multiple layers of data, including mobile coverage for 3G, 4G, and 5G networks, backhaul infrastructure such as fiber and microwave links, and population overlays for connectivity analysis.

The platform operates on a hybrid architecture combining ArcGIS Enterprise and ArcGIS Online, supported by ESRI applications. Data is sourced primarily from licensed operators and updated regularly, typically every three to six months, while mobile coverage maps are refreshed quarterly. In addition, NCC produces monthly progress reports on new site deployments to track the expansion of mobile broadband coverage. These updates are essential for monitoring the implementation of the NBP 2020, 2025, which relies heavily on GIS, derived insights.

Data submitted by operators follows predefined templates that enforce format consistency. Initially, quality assurance relied on semi- manual checks, but this approach proved time consuming and limited in effectiveness. To address these challenges, NCC implemented the Obligation Management System (OMS), which applies validation rules at the point of data submission. The system rejects records that do not comply with required formats, such as incorrect coordinate format or invalid geographic names. Additional quality control measures are applied during mapping, where automated scripts exclude illogical records and flag anomalies for correction.

Further validation occurs through geodatabase rules that detect spatial inconsistencies, such as a base station reported in the wrong local government area. Field verification using geo-enabled mobile applications complement these processes, ensuring that errors undetected in office based checks are corrected on-site. Despite these improvements, the Commission acknowledges the need for a formal geospatial data governance policy to standardize accuracy requirements, define collection protocols, and guide interoperability.

Operators typically provide data in structured spreadsheets, which are ingested into the GIS environment for processing and visualization. While the system supports multiple formats internally, the lack of a standardized schema for fiber network mapping remains a gap. Updates occur every three to six months for infrastructure and microwave link data and quarterly for coverage maps, with additional monthly reports for new deployments. This cadence reflects a balance between operational feasibility and the need for timely insights, but increasing demands for real, time data may require further automation and integration.

Broadband data is processed primarily by two departments within NCC: Spectrum Administration, responsible for mobile networks and GIS operations, and Technical Standards and Network Integrity, which oversees fixed networks and fiber deployments. Collaboration

with other agencies has occurred, but mostly on a need-by-need basis. Past engagements include data sharing with the Independent National Electoral Commission (INEC) for election planning, the NPC for census preparation, and the Central Bank of Nigeria for financial inclusion initiatives. Current discussions with the Rural Electrification REA aim to align broadband and energy access planning, while engagement with the Federal Ministry of Works seeks to protect fiber infrastructure during civil works.

Despite these efforts, the absence of a formal data sharing framework limits systematic collaboration. The Commission recognizes the need for clear protocols that balance security concerns with the benefits of open data, particularly for research and investment purposes.

Operators are the primary source of broadband infrastructure data, providing details on base stations, fiber routes, microwave links, and coverage footprints. These datasets enable NCC to produce maps and dashboards that inform regulatory decisions and public policy. However, the current reporting framework focuses mainly on physical infrastructure and coverage, leaving gaps in service quality and contextual information. Additional attributes, such as network speed, latency, and availability at critical institutions like schools, hospitals, and polling stations, would enrich the mapping system and support more targeted interventions. Similarly, data on redundancy, capacity utilization, and resilience could help address quality of service challenges and guide infrastructure investment.

While Nigeria's broadband mapping initiative has achieved significant progress, several gaps remain. Data accuracy is a persistent concern, particularly when coordinates are captured using handheld GPS devices with error margins of up to ten meters. The lack of authoritative datasets, such as standardized urban, rural classifications and metadata, complicates analysis and planning. Furthermore, the absence of a comprehensive geospatial strategy limits interoperability and long, term sustainability.

As part of its ongoing efforts to improve transparency and public access to broadband information, the Nigerian Communications Commission maintains an online Coverage Maps Portal that provides interactive visualizations of mobile network availability and performance across the country. The platform allows users to explore 3G, 4G and 5G coverage by operator, view Speedtest®-based indicators of signal and performance, and examine connectivity conditions at national, state and local levels, illustrating NCC's commitment to data-driven and user-oriented regulatory practice.

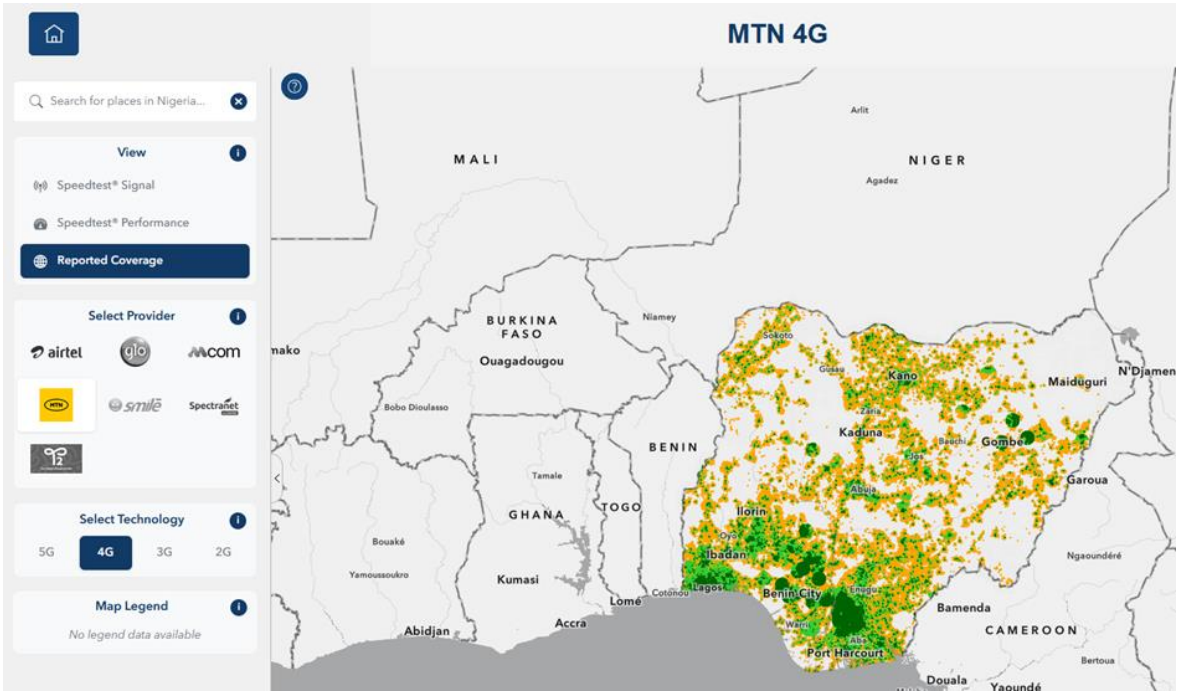


Figure 4 *Example view from the NCC Coverage Maps Portal (https://ncc.gov.ng/coverage-map)*

To address these issues, NCC plans to develop a Broadband Geospatial Framework/Strategy that will define governance structures, accuracy standards, and data sharing protocols. The Commission also intends to adopt standardized methodologies for infrastructure mapping, incorporate service quality metrics into coverage maps, and deploy field validation teams across zonal offices. Emerging technologies such as GeoAI will be explored to enhance mapping efficiency and analytical capabilities.

Table 1 Current mapping data collection in Nigeria

What is mapped?	Update frequency	Responsible NCC department	Main gaps
Mobile networks (3G/4G/5G)	Quarterly	Spectrum Administration (mobile coverage)	Lack of geospatial framework/strategy; limited data sharing
Fiber optic infrastructure	Every 3, 6 months	Technical Standards & Network Integrity	Accuracy issues; no standardized schema, Lack of topology validation, duplicated /overlapping routes
Microwave frequency links	Every 6 months	Spectrum Administration (backhaul links)	Manual/ Limited Validation challenges; metadata gaps

Base stations (Spectrum biase / Infractructure biase	3-6 Months and 1 Month for newly built sites	Spectrum Administration + Technical Standards	Limited QoS attributes; no speed metrics, however, NCC already collects and analyzes speed and QoE metrics via crowdsourced data (e.g., Ookla). Speed maps — including download speeds by location — are publicly available: https://ncc.gov.ng/coverage-map.

3.5. Stakeholder Engagement and Collaboration

The development of Nigeria's national broadband mapping ecosystem is not a standalone regulatory exercise but part of a broader, harmonized effort under the EU Support to Africa's National Broadband Mapping Systems (Africa, BB, Maps) project. Implemented by the International Telecommunication Union (ITU), this initiative aims to establish standard, compliant mapping systems across Sub, Saharan Africa. Nigeria, as a regional leader, formalized this partnership during the National Broadband Mapping Event held in Abuja in August 2025.

This event, hosted by the NCC, brought together key stakeholders including the European Union Delegation to Nigeria, the West Africa Telecommunications Regulators Association (WATRA), and high, level representatives from the ITU Telecommunication Development Bureau.The consensus achieved during these consultations has structured the stakeholder engagement into a formalized National Broadband Mapping Task Force, chaired by the NCC.

The Mapping Ecosystem: Roles and Responsibilities

The Task Force operates on a "whole, of, government" and "industry, collaborative" model, assigning distinct roles to ensure data accuracy, security, and utilization.

- The Regulatory Anchor (NCC): The Commission acts as the central data custodian. Beyond collecting static infrastructure data, the Commission has deepened its strategic partnership with Ookla to integrate crowdsourced Quality of Service (QoS) data. This shifts the mapping focus from theoretical "simulation coverage" to "real, world user experience," allowing the Commission to validate operator claims against actual latency and throughput metrics reported by user devices.
- Critical Infrastructure & Security Partners: Following the Designation and Protection of CNII Order, 2024, the Office of the National Security Adviser (ONSA) ensures that while maps are public, the precise geolocation of vulnerable backbone nodes is protected to prevent sabotage.
- Geospatial Partners: the OSGOF provides the authoritative base maps and geodetic controls (NIGNET), while the NBS supplies demographic grids for calculating penetration rates.

Telecommunications Operator Ecosystem

The success of the mapping initiative relies heavily on the cooperation of licensees who generate the primary data. In Nigeria, the data landscape is segmented across Mobile Network Operators (MNOs), Infrastructure Companies (InfraCos), and Fixed/Satellite providers.

Mobile Network Operators (MNOs)

These entities provide the bulk of the Radio Access Network (RAN) data (2G, 3G, 4G, and 5G coverage polygons) and significant portions of the national fibre backhaul.

- MTN Nigeria: The market leader with the largest subscriber base and the most extensive 4G/5G footprint. MTN holds critical datasets regarding national fibre backbone routes (formerly part of the *Broadband Consortium*) and is a key partner for mapping 5G densification in urban centres.
- Airtel Nigeria: The second, largest operator, holding significant spectrum assets in the 3.5GHz band for 5G. Airtel's data is vital for mapping rural coverage gaps, particularly in the North, West and North, East zones, where they have substantial deployment.
- Globacom (Glo): A fully indigenous operator and the first to build a submarine cable (Glo, 1) landing in Nigeria. Glo possesses a massive, privately, owned national fiber ring ("Glo 1 Domestic") that is critical for mapping inter, city transmission capacity.
- T2 mobile: While holding a smaller market share, T2 mobile remains a key data source for urban youth demographics and specific data, centric corridors.

B. Passive Infrastructure Providers (TowerCos)

These companies own the physical towers and masts. Their data is essential for mapping Colocation opportunities and passive infrastructure availability.

- IHS Towers: The largest tower company in Nigeria. IHS controls the majority of base station sites. Their geospatial database of tower locations, power availability (hybrid/solar/diesel), and height availability is the "base layer" for any infrastructure sharing map.
- ATC Nigeria: A major player in the passive infrastructure market. ATC's data is critical for identifying available vertical real estate for radio equipment, particularly in metropolitan areas.
- Pan African Towers: An indigenous tower company focused on bridging the infrastructure gap. Their site data is particularly relevant for mapping deployments in underserved and semi, urban areas.
- East Castle Infrastructure Ltd.
- Africa Mobile Network

C. Long, Haul Transmission and Wholesale Providers

- MainOne (an Equinix Company): A wholesale giant providing international connectivity via its submarine cable and an extensive terrestrial fiber network across Lagos and Edo State. Their data includes critical landing station coordinates and metro, fiber ducts.
- Phase3 Telecom: A leading aerial fiber optic network operator. Phase3 leverages the high, voltage power transmission lines of the Transmission Company of Nigeria (TCN) to run fiber. Mapping their network offers a unique view of aerial routes that differ from standard buried cable paths.

D. Satellite and merging Technologies

- Starlink: Since launching in Nigeria, Starlink has disrupted the connectivity landscape. While they do not have terrestrial fiber to map, their active user terminals provide data on "served" locations in deep rural areas where terrestrial networks are absent, fundamentally altering the "White Spot" definition.
- Galaxy Backbone: The government owned agency responsible for connectivity to public institutions. They operate the National Information and Communication Technology Infrastructure Backbone (NICTIB). Mapping NICTIB is a matter of national security and government continuity.

Structured Consultation Outcomes

The stakeholder engagement process has moved beyond general discussions to technical implementation. Key outcomes from the August 2025 National Event and subsequent Working Group meetings include:

1. Transition to Crowdsourcing: Stakeholders agreed to supplement operator, submitted coverage maps (which often overestimate service) with third, party crowdsourced data.
2. Standardized Reporting Templates: A unified data schema was adopted for Fiber (backbone/metro), Towers (passive infra), and Microwave links, aligning with ITU Recommendation ITU, T E.813.
3. Data Sovereignty & Hosting: It was resolved that the mapping database would be hosted locally within Nigeria's sovereign cloud infrastructure (Galaxy Backbone), ensuring compliance with the Nigeria Data Protection Act (NDPA) 2023.

3.6. Impact Assessment of Broadband Mapping

The implementation of a high, fidelity broadband mapping system is a strategic imperative for Nigeria. While the government, led fiber fund is a significant headline figure, the actual national infrastructure deficit is substantially larger. The mapping system serves as the primary diagnostic tool to de, risk investment and close the wider infrastructure gap identified by the World Bank and the NCC.

Risking the Infrastructure Gap

It is essential to contextualize the scale of investment required for Nigeria's digital transformation by distinguishing between current government interventions and the total market requirement. While the Federal Ministry of Communications, Innovation, and Digital Economy has launched a substantial Special Purpose Vehicle (SPV), often referred to as Project 774, targeting approximately $2 billion to deploy 90,000 km of fiber optic cable, this represents only a portion of the necessary capital.

According to estimates by the NCC, the World Bank, and the International Finance Corporation (IFC), the total infrastructure gap to fully bridge the digital divide in Nigeria is approximately $6 billion. This larger figure encompasses not just the backbone network, but also "last mile" connectivity to homes and businesses, rural telephony expansion, and the densification required for 5G networks. Furthermore, industry reports suggest that the cost of inaction, defined by lost economic opportunities and inefficiencies due to poor connectivity, could cost the Nigerian economy up to $15 billion annually.

In this context, broadband mapping acts as a critical de, risking tool. By providing a transparent investment heatmap, the mapping system bridges the divide between the public sector's $2 billion commitment and the remaining $4 billion needed from private investors. A precise map allows the private sector to identify exactly where, government funded backbone infrastructure ends, creating clear, data, driven business cases for Internet Service Providers (ISPs) to build the necessary last, mile connections without fear of duplication or regulatory uncertainty.

Impact of Mapping: By providing a transparent "Investment Heatmap," the system de, risks the remaining $4 billion opportunity for the private sector. It allows investors to see exactly where the government's backbone ends, creating clear business cases for "last mile" ISPs to connect homes and businesses to that new backbone.

Economic Multipliers and GDP Growth

Broadband mapping is a catalyst for economic efficiency. World Bank research indicates that a 10% increase in broadband penetration can yield a 1.38% to 2.5% increase in GDP for

developing economies. For Nigeria, where the ICT sector contributed 16.66% to real GDP in Q4 2023, the multipliers are significant:

- Agricultural Productivity: The mapping of rural connectivity allows the Ministry of Agriculture to target e, extension services to the 40% of the population employed in farming. Precision agriculture relies on knowing exactly which farmlands have 4G coverage for loT sensors.
- Financial Inclusion: The Central Bank of Nigeria's cashless policy relies on Point of Sale (PoS) terminals. Mapping "dead zones" helps Fintech operators understand where transaction failures are due to network absence rather than device failure.

Enhancing Network Resilience (Lessons from March 2024)

The strategic value of mapping was starkly illustrated during the March 2024 Undersea Cable Cuts, which severed the MainOne, WACS, ACE, and SAT, 3 cables simultaneously, causing massive internet outages across West Africa.

- The Problem: During the crisis, there was a lack of a unified, real, time view of alternative terrestrial routes. Operators struggled to identify redundant capacity on overland fiber links to neighbouring countries.
- The Solution: The new mapping system includes a Resilience Layer. In the event of a future cut, the NCC can instantly visualize all available alternative paths (e.g., Phase3's aerial fiber on power lines or Glo's redundant rings) to reroute national traffic dynamically, minimizing economic loss.

Promoting the "Dig Once" Policy and Reducing RoW Costs

One of the costliest barriers to fiber deployment in Nigeria is the lack of coordination in civil works and the fragmented RoW charges.

- The "Dig Once" Impact: By overlaying the Fiber Infrastructure Map with the Ministry of Works' Road Projects Map, the government can enforce a "Dig Once" policy. For example, if the Lagos, Calabar Coastal Highway is being constructed, the map ensures ducts are laid during road construction. This coordination can reduce civil engineering costs (CAPEX) by up to 40%.
- Visualizing RoW Disparity: The map will highlight state, level disparities, showing, for instance, the density of fiber in Anambra State (which waived RoW fees) versus states charging over N4,000 per meter. This geospatial evidence provides the National Economic Council (NEC) with the data needed to pressure non, compliant states into harmonizing their fees to the recommended N145/meter.

4. Policy and regulatory assessment Nigeria

4.1. Existing Legal and Regulatory Environment

Broadband mapping in Nigeria is firmly grounded in the Nigerian Communications Act (NCA) 2003, which serves as the primary legal instrument for regulating the communications sector. The Act establishes the NCC as the national regulatory authority with a mandate to oversee the development, management, and monitoring of telecommunications infrastructure and services. This mandate extends to the collection, validation, and use of data necessary for planning, policy formulation, and regulatory enforcement.

The Act articulates broad powers for NCC to ensure transparency, efficiency, and universal access in the communications industry. These powers include the ability to request and obtain information from licensees, regulate access to network facilities, and issue binding directions and guidelines. Such provisions create the legal foundation for broadband mapping as a regulatory tool to identify coverage gaps, monitor infrastructure deployment, and support evidence-based decision-making.

Two sections of the Act are particularly relevant to broadband mapping:

- Section 64 - Information-Gathering Powers

  This section empowers NCC to require any person subject to the Act-primarily licensed operators-to provide information, accounts, records, or documents that are relevant to the exercise of its regulatory functions. The Commission may prescribe the manner, form, and timelines for submission, ensuring that data is provided in a structured and verifiable format.

  Operators are legally obliged to ensure that all information submitted is true, accurate, and complete, and must provide a representation to that effect. Failure to comply, omission of relevant data, or submission of false or misleading information constitutes an offence under the Act, attracting penalties that may include fines or other enforcement action.

  This provision is critical for broadband mapping because it gives NCC the authority to collect geospatial and technical data on network coverage, infrastructure routes, and service availability from all licensed operators.

- Section 103 - Provision of Access

  This section underpins NCC's authority to regulate access to network facilities and services. It obligates licensees to share infrastructure-related information and cooperate in measures that promote interoperability and transparency. These obligations are essential for accurate broadband mapping, as they enable the Commission to consolidate data across multiple operators and create a unified view of national connectivity.

  By linking infrastructure sharing with data disclosure, Section 103 ensures that mapping is not only a technical exercise but also a regulatory requirement aligned with broader goals of open access and fair competition.

In addition, section 64 empowers NCC to collect accurate data from the licensees while Sections 53 and 70 grant NCC the power to issue directions, regulations, and guidelines to operationalize these obligations. Through these instruments, NCC can define reporting templates, validation rules, and compliance timelines, thereby standardizing the process of data collection for broadband mapping.

Beyond statutory provisions, Nigeria's National Broadband Plan 2020-2025 provides strategic direction for broadband development and explicitly recognizes the importance of mapping as a policy instrument. The Plan treats broadband mapping as a critical enabler for achieving

national connectivity targets and sets out clear requirements for its implementation. It calls for the establishment of a national GIS-based platform designed to consolidate data on fiber optic routes, mobile network coverage, and other backhaul and access facilities. This platform is intended to serve multiple regulatory and policy functions, including supporting investment planning through visibility of existing assets and gaps, enabling targeted interventions in underserved and unserved areas, and providing a decision-support tool for government, industry, and development partners.

The Plan further emphasizes the need for standardization and harmonization of data. It recommends the adoption of uniform data schemas and interoperable formats to ensure consistency across operators and agencies, as well as integration with national geospatial frameworks. These measures are aimed at promoting transparency, reducing duplication of effort, and creating a single authoritative source of broadband infrastructure data. In addition, the NNBP introduces obligations for periodic reporting of infrastructure and coverage data to monitor progress toward national targets, such as achieving ninety percent population coverage with 4G or 5G by 2025. These reports are intended to inform policy decisions, guide resource allocation, and support interventions under the Universal Service Provision Fund (USPF) to close access gaps.

Finally, the Plan aligns broadband mapping activities with Nigeria's broader data governance and cybersecurity frameworks. It requires compliance with the Nigeria Data Protection Act of 2023 and the Cybercrimes Act to ensure that mapping processes respect privacy, safeguard sensitive information, and protect critical national infrastructure from misuse or security threats. Taken together, these provisions position broadband mapping as a regulated and strategic activity, integral to the achievement of universal access and the advancement of Nigeria's digital economy objectives.

Broadband mapping requires more than data from telecommunications operators. To create a comprehensive view of connectivity and infrastructure, it is essential to integrate information from other public institutions responsible for population statistics, geospatial data, address systems, transportation networks, and energy infrastructure. These datasets help identify underserved areas, support investment planning, and ensure alignment with national development strategies. Each institution operates under specific legal frameworks that define its mandate and the scope of data it manages. The table below outlines key institutions, the types of data they can provide, and the legal instruments governing their activities.

Table 2 Potential mapping ecosystem in Nigeria

Institution	Useful Data for Broadband Mapping	Legal Act/Policy
National Population Commission (NPC)	Demographic data, population by state and LGA, settlement grids	National Population Commission Act, re-enacted as CAP N67 LFN 2004
Nigerian Postal Service (NIPOST)	Address database, postal locations, geocoding reference points	Nigerian Postal Service Act, Cap N127, LFN 2004,
Office of the Surveyor General of the Federation (OSGoF)	Topographic maps, administrative boundaries, elevation data	Office of the Surveyor General of the Federation Act, Survey Coordination Act (1962).
National Geospatial Data Infrastructure (NGDI)	National geospatial datasets, boundaries, transport networks, hydrology	National Geospatial Data Infrastructure Policy (in view)
Federal Ministry of Works (FMW)	Road projects documentation; standards for ducts in road works; transport corridors (project plans)	Federal Ministry of Works Establishment Act; FERMA Act
Nigerian Governors Forum (NGF)	Facilitates access to state-level road/ROW data via coordination	NGF Governance Framework; Land Use Act (1978)
National Bureau of Statistics (NBS)	Socio-economic indicators, household data, development metrics	National Bureau of Statistics Act, 2007
Nigeria Electricity Regulatory Commission (NERC)	Electricity grid data (poles)	Electricity Regulation, 2023

Rural Electrification Agency (REA)	Electricity grid data, rural electrification projects	Rural Electrification Agency Act
National Space Research and Development Agency (NASRDA)	Satellite imagery, orthophotos, terrain models	National Space Research and Development Agency Act

National Population Commission (NPC)

As indicated in the table, the NPC plays a crucial role as a source of demographic and spatial data. The data collected by NPC includes, among others, enumeration area boundaries, ward boundaries, settlement locations, buildings with basic classification (residential, non-residential, institutional), and demographic data, including population projections. This information is essential for accurate broadband infrastructure planning, as it enables the identification of high-density areas, analysis of service availability, and determination of priority locations for investment.

NPC's activities are governed by the National Population Commission Act (1989), which establishes the Commission as an independent and autonomous body responsible for conducting population censuses, registering births and deaths, and creating location frameworks for public statistics. Particularly relevant to the project are the following provisions:

- Section 6, which obliges the Commission to prepare and maintain national location frameworks, including locality lists and house numbering, as well as to collect demographic and migration data.
- Section 7 defines the composition, functioning, and internal governance of the Commission. Although it does not explicitly regulate data-sharing or methodological autonomy, it establishes NPC as a statutory body with decision-making powers over its operational activities, including the conduct of censuses and the management of population data within the scope of its mandate.
- Sections 20-21, introducing a prohibition on unauthorized disclosure of data and penalties for breaches of confidentiality, which directly affect data exchange procedures with other institutions.
- Section 31, granting the Commission the authority to issue implementing regulations, including setting fees for data-related services.

From the perspective of data exchange with NCC, the Act does not exclude such cooperation, if data protection principles are observed. NPC has confirmed that data sharing is possible based on a Memorandum of Understanding (MoU) and inter-agency agreements. The data is not fully publicly accessible, and its transfer requires formal arrangements.

NPC's data-sharing methods include GIS formats (Shapefile, File Geodatabase) and access via API and SDK. The Commission uses the EnumPad Mobile Application for geospatial data collection and also offers integration mechanisms through API. There is no public geoportal, which means that data access is granted only upon request and after meeting formal requirements. NPC also indicated that there is currently no schedule for data updates, except for planned activities related to the upcoming national census.

Nigerian Postal Service (NIPOST)

As indicated in the table of key institutions for the broadband mapping process, the Nigerian Postal Service (NIPOST) also plays a strategic role due to its mandate as the entity responsible for the national addressing system and postal codes. The data collected by NIPOST, particularly regarding postal codes and address points, is extremely important for broadband infrastructure planning. It enables precise identification of buildings, analysis of service distribution, and integration of the addressing system with telecommunications network planning.

NIPOST manages postal operations across the country and maintains operational datasets necessary for postal routing and service delivery. While the Act does not refer to GIS-based postcode systems or building-level datasets, NIPOST may, in practice, use geographic tools and internally developed systems to manage postal codes and delivery routes. Data exchange with other institutions, when required, is conducted through formal agreements such as MoU, since the Act does not provide open public access to operational postal datasets.

NIPOST's activities are governed by the Nigerian Postal Service Act (1992), which establishes the Postal Service as a corporate body with exclusive privileges for mail conveyance and postal services. Although the Act focuses mainly on postal operations, it contains provisions relevant to data management and potential collaboration within the Broadband Mapping project:

- Section 4 - defines NIPOST's functions, including providing efficient postal services, establishing and maintaining postal facilities across the country, and ensuring nationwide postal delivery. These functions underpin the operational basis for maintaining postal routing structures and location-based service frameworks.
- Section 5 - grants NIPOST the authority to determine infrastructure needs, establish facilities, and enter agreements with other entities on matters relating to the postal system, enabling formal collaboration with NCC for data exchange.
- Section 30 - gives NIPOST the right to negotiate international postal agreements, demonstrating its capacity to create structured data-sharing mechanisms.
- Section 61 - empowers the Postmaster-General to issue the *Post Office Guide*, which regulates postal operations, service classifications, and conditions for postal services. While not explicitly addressing digital addressing or data interoperability, this authority allows NIPOST to define operational standards that may relate indirectly to address formats or postal routing rules.
- Section 62 - authorizes the Minister to issue implementing regulations to give effect to the Act. Such regulations could include provisions supporting digital postal services, addressing standards, or data-exchange frameworks, should the government choose to develop them.

From a legal perspective, the Act does not restrict cooperation with the NCC or other institutions on data-sharing matters. On the contrary, provisions enabling NIPOST to enter agreements (Section 5) and issue operational guidelines (Section 61-62) provide a lawful foundation for structured collaboration. However, it must be noted that the Act emphasizes operational control of postal information, which means that any exchange of postal data must comply with internal NIPOST rules and formally approved procedures.

Office of the Surveyor General of the Federation (OSGoF)

OSGoF plays also important role as the national authority responsible for geodetic and cartographic data. The data collected by OSGoF includes, among others, geodetic control points, digital terrain models (DTM), administrative boundaries, road and river networks, and large-scale topographic maps. These datasets are essential for broadband mapping because

they provide the spatial framework needed for accurate network planning, infrastructure analysis, and service coverage modeling.

OSGoF's activities are governed by the Survey Coordination Act (1962), which establishes the obligation to notify and submit all survey work to the federal authority. Particularly relevant to the project are the following provisions:

- Section 1, which requires any entity conducting survey work to notify the Director of Federal Surveys (now OSGoF) and submit outputs such as maps, aerial photographs, field observations, and geodetic data.
- Section 1(3)(c), which stipulates that all submitted materials become government property and may be used for official purposes.
- Section 2, which introduces penalties for failure to comply with these requirements.

From the perspective of broadband mapping, OSGoF is also a key stakeholder in the NGDI. NGDI is not a separate institution but a national policy and technical framework for interoperable geospatial data sharing. OSGoF's statutory mandate to centralize survey data forms the legal backbone of NGDI, while operational integration (API services, cloud hosting, metadata standards) is coordinated under NGDI guidelines.

The Act does not exclude cooperation with the NCC. On the contrary, OSGoF can share data under formal agreements, provided compliance with NGDI standards and confidentiality rules.

OSGoF's data-sharing methods currently rely on manual transfer (e.g., shapefiles on physical media), but NGDI aims to enable automated exchange through APIs and cloud services. Public access is not available; data is shared upon request and subject to a MoU.

National Space Research and Development Agency (NASRDA)

As indicated in the table, the NASRDA plays a strategic role as the custodian of satellite imagery and space-based geospatial data. NASRDA provides datasets such as Earth observation imagery from NigeriaSat missions, remote sensing products, geodetic measurements, and application-specific data for sectors like energy, disaster management, and environmental monitoring. These resources are critical for broadband mapping because they enable nationwide coverage analysis, terrain modeling, and integration of high-resolution imagery into planning tools.

NASRDA's activities are governed by the National Space Research and Development Agency Act (2010), which establishes the Agency as the lead institution for space science and technology. Particularly relevant to the project are the following provisions:

- Section 6(k), which designates NASRDA as the national repository for all satellite data over Nigeria's territory.
- Section 6(a-m), which outlines NASRDA's mandate to develop satellite technology, coordinate space applications, and support research and education.
- Section 11, which provides for specialized development centers, including the National Centre for Remote Sensing (Jos) and the Centre for Geodesy and Geodynamics (Toro), both of which are relevant for geospatial data production and integration.

The National Geospatial Data Infrastructure (NGDI)

The NGDI is a framework designed to facilitate the collection, management, and sharing of geospatial data through a centralized, digital network. It aims to eliminate data duplication, establish standards, and support national development planning through improved access to geospatial information. It is responsible for developing harmonized national geospatial data standards, metadata protocols as well as eventually serve as a national clearinghouse for all

geospatial data in Nigeria. It is not yet fully operational as the framework is still under development and yet to be ratified by Government. When fully operational, the National Broadband Mapping project would benefit from the collective benefits provided by the NGDI, including facilitation of seamless data sharing with all relevant government agencies through standardized APIs etc.

Federal Ministry of Works

According to the institutional table, the FMW is the key authority responsible for road construction standards and the protection of linear infrastructure in Nigeria. Its mandate includes developing policies and operational procedures that directly affect the placement and safeguarding of fiber optic cables during road construction and maintenance. Incorporating requirements for telecommunications infrastructure into road projects is essential to ensure the durability of broadband networks.

The legal basis for FMW's operations includes public works regulations and the Federal Roads Maintenance Agency Act (2002, amended in 2007), which transferred routine road maintenance to FERMA while leaving regulatory and strategic functions with the Ministry. Particularly relevant to the project are:

- Section 7 of the FERMA Act, which provides for the development of guidelines and recommendations on the maintenance of federal roads.
- Section 8 provides a basis for planning and implementing safety standards. The mandatory integration of fiber ducts in new road projects would normally be introduced through separate ministerial regulations or technical guidelines rather than directly by the FERMA Act text.

The Minister's authority to approve regulations and coordinate inter-ministerial cooperation on infrastructure protection.

The Ministry is working on a policy introducing mandatory installation of fiber ducts in new road projects. Currently, informal procedures are in place (e.g., notifying NCC before starting works), but formal regulations are under development.

FMW does not maintain its own geospatial databases but can provide project documentation and construction guidelines upon request. Cooperation with NCC is expected to be formalized through a MoU to ensure integration of mapping with investment planning and early notification of works.

Data sharing methods

- Current: Providing documentation in paper or digital form upon request.
- Planned: Digitization of road project data and integration with national mapping platforms.
- Public access: None; institutional access requires formal agreements.

Nigeria Governors' Forum (NGF)

According to the institutional table, the NGF is a collaborative platform for 36 governors that plays a key role in harmonizing state policies on infrastructure, including fees for RoW access. The Forum acts as an advisory and coordinating body, supporting the implementation of uniform rules that foster broadband network development.

The basis of NGF's influence on regulations is the Land Use Act (1978), which grants governors control over land in their states, including the authority to issue permits and set fees for occupying road corridors. NGF uses this mandate to promote policy harmonization and reduce administrative barriers. Particularly relevant provisions include:

- Section 5 of the Act, which grants the governor the right to confer titles and regulate land use.
- Section 22, which requires the governor's consent for transferring land use rights - significant for telecom infrastructure installation.

NGF does not collect geospatial data but can facilitate access to state-level information through its technical office. Its main strength lies in advocacy and policy coordination within projects such as SABER, which promote regulatory reforms and infrastructure security.

Data sharing methods

- NGF does not directly produce geospatial technical datasets; its role is primarily coordinating and mediating access to state-level information via state authorities and technical offices.
- Cooperation with NCC will be implemented through an MoU and may include establishing a Broadband Mapping Committee within NGF.
- Public access: Not applicable; institutional access depends on agreements with individual states.

National Bureau of Statistics (NBS)

The National Bureau of Statistics is the central authority responsible for coordinating the National Statistical System (NSS) and producing official statistics in Nigeria. Data collected and published by NBS covers a wide range of areas, including transportation, communication, land use, economy, and demographics. This information is critical for broadband infrastructure planning as it enables analysis of population distribution, service availability, and identification of priority investment locations.

NBS operations are governed by the Statistics Act (2007), which establishes the Bureau as an autonomous entity under the Presidency, tasked with ensuring the quality, consistency, and accessibility of statistical data. Particularly relevant to the project are the following provisions:

- Sections 5-6 define NBS as the primary national agency responsible for the coordination, development and management of official statistics and for maintaining a national data bank (subject to the Act's provisions).
- Sections 19-21, which establish the National Consultative Committee on Statistics as a mechanism for coordinating statistical activities among government agencies.
- Section 22, granting NBS the authority to collect data nationwide, including from private entities, and to enforce compliance with established standards.
- Section 25, requiring private and foreign institutions to obtain NBS approval before conducting nationwide statistical surveys.
- Section 24 requires the development and promotion of a Code of Practice for agencies producing official statistics, to promote quality and consistency; implementation details are specified in NBS guidance.

From the perspective of data exchange with the NCC, the Act does not preclude such cooperation, provided confidentiality principles are observed and formal agreements are in place. NBS can support the project by integrating statistical data with broadband infrastructure mapping and developing unified standards for spatial data.

Data-sharing methods:

- Current: Publication of statistical reports and summaries in digital and print formats; microdata available upon request, subject to confidentiality rules.
- Planned: Development of a national data bank and an open-access policy for selected datasets, with download options via digital platforms.

- Public access to NBS outputs is tiered: aggregated statistical reports are publicly available, while microdata/full datasets usually require a formal request, agreement or licence and compliance with confidentiality rules under the Statistics Act.

Cooperation with NCC may include:

- Integration of statistical data with broadband infrastructure mapping,
- Joint development of standards for spatial data,
- Establishment of a working group within the National Consultative Committee on Statistics.

Rural Electrification Agency (REA)

REA plays a crucial role as a source of geospatial and infrastructure data relevant for broadband mapping. The datasets maintained by REA include nationwide settlement locations and extents, electrification status (grid, off-grid, mini-grid), mini-grid project footprints, candidate MV/LV line routes used for planning, and selected technical parameters of REA-managed energy systems (e.g. source type, installed capacity, voltage class). Data completeness and level of detail are highest for rural and underserved areas, reflecting REA's mandate and least-cost electrification modelling focus.

REA's activities are governed by the Electric Power Sector Reform Act (2005) and strategic policy instruments such as the Rural Electrification Strategy and Implementation Plan (RESIP). Project implementation is subject to the Environmental Impact Assessment Act (1992) and the World Bank Environmental and Social Framework (ESF). Key implementation instruments include national electrification programmes such as DARES/NEP, which combine infrastructure deployment with geospatial planning and monitoring components.

From the perspective of data exchange with NCC, the existing legal framework does not preclude inter-agency cooperation, provided data protection and confidentiality requirements are observed. REA confirmed that data sharing currently takes place on the basis of MoUs and joint inter-agency committees. REA datasets are not publicly accessible; their transfer requires formal agreements and authorisation by the Agency's data and ICT governance units.

REA's data are maintained in standard GIS formats (e.g. Shapefile, GeoJSON, CSV). The Agency uses geospatial planning tools and internal web-based mapping platforms for decision-making but does not operate a public geoportal. Technical integration with partner institutions, including read-only or controlled interfaces, is feasible but currently implemented on a project-specific basis rather than through a formalised national API framework. Dataset updates are project-driven and typically aligned with procurement, monitoring, and implementation cycles of electrification programmes.

Data and Infrastructure Security in the Context of Broadband Mapping

Broadband mapping in Nigeria operates within a legal environment that places strong emphasis on the protection of personal data and the security of critical infrastructure. Two key legal instruments regulate these issues: the Nigeria Data Protection Act (2023) and the Cybercrimes (Prohibition, Prevention, etc.) Act, as amended in 2024. Together, they create a framework that ensures mapping systems are not only accurate and interoperable but also secure and compliant with legal requirements.

Nigeria Data Protection Act (2023)

The Data Protection Act introduces comprehensive rules for data processing, which directly apply to broadband mapping when location information or user-related data is collected.

Section 24 sets out fundamental principles: lawfulness, fairness, transparency, purpose limitation, and data minimization. NCC and its partners must ensure that data used in mapping is limited to what is strictly necessary.

- Sections 39-40 of the NDPA require controllers and processors to implement appropriate technical and organizational measures (e.g., encryption, pseudonymisation) and impose breach-notification obligations, including notifying the Data Protection Commission within 72 hours and informing affected individuals where high risk is identified.
- Section 28 introduces the requirement to conduct a Data Privacy Impact Assessment for high-risk operations, such as large-scale geospatial mapping combined with demographic data.
- Sections 41-43 regulate cross-border data transfers-these are permitted only when an "adequate level of protection" is guaranteed, reinforcing the principle of data sovereignty.

Cybercrimes Act (2015, as amended in 2024)

The Cybercrimes Act focuses on the resilience and security of digital systems, including broadband mapping platforms.

- Sections 3-4 of the Cybercrimes Act empower the Federal Government to designate specific information systems as CNII. Telecommunications platforms, including broadband mapping systems, may fall under this designation through an executive instrument. Once designated as CNII, such systems must comply with enhanced security requirements, including the implementation of rigorous technical and organizational safeguards, business continuity and resilience plans, and mandatory incident reporting to the national CERT within 72 hours of detecting a security breach.
- Sections 5-6 provide for severe penalties for unauthorized access, data modification, or disruption of CNII systems (up to 10 years' imprisonment).
- Section 38 of the Cybercrimes Act establishes obligations for service providers to retain specified categories of traffic and subscriber information and to make such data available to law enforcement agencies in accordance with due process. While the Act provides the legal basis for retention, the scope, duration, and procedures for lawful access must be interpreted in line with data protection requirements under the Nigeria Data Protection Act (2023) and any applicable implementing regulations, ensuring that retention practices remain proportionate, secure, and compliant with confidentiality obligations.

The 2024 amendment strengthens cybersecurity requirements by introducing obligations to establish sectoral Security Operations Centers (SOC) and integrate public and private networks into the national cybersecurity infrastructure.

In practice, this means that broadband mapping is not merely a regulatory tool but a system highly sensitive from a national security perspective. NCC must implement an architecture based on security-by-design principles, incorporating multi-layered protection mechanisms such as encryption, access control, intrusion detection systems, and incident response procedures. It is also essential to integrate the platform with the national CERT and SOC to ensure rapid threat response.

Effective implementation of the broadband mapping system requires close coordination between various ministries and technical institutions. Each entity plays a distinct role-from developing policies and legal frameworks, through managing spatial data, to overseeing

security and data protection. The absence of clear cooperation mechanisms can lead to fragmented responsibilities, delays in data exchange, and inconsistencies in standards.

4.2. Gaps and Challenges

Gaps in Current Regulations

Nigeria has a solid legal foundation for the development of digital infrastructure and broadband mapping. The NCA of 2003 grants the Commission the mandate to collect data from operators (Section 64), regulate access to infrastructure (Section 103), and issue binding guidelines (Sections 53 and 70). The NBP 2020-2025 emphasizes the need to establish a national GIS platform and integrate it with NGDI. The NDPA of 2023 introduces principles for data protection, while the amended Cybercrimes Act of 2024 sets security requirements for critical infrastructure.

However, current regulations do not include detailed provisions regarding data structure and format. There is no unified geospatial data schema, interoperability standards, or requirements for using APIs aligned with international norms (e.g., OGC). As a result, data is delivered in multiple formats, making automated integration and validation difficult. Although the NBP calls for the creation of a GIS platform, the absence of precise technical requirements in law means implementation depends on interpretation and regulatory initiatives rather than clear norms.

Another gap is the lack of mechanisms ensuring systematic access to and exchange of reference datasets. NGDI and other government institutions hold geodetic resources, satellite imagery, and address data, yet there is no unified legal mechanism guaranteeing their provision through network services. In practice, data exchange occurs manually, limiting timeliness and accuracy.

There is also no national address database with geocoding, which hinders precise localization of infrastructure points. Clear legal frameworks for cross-sector data sharing-such as between telecommunications, energy, and transport-are missing, even though they are essential for coordinated planning and joint resource utilization. Regarding the security of disclosing critical infrastructure data, there are no mechanisms for tiered access, risk assessment procedures, or methods for masking coordinates in public availability portals.

The legislative process for NGDI remains incomplete-there are no adopted national standards for metadata, dictionaries, and schemas, nor a clear designation of the coordinating authority (NASRDA vs OSGoF). The exchange of statistical and demand data (e.g., demographic data, school locations, healthcare facilities) requires formalization through agreements between NCC, NBS, and NPC. Additionally, the preference for local hosting and data sovereignty requires clear operational guidelines for certified data centers, retention policies, and disaster recovery plans in line with CNII requirements. Finally, ambiguity in territorial division and competencies between federal and state levels affects data availability and the time needed to obtain approvals.

Challenges in Current Regulation

The most pressing challenge is to refine primary and secondary regulations governing interoperability and data standards. Legal provisions should establish enforceable unified data schemas, mandate standardized automated data exchange mechanisms, including API-based services and OGC-compliant standards, and create mechanisms for automated cross-sector data exchange. This also includes extending infrastructure and asset reporting obligations to other sectors-such as energy, transport, and water-to enable coordinated planning and joint infrastructure deployment.

Another critical challenge is the creation of legal frameworks that guarantee access to authoritative reference datasets. Regulations should ensure interoperability and controlled openness of such datasets to the extent required for public policy objectives, while maintaining robust security and privacy protections.

In the area of cybersecurity and data protection, detailed implementing guidelines are needed to operationalize the requirements of the NDPA and the Cybercrimes Act for broadband mapping systems. These should include procedures for anonymization, data-layer classification, incident response workflows, and integration with the national CERT and, where applicable, SOCs.

Additional regulatory challenges identified through stakeholder consultations include:

- Legal basis for automation and interoperability
  Current workflows for submitting infrastructure and coverage data to NCC remain largely manual. To enable automation, regulations must mandate electronic data submission, define API-based exchange as the standard mechanism, and require alignment with national interoperability standards and internationally recognized best practices (e.g. OGC). These provisions should be embedded in implementing regulations under the Nigerian Communications Act and linked to licensing obligations for operators.
- Formalizing cross-sector data integration
  Institutions such as the REA maintain critical geospatial datasets, but integration with broadband mapping is not legally enforced. Regulations should extend reporting obligations to energy and transport sectors, define secure data-sharing protocols, and establish permanent governance structures (e.g., technical committees) to coordinate infrastructure planning. This requires amendments or implementing rules under the NBP and NGDI framework.
- Addressing uncertainty in the national address register
  NPC is not the statutory custodian of Nigeria's address database but is willing to cooperate during the initial phase. A regulatory challenge is to authorize NCC to use NPC datasets as an interim solution, pending the establishment of an official national address system, while requiring a comparative assessment and migration plan once the official address system is established. This should be reflected in NGDI-related provisions and future broadband mapping guidelines.
- Tiered access and confidentiality rules
  Stakeholders support a tiered access model-public view for aggregated data, restricted view for institutional users, and regulator-only for sensitive details. Current law does not define such a model. Implementing regulations should introduce role-based access controls, specify data classification levels, and require Data Protection Impact Assessments (DPIA) for sensitive infrastructure layers to ensure compliance with NDPA and cybersecurity laws.
- Technical standards and compliance enforcement
  Operators highlighted the absence of harmonized templates and validation rules. Regulations should codify minimum technical standards for data formats, attributes, and validation checks, and link compliance to licensing conditions or performance indicators. This ensures consistency and reliability of mapping outputs and facilitates integration with NGDI.

In summary, the existing legislation provides a strong foundation but requires further refinement to ensure consistency and predictability. Addressing these areas-by specifying technical requirements, expanding cross-sector obligations, and introducing clear security

guidelines-is essential for Nigeria's broadband mapping system to align with international best practices and effectively support digital development.

5. Data governance and interoperability frameworks

This chapter describes the current data governance baseline in Nigeria, identifies the main interoperability and trust constraints, and outlines a target governance framework for the national broadband mapping system under Africa-BB-Maps. It focuses on legal/technical foundations for data collection, exchange, publication, security and multi-stakeholder coordination, which are prerequisites for a credible mapping system that can support investment planning and evidence-based regulation.

Nigeria already has active broadband mapping and QoS monitoring practices within the NCC. During the national Africa-BB-Maps event (Abuja, 5-7 August 2025), NCC presented its GIS-driven mapping outputs (2G-5G coverage visualization, fibre and microwave layers) and highlighted the intention to evolve toward a dedicated Broadband GIS strategy and stronger integration with national digital platforms. The same discussions also confirmed persistent constraints: data quality and reliability, cross-MDA coordination, and stakeholder buy-in/confidentiality expectations.

5.1. Institutional and legal foundations for data governance

Data scope, granularity and validation principles

International guidance emphasizes that mapping should support the identification of unserved/underserved areas and decision-making to reduce the digital divide, while reflecting connectivity through multiple perspectives (presence/absence, quality, and other dimensions). ITU-T Recommendation E.813 provide a high-level framework for mapping and visualization strategies to assess connectivity.

For Nigeria, stakeholders repeatedly stressed that the immediate priority is an approach that is operationally feasible now and can be scaled over time, given gaps in reference datasets and uneven readiness across regions and institutions.

State of play:

- NCC already visualizes mobile coverage and backbone layers using GIS tools and applies harmonised QoS reporting practices supported by drive tests, with a stated direction to expand validation by integrating crowdsourced evidence layers.

- Public agencies confirmed the availability of multiple reference datasets (boundaries, demographics, electrification and related layers) but flagged inter-agency coordination and data protection as practical barriers.

Key gap: national reference/addressing readiness

Stakeholder engagement and institutional discussions highlight that Nigeria does not yet have a uniformly geocoded, nationwide address reference that can be relied on as a single “source of truth” for address-level broadband mapping across all settlement types. This makes a purely address-level approach difficult as an initial national baseline without a staged transition plan.

Target framework principle (descriptive): a staged granularity strategy

Nigeria’s mapping framework should be designed so that:

- Engineering layers (fibre routes, towers, PoPs, landing stations) remain vector-based (point/line features) to preserve operational planning value.
- Service availability/coverage layers use a harmonised reporting unit that is implementable nationwide (e.g., grid/area-based reporting), while allowing a future migration toward finer resolution where/when national reference datasets mature.

- Validation is multi-layered and transparent, combining automated checks, logic checks, and independent evidence sources, plus a clear challenge/correction process (consistent with best practice in BEREC's geographical survey and verification guidance).

Scope of data collection: the required layers

Nigeria's national event outcomes converged around harmonised schemas for core telecom layers and the systematic use of contextual layers, so maps translate into actionable inclusion planning ("map people to serve people").

A coherent Nigerian broadband mapping data scope should include:

Layer A - Infrastructure (vector/sensitive)

- Fibre/backbone/metro routes (line features) plus key nodes (PoPs/meet-me rooms/landing stations) (point features).
- Towers and other key passive infrastructure points, including relevant attributes for reliability planning where available.

Layer B - Service availability and quality (harmonised reporting unit)

Mobile and fixed availability by technology, plus performance indicators aligned with NCC QoS practices and verification evidence (drive tests and, where adopted, anonymised crowdsourced layers).

Layer C - Demand and context

Population and socio-economic overlays and anchor institutions (schools, health facilities) to support prioritisation and investment targeting, as strongly advocated by stakeholders.

Validation and assurance: toward a repeatable pipeline

Nigeria's national discussions explicitly recommended automated scripts, manual review processes, feedback loops to operators, and iterative rule refinement coordinated through an industry working group.

A targeted validation pipeline should therefore combine:

1. Automated schema and completeness checks at ingestion.
2. Logic/topology checks (plausibility and consistency rules).
3. Independent evidence overlays (NCC monitoring/drive tests; and/or anonymised crowdsourced measurement layers where agreed).
4. A documented challenge and correction mechanism with clear timelines and versioned releases.

Security, confidentiality and data protection constraints (legal baseline)

Broadband mapping in Nigeria operates under a legal environment that places strong requirements on both personal data protection and critical infrastructure security, including the NDPA, 2023 and the Cybercrimes Act (2015, as amended in 2024), which enables designation of CNII with enhanced protection obligations.

This means that governance must incorporate:

- Data minimisation and privacy-by-design for any datasets that can involve personal/location-linked information.
- Controlled disclosure and strict access controls for sensitive infrastructure layers.
- Auditability and incident-response readiness consistent with CNII-grade expectations.

5.2. Data sharing protocols and access rights

Current exchange patterns and constraints

Nigeria's data ecosystem includes multiple public institutions with relevant geospatial datasets (e.g., OSGOF/NGDI/NPC/REA and others). Agencies indicated willingness to contribute data streams, while recognizing barriers including inter-agency coordination and data protection concerns.

An illustrative example is REA: data sharing is feasible but generally MoU-based and project-specific; datasets are maintained in standard GIS formats (e.g., Shapefile/Godson/CSV) and integration is not yet implemented via a formalised national API framework.

Target protocols for exchange and publication (descriptive)

To reduce fragmentation and improve predictability, the national broadband mapping system should operate with:

- Defined update cadences for key datasets (coverage/service more frequent than passive infrastructure).
- A dual submission approach (secure portal uploads + API-driven submissions for mature providers), consistent with national event recommendations for API-driven formats and harmonised schemas.
- Publication rules that balance transparency and confidentiality.

Interoperability standards and technical interfaces

Stakeholders discussed interoperable approaches and layered API access. A target interoperability model should rely on:

- A national data dictionary + metadata profile (definitions, provenance, timestamps, accuracy, confidentiality classification), aligned with NGDI principles where applicable.
- Common geospatial service interfaces such as WMS (portrayal) and WFS (feature access/exchange), and/or modern API-based successors to enable cross-platform integration across government and industry systems.

Tiered access model (descriptive)

Nigeria's national event discussions and template analysis point to a tiered access approach as the most workable model for trust and CNII-style sensitivity management: public aggregated outputs; authenticated access for government/planning users; and restricted layers for NCC and authorised entities.

5.3. Governance models for multi-stakeholder collaboration

Current stakeholder landscape

The national event demonstrated a strong whole-of-government and private-sector engagement model, with participation spanning NCC, multiple MDAs and geospatial/data institutions, and major operators/infrastructure providers. This breadth is a strength, but it also reinforces the need for formal governance mechanisms to ensure continuous data flows, consistent rules, and reliable dispute handling.

Target governance operating model (descriptive)

The mapping system should be operated as a regulated national capability with clear roles:

- NCC as system custodian (platform operation, access control, publication, validation governance).

- Operators/Infra providers as primary telecom data contributors (submitted under standard templates and definitions).
- Public reference agencies as authoritative base-layer providers (boundaries, geodetic reference layers, socio-economic layers, electrification overlays, etc.).
- A standing technical working structure (multi-stakeholder) to maintain schemas, resolve technical disputes, and oversee iterative improvements-reflecting the event's emphasis on working group coordination and rule refinement.

6. Institutional capacity

The successful implementation of a national broadband mapping system in Nigeria requires an evaluation of the existing institutional capacity, including the identification of key stakeholders, their roles, and the current state of human and technical resources. This chapter outlines the relevant stakeholders, the current capacity landscape, and the mechanisms for institutional coordination as they currently exist, prior to the establishment of the broadband mapping system.

6.1. Relevant stakeholders and institutional roles

Nigeria's broadband ecosystem involves a diverse range of stakeholders, each playing a critical role in the development, regulation, and operation of digital infrastructure. The following are the key stakeholders and their current roles in broadband development and management:

1. Nigerian Communications Commission (NCC):

The NCC is the primary regulatory authority for the telecommunications sector in Nigeria. It is responsible for licensing, spectrum allocation, monitoring compliance with regulations, promoting competition, and ensuring quality of service. Currently, the NCC collects infrastructure data from operators but lacks a centralized, standardized broadband mapping system to consolidate, analyze, and visualize this data effectively.

2. Federal Ministry of Communications, Innovation and Digital Economy (FMCDE):

The FMCDE oversees the development and implementation of policies and strategies related to the ICT sector. It plays a coordinating role between the NCC, other ministries, and stakeholders to ensure alignment with national development objectives. Currently, the ministry provides high-level policy guidance but lacks the tools to monitor and evaluate the implementation of broadband initiatives comprehensively.

3. Operators and Service Providers:

Telecommunications operators and internet service providers (ISPs) are key contributors to Nigeria's broadband ecosystem. They are responsible for deploying and maintaining infrastructure, providing services to end-users, and reporting data to the NCC. However, data reporting is often inconsistent, and there is no standardized framework for infrastructure data submission.

4. Ministries, Departments, and Agencies (MDAs):

Various MDAs play a role in broadband development through their involvement in infrastructure deployment, policy enforcement, and service delivery.

For example:

- The Ministry of Power oversees the provision of electricity, which is critical for broadband infrastructure.
- The Ministry of Works and Housing governs RoW policies for infrastructure deployment.
- The Ministry of Education focuses on improving digital literacy and school connectivity.
- The Ministry of Agriculture and Rural Development is increasingly exploring the use of broadband for smart farming and rural development.
- The Ministry of Health works on leveraging broadband for telemedicine and e-health services.

5. State and Local Governments:
   State and local governments play an important role in broadband deployment through the management of right-of-way permits, infrastructure approvals, and community engagement. However, coordination between federal, state, and local authorities is often fragmented, leading to inefficiencies and delays in infrastructure rollout.

6. Development Partners and International Organizations:

Organizations such as the International Telecommunication Union and the World Bank provide technical assistance, funding, and policy advice to support broadband development in Nigeria. These partners have been instrumental in initiating discussions about broadband mapping and capacity building.

7. Private Sector and Civil Society:

Private sector stakeholders, including technology companies and industry associations, contribute to innovation, investment, and capacity building. Civil society organizations advocate for equitable access to broadband and raise awareness about digital inclusion.

6.2. Human and technical capacity development

Current State of Human Capacity

Nigeria's ability to implement and sustain a broadband mapping system is currently constrained by limited human capacity in key areas such as GIS, data management, and broadband network planning. While the NCC has a team of skilled professionals, the number of GIS specialists, data analysts, and technical experts is insufficient to meet the demands of a national broadband mapping initiative. Moreover, there is limited expertise in advanced geospatial analytics, data governance, and cybersecurity.

At present:

- GIS expertise is concentrated in a few institutions, such as the NASRDA and some academic institutions, but there is limited collaboration between these entities and the NCC.
- Training opportunities for advanced GIS and broadband technologies are limited, and there is a lack of structured career development pathways for technical staff in relevant institutions.
- High staff turnover, particularly in the public sector, poses a challenge to retaining institutional knowledge and building long-term capacity.

Current State of Technical Capacity

The technical capacity to support broadband mapping is also limited. Key challenges include:

- Data Fragmentation: Infrastructure data is scattered across multiple operators, MDAs, and private entities, with no centralized repository or standardized format for submission.
- Insufficient Storage and Processing Infrastructure: The NCC and other institutions lack the robust IT infrastructure required to store, process, and analyze large volumes of geospatial and broadband data.
- Limited Automation and Integration: Current data collection and reporting processes are largely manual, resulting in inefficiencies and delays. There is minimal use of APIs or automated data feeds to streamline reporting.
- Cybersecurity Concerns: Existing systems lack adequate measures for securing sensitive data, posing risks to data integrity and confidentiality.

6.3. Institutional coordination mechanisms

Current State of Coordination

At present, institutional coordination for broadband infrastructure development and data governance in Nigeria is fragmented. While the NCC plays a central role in regulating the telecommunications sector, there is no formalized mechanism for coordinating broadband-related activities across ministries, operators, and other stakeholders. This has led to challenges such as:

1. RoW Issues:

   Coordination between the NCC, the Ministry of Works and Housing, and state governments is inconsistent, leading to delays and high costs for infrastructure deployment.

2. Data Sharing and Reporting:

   Operators and MDAs are required to submit infrastructure data to the NCC, but there is no standardized framework for data submission. This results in inconsistent and incomplete datasets, limiting the NCC's ability to make data-driven decisions.

3. Stakeholder Engagement:

   While the NCC engages with operators and other stakeholders through public consultations and workshops, there is no permanent platform for ongoing collaboration and decision-making.

4. Cross-Ministerial Cooperation:

   Collaboration between the NCC and other ministries, such as the Ministry of Power and the Ministry of Education, is ad hoc and project-based, rather than being governed by a formal coordination structure.

Challenges

- Lack of Clear Roles and Responsibilities: The absence of a defined governance structure for broadband mapping has led to overlapping responsibilities and gaps in accountability.
- Limited Resources: Many MDAs lack the technical and financial resources needed to support broadband mapping and data governance initiatives.
- Policy Gaps: While Nigeria has a NBP and operators report data to the NCC, the current framework for broadband mapping lacks standardization and comprehensiveness in certain areas, such as uniform data submission formats, update cycles, and mechanisms for integration across sectors. This limits the ability of stakeholders to fully leverage broadband data for strategic planning, decision-making, and cross-sectoral coordination.

7. Proposals and Recommendations

7.1. Policy and Strategic Recommendations

Nigeria already has most of the necessary legal and regulatory foundations for broadband infrastructure reporting and data protection. Therefore, the recommendations presented here do not aim to create new regulations, but rather to organize, clarify, and operationalize existing mechanisms. The key areas requiring strengthening include the development of a uniform data schema, defining a clear reporting frequency, introducing validation rules and minimum quality standards, as well as formalizing inter-institutional cooperation, which currently operates inconsistently. Additionally, it is important to specify practical guidelines for data security and access management, so that existing laws can be applied in a coherent and operational manner. The recommendations in this chapter therefore focus primarily on refining and structuring guidelines, rather than changing the regulatory foundations.

Recommendation: Establishing a Standardized and Unified Data Reporting Framework for Broadband Infrastructure

To ensure the reliability, comparability and long-term usability of broadband-related datasets submitted by operators and public institutions, it is recommended that NCC introduce a unified national reporting framework. At present, operators and infrastructure providers rely on different data schemas and reporting conventions, which leads to inconsistencies in the documentation of fiber infrastructure, towers, radio parameters and service availability. This reduces the accuracy of national broadband mapping and complicates evidence-based infrastructure planning.

Key Actions:

- NCC should adopt a single, nationally applicable data-reporting schema and require all data providers to use standardized reporting templates aligned with it.
- NCC should define clear expectations regarding minimum data-quality requirements and ensure that all submitted datasets undergo a formal validation process prior to inclusion in national mapping outputs.
- The unified data-reporting framework should be referenced in the Commission's existing regulatory instruments so that compliance becomes an integral and enforceable part of operators' reporting obligations.

Justification

Standardization is essential for producing high-quality national broadband maps. A unified reporting framework improves interoperability between datasets, enhances modelling accuracy and reduces the administrative burden for both NCC and operators. Countries with advanced broadband mapping-such as Germany, Sweden and Poland-have demonstrated that harmonised templates and clearly regulated reporting expectations significantly improve the quality and credibility of national infrastructure inventories.

Recommendation: Clarifying and Strengthening the Legal and Regulatory Provisions Governing Broadband Data Submission

For the national broadband mapping system to function reliably and sustainably, it is recommended that NCC strengthen the regulatory basis for data submission by clearly defining operators' reporting obligations within existing regulatory instruments. At present, the regulatory framework does not sufficiently specify the required reporting formats, the expected

frequency of submissions, nor the consequences of failing to comply. As a result, data are submitted irregularly, with gaps and inconsistencies that weaken the national broadband map and reduce interoperability.

Key Actions:

- NCC should clarify and consolidate reporting obligations under the NRA and associated regulatory instruments, ensuring that operators are aware of the expectations concerning electronic data submission, alignment with the national data schema, and adherence to defined reporting timelines for key dataset categories.
- NCC is encouraged to strengthen enforcement provisions by linking consistent compliance with reporting requirements to regulatory processes such as licence renewal, service authorisations or spectrum awards, thereby making data quality an integral component of regulatory performance.
- NCC should articulate operators' formal responsibilities for accuracy, completeness and timeliness, including the expectation that submitted datasets reflect due diligence and can be audited if inconsistencies arise.
- To support compliance, NCC may develop operational guidance that explains procedures, timelines and supporting materials. These documents would complement the regulatory requirements but not replace them, and they may be updated independently of formal regulatory decisions.

Justification

International experience shows that broadband mapping frameworks are most effective when anchored in clear regulatory obligations. Regulators such as Ofcom (UK) and BNetzA (Germany) explicitly link broadband reporting requirements to licensing conditions, which ensures predictable data flows and strengthens data quality. Adopting similar regulatory clarity in Nigeria will enhance compliance, reduce uncertainty for operators, and reinforce NCC's role as the authoritative custodian of broadband infrastructure data.

Recommendation: Formalizing and Enhancing Institutional Cooperation Mechanisms Across Key National Stakeholders

Effective broadband mapping depends on predictable access to reference datasets held by multiple public institutions. However, cooperation between NCC and key national stakeholders-such as NPC, NIPOST, OSGOF, REA, NBS, Galaxy Backbone and relevant sector ministries-is currently based on ad-hoc arrangements, which limits data completeness, continuity and the alignment of national planning activities. It is therefore recommended that NCC strengthen the policy and regulatory framework for inter-institutional cooperation to ensure stable, repeatable and well-defined data-sharing practices.

Key Actions:

- NCC should formalize cooperation with relevant public institutions through Memoranda of Understanding or similar instruments that set out roles, responsibilities, access rights, data-sharing conditions and expected reporting cycles.
- NCC is encouraged to establish policy expectations that reference datasets-such as population and building data, addressing information, geospatial baselines, energy infrastructure and public-facility registers-should be made available in a consistent and structured manner, aligned with the national broadband mapping framework.

- NCC should reference inter-institutional cooperation requirements within its regulatory guidance, ensuring that collaboration becomes a predictable component of broadband governance, rather than a project-based initiative.
- Operational elements of cooperation-such as technical alignment, working groups and data integration activities-can be implemented through internal procedures or capacity-building initiatives, but should be grounded in the broader policy commitment to structured data exchange.

Justification

International broadband-mapping frameworks consistently demonstrate that successful national systems require stable cooperation between telecom regulators and public bodies that maintain authoritative datasets. Countries such as Sweden, Germany and Poland have established formal cooperation mechanisms that govern the exchange of address registries, geospatial data, socio-economic indicators and infrastructure records. Strengthening institutional cooperation in Nigeria will reduce data silos, improve data completeness and support coherent national infrastructure planning.

Recommendation: Implementing a Tiered Data Security, Confidentiality, and Access Management Framework Aligned with National Regulations

Given the sensitivity of broadband infrastructure datasets-particularly the detailed information on fiber routes, base stations and network capacity-it is recommended that NCC strengthen its policy framework for data confidentiality and access management. The current approach does not provide differentiated access levels, which increases security and compliance risks and limits the safe and appropriate use of data by various stakeholder groups.

Key Actions:

- NCC should introduce a tiered access policy that distinguishes between:
  • *public, aggregated outputs* suitable for transparency and general communication;
  • *institutional access* for government agencies involved in planning and service delivery;
  • *restricted access* to sensitive infrastructure datasets, available only to NCC and specifically authorised bodies.
- NCC should ensure that the overall policy framework governing broadband infrastructure data is fully aligned with the Nigeria Data Protection Act (2023) and the Cybercrimes Act (2024), including expectations regarding confidentiality, purpose limitation and secure handling of sensitive information.
- NCC may develop supplementary implementation guidance describing how data-protection principles are operationalised within the broadband mapping system. These materials would support consistent practice across stakeholders while allowing the regulatory framework to remain concise.

Justification

Broadband infrastructure data can have implications for national security and critical infrastructure protection if not managed appropriately. Mature regulatory regimes in the EU, UK and USA apply structured access models to balance transparency with the need to protect sensitive network information. Introducing a similar policy framework in Nigeria would enhance trust, support informed policymaking and provide clear safeguards for the management of sensitive broadband data.

7.2. Institutional Capacity Recommendations

Capacity building is a fundamental requirement for the successful implementation of broadband mapping in Nigeria. Strengthening the technical, institutional, and operational capacities of all stakeholders involved is essential to ensure the effective collection, analysis, and management of broadband data. This, in turn, supports evidence-based policymaking, infrastructure planning, and the achievement of Nigeria's broadband penetration targets.

Based on an in-depth analysis of current practices, international best practices, and feedback from stakeholders, this chapter outlines a set of recommendations aimed at addressing capacity gaps, fostering collaboration, and positioning Nigeria as a leader in broadband mapping. These recommendations include the establishment of a dedicated broadband mapping team, capacity-building programs for external stakeholders, certification initiatives, and knowledge sharing through conferences and mentorship programs.

Recommendation: Establishing a Dedicated Broadband Mapping Team within the Nigerian Communications Commission

A dedicated broadband mapping team is critical to the success of broadband mapping initiatives in Nigeria. After evaluating the current structure and capacity of the Nigerian Communications Commission, two potential options for the establishment of such a team have been identified. These options consider the practical challenges of resource constraints, expertise gaps, and the need for efficient coordination within the organization.

The first option is to establish an interdisciplinary internal team within the NCC, comprising experts from various departments such as data analytics, GIS, telecommunications infrastructure, policy, and regulation. This team would operate as a cross-functional project group, with a designated Project Manager responsible for coordinating its activities. Such a structure would allow the NCC to leverage its existing resources and expertise while promoting collaboration among departments. To ensure alignment with technical goals and efficient decision-making, the team could report directly to the Executive Commissioner for Technical Services or to some other technical Director if the team is structured as a unit with relevant expertise covering both fixed and wireless broadband mapping. This approach offers flexibility in resource allocation and encourages innovation through cross-functional cooperation. However, it is important to ensure that team members can balance their primary departmental responsibilities with their commitments to broadband mapping.

The second option is to establish a dedicated Broadband Mapping Department within the NCC. This department would consist of a director and a permanent team with specialized expertise in GIS, data analytics, and telecommunications infrastructure. This centralized structure would provide a clear and focused mandate for broadband mapping, ensuring continuity and the development of institutional memory. It would also facilitate the growth of specialized expertise and knowledge within the NCC. However, this option requires significant investment in resources and training to address current expertise gaps, making it a more viable long-term goal.

Both options offer distinct advantages and challenges, and the choice between them should be guided by a detailed assessment of the NCC's current capacity and strategic priorities. Drawing from international examples, countries such as Poland, Germany, and the United Kingdom have successfully implemented dedicated broadband mapping teams within their regulatory agencies, demonstrating the benefits of centralized oversight, high-quality data collection, and effective stakeholder collaboration. For instance, Germany's Federal Network Agency (BNetzA) and the UK's Ofcom have established specialized teams that work closely

with local governments and ISPs to produce reliable broadband maps that support national connectivity goals.

Recommendation: Developing and Implementing a Capacity-Building Program for External Stakeholders

A comprehensive capacity-building program is necessary to equip external stakeholders with the skills and tools required for effective broadband mapping. These stakeholders include telecom operators, public utility entities, local governments, academia, GIS specialists, planners, and IT staff. The program should address identified skills gaps and align stakeholders with the technical and operational standards necessary for broadband mapping.

A thorough needs assessment should be conducted to identify specific areas where stakeholders require support. Training programs should then be developed to cover key areas such as GIS and spatial data modelling, metadata management and documentation standards, API development and integration, data protection and privacy techniques, and coverage modelling best practices. The program should also include the distribution of standardized templates and guidelines to ensure consistency and accuracy in data collection and integration.

To ensure the effectiveness and sustainability of the program, it is recommended that the NCC leverage the Digital Bridge Institute (DBI) as the primary platform for delivering training. The DBI has the capacity to host training sessions, issue certifications, and charge fees for participation, which could help offset costs. Workshops, webinars, and knowledge-sharing sessions should be organized to foster collaboration and alignment among stakeholders, with a particular focus on tailoring the training to the local context. This approach ensures that the specific needs of Nigerian stakeholders are addressed, as international programs such as ITU Academy may not always be fully applicable.

Additionally, it is essential to build the capacity of NCC staff to enhance their ability to deliver high-quality workshops and scale up capacity-building efforts. This will enable the NCC to expand its training programs to include a broader range of stakeholders, such as government agencies, academia, and smaller operators.

Recommendation: Developing a Certification Program for Broadband Mapping Professionals

A certification program for broadband mapping professionals would provide a standardized framework for ensuring the competence and expertise of individuals involved in broadband mapping projects. Such a program would enhance the credibility of broadband mapping efforts, while also positioning Nigeria as a regional leader in this field.

The certification program should be developed in partnership with academic institutions and international organizations to ensure alignment with global best practices. Key areas of focus should include GIS and spatial data analysis, metadata management, API design and integration, and data protection and privacy techniques. The program could be implemented through the Digital Bridge Institute (DBI). NCC professionals could act as co-facilitators, ensuring the program's technical credibility. During training sessions, less experienced stakeholders can be paired with more experienced ones to facilitate knowledge transfer and practical learning. These temporary pairings would focus on specific training contexts, ensuring that the mentorship process remains manageable and effective. This approach would foster collaboration and strengthen the overall broadband mapping ecosystem while minimizing the administrative burden on the NCC.

Providing incentives for operators and agencies to have their staff certified would encourage participation. For example, certified professionals could be highlighted in NCC reports as meeting the highest standards of expertise and competence, reinforcing their credibility in the

field. The certification criteria should be regularly updated to reflect technological advancements and evolving industry standards, ensuring that certified professionals remain at the forefront of broadband mapping expertise.

Recommendation: Organizing Broadband Mapping Conferences and Knowledge Exchange Programs

To promote knowledge sharing, collaboration, and capacity building, it is recommended that the NCC organize or actively participate in broadband mapping conferences. These events would serve as valuable platforms to bring together stakeholders, experts, and policymakers to discuss the latest developments, challenges, and opportunities in broadband mapping. Conferences could include expert panels, workshops, and discussions on relevant technical and operational topics.

Participating in or organizing broadband mapping conferences would also provide an opportunity to showcase progress and results, highlight the impact of broadband mapping initiatives on stakeholders, government, and citizens, and foster collaboration by sharing best practices with other stakeholders. These events would allow the NCC to demonstrate its leadership in broadband mapping while facilitating the exchange of ideas and solutions across different sectors and regions.

Leveraging existing conferences in Nigeria and West Africa, such as telecom and GIS events, would provide cost-effective opportunities to raise awareness about broadband mapping and its benefits. Collaborating with conference organizers to dedicate sessions or days to broadband mapping would further enhance the visibility and impact of these initiatives. Additionally, inviting representatives from other African countries with experience in broadband mapping, would facilitate valuable knowledge exchange and foster regional collaboration.

Post-conference resources, including workshop materials, templates, and guidelines, should be made available online to ensure that the knowledge shared during the event is accessible to a wider audience.

7.3. Data governance and interoperability

To ensure that Nigeria's national broadband mapping system is credible, trusted, secure and sustainable, it is recommended that the Nigerian Communications Commission (NCC) establish and operationalise a National Broadband Data Governance and Interoperability Framework. This framework should define how broadband mapping data is collected, validated, exchanged, protected, published, version-controlled and continuously improved across: (i) telecommunications operators and infrastructure providers, including tower companies and fibre infrastructure providers; and (ii) public institutions that hold authoritative reference datasets or use mapping outputs for planning and public investment, including the Federal Ministry of Communications, Innovation and Digital Economy, the Office of the Surveyor-General of the Federation (OSGOF), Galaxy Backbone, the NPC, the NBS, the REA, the Federal Ministry of Power, the Federal Ministry of Works, the Federal Ministry of Budget and Economic Planning, the Federal Ministry of Education, the Federal Ministry of Health and Social Welfare, the Nigerian Postal Service (NIPOST), and the Nigeria Data Protection Commission (NDPC).

Governance model and institutional responsibilities

Recommendation: Formalise one of the following two implementable governance arrangements.

Option 1: NCC-centric governance model (central custodian with designated dataset stewards)

NCC serves as the central custodian of the national broadband mapping platform and formally appoints internal Dataset Stewards for each dataset family (fixed availability, mobile availability, fibre routes, towers, quality indicators, anchor institutions, and demographic/electrification overlays).

Advantages:

- Single, authoritative governance locus and clear accountability.
- Faster implementation and stronger oversight of reporting compliance.
- Simplified confidentiality management, access control, auditability and publication decisions.
- Clear responsibility for corrective actions when validation identifies discrepancies.

Option 2: Federated governance model (multi-institution governance council with NCC as technical operator)

A National Broadband Data Governance Council is established comprising NCC, the Federal Ministry of Communications, Innovation and Digital Economy, OSGOF (and relevant national geospatial coordination mechanisms), NDPC, Galaxy Backbone, and other designated institutions holding authoritative reference datasets, including NPC, NBS, REA, and the relevant sector ministries responsible for anchor-institution registers (education and health). NCC remains the technical operator, while authoritative national reference datasets are governed jointly.

Advantages:

- Stronger institutional ownership and reduced data silos.
- Sustainable access to authoritative reference datasets (boundaries, geodetic reference, population and sector registers).
- Reduced disputes related to boundary alignment, geocoding practices and reference baselines.
- Governance continuity beyond a single project cycle.

Standardised technical specifications and metadata requirements

Recommendation: NCC should issue and maintain standardised technical specifications applicable to all data contributors, including:

- Standard data models and reporting templates for each dataset family, including infrastructure vector layers and service availability/coverage layers (with fixed wireless and satellite availability/coverage included where relevant).
- A national data dictionary defining key terms and classification rules (e.g., covered/served/available; technology categories; speed tiers; and object definitions such as “site/tower/node/route”).

- A mandatory metadata profile (data owner, timestamp, method, accuracy indicator, update frequency, coordinate reference system/resolution, and confidentiality classification).
- Version control requirements for schemas and templates, including change logs and retention rules to ensure reproducibility for audits and policy processes.

Data lifecycle governance and formal release management

Recommendation: NCC should institutionalise end-to-end data lifecycle governance, with auditable controls from submission to publication:

Submission → Ingestion → Validation → Correction → Approval → Publication → Archiving

Minimum operational controls should include:

- A formal baseline release calendar (e.g., quarterly national baseline releases) so outputs become official, traceable and reproducible.
- Audit trail requirements (access logs, dataset change histories and evidence repositories for disputed areas).
- Retention and archiving rules so historic baselines remain available for programme evaluation, dispute resolution and policy audits.
- Defined escalation procedures for non-compliance (late submission, repeated quality failures and refusal to correct).

Deliverables:

- A Data Governance Manual describing workflows, responsibilities and escalation procedures.
- Release documentation for each baseline update (scope of changes, rationale and data quality notes).

Staged granularity strategy aligned with national reference-data readiness

Recommendation: Adopt a staged approach that is operationally feasible nationwide while preserving a defined pathway to higher granularity as reference datasets mature:

- Infrastructure engineering layers (fibre routes, towers, points of presence, landing stations) should remain vector-based (point/line features) to preserve operational planning value.
- Service availability and coverage layers should use a nationally implementable harmonised reporting unit (such as grid- or area-based reporting) for baseline completeness, with conditions defined for increasing resolution in areas where authoritative reference datasets support it.
- The staged approach should explicitly document the conditions under which higher granularity is adopted (e.g., validated national reference addressing coverage, stable location identifiers, and consistent geocoding quality), thereby enabling a clear migration path without delaying initial implementation.

Multi-layer validation, assurance and challenge-and-correction procedures

Recommendation: NCC should operationalise a repeatable validation and assurance pipeline that mitigates self-reporting bias and improves confidence in published outputs:

- Automated schema and completeness checks at ingestion (mandatory fields, coordinate validity, geometry integrity, naming conventions).

- Logic and topology plausibility checks (outliers, internal contradictions and cross-layer consistency).
- Independent evidence overlays, including NCC monitoring and drive tests, and anonymised measurement datasets where agreed.
- A formal challenge-and-correction mechanism with evidence requirements, decision rules, timelines and versioned outcomes.

NCC should define minimum quality indicators (timeliness, completeness, spatial consistency and median time-to-correction) and include aggregate compliance statistics in baseline release documentation.

Interoperability standards and cross-institutional exchange arrangements

Recommendation: Interoperability between datasets and systems requires the use of common technical standards to ensure consistent data exchange across institution

Key elements should include:

- Adoption of the national data dictionary and metadata profile by all contributors.
- Implementation of standard geospatial service interfaces (for example, WMS/WFS and/or OGC API standards) to enable cross-platform consumption across NCC systems, state GIS environments and relevant federal institutions.
- Stable identifiers for infrastructure objects and consistent coordinate reference system and boundary alignment rules, anchored in authoritative national geospatial baselines provided by OSGOF.

International best practices and relevance for Nigeria

Germany (Bundesnetzagentur): Demonstrates tiered disclosure through publishable raster/aggregate outputs complemented by restricted analytical capabilities for authorised users, enabling both transparency and policy-grade analysis.

Relevance for Nigeria:

Implement tiered disclosure with enforceable reporting routines and structured access controls.

United Kingdom (Ofcom): Demonstrates that address/building-level mapping requires an authoritative national premises/location reference dataset and robust matching and exception-handling rules.

Relevance for Nigeria:

plan for staged migration to higher granularity by aligning with national reference datasets and defining matching rules, while adopting a feasible national baseline immediately.

Croatia (HAKOM): Demonstrates institutionalised periodic data collection, explicit linkage of mapping outputs to intervention logic for public support, interoperability sharing to local authorities through standard services, and strengthened credibility through independent measurement tools used in validation and dispute resolution.

Relevance for Nigeria:

Institutionalise mapping as a recurring national routine, link outputs to intervention logic, enable interoperable sharing with states and public institutions, and strengthen validation through independent evidence.

Implementation roadmap

0-6 months

- Confirm governance model (Option 1 or Option 2), including roles, custodianship arrangements, decision rights and tiered access responsibilities.
- Publish Version 1.0 of the technical specifications (data models/templates, data dictionary, metadata profile, confidentiality classification and version-control rules).
- Define Validation Rules Version 1.0 (automated checks, plausibility checks, minimum quality indicators, correction workflow, and challenge process design).
- Agree and document confidentiality classification and publication rules for public and institutional outputs.

6-12 months

- Deploy the secure submission portal for smaller providers and implement API-based submissions for mature providers (API-first approach for major operators and infrastructure providers).
- Operationalise the validation pipeline (automated ingestion checks, plausibility checks, and agreed evidence overlays).
- Publish the first versioned national baseline outputs (public tier) and restricted institutional views for authorised users.
- Formalise inter-agency exchange arrangements through MoUs and data-sharing protocols for priority reference datasets.

12-24 months

- Expand and operationalise contextual layers (population, anchor institutions, electrification and other agreed layers) and integrate them into prioritisation analytics.
- Mature inter-agency integration (more systematic synchronisation, standard services, improved metadata completeness and consistent identifiers).
- Harden security controls and audit trails in line with NDPA requirements and CNII-related expectations where designated (access review, export controls, incident readiness).
- Refine methodologies based on challenge outcomes, verification evidence and the technical working group's iterative updates.

Monitoring indicators

To measure effectiveness and continuous improvement, NCC should monitor:

- Timeliness of reporting submissions.
- Percentage of submissions passing schema checks on first submission.
- Discrepancy rates between reported coverage and independent evidence overlays (sampled).
- Median time-to-correction for flagged issues.
- Adherence to the baseline release calendar (planned versus actual releases).
- Adoption of interoperability interfaces by federal institutions and state-level planning bodies (usage statistics).
- Volume and resolution rate of challenges within agreed service levels.

8. Risk Analysis and Mitigation Strategies

The development of a national broadband mapping system is a complex, multi-stakeholder process which on top of policy framework highly that depends on coordinated data flows, institutional readiness, and technical robustness. In the early phases of implementation, several risks may affect progress, data quality or stakeholder engagement. While most risks can be anticipated and managed proactively, they require continuous monitoring and clear mitigation strategies.

8.1. Institutional and Coordination Risks

Risk: Delays due to slow decision-making process, limited availability and responsiveness of key institutions, or unclear responsibilities during the start-up phase.

Mitigation:

- Maintain active monthly Technical Working Group/Data Working Group meetings and quarterly Project Steering Committee oversight.
- Establish a clear escalation mechanism (Technical Working Group → Project Steering Committee) for resolving bottlenecks quickly.

8.2. Data Submission and Data Quality Risks

Risk: Operators or utilities may submit incomplete, delayed, or inconsistent datasets, particularly before templates and processes are fully internalised.

Mitigation:

- Start with simplified templates and gradually increase detail (define transition period).
- Provide an extended explanation and clear instructions on reporting, including random examples of specific cases to report.
- Provide targeted training sessions and walkthroughs on data preparation.
- Implement a lightweight QA/QC feedback loop during the early cycles to build trust and common understanding.

8.3. Technical Capacity and System Readiness Risks

Risk: Limited in-house GIS or IT capacity may slow platform setup, validation or integration.
Mitigation:

- Adopt the “learning by doing” approach with ITU support.
- Use a phased platform deployment (test → pilot → production).
- Assign dedicated technical focal points within NCC
- Provide targeted training sessions for GIS and IT staff.
- Develop clear technical documentation and Standard Operating Procedures for platform operation and maintenance.
- Engage external technical experts or short-term consultants during critical setup and integration phases.

8.4. Legal and Governance Risks

Risk: Absence of formalised data-sharing agreements or unclear confidentiality requirements may discourage full participation.

Mitigation:

- Use interim MoUs and Data-Sharing Agreements while broader frameworks are finalised.
- Prioritise early agreement on sensitive vs. public data.
- Engage legal officers within ministries and NCC to accelerate drafting.

8.5. Stakeholder Engagement Risks

Risk: Some stakeholders may perceive the process as burdensome or unclear, leading to reduced cooperation.

Mitigation:

- Communicate regularly and clearly via NCC's Secretariat.
- Highlight mutual benefits (reduced duplication, better planning, improved service rollout).
- Recognise and incorporate stakeholder feedback into platform features.

8.6. Sustainability and Resource Risks

Risk: Lack of long-term funding or staff turnover could affect continuity after initial implementation.

Mitigation:

- Secure a dedicated budget line within NCC and Federal Ministry of Communications, Innovation and Digital Economy.
- Ensure knowledge transfer through extensive documentation and cross-training.
- Integrate mapping responsibilities into permanent job descriptions where relevant

8.7. Political or Strategic Alignment Risks

Risk: Shifts in national priorities, or misalignment across ministries, may impact continuity.
Mitigation:

- Embed broadband mapping within national strategies (National Digital Economy Policy and Strategy, National Broadband Plan, National Development Plan, digital policies).
- Ensure high-level representation of the Nigerian Communications Commission at the Permanent Secretary level or equivalent in cross-ministerial forums, such as the Federal Executive Council and the National Economic Council (NEC). This representation will strengthen collaboration, policy alignment, and decision-making for broadband development, ensuring that broadband priorities are integrated into national strategies and supported by relevant ministries
- Popularize the positive impacts of mapping among the wider public and especially to the key stakeholders.

8.8. Overall Assessment

None of the identified risks are prohibitive. With structured governance, consistent communication and phased implementation, these risks can be effectively managed. The roadmap, combined with regular monitoring and early stakeholder engagement, provides a strong foundation for mitigating disruptions and ensuring that the system matures into a stable, trusted national asset.

9. Funding and Resource Mobilization

Establishing a national broadband mapping system is not a one-time technical project but a sustained public function that requires predictable funding, dedicated human resources, and long-term institutional commitment. Experience from other jurisdictions, including a specific Polish and Croatian cases, shows that the sustainability of a mapping system depends far less on the choice of software and far more on whether the NRA has stable financial and human capacity to operate, update, validate and publicly disseminate geospatial broadband data. For Nigeria, where NCC has been confirmed as the custodian of the system, this chapter outlines the funding needs, trade-offs, and strategic considerations required to secure long-term operational continuity.

9.1. Understanding the True Cost of Broadband Mapping

A recurring issue in broadband mapping initiatives globally is the perception that the technology itself is the main cost. There is no “free lunch” in GIS. Whether the system is proprietary or open-source, governments incur costs for hardware, staff, validation activities, stakeholder coordination, data governance, cybersecurity, change management, and continuous system evolution. The sustainability challenge emerges not at launch, but two to three years later, when data updates slow down because staff have changed, budgets are reallocated, or platforms are not maintained.

For Nigeria, given the current capacity assessment of the NCC-such as the limited number of GIS specialists, the need for expanded storage, enhanced monitoring equipment, and structured data governance-funding should be treated as a permanent budgetary line item rather than a one-off, project-based expenditure. This approach ensures sustained investment in critical resources and infrastructure, enabling the NCC to address ongoing operational needs and maintain effective broadband mapping and management systems.

9.2. CAPEX Requirements: Proprietary vs. Open-Source Pathways

During the national event, stakeholders recommended adopting ArcGIS Enterprise as the core platform due to its widespread familiarity within Nigeria, proven reliability, robust security features, seamless interoperability with existing government systems, and access to well-established support networks. This choice provides a clear and predictable CAPEX profile.

If Nigeria adopts a proprietary solution (ArcGIS Enterprise):

- A dedicated budget line for software licensing, upgrades, and support contracts is essential. This includes:
  - Enterprise software licenses (server and user types),
  - Annual maintenance and technical support,
  - Additional storage, memory, and monitoring hardware,
  - Occasional specialized consultancy (e.g. architecture optimization, integration with validation tools).
- This CAPEX must be predictable in the national NCC budget and ideally linked to a multi-year procurement framework to avoid system downtime or delays.

If Nigeria opts for an open-source stack (e.g. QGIS, GeoServer, PostGIS):

The CAPEX for software acquisition will be minimal or even negligible. However, this does not necessarily mean the overall system will be cheaper. Instead, the cost shifts from licensing CAPEX to OPEX for human resources. This is because:

- Open-source systems require continuous in-house development and maintenance.
- Updates, bug fixes, and integrations must be managed internally, without vendor support.
- Staff turnover poses a significant risk, as specialized skills cannot simply be acquired through external support contracts.
- Advanced expertise is needed for tasks such as security hardening, API development, and system scaling.

While open-source GIS solutions can potentially be more cost-effective in the long term, this is only achievable if the regulatory authority has stable, long-term staff with the necessary expertise, and if the institution is willing to make substantial investments in capacity building. Without these conditions, the system is likely to deteriorate over time, resulting in inefficiencies and higher costs in the future.

9.3. OPEX Requirements: The Unavoidable Constant

In both scenarios-whether adopting a proprietary or open-source solution-operational costs are the dominant expense. These costs primarily revolve around maintaining and supporting the system, particularly through skilled human resources. Key roles include:

- Human Resources,
- GIS system administrator,
- Data engineer / database specialist,
- Policy and data governance officer,
- Legal officer for data-sharing agreements,
- Field validation coordinators,
- Analysts supporting publication, quality checks, and dashboards.

All international case studies, including Poland and Croatia, show that human resources are the largest determinant of success.

Data Collection and Validation

Costs include:

- Field surveys (vehicles, devices, software, staff time),
- Crowdsourcing tools (maintenance of data pipelines),
- Quarterly updates from operators and utilities,
- Quality-of-service testing equipment,
- Independent audits for data accuracy,
- Governance and Coordination,
- Working group meetings (Project Steering Committee, Technical Working Group),
- Workshops with operators and public-sector institutions,
- Maintenance of MoUs and future stakeholder agreements,
- System Operation,
- Hosting costs (whether at NCC or at a national data center),
- Cybersecurity and backup infrastructure,
- API maintenance for automated data submissions.

Trouble-ticketing, monitoring, and logging systems

These OPEX costs are inescapable, regardless of software choice.

10. Sustainability and Long-Term Vision

Ensuring the sustainability of Nigeria's national broadband mapping system requires a comprehensive long-term vision that integrates technical resilience, institutional stability, regulatory clarity, and continuous capacity development. A broadband mapping system is not a one-off technical project but an evolving national asset that must remain accurate, reliable, and operational for decades. As digital infrastructure becomes increasingly critical to Nigeria's economic growth, public service delivery, social inclusion, and national security, the broadband mapping system will be a cornerstone for strategic planning, policy implementation, and investment decisions. The long-term vision must position broadband mapping as a core pillar of Nigeria's digital governance framework, aligned with the NBP 2020-2025, the National Digital Economy Policy and Strategy (NDEPS) 2020-2030, and the National Development Plan (NDP) 2021-2025, while remaining adaptable to future technological and policy advancements.

10.1 Technical Sustainability

Achieving technical sustainability in Nigeria's broadband mapping system requires a robust, secure, and scalable geospatial platform. The adoption of an enterprise-grade solution such as ArcGIS Enterprise-as recommended by stakeholders-will ensure a reliable, scalable, and interoperable environment capable of integrating new datasets, handling larger data volumes, and supporting advanced analytics in the future.

Long-term technical sustainability will depend on:

- Establishing systematic data collection and validation mechanisms, including automated reporting, API-based data integration, regular audits, and harmonized data standards.
- Developing resilient data storage solutions with redundancy, regular backups, and disaster recovery protocols to ensure business continuity in the event of technical disruptions.
- Ensuring the platform's compatibility with other government systems to support cross-sector data sharing and integration.

NCC must take the lead in hosting, maintaining, and continuously enhancing the broadband mapping system. This includes assigning clear operational responsibilities within the Commission, as outlined in previous chapters, to ensure the system remains up-to-date and functional.

10.2 Institutional Sustainability

Institutional stability is essential for the long-term success of Nigeria's broadband mapping system. To ensure its effectiveness, the country must establish governance structures that endure beyond changes in leadership or shifting institutional priorities. A Broadband Mapping Steering Committee, chaired at the Permanent Secretary level within the FMCDE, should be established to oversee the system's governance. This committee should include representatives from key ministries and agencies, such as:

- Ministry of Finance, Budget, and National Planning
- Ministry of Power
- Ministry of Works and Housing
- Ministry of Education

- Ministry of Health
- Ministry of Agriculture and Rural Development

This body would serve as a permanent cross-sector coordination mechanism, responsible for oversight of data governance, stakeholder compliance, and long-term strategic direction. Embedding broadband mapping responsibilities into the institutional mandates, job descriptions, and budget cycles of the NCC and other relevant agencies will ensure continuity and reduce dependency on individual champions or temporary project teams.

10.3 Regulatory Sustainability

Regulatory sustainability is another critical pillar for the long-term success of Nigeria's broadband mapping system. The NCC already has the authority to collect and publish infrastructure data under the Nigerian Communications Act (2003). However, the regulatory framework must be strengthened to ensure the longevity of the system. This can be achieved by:

- Establishing clear obligations for data submission by operators, utilities, and other stakeholders.
- Defining standardized reporting formats and update cycles for data collection.
- Developing a National Data-Sharing Framework and Data Classification Policy to provide clear guidelines for managing sensitive, commercial, and public datasets.
- Enforcing compliance through penalties for non-compliance with data submission requirements.

In the long term, broadband mapping requirements could be integrated into sectoral policies, including urban planning, energy infrastructure, transportation, education, and emergency response systems. This integration would transform the broadband mapping platform into a strategic national planning tool used by multiple ministries and agencies to optimize infrastructure deployment and public investment.

10.4 Human Capacity Development

Human capacity is the cornerstone of a sustainable broadband mapping system. For Nigeria, building and retaining a skilled workforce in GIS, data management, and broadband technologies is essential. The NCC and other relevant institutions should adopt a continuous professional development program that includes training in:

- GIS analysis and geospatial data management.
- Data validation and geostatistical modelling.
- Cybersecurity and data protection.
- Broadband technology trends and system scaling.

Collaboration with universities, technical institutes, and regional organizations (such as the WATRA) can help establish a pipeline of skilled professionals to support the system in the long term. Capacity building efforts should extend beyond the NCC to include operators, public agencies, and municipal planners, ensuring all stakeholders understand data standards, quality expectations, and how to use the mapping platform effectively.

10.5 Financial Sustainability

Financial sustainability is critical to the long-term operation of Nigeria's broadband mapping system. While initial development may be supported by international organizations such as the ITU or World Bank, long-term funding must come from stable national sources. Nigeria could adopt a mixed funding model that includes:

- Government appropriations within the national budget.
- Regulatory fees collected by the NCC.
- Integration with the Universal Service Provision Fund (USPF) for rural connectivity.
- Cost-sharing arrangements with operators, utilities, and other stakeholders.

A comprehensive financial plan should cover ongoing costs such as hosting infrastructure, software licenses, system upgrades, staff training, security enhancements, and periodic external audits.

10.6 Long-Term Vision

The long-term vision for Nigeria's broadband mapping system is to establish it as a strategic national asset, capable of expanding in scope and sophistication as the country's digital ecosystem evolves. Future iterations of the platform could include:

- Predictive analytics for investment planning.
- Artificial intelligence for anomaly detection and data insights.
- 3D visualization for urban and infrastructure planning.
- Integration with environmental monitoring, transport, and energy systems.
- Support for emerging technologies like 5G densification modelling, fibre route optimization, and satellite broadband integration.

By positioning the broadband mapping system as a central component of Nigeria's digital governance ecosystem, the country can ensure it remains a valuable tool for government, operators, and the broader economy.

10.7 Regional and International Collaboration

Nigeria's broadband mapping system can also play a leadership role within the region. By contributing to harmonized approaches in WATRA and the Economic Community of West African States , Nigeria can support cross-border coordination for infrastructure development, data comparability, and disaster recovery. Establishing Nigeria as a regional centre of excellence for broadband mapping would enhance its standing in Africa's digital transformation initiatives and reinforce the sustainability of the system through international collaboration.

Sustainability summary

Sustainability requires viewing broadband mapping not as a standalone IT tool, but as an evolving component of Nigeria's digital governance framework. Through strong institutions, clear regulations, robust technology, skilled personnel, and committed long-term investment, the broadband mapping system will continue to generate value for the government, operators, and citizens for many years to come.

11. Conclusion

This policy report presents a comprehensive framework for establishing a sustainable, credible, and fully institutionalised national broadband mapping system for Nigeria under the Africa-BB-Maps initiative. The analysis confirms that Nigeria already possesses many of the key prerequisites for success: a strong and capable regulatory authority in the NCC, a growing footprint of fixed and mobile broadband infrastructure, active engagement from operators and infrastructure providers, and strong political commitment to national digital transformation goals.

A central conclusion of the report is that broadband mapping should not be treated as a one-off technical activity, but rather as a long-term regulatory, planning, and policy instrument. When properly implemented, it becomes a national reference system that strengthens evidence-based policymaking, improves coordination across sectors, helps prevent duplication of infrastructure investments, and enhances transparency for citizens, investors, and public institutions. In this context, NCC's role as the neutral custodian of the mapping system is both appropriate and essential for ensuring trust, consistency, and regulatory credibility.

The report also emphasises that technology alone will not determine success. Whether Nigeria implements an enterprise-grade GIS platform, incorporates open-source tools, or adopts a hybrid approach, long-term sustainability will depend on: clear regulatory mandates, enforceable reporting obligations, predictable funding, well-defined governance structures, strong institutional partnerships, and continuous investment in skills and capacity. It is important to acknowledge that broadband mapping requires long-term operational expenditure-system maintenance, skills retention, and data governance cannot be sustained through one-time project funding.

International experience-including lessons from Slovenia, Croatia, Germany, and the United Kingdom-shows that high-quality broadband maps are enabled by clear legal mandates, standardised reporting, cyclical data collection, and rigorous validation processes. Nigeria is well positioned to adapt these lessons to its own context, leveraging existing regulations while progressively strengthening policy instruments related to data governance, cybersecurity, and critical infrastructure protection.

The phased roadmap developed with stakeholders provides a realistic and achievable pathway from foundational readiness, through platform development and operationalisation, towards long-term institutionalisation and sustainability. If implemented consistently, Nigeria's broadband mapping system can evolve into a strategic national asset, supporting universal service objectives, guiding public and private investment, and reinforcing Nigeria's position as a regional leader in digital infrastructure intelligence.

In conclusion, the Africa-BB-Maps initiative represents an important opportunity for Nigeria to embed broadband mapping as a core component of its regulatory and development architecture. With continued stakeholder commitment, sufficient and predictable resources, and strong leadership from NCC, Nigeria can build a transparent, resilient, and future-ready broadband mapping system that delivers lasting socio-economic benefits for citizens, government, and industry.

The following operational checklist is designed as a practical tool for managing and sustaining the national broadband mapping function. It translates the strategic recommendations of this report into concrete, ongoing actions to support informed decision-making, minimise implementation risks, and transition from project-based delivery to a fully institutionalised national capability.

1. Governance & Institutional Setup

- Formalise NCC's role as system custodian and data steward.
- Establish a high-level Steering Committee (Commissioner/Director level).
- Create a Technical Working Group responsible for day-to-day implementation.
- Clearly define roles: data providers, dataset stewards, validators, publishers.
- Hold regular coordination meetings (monthly/quarterly).

2. Legal & Policy Framework

- Clarify reporting obligations within existing NCC regulatory instruments.
- Develop or support a cross-sector national data-sharing framework.
- Prepare a data classification policy (public / institutional / restricted).
- Use MoUs as interim tools where formal frameworks are not yet in place.
- Align broadband mapping with NDPA and national cybersecurity policies.

3. Technical Platform & Architecture

- Decide and formally approve the GIS platform strategy (enterprise + open-source components where appropriate).
- Ensure adequate hosting, storage, backup, and disaster-recovery capacity.
- Standardise data models, formats, and submission templates.
- Enable API-based and automated data submissions where possible.
- Design the system for long-term scalability rather than current needs alone.

4. Data Collection & Quality Assurance

- Define the mandatory datasets (fibre, towers, coverage, QoS, public institutions, population).
- Set clear reporting obligations and update cycles for all data providers.
- Implement validation mechanisms: automated tests, cross-checks, field verification, independent measurement data.
- Require machine-readable GIS data-not static formats such as PDFs.
- Maintain a documented data lifecycle: submission → validation → correction → publication → archive.

5. Human Capacity & Skills

- Ensure dedicated NCC internal capacity for GIS, data, and telecoms.
- Plan for continuous training and capability development.
- Mitigate reliance on single individuals (knowledge retention risk).
- Use a "learning by doing" approach during system development.
- Budget for external support only where internal capacity cannot be sustained.

6. Funding & Sustainability

- Secure a dedicated budget line for broadband mapping.
- Clearly distinguish CAPEX (initial system setup) and OPEX (ongoing operation, staff, tools, licences).
- Avoid assuming that open-source tools are cost-free.
- Plan for long-term funding beyond donor or project cycles.
- Explore synergies with the Universal Service Fund and infrastructure programmes.

7. Transparency & Public Value

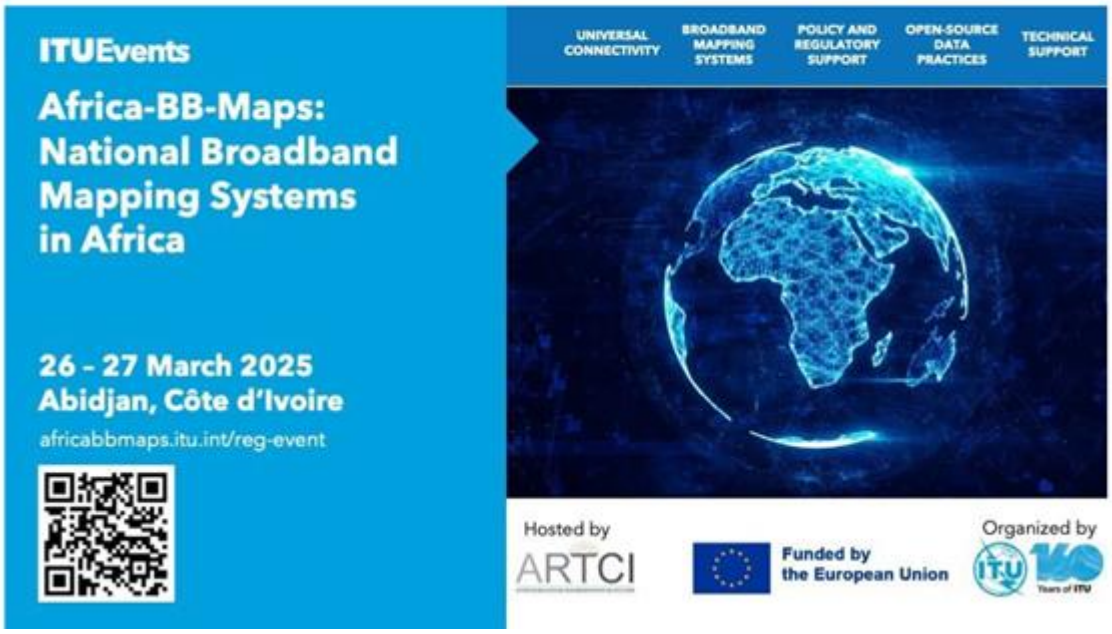
- Define which datasets will be published and how frequently they will be updated.

- Publish maps and indicators in a user-friendly, accessible manner.
- Ensure transparency does not compromise critical infrastructure security.
- Use the mapping system actively in regulatory analysis and planning.
- Communicate the public value and benefits of broadband mapping to stakeholders.

Annexes

Annex 1: Nigeria national questionnaire

AFRICA-BB-MAPS QUESTIONNAIRE



SECTION 1: BROADBAND POLICY AND STRATEGIC PLANNING

1. **Does your country have government initiatives or public policies related to broadband mapping?**
   - ☑ Yes, with a structured plan and budget
   - ☐ Yes, but without a structured implementation plan
   - ☐ No formal broadband mapping strategy exists
   - ☐ Other, please specify:

2. **Which types of broadband technologies are most widely deployed in your country? (Multiple selections possible)**
   - ☑ Fiber optic
   - ☐ Coaxial cable
   - ☑ Wireless networks
   - ☐ Copper pair
   - ☑ Satellite
   - ☐ All of the above

3. **What is the main objective of your broadband expansion strategy?**
   - ☑ Development of mobile broadband (3G/4G/5G)
   - ☐ Expansion of satellite broadband
   - ☑ Extension of fiber optic broadband
   - ☐ Other, please specify:

4. **Does your country have specific broadband penetration targets for the next five years?**
   - ☑ Yes, for both urban and rural areas
   - ☐ Yes, but only for urban areas
   - ☐ No formal broadband penetration targets

5. **Does your country have a broadband mapping system?**
   - ☐ Yes, it is publicly accessible (If yes, please provide the link)
   - ☐ Yes, but it is not publicly accessible
   - ☑ We collect and develop internal maps, but they do not constitute a true broadband mapping system
   - ☐ We collect data only, without mapping
   - ☐ No, and we do not collect any data

6. **Are there policies or incentives to encourage the expansion of mobile and satellite broadband in rural areas?**
   - ☑ Yes, with active government support

- ❑ Some incentives exist, but implementation is weak
- ❑ No policies or incentives

7. **Does your country have a broadband roadmap specifically for underserved communities?**
   - ☑ Yes, with active government support
   - ❑ Some initiatives exist, but implementation is weak
   - ❑ No policy or incentives

8. **Does your agency have a dedicated division responsible for broadband infrastructure and development?**
   - ☑ Yes (If yes, does it include GIS experts? ☐ Yes / ☐ No)
   - ❑ No

9. **How many personnel are part of the legal and policy department?**
   - ❑ More than 15
   - ☑ 5-15
   - ❑ Less than 5

10. **How many employees are part of the network and infrastructure division?**
    - ☑ More than 5
    - ❑ Between 3 and 5
    - ❑ Less than 3

11. **Are there national broadband targets for the next 5 years?**
    - ☑ Yes:
    - ❑ No:

12. **Is broadband mapping integrated into national infrastructure projects?**
    - ❑ Yes:
    - ☑ No:

SECTION 2: BROADBAND INFRASTRUCTURE MAPPING SYSTEMS

13. **Does your country have a national broadband infrastructure mapping system?**
    - ❑ Yes, with regularly updated data and public access
    - ☑ Yes, but it is not regularly updated or fully accessible
    - ❑ No formal broadband infrastructure mapping system exists

14. **If yes, who manages the system?**
    - ☑ National Regulatory Authority (NRA)
    - ☐ Ministry responsible for ICT
    - ☐ Other, please specify:

15. **Which infrastructure or coverage data are included in broadband mapping efforts? (Multiple selections possible)**
    - ☑ Backbone networks and fiber backhaul
    - ☑ Mobile broadband towers (3G, 4G, 5G)
    - ☑ Satellite broadband coverage areas
    - ☐ Fixed broadband access networks (DSL, FTTH, Cable)
    - ☐ Power and energy infrastructure related to broadband (backup power, grid connections)
    - ☐ None of the above – no infrastructure data is mapped
    - ☐ Other, please specify:

16. **How are broadband infrastructure mapping data collected? (Multiple selections possible)**
    - ☑ Data provided by ISPs and telecom operators
    - ☑ Field surveys conducted by the government
    - ☑ Validation by independent third parties
    - ☑ Crowdsourced user reports and participatory data
    - ☐ No structured data collection on broadband infrastructure

17. **Is broadband infrastructure mapping integrated with other national infrastructure planning systems?**
    - ☐ Yes, broadband mapping is integrated with national transport, energy, and urban planning initiatives
    - ☐ Some level of integration exists, but it is not fully structured
    - ☑ Broadband infrastructure mapping is isolated from other national planning efforts

SECTION 3: BROADBAND SERVICE MAPPING AND REGULATORY MONITORING

18. **Does your agency collect broadband coverage data?**
    - ☑ Yes, regularly and systematically
    - ☐ Occasionally, but not systematically
    - ☐ No broadband coverage data is collected

19. **How is broadband coverage data collected? (Multiple selections possible)**
    - ☑ Self-reported by Internet Service Providers (ISPs)

- ❑ Government-led surveys
- ☑ Crowdsourced user data (speed tests, complaints, etc.)
- ☑ Field audits and independent verification

20. Are ISPs legally required to submit broadband coverage and Quality of Service (QoS) data?

- ☑ Yes, with strict enforcement and penalties for non-compliance
- ❑ Yes, but enforcement is weak
- ❑ No legal obligation

21. Does your country publish broadband coverage data for public consultation?

- ❑ Yes, fully open and accessible (If yes, please provide the link)
- ❑ Limited access for stakeholders only
- ☑ No public access to broadband data

22. Is there a national or regional framework to coordinate cross-border data collection and broadband mapping standards?

- ❑ Yes, a robust framework is in place
- ☑ Partial cooperation, but no structured framework
- ❑ No framework exists

23. Are there formal sanctions or incentives to ensure compliance with broadband data submission?

- ☑ Yes, with clear penalties and/or incentives
- ❑ Some measures exist, but they are rarely enforced
- ❑ No enforcement mechanism

SECTION 4: DATA COLLECTION, VERIFICATION, AND ACCURACY (For countries with a broadband mapping system only)

24. What methods are used to collect broadband coverage data? (Multiple selections possible)

- ☑ ISP reports
- ☑ Crowdsourced data
- ❑ Automated real-time data validation tools
- ☑ Independent field surveys
- ❑ Government-led audits

25. Does your broadband mapping system follow standardized GIS protocols (e.g., ITU recommendations)?

- ❑ Yes, fully standardized

- ☑ Partially standardized
- ☐ No standardization

26. How frequently are broadband coverage maps or datasets updated and verified?

- ☐ Continuously / in real-time
- ☑ Quarterly or more frequently
- ☐ Annually
- ☐ Ad hoc updates

27. Does your broadband mapping system systematically integrate user-reported issues and network complaints?

- ☐ Yes, with automated verification and real-time updates
- ☐ Yes, but user reports are manually verified and rarely updated
- ☑ No, user feedback is not systematically included

28. Does your broadband mapping process include validation by an independent third party (e.g., audits, field tests)?

- ☐ Yes, with regular independent audits verifying ISP-reported data
- ☑ Yes, but audits are occasional and not standardized
- ☐ No third-party validation

SECTION 5: INFRASTRUCTURE, COVERAGE, RESILIENCE, AND EXPANSION

29. How does your country define "rural areas"? (Please select the closest definition)

- ☐ Population density between 0 and 100 inhabitants/km²
- ☐ Population density between 101 and 200 inhabitants/km²
- ☐ Settlements with fewer than 2,500 inhabitants
- ☑ Areas outside urban municipalities with limited infrastructure
- ☐ Other, please specify:

30. What percentage of rural areas in your country have access to basic broadband (≥2 Mbps)?

- ☑ Above 60%
- ☐ Between 30% and 60%
- ☐ Below 30%

31. What percentage of rural areas have access to broadband speeds meeting the ITU's minimum recommended threshold for sustainable development (≥10 Mbps)?

- ☐ Above 60%, with national resilience and crisis response plans

- ☑ Between 30% and 60%, with partial resilience planning in some areas
- ☐ <30%
- ☐ Below 30%, with no resilience strategy

32. **Does your country use the Universal Service Fund (USF) to develop broadband in underserved areas?**
    - ☑ Yes, with clear eligibility criteria
    - ☐ Yes, but funding is limited
    - ☐ No, the USF is not used for broadband

33. **Are there specific policies to encourage investment in rural broadband infrastructure?**
    - ☑ Yes, with clear incentives
    - ☐ Some efforts exist, but they are not well-structured
    - ☐ No dedicated policy for rural broadband investment

34. **Are there specific projects to improve network resilience (e.g., backup power, redundant links)?**
    - ☐ Yes, with published Service Level Agreements (SLAs)
    - ☑ Under development
    - ☐ No such projects exist

35. **To what extent are local municipalities or other community groups involved in broadband deployment planning and execution?**
    - ☐ Highly involved
    - ☑ Some coordination, but limited
    - ☐ Minimal involvement

36. **Does your country have a roadmap or pilot programs for next-gen tech (e.g., 5G, advanced satellite) in urban and/or rural areas?**
    - ☑ Yes, with a fully developed pilot program
    - ☐ Yes, but limited in scope
    - ☐ No pilot program exists

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Annex 2: List and topics for stakeholders meetings

S/N	CLASS OF STAKEHOLDER	AGENCY	PROPOSED MEETING DATE	MEETING TIME
1	Public Sector	National Population Commission (NPC)	20th November, 2025	9:30 - 10:30am
2		Nigerian Postal Service (NIPOST)	20th November, 2025	10:45 – 11:45am
3		OSGoF (Office of the Surveyor General of the Federation)	20th November, 2025	12:00 – 1pm
4		NGDI (National Geospatial Data Infrastructure) /GRID	20th November, 2025	2:00 - 3:30pm
5		FMW (Federal Ministry of Works)/ NGF (Nigerian Governors Forum)	21th November, 2025	9:30 - 11:00am
6		REA (Rural Electrification Agency)	21th November, 2025	2:00 - 3:30pm
7	Private Sector (MNOs/MVNOs)	MTN, Airtel, Globacom, T2, and the MVNOs etc	25th November, 2025	10:00 - 11:30am
8	Private Sector (ISPs)/ Fiber Companies	IPNx, Mainone, Smile, Spectranet, Bitflux, etc.	25th November, 2025	11:45 - 1:15pm
9	Private Sector (Towercos)	IHS, ATC, etc	25th November, 2025	2:15 - 3:30 pm
10	NCC- Internal Departments	Legal, Policy Competetion and Economic Analysis, Technical Standards	28th November, 2025	10.00am-12:30pm

		and Network Integrity, Spectrum Admin Dept., Cybersecuirty and Internet Governance Dept.		

NCC – Regulator and Broadband Mapping Coordinator

Objective:

- Understand current reporting obligations and departmental structure.
- Identify plans for regulatory changes related to Broadband Mapping.
- Gather input for the “Policy & Regulation” draft chapter and presentation.

Suggested Participants:

- Head of Policy, Competition & Economic Analysis
- GIS/Data Management Team

1. Policy and Regulation of Broadband Mapping

This section focuses on understanding the current regulatory environment, identifying gaps, and aligning with international best practices.

Topics and Questions

Current Policies and Frameworks

- What are the existing policies or regulations governing broadband mapping in Nigeria?
- Can you describe the legal frameworks currently governing broadband infrastructure deployment and mapping in Nigeria? How do these frameworks support or hinder implementation?
- How does the NCC ensure compliance with these policies among stakeholders (e.g., ISPs, telecom operators)?
- Which Right of Way regulations and infrastructure policies are linked to Broadband Mapping?

Roles and Responsibilities

- Which government agencies are currently responsible for broadband mapping in Nigeria, and how does the NCC collaborate with them? According to existing laws and policies, what roles can these agencies play? Additionally, from the NCC’s perspective, what roles should they ideally take on to ensure the success of broadband mapping initiatives?
- What role does the NCC play in coordinating broadband mapping efforts at the national level?

Challenges and Gaps

- What are the main challenges or barriers to implementing broadband mapping in Nigeria?
- What gaps or challenges exist in the current regulatory framework that may hinder the effective implementation of broadband mapping in Nigeria? Can you provide examples or elaborate on specific areas that need improvement?

Alignment with International Standards

- How does Nigeria's broadband mapping policy align with ITU and EU policy directions?
- Does the NCC have plans to adopt international best practices for broadband mapping? Considering that the context in Africa differs from regions like Europe, would you be open to exploring best practices from countries such as Poland or Croatia? In your opinion, which specific areas of broadband mapping could benefit most from adopting such practices?

Data Availability and Transparency

- What policies exist to ensure transparency and accessibility of broadband mapping data for stakeholders?
- What data-sharing agreements or requirements are currently in place for telecom operators to provide coverage and quality data? How does the NCC ensure compliance, and are there any challenges in enforcing these agreements?

Data Governance and Interoperability Frameworks

This section focuses on the management, security, and interoperability of data collected for broadband mapping.

Topics and Questions

Data Collection and Management

- Which NCC departments currently collect data from operators, and how is the structure organized?
- What types of data are required from operators (e.g., infrastructure, QoS, coverage, capacity)?
- In what formats are data reported (e.g., GIS, CSV, PDF)? Are there metadata guidelines in place?
- How is this data managed, stored, and updated?
- Are there standardized methods for data collection across different stakeholders?
- Will NCC provide an API for data integration with operators and institutions? Which standards (REST, OGC WMS/WFS)?
- Is NCC considering penalties or incentives for operators regarding geospatial data reporting?
- What are the data quality standards (geolocation accuracy, timeliness)?

Data Security and Privacy

- What measures are in place to ensure the security and privacy of data collected for broadband mapping?
- How does the NCC address concerns related to data breaches or misuse of sensitive information?
- How will the NCC ensure compliance with data protection regulations under the Nigerian Data Protection Act (NDPA, 2023)?

Interoperability

- Are there interoperability frameworks in place to ensure seamless data exchange between stakeholders (e.g., telecom operators, government agencies)?

- What challenges exist in achieving interoperability between different systems and stakeholders?
- How does NCC intend to integrate data from multiple sources (operators, public institutions) into the Broadband Mapping System?

Access to Data

- Who should have access to broadband mapping data once the system is established, and under what conditions does the NCC envision granting access?
- What is the NCC's perspective on implementing open data initiatives or platforms for stakeholders to access broadband mapping data in the future? Are there specific concerns or preferences regarding transparency and accessibility?
- What is the NCC's opinion or preference regarding access to broadband mapping data once the system is established? Should access be open to the public, restricted to specific stakeholders, or managed through specific conditions?
- Will the API support real-time updates or scheduled synchronization?

Capacity Building for Data Governance

- What steps is the NCC taking to build institutional capacity for managing and governing broadband mapping data?
- Are there any training programs or initiatives aimed at improving data governance skills among stakeholders?

Institutional Capacity and Regional Harmonisation

This section focuses on the capacity of institutions to implement broadband mapping and how Nigeria collaborates with regional and international partners.

Topics and Questions

Institutional Roles and Capacity

- What is the NCC's institutional capacity to oversee and implement broadband mapping initiatives?
- Which departments or teams within the NCC should be involved in broadband mapping efforts? Should there be a centralized analytical department coordinating the project, or should responsibilities be distributed across multiple departments with clear collaboration mechanisms
- Which NCC departments currently collect data from operators? How is the structure organized?
- What resources (financial, technical, and human) are available to support broadband mapping efforts?

Collaboration with Other Institutions

- Once broadband mapping is established, how does the NCC envision collaborating with other government agencies, such as the Ministry of Communications and Digital Economy, to ensure the success of the initiative?
- In the NCC's opinion, what role should state governments play in broadband mapping, and how can coordination between the national and state levels be effectively managed?

Stakeholder Engagement

- How does the NCC perceive cooperation with industry stakeholders, such as ISPs and telecom operators? Are these stakeholders generally cooperative, or do they present challenges in initiatives like broadband mapping?
- What specific mechanisms does the NCC envision for regular consultation with stakeholders to address challenges and gather input during broadband mapping efforts?

Regional and International Collaboration

- What opportunities does the NCC see for collaboration with regional bodies, such as ECOWAS, to support broadband mapping and digital transformation initiatives in Nigeria?
- How does the NCC plan to leverage its ongoing partnerships with international organizations, such as the ITU and the European Commission, to enhance broadband mapping efforts in Nigeria?

Harmonisation of Policies

- How does the NCC plan to incorporate international best practices, such as those from the ITU, while ensuring alignment with Nigeria's national laws and priorities in broadband mapping efforts?
- In the NCC's opinion, what challenges might arise in aligning national broadband mapping policies with regional or international standards, and how could these challenges be addressed?

Future Plans and Vision

- What are the NCC's long-term plans for broadband mapping in Nigeria?
- How does the NCC envision broadband mapping contributing to Nigeria's overall digital transformation agenda?

General Questions:

- What are the NCC's priorities for broadband development over the next 5–10 years?
- How does the NCC measure the success of its broadband mapping initiatives?
- Are there any specific recommendations or support the NCC would like from ITU or other international partners?
- How can broadband mapping be used to address connectivity gaps in underserved and rural areas?
- What role does the private sector play in supporting broadband mapping efforts?

Public Institutions Collecting Geospatial Data

Objective:

- Identify datasets that can support Broadband Mapping (roads, buildings, addresses, demographics).
- Analyze legal and technical frameworks for data sharing and NGDI integration.
- Gather sources for documentation and recommendations.

Suggested Participants (if we avoid somebody please add tchem to the list):

- OSGoF (Office of the Surveyor General of the Federation)
- NASRDA (National Space Research and Development Agency)
- NIPOST (National Addressing System)
- NPC (National Population Commission)

- Federal Ministry of Works and Housing
- NiMet (Meteorological Agency)

Detailed Questions:

- What geospatial datasets does your institution currently collect (e.g., road networks, buildings, addresses, demographic data)? How do you see these supporting broadband mapping efforts?
- In what formats and standards are these datasets available? Are they aligned with NGDI standards or other international best practices?
- Are there legal restrictions or challenges related to sharing these datasets (e.g., Survey Coordination Act, FOI Act)? How can these restrictions be addressed to support broadband mapping?
- How often are your datasets updated, and what procedures do you follow to ensure accuracy and completeness?
- Is your institution prepared to integrate its geospatial data with the Broadband Mapping System? What steps would be needed to achieve this?
- Do you provide an API for data access (e.g., REST, OGC WFS/WMS)? What are the conditions for accessing the API (e.g., licensing, fees)?
- Does your API support spatial queries (e.g., bounding box, H3 grid)? Are there any limitations or planned improvements?
- What are the costs associated with maintaining your API, and do you foresee regulatory changes needed to fund its operation and maintenance?
- Which laws or policies should be amended to facilitate better inter-agency data exchange and integration with the Broadband Mapping System?
- Can NIPOST's address data be linked to NCC's mapping system? What steps would be required to make this connection possible?
- What technical barriers does your institution face in sharing or integrating geospatial data (e.g., lack of infrastructure, missing API documentation, outdated systems)?
- Are there plans to modernize your GIS systems or infrastructure to facilitate integration with Broadband Mapping? If not, what support would be needed to initiate modernization efforts?
- How does your institution currently collaborate with other public agencies (e.g., OSGoF, NASRDA)? Are there existing frameworks or agreements that could be leveraged for broadband mapping?
- What incentives or motivations would encourage your institution to actively participate in broadband mapping efforts?
- What recommendations would you provide to ensure successful integration of geospatial data into the Broadband Mapping System?

Telecom Operators (Market)

Objective:

- Assess availability of infrastructure and coverage data.
- Evaluate readiness for reporting in required formats.
- Identify barriers and regulatory needs.

Suggested Participants:

Telecom operators (NCC suggetions who should be invited)

Detailed Questions:

- What types of infrastructure data does your organization currently maintain (e.g., BTS locations, POPs, fiber routes, microwave links)?
- Do you maintain coverage maps in GIS format (e.g., polygons, grids)? If yes, how frequently are these maps updated?
- What level of granularity do your coverage maps provide (e.g., city-level, street-level, or by grid)?
- Are there any infrastructure or coverage data that you currently do not collect but could collect in the future to support broadband mapping?
- What are your current reporting procedures to the NCC? In what formats do you submit infrastructure and coverage data?
- Are you prepared to meet mandatory geospatial data reporting requirements for broadband mapping? What additional resources or support would you need to comply?
- Do you currently provide an API to the NCC for accessing data (e.g., BTS locations, network status)? If not, would you be willing to implement one?
- What are your technical capabilities for integration with the Broadband Mapping System (e.g., API, automated reporting, real-time data sharing)?
- Are your GIS systems compatible with NGDI standards or other international geospatial standards? If not, what challenges would you face in achieving compatibility?
- What barriers do you foresee in sharing infrastructure and coverage data with the NCC (e.g., cost, data security, confidentiality, competitive concerns)?
- Do you see a need for data anonymization or aggregation to comply with the Nigeria Data Protection Act (NDPA) or other privacy regulations?
- What are the costs (financial, technical, or operational) associated with preparing data in the required format for broadband mapping?
- Would you expect regulatory incentives, funding, or relief to support your participation in broadband mapping? What specific incentives would encourage your cooperation?
- Which existing regulations (e.g., Nigerian Communications Act) should be updated to make data reporting and sharing easier for operators?
- Are there specific policies or frameworks you would recommend to ensure data sharing is secure, fair, and beneficial for all parties?
- How do you think the NCC can balance the need for detailed broadband mapping data with operators' concerns about data confidentiality and competitive risks?
- From your perspective, what does success look like for this broadband mapping project? What outcomes would benefit your organization the most?
- What role do you see telecom operators playing in maintaining and updating the Broadband Mapping System after its initial implementation?
- Are there any international best practices or lessons learned from similar projects in other countries that you think should be applied here?
- How can the NCC and telecom operators work together to ensure the sustainability of the Broadband Mapping System?

Annex 3: Follow up questions for stakeholders

Follow-up questions for FMW

1. Collaboration and Stakeholder Engagement

1. Could the Ministry provide more details about its existing collaboration with NCC and other stakeholders (e.g., operators, Ministry of Communications)?
- Are there any formal agreements, guidelines, or procedures governing this collaboration?
- How is communication managed between the Ministry and operators during construction projects?
2. Would the Ministry consider establishing a formal collaboration framework (e.g., Memorandum of Understanding) with NCC to streamline efforts for the broadband mapping project?
- Such an agreement could outline shared responsibilities, data exchange protocols, and regular communication channels to ensure alignment.
- Could NCC and ITU experts assist in drafting this framework to simplify the process?

2. Data and Integration

3. What specific data sets does the Ministry of Works currently hold that could be useful for broadband mapping?
- For example, road networks, construction zones, or infrastructure plans.
- Are these datasets available in digital formats, such as GIS (e.g., shapefiles, GeoJSON)?
4. Does the Ministry have a centralized database or platform for managing infrastructure data, and if so, could this be integrated with the broadband mapping system?
5. Are there challenges in data sharing between the Ministry and other stakeholders (e.g., NCC, operators)?
- What support or resources would be needed to facilitate smoother data exchange?

3. Policy and Regulatory Framework

6. Could the Ministry share existing guidelines or policies related to construction and excavation activities, particularly those impacting telecommunications infrastructure?
- Are these guidelines publicly available, or could they be shared with NCC and ITU experts for review?
7. What progress has been made on the policy for constructing service ducts to safeguard telecommunications cables?
- Is there a timeline for implementing this policy, and what challenges need to be addressed?
8. Does the Ministry foresee any regulatory gaps that could hinder the integration of broadband mapping with construction workflows?
- If so, what recommendations would the Ministry suggest to address these gaps?

4. Operational Processes

9. What are the standard operating procedures for contractors to notify NCC and operators before starting construction projects?
- Are these procedures formalized, or are they more informal practices?
10. How does the Ministry ensure that contractors comply with these procedures, particularly in remote or underserved areas?
11. Could the Ministry provide a list of upcoming construction projects where collaboration with NCC might be required to safeguard existing infrastructure?

5. Broadband Mapping System Usage

12. Does the Ministry see itself as a potential user of the broadband mapping system?
- If so, what features or functionalities would be most useful for the Ministry (e.g., identifying fiber locations, avoiding infrastructure damage)?

6. Integration with Construction Projects

13. How can the broadband mapping system be integrated into the Ministry's construction planning processes?
- For example, could the Ministry use broadband mapping data to identify areas where service ducts are most needed?

14. Are there any technical challenges the Ministry foresees in integrating broadband mapping data with its existing systems?
- If so, what support would be needed to address these challenges?

7. Future Collaboration and Next Steps

15. Would the Ministry be willing to participate in regular meetings or working groups with NCC and other stakeholders to ensure smooth collaboration on broadband mapping?
16. What are the Ministry's expectations or recommendations for the next steps in this collaboration?
17. Does the Ministry have any feedback or suggestions for improving the broadband mapping project based on its experience with infrastructure management?

8. Service Duct Policy Implementation

18. What are the Ministry's plans for implementing the service duct construction policy?
- Will this policy include specific guidelines for integrating telecommunications infrastructure into road construction projects?
- Are there any pilot projects or case studies the Ministry is planning that could demonstrate the effectiveness of service ducts in safeguarding infrastructure?

9. Data Accessibility

19. Could the Ministry provide access to road construction plans or maps that could be integrated into the broadband mapping system?
- Are there specific formats or restrictions for accessing this data?

20. What steps would the Ministry recommend to ensure data accuracy and consistency across different stakeholders involved in the broadband mapping project?

10. Long-Term Vision

21. How does the Ministry envision its role in supporting Nigeria's digital transformation through broadband mapping?
- Are there specific goals or initiatives the Ministry would like to align with this project?

22. Does the Ministry foresee any long-term benefits of having a unified broadband mapping system in Nigeria?
- If so, how could these benefits be maximized for infrastructure planning and development?

Follow-up questions for NIPOST

1. Policy and Legal Framework
    1. Could NIPOST share any documents outlining the national addressing/postcode framework and its legal basis?
    2. Are there existing formal or informal collaboration frameworks with NPC, NGDI/NASRDA, or NCC regarding data sharing?
2. Data Standards and Formats
    3. What geospatial standards, metadata schemas and file formats (e.g., shapefiles, geodatabases) does NIPOST use for postcode areas and postal units?
    4. Which coordinate reference system is applied, and are all datasets harmonized under a single CRS?
3. Data Collection, Infrastructure and Data Sharing
    5. Could NIPOST outline the workflow for data collection, verification and ground-truthing, including update frequency?
    6. What data-sharing mechanisms currently exist (e.g., file transfers, platform access), and which datasets require an MoU?
4. Collaboration and Institutional Framework
    7. How does NIPOST coordinate technically with NPC, NGDI/NASRDA and NCC, and are any technical working groups active?
    8. Would NIPOST support forming a joint working group with NCC/ITU for integrating addressing data into broadband mapping?
5. Geospatial Data and Applications
    9. Which datasets can NIPOST provide for broadband mapping (building points, postcode areas, postal districts, postal units)?
    10. What proportion of the country has completed verification/ground-truthing, and are there priority regions ready for immediate use?
6. Alignment with Broadband Mapping
    11. How does NIPOST view the use of postcode areas (2-hectare grid) as a reference spatial layer for broadband infrastructure planning?
    12. Are there any known data gaps or limitations that should be addressed to ensure full alignment with broadband mapping?
7. Reference Systems and Standardization
    13. Are postal districts, postcode areas and postal units fully aligned with administrative boundaries (state, LGA)?
    14. Could NIPOST provide a concise glossary of key terms (postal district, postcode area, postal unit) for consistent use across agencies?
8. Next Steps
    15. Could NIPOST confirm timelines for sharing the postcode documentation and updated building footprint datasets?
    16. When can NIPOST deliver the detailed presentation on data structure and definitions planned for the next meeting?

Follow-up questions for NGF

1. Collaboration and Advocacy

1. Could NGF assist in establishing a Governor's Committee for broadband mapping, as suggested during the meeting?
- How soon could this committee be formed, and what would be the steps to initiate it?
- Could NGF help identify six governors, one from each geopolitical zone, to drive advocacy for the project?
2. How can NGF use its platform to advocate for broadband mapping at the state level?
- What specific actions could governors take to support the project (e.g., promoting data sharing, reducing right-of-way challenges)?
3. Would NGF be open to including broadband mapping as part of its ongoing advocacy efforts for digital transformation and infrastructure development?

2. Data Collection and Support

4. Could NGF facilitate data collection from state governments, particularly for granular geospatial data that may not be available at the national level?
- Are there specific steps or processes NGF would recommend to make this collaboration more efficient?
5. Are there state-level contacts or focal points NGF could connect NCC with to streamline data collection and policy alignment?
6. Does NGF have any experience or best practices from previous projects (e.g., property tax mapping, land digitization) that could inform the broadband mapping project?

3. Policy and Regulatory Framework

7. Could NGF share examples of executive orders or regulations issued by states regarding right-of-way fees and fiber optic deployment?
- Are there any states with particularly effective frameworks that could serve as models for others?
8. Are there ongoing efforts by NGF to harmonize right-of-way policies across states to reduce disparities and hidden charges?
- What progress has been made in encouraging states to adopt the 145 naira per meter fee?

4. Digital Transformation and Infrastructure

9. Could NGF share details about its digital archives for lands or other digitization projects?
- Are there any lessons from these projects that could be applied to broadband mapping?
10. How does NGF envision broadband mapping supporting state-level digital strategies?
- Are there specific goals or priorities NGF would like the project to align with?
11. Could NGF help advocate for the adoption of Dig Once policies at the state level to encourage shared infrastructure and reduce deployment costs?

5. Challenges and Recommendations

12. What are NGF's main challenges in working with states to harmonize policies for broadband deployment?
13. Does NGF foresee any political or operational barriers to the success of the broadband mapping project at the state level?

14. Are there specific recommendations NGF would like to make to NCC or ITU to ensure the project's success?

6. Right-of-Way (RoW) and Regulatory Insights

15. Could NGF provide a list of states that have adopted regulations or executive orders for right-of-way fees?
- Are there any states that have fully waived fees or implemented innovative approaches?

16. How can NGF help ensure transparency and accountability in the implementation of right-of-way regulations?
- For example, could NGF encourage states to publish approved permits and fees online?

17. Are there any ongoing discussions about creating a centralized system for managing right-of-way applications across states?

7. Future Engagement

18. Would NGF be open to participating in regular working group meetings with NCC to ensure alignment and collaboration on broadband mapping?
19. Can NGF suggest any upcoming forums or events where broadband mapping could be highlighted to gain more visibility and support from governors?
20. Are there any state-level initiatives NGF is currently supporting that could align with or benefit from the broadband mapping project?

8. Long-Term Vision

21. How does NGF see its role in supporting Nigeria's digital transformation through broadband mapping?
- What specific outcomes does NGF hope to achieve with this project?

22. Could NGF help promote the use of broadband mapping for economic development, such as attracting investments or improving service delivery at the state level?
23. Does NGF have any suggestions for ensuring the sustainability of the broadband mapping system after the project concludes in 2028?

9. Contact and Communication

24. Could NGF confirm the key points of contact for collaboration on this project?
- Should all correspondence go through Mr. Benga Loki or the digital desk team?

25. Would NGF be open to hosting advocacy workshops or training sessions for state governments to highlight the benefits of broadband mapping?

Follow-up questions for NPC — Questions & Responses

1. Data and Availability

· Could NPC provide a detailed list of available datasets along with descriptions (e.g., demographic data, buildings, locations, roads, administrative boundaries)?

- Enumeration areas
- Buildings
- Ward Boundaries
- Settlements/localities
- Demography data(projected population data)

· Are building and address datasets available in GIS formats (e.g., shapefile, GeoJSON)? If so, what are the limitations for sharing them?

- Yes available in Shapefiles, file geodatabase and APIs

· Is there a schedule for updating datasets, such as those related to buildings or demographics? How frequently are these updates made?

– No schdduled update at the moment however, the only envisaged update is the Household listing exercise prior to census.

2. Standards and Data Formats

· Does NPC already have established standards or data formats that could be useful for broadband mapping projects (e.g., standards for addresses, building classifications)?

- NPC data standard formats will be shared via APIs and SDKs

· Could NPC share details regarding the methodology for building classification (e.g., how residential, commercial, or public infrastructure buildings are categorized)?

- Building Classification was done On-field by observation and identification by data collectors

· What are the details of the six urbanization classes mentioned during the meeting? Is there documentation describing these classifications?

Yes. However, official documentation is yet to be gazetted.

- Urban - urban
- Urban
- Urban-rural
- Rural - urban
- Rural
- Rural - Rural

3. Collaboration with Other Institutions

· What does NPC's current collaboration look like with other institutions, such as Nipost, ALGON, or INEC, in terms of geospatial data? Are there formal protocols for collaboration that could be shared?

Collaboration is based on inter-agency agreements tailored to the specific requirements of a project.

· What are the main challenges NPC faces in data exchange with other institutions? What are potential ways to address these challenges?

Inconsistent data format

· Could NPC help establish contact with the National Addressing Council or other key entities relevant to the broadband mapping project?

No

4. Legal Regulations

· Could NPC share the full text of the legal act (National Population Commission Act) governing its operations? Are there additional regulations defining the scope and structure of collected data?

Legal act available on National Population Commission

· Are there legal or procedural restrictions on sharing data with other institutions or projects, such as broadband mapping?

Legal and procedural restrictions primarily prevent sharing direct individual identifiers, such as names, ensuring compliance with data privacy laws.

5. Address and Building Data

· Could NPC provide more information about its collaboration with Nypost on address standardization? What is the current status of the national addressing system project?

- NPC/Nipost collaboration was initiated to help develop and roll out a national postcode for the nation. Collaboration is still ongoing

· Do the building datasets include detailed attributes, such as building type (residential, commercial), number of residents, or construction year?

- NPC residential types are basically classified into residential, non-residential, and institutional (hotels, prisons, etc.).

· Are there plans to update address and building data in the near future? If so, what is the timeline?

Yes, the timeline isn't defined yet

6. Urbanization Classification

· Could NPC provide detailed criteria used for urbanization classification (e.g., six urbanization classes)? What data is considered in this classification (e.g., infrastructure, population, service availability)?

- (population, conurbation, socioeconomic infrastructure)

· Are there maps or spatial data showing the country's division based on these urbanization classes?

- Not yet, but it can be created

7. Collaboration Possibilities

· What are the conditions for collaborating with NPC on data sharing? Does NPC require a Memorandum of Understanding (MOU) before initiating collaboration?

Yes

· Could NPC suggest specific steps to improve collaboration between NPC and NCC within the broadband mapping project?

- Official MOU

8. Technical Challenges and Support

· Could NPC suggest tools or platforms for data exchange (e.g., APIs, geospatial data portals)?

Enumpad Mobile Application (geospatial tool for data collection)

APIs and SDKs

· What are the main technical challenges NPC faces in managing large geospatial datasets?

- Super workstations and training gaps

9. Future Meetings and Needs

· Does NPC see the need for additional workshops or meetings to discuss specific technical or legal aspects of the project? Yes

· What are NPC's expectations for future actions within the broadband mapping project?

- utilize the existing Enumeration Area (EA) baseline data and the EnumPad platform to efficiently and securely provide the foundational geographic framework required by the project.

Follow-up questions for OSGoF — Questions & Responses

1) Data Inventory and National Coverage

1. What key geospatial datasets can OSGoF currently provide for the broadband mapping project? (e.g., topographic base maps, road network, hydrography, building footprints, administrative boundaries, elevation layers/DTM, settlement points, city "digital twins"). Please share a list with short descriptions, scale, and currency.
2. At what territorial coverage are layers available at scales 1:25,000, 1:50,000, 1:100,000, and 1:5,000? Which states/cities are complete and where are the gaps?
3. What very large-scale data (1:1,000, 1:5,000) does OSGoF hold for cities (e.g., Abuja – 3D digital twin)? What is the plan to extend this to Lagos, Port Harcourt, Kano, etc.?

2) Scale, Resolution, and Quality

4. For which layers (buildings, roads, rivers, settlement polygons) does the minimum scale ensure correct geometry representation (point/line/polygon)?
5. Quality standards (QA/QC): Does OSGoF apply formal quality control procedures (e.g., positional accuracy, attribute completeness, topology checks)? How are metadata documented?

3) Data Formats and Metadata

6. Which data formats can be delivered (Shapefile, GeoPackage, GeoJSON, GDB, GeoTIFF, LAS/LAZ for point clouds, CityGML for 3D)? Any preferred format per layer?
7. Can OSGoF provide metadata sheets (ISO 19115 or similar) for each dataset: source, acquisition date, method (UAV/satellite/drone), accuracy, update frequency?

4) Updates and Schedule

8. How often are key datasets updated (buildings, roads, hydrography, DTM/DSM)? Is there an annual revision plan with dates and priorities?
9. What is the procedure for adding new objects (e.g., newly built structures, telecom towers) – sources of notification, validation steps, time from report to publication?

5) Data Sharing and Interfaces (API/Web Services)

10. What is the current data delivery mechanism – beyond file copies (HDD, email), are there WMS/WFS/WMTS/REST services or data catalogs? If not, what is the timeline for launching on-prem data center + cloud (AWS/Azure/Google) and public read-only APIs?
11. Does OSGoF plan a National Geospatial Data Repository/NGDI portal for browsing and downloading layers (with access control) that we could integrate with the broadband mapping platform?

6) Sharing Policy, Fees, and Licensing

12. What data sharing rules apply today (G2G, G2B, G2C)? For national development projects (e.g., broadband mapping), are there preferential conditions or exemptions? What are the standard price lists and license terms (read-only, processing, redistribution)?
13. Is a hybrid model possible: live data via read-only API at no cost (for the government project), and full offline snapshots under separate terms?

7) Legal Framework and Documents

14. Please provide the full text of the Survey Coordination Act (with amendments) and other relevant acts (e.g., Land Use Act, NGDI regulations).
15. Are there technical guidelines for data standards (building classification, attribute dictionaries, SRID/coordinate systems, elevation standards)?

8) Interagency Collaboration (NIPOST/NPC/NCC)

16. What is the status of cooperation with NIPOST under the National Addressing System – how does OSGoF supply base maps (1:5,000, footprints) and NIPOST address points? How is data flow and responsibility structured?
17. Cooperation with National Population Commission (NPC): which OSGoF layers support EA demarcation (enumeration areas) and census tracts? Do you maintain building aggregations/settlement grids used by NPC?
18. Collaboration with NCC: can OSGoF designate a contact point and propose an MOU + data exchange protocol (scope, formats, SLA, security)?

9) Technical Infrastructure and Security

19. What IT infrastructure does OSGoF have (servers, storage, backup, DR, ESRI/ArcGIS Enterprise, GeoServer)? What are the security requirements (access control, audit, encryption, information classification)?
20. Will the planned on-prem data center and cloud layer support map services for government agencies with SSO and federated login?

10) Telecom Infrastructure Data

21. Does OSGoF collect telecom tower locations (XY) and/or height information (Z) needed for Obstacle Maps? Can collaboration with NCC and operators help fill missing height data?
22. Is there a plan to register passive infrastructure (ducts, poles, cable routes) – even if not for coverage maps, at least in the infrastructure repository?

11) Addresses, Buildings, and Urbanization

23. What building attributes are currently available (type: residential/commercial/public, number of floors, height), and can they be standardized and shared for network planning?
24. Does OSGoF maintain urbanization classes (e.g., urban/suburban/rural) with criteria and maps – or plan to develop them?

12) Harmonization, Roadmap, and Capacity Building

25. Can OSGoF outline a short- and mid-term roadmap:
- launch of NGDI/Repository (beta → production),
- publication of WMS/WFS/REST for key layers,
- “digital twin” for additional cities,
- formalization of MOU with NCC?

26. What training or advisory support does OSGoF expect from the project team (e.g., ArcGIS Enterprise/GeoServer architecture, data catalog policy, API, data standards)?

13) Organizational Matters

27. Please indicate contact persons (technical, legal, data/licensing), preferred communication channel (email, Teams/WhatsApp), and SLA for responses.
28. Can we schedule a technical workshop (2–3 hrs) focused on API/web services and data formats – ideally with a demo of Abuja 3D digital twin?

Follow-up questions for REA — Questions & Responses

Questions	Response
1. What datasets does REA currently hold that could support the broadband mapping project? (e.g., settlement locations, household data, energy access status, MV/MV lines, power sources, mini-grid locations, information on base stations in communities).	REA / Nigeria Electrification Programme (NEP) maintains a core set of geospatial datasets used for electrification planning: settlement locations and extents, electrification status (grid / off-grid / mini-grid / SHS), mini-grid project footprints and status, connection counts, and network layers used in least-cost planning. These are delivered as part of NEP/DARES planning and mini-grid procurement workflows. (nep.rea.gov.ng, https://vida.place)
2. Do these datasets cover the entire country or only rural/off-grid areas? What is the territorial coverage and level of detail?	Coverage is national in scope but focused on classification relevant to electrification (every settlement is modelled). Detail and completeness vary: great detail for targeted unserved/underserved/rural settlements used in least-cost modelling; denser urban network detail may be limited because REA's mandate focuses on off-grid and underserved communities. Actual pre-settlement attributes (household counts, density) are available for use in NEP modelling. (https://iept.nesip.rea.gov.ng)
3. Are the datasets in geospatial format (with precise coordinates) or only aggregated (e.g., number of base stations per community)?	Primary planning datasets are geospatial (points, polygons, and lines with coordinates) used in GIS and modelling tools (GeoJSON/Shapefiles). Some operational/aggregated tabular summaries (xlsx, csv) also exist for reporting.
4. What information does REA collect on the electricity network (transmission lines, connection points, power source locations)? Does this include the national grid or only mini-grids?	REA's datasets include vector layers for candidate MV/LV lines (for planning), mini-grid footprints, connection point locations, and geo-located productive-use and public facilities. The dataset incorporates both national grid extents (to determine distance-to-grid) and detailed mini-grid assets used in REA tenders/DARES projects. (Odessy: nep.rea.gov.ng)
5. Do the datasets include technical parameters (e.g., voltage, capacity, type of source: solar, diesel, hybrid)?	For REA-managed mini-grid and NEP project data, technical metadata are captured (technology type, installed capacity, system components, and often design voltage classes). The detail level may vary by project and data capture method (procurement, M&E, remote monitoring feeds).

6. Does REA maintain data on planned projects (network expansion, new mini-grids), and can these be shared?	Yes — REA/NEP maintains pipelines and planned project layers (MST and other mini-grid pipelines, planned SHS deployments). Sharing is subject to internal governance and MoU/agreements with partners; many project pipelines have been shared with partners under formal agreements.
7. What community attributes are available (number of households, income level, energy access status, distance to grid)?	Typical attributes in REA planning layers include: estimated household counts (or proxies from settlement models), electrification status, distance to the nearest grid point, and socioeconomic proxies where available (e.g., population density). Income-level data are usually proxied (poverty indices, proxies from census or surveys) rather than household income reported by REA. (https://iept.nesip.rea.gov.ng)
8. Are these datasets updated regularly? How often and by what method (own surveys, external sources, integration with NBS/NPC)?	Updates occur periodically: during major project cycles (tenders, procurement, monitoring) and when new remote or field data arrive. Sources include REA field M&E, implementer (RESCO) reporting, remote sensing, and periodic integrations with partner datasets. Update frequency is project-driven (e.g., quarterly for active pipelines, ad-hoc for national model updates). (dares.rea.gov.ng)
9. Does REA plan to integrate with official statistical data (NBS, NPC)? What is the status of the MOU with NBS?	- -
10. What information does REA hold on base stations in rural areas (number, operator, power supply type)?	Through the joint initiatives and committees with NCC, the Agency works to join energy and digital mapping efforts. However, comprehensive national-scale telco base station inventories are normally held by NCC and operators. Joint datasets are increasingly developed through collaboration.
11. Do these datasets include precise geolocations (XY) or only counts per community?	-
12. Does REA collaborate with NCC on mapping base stations and their power supply? How is data exchanged?	Yes! REA and NCC have established joint committees/working groups to boost digital-energy inclusion and to map infrastructure intersections. Data exchange is done under MoUs/committee terms; the typical mechanism is formal data-

	sharing agreements or working group exchanges rather than open public release, and includes secured file transfers depending on sensitivity.
13. In which formats can REA provide data (Shapefile, GeoJSON, CSV, API)?	REA/NEP planning teams work in standard GIS and data formats: Shapefile, GeoJSON, CSV (tabular exports).
14. Are there data governance procedures for sharing? What is the authorization process, and is a read-only API possible for this project?	Yes. DARES/NEP documentation and procurement TORs reference data protection, compliance, and partner data governance. Data sharing typically requires an MoU / data-sharing agreement and approval by REA's data/ICT unit.
15. Does REA plan to establish a data warehouse/repository for the energy sector with integration options for telecom projects?	REA/NEP has developed integrated planning tools and centralised datasets (https://iept.nesip.rea.gov.ng) and has recently signed MoUs with (backbone ICT agencies) to support integration. So, formal enterprise data-warehouse plans exist within DARES/NEP technical documentation. (Odessy, https://vida.place)
16. Which legal acts govern REA's operations (e.g., Electricity Act)? Are there strategic documents (National Electrification Strategy, Implementation Plan)?	REA operates under Federal statutes and mandates for electrification (including elements of the Electricity Act and federal policy instruments). REA/NEP publishes strategic documents and implementation plans (National Electrification Programme materials, least-cost electrification model reports, DARES/NEP PIM and TORs). These should be referenced for legal/regulatory specifics. (https://rea.gov.ng , nep.rea.gov.ng)
17. Does REA have standards or guidelines for data structure, community classification, GIS formats?	Yes! REA/NEP/DARES technical documents and TORs prescribe data formats, metadata, and classification approaches used in least-cost modelling and procurement (settlement classification, community typologies, and GIS conventions). Project tender documents also include data structure requirements for bidders and implementers.
18. Is there a policy for data sharing with other agencies (NCC, NPC, NIPOST)?	REA routinely signs MoUs with government agencies and private partners to formalize data sharing. Cross-agency data sharing is policy-driven and executed under MoUs or joint working

	agreements; specific terms depend on the partner and data sensitivity.
19. What is the current level of cooperation between REA and NCC (e.g., joint mapping of mini-grids and base stations)?	Cooperation is active and recently strengthened: REA and NCC inaugurated a joint committee to coordinate digital and energy inclusion and infrastructure mapping. This indicates operational collaboration for joint mapping and planning.
20. Can REA provide contact persons for data and technical matters?	Yes -
21. Is it possible to sign an MOU with NCC for data exchange and system integration?	Yes. Given the current joint committee with NCC, signing a formal MoU for data exchange and system integration is both possible and consistent with recent practice.
22. What are REA's plans for GIS system development (e.g., integration of new data sources, APIs, dashboards)?	REA/NEP has been modernising its planning stack (least-cost geospatial models, interactive webmaps, resource hubs). Future development emphasizes integration of partner datasets to support decision dashboards and automated reporting.
23. What technical or training support does REA expect under this project (e.g., data standards, interoperability, integration with broadband mapping)?	REA typically requests support in: (1) harmonising data standards and metadata; (2) API and interoperability design for cross-agency integration; (3) capacity building for GIS/remote-monitoring of mini-grids and assets; (4) joint workflows for telecom-energy mapping (base station power status); and (5) assistance setting up secure read-only access and dashboards for partner stakeholders. These align with DARES/NEP TORs and past partner deliverables.

Follow-up questions for NGDI — Questions & Responses

FOLLOW UP QUESTIONS FOR NGDI

1. Policy and Legal Framework

1. Could NGDI provide a copy of the draft policy document that has been in use for the past 15 years?
   - If possible, could you also share any supporting documents or guidelines that detail the standards and metadata requirements mentioned?

Response: Yes. The key foundational documents have been provided:

- National Geoinformation Policy (Updated March 2024): Revised based on the stakeholder workshop held March 19-22, 2024.
- Draft NGDI Bill (May 2024): The legislative framework document intended to enact the NGDI into law.

Key Supporting Documents Referenced in the Policy and Bill:

- NGDI Metadata Guidelines (referenced in Policy Section 5.5 and Bill Part 2, Section 2(3)g).
- Data Management Guidelines, Spatial Data Access and Security Conditions, and Pricing Regimes (referenced in Bill Part 2, Section 2(4)j and Policy Section 5.6).
- Note on Availability: These specific guideline documents are referenced as being developed by the NGDI Committee. Their distribution may be subject to formal request through institutional channels.

Standards Specified:

- Metadata Standard: ISO 19115/19139 (Bill Part 2, Section 2(3)e).
- Data Quality Elements: Positional accuracy, attribute accuracy, temporal accuracy, lineage, completeness, logical consistency (Bill Part 2, Section 2(3)d).
- Interoperability: OGC Standards (WMS, WFS, WCS, WMTS) are supported.

2. What are the next steps for finalizing the NGDI policy and having it enacted into law?
   - Are there specific challenges delaying this process, and how can NCC or other stakeholders assist in accelerating the approval?

Response:
Required Steps:

- Federal Executive Council (FEC) Approval: The updated National Geoinformation Policy (2024) requires formal FEC approval (Policy Section 6.1).
- National Assembly Passage: The harmonized NGDI Bill (2024) must be transmitted to and passed the National Assembly.
- Presidential Assent: Final step for enactment into law.

Documented Challenges:

- Coordination & Momentum: Multiple drafts (2003, 2010, 2021, 2024) exist but none have been enacted. Sustaining momentum is critical.
- Funding Constraints: Over-reliance on NASRDA's budget. The NGDI Fund outlined in the Bill is not yet operational because the bill is yet to be enacted into an Act.
- Overlapping Mandates: Lack of a clear, enacted legal authority prevents enforcement of standards and coordination.

- Voluntary Participation Failure: The 2009 pilot nodes faced sustainability issues due to delays in the enactment of the legal framework to institutionalize participation and collaboration rather than rely on voluntary participation.

How NCC Can Assist:

- Joint Advocacy: Support the advocacy for a choherent and collaborative geospatial ecosytem through the NGDI implementation as a fundamental catalyst to the success of the Africa BB Maps. Coordinate with the NGDI Secretariat to co-present policy briefs to key stakeholders including FEC and the National Assembly, demonstrating tangible use cases like broadband mapping.
- Technical Input: Provide broadband-specific geospatial requirements to strengthen the case for the policy.
- Stakeholder Solidarity: Publicly support the harmonized NGDI Bill (2024) as the accurate framework, helping to resolve inter-agency conflicts over mandates.

3. Are there existing legal frameworks or agreements that regulate collaboration between NGDI and other government agencies (e.g., NCC, NASRDA)?
   - If not, would NGDI recommend drafting an overarching framework to standardize collaboration and data sharing?

Response:

- **Current Status:** No comprehensive legal framework currently exists. Collaboration is largely based on inter-agency cooperation and ad-hoc arrangements. Some collaborations are guided by individual MOUs, but there is no single overarching framework.
- **NGDI Recommendation:** YES. The NGDI framework is specifically designed to be this overarching structure.
- **Evidence from Draft Bill:** Part 1, Section 4(b) empowers the NGDI Committee to "ensure compliance with rules and standards." Part 4 provides for the "Establishment of Protocols" for national coordination.
- **Historical Lesson:** The 2009 pilot nodes languished in the absence of a legally backed central authority. The NGDI Bill aims to create the NGDI Council and Secretariat with legal mandate to enforce standards and coordination across all MDAs.
- **Formalizing Collaboration with NCC:** NCC can formally collaborate with the NGDI as a priority Thematic Node with provisions for direct API integration and a dedicated data schema, which can be formalized via an MOU while the processes for enacting the NGDI Bill is ongoing.

2. Data Standards and Formats

4. Could you provide a detailed list of the geospatial standards and formats currently used by NGDI, including those for:
   - Metadata
     - Primary Standard: ISO 19115/19139 (explicitly stated in Bill Part 2, Section 2(3)e).
     - Mandatory Elements include Data Quality, Geospatial Reference, Identification, Entity/Attribute, and Distribution information.
   - Reference systems (e.g., WGS84)
     - Primary System: WGS84 (World Geodetic System 1984) is specified in portal documentation as the standard for metadata and spatial extent. Nigeria defined the Minna Datum in the past but now mostly use WGS84. The working group on

Standards is saddled with this task and would define and finalize once they are up and running.

- Data collection and sharing protocols
  - Vector Formats: Shapefile, GeoJSON, TopoJSON, etc.
  - Raster: GeoTIFF, GDAL, JPEG, PNG, etc.
  - Service Protocols: OGC standards (WMS, WFS, WCS, WMTS), ArcGIS REST API, and OGC API - Features.
  - Sharing Rule: Every data transfer must be accompanied by relevant metadata (Bill Part 2, Section 2(3)f).

5. Are there any specific standards or formats NGDI recommends for broadband mapping to ensure interoperability with existing geospatial systems in Nigeria?

Response:
Recommended Standards for Broadband Mapping:

- Coordinate Reference System: WGS84 (EPSG:4326) for all infrastructure coordinates.
- Data Formats: GeoJSON for vector data (broadband routes, tower locations).
- Metadata: Complete ISO 19115-compliant metadata for all datasets, including temporal extent and update frequency.
- Service Integration: Use WFS for feature access and WMS for visualization to ensure compatibility with the NGDI clearinghouse.
- NCC-Specific Provision: The NGDI portal we are building can include a dedicated Schema for customized metadata profiles for fiber routes, tower locations, and coverage heatmaps.

6. How does NGDI handle data standardization when receiving datasets with varying reference systems from different states?
   - Are there any tools or processes NGDI uses to convert and harmonize such data?

   Response:
   Harmonization Process:

   - Transformation: Datasets are reprojected into the common reference system (WGS84).
   - Tools: Established GIS tools are used, including PostGIS (for database transformations), GeoServer (for on-the-fly reprojection in services), and GDAL/OGR libraries.
   - Quality Control: Processes include consistency checks, reference system harmonization, and review against national/international standards (Bill Part 2, Section 2(6)).
   - Legacy Data: Conversions are done on a project or need basis, with a plan for progressive harmonization as part of national integration efforts.

3. Physical Infrastructure and Data Sharing

7. What is the current status of the clearinghouse infrastructure for geospatial data?
   - Could you provide more details about its capabilities, such as API integration and interoperability features?
   - Is there a timeline for completing the infrastructure by Q1 2026, as mentioned during the meeting?

Response:

- Current Status (as of November - December 2025): The project is in the advanced development and infrastructure deployment phase.

Capabilities (Active/Developed):

- Metadata Management: Full CRUD operations with Role-Based Access Control (RBAC).
- Discovery & Search: Keyword, faceted, and spatial (bounding box) search.
- Visualization: Interactive maps using Leaflet and MapLibre GL JS.
- API Integration: Active RESTful APIs for Metadata, Search, and Map Services (OGC standards). Supports OAuth 2.0/JWT authentication.
- GIS Service Integration: Acts as a proxy/aggregator for ArcGIS and OGC (WMS, WFS, WCS) services.

Timeline:

- The current projected completion for full operational portal is April-June 2026.
- Timeline is dependent on hardware procurement, user acceptance testing (UAT), and security certifications.

8. Could NGDI share the data standards and formats document for the Grade 3 data portal?
   - Are there any specific requirements for accessing or integrating with this portal?

Response:

- Data Standards: The Grade 3 portal operates on NGDI guidelines: ISO 19115/19139 metadata, WGS84 coordinate system, and OGC service standards.
- Access Requirements:
  - Tier 1 (Public): Read-only access to search and metadata.
  - Tier 2 (Registered Partner): Access to download links and basic API keys. Requires institutional email verification.
  - Tier 3 (Node Officer): Authority to upload/manage organizational data. Requires NASRDA authorization.
- Integration: Requires OAuth 2.0/JWT capability, support for RESTful APIs, and data compliance with ISO 19115 and WGS84.
- Document Availability: This documentation may be shared upon formal request through the appropriate institutional channels.
- NCC-Specific Path: As noted earlier, NCC would be designated as a Priority Thematic Node, which includes provisions for direct API integration.

9. Does NGDI have a centralized data repository for geospatial datasets?
   - If so, how can stakeholders like NCC access this repository for broadband mapping purposes?

Response:

Repository Status: NGDI is working towards a centralized national repository. The core infrastructure is the Apex Clearinghouse, which primarily warehouses metadata, not necessarily the full datasets. Data often remains with the custodian agency.

Access for NCC:

- Formal Agreement: Through the NGDI Secretariat and the NGDI Committee, through collaboration agreements, MOUs, or data requests. NCC is already identified as a partner.
- Direct API Integration: Real-time sync between NCC internal databases and the NGDI portal is proposed but with the necessary access control protocols.

- Secure Workspace: A private staging area for NCC to validate infrastructure data before publication.
- Discovery Process: Search the metadata catalog, identify the custodian, and request access through formal channels.
- Priority Datasets for Broadband: Addresses, Administrative boundaries, land use and land cover, settlements, population distribution, and transportation networks.

4. Collaboration and Stakeholder Engagement

10. What are the current collaboration mechanisms between NGDI and other agencies like NCC, NASRDA, and Grid 3?
    - Are there any formal agreements (e.g., MOUs) in place to govern data sharing and joint projects?

Response:

- NASRDA: Yes. The NGDI is a national infrastructure established by a 2001 Presidential Directive (given by President Olusegun Obasanjo GCFR) which transferred what was formerly called the National Geographic Information System (NAGIS) from the National Planning Commission to NASRDA. This directive explicitly designated NASRDA as the Secretariat. It is a collaboratively implemented infrastructure governed by a multi-agency committee. Following multi-stakeholder consensus and the harmonization of the NGDI Bill, the NGDI committee was reconstituted and inaugurated in March 2024 by the Honourable Minister for Budget and Economic PlanningThe harmonized NGDI Bill (2024), now awaiting Federal Executive Council transmission, seeks to formalize this existing framework. NASRDA remains the Lead Agency and Secretariat for NGDI, as per the harmonized Bill and Policy. This is not MOU-based but part of the governance structure.
- Grid 3: Collaboration is based on shared work on fundamental datasets, standards, and methodologies. This partnership can be leveraged not just for coherent base maps and settlement data for broadband planning, but also for learnings on the coordination and management of Grid 3, which NASRDA also leads as the National Project Coordinator.
- NCC: Currently, collaboration is informal and ad-hoc. No existing formal MOU is documented. However, the NGDI framework is a great ently point.
- Overall Challenge: Without a central legal authority (the NGDI Act), collaboration remains voluntary and fragile, as evidenced by the fade-out of the 2009 pilot nodes.

11. How can NGDI and NCC work together to amplify advocacy for the NGDI policy and ensure its enactment?
    - Are there specific actions or campaigns that could help accelerate this process?

Response:

Joint Advocacy Strategies:

- Unified Messaging: Develop joint policy briefs for the FEC and National Assembly, demonstrating how NGDI enables critical projects like broadband mapping.
- Use-Case Demonstration: Use the broadband mapping project as a proof-of-concept to showcase the value of a finalized NGDI policy. Highlight milestones like harmonized datasets and interoperable systems.
- Quantifiable Benefits: Co-present evidence of economic impact: elimination of duplicated costs and wastage of resources, potential revenue generation, and economic multiplier effects.

- Stakeholder Engagement: Conduct joint presentations at NGDI Committee sessions and National Assembly committee hearings.
- Formal Working Group: Establish a formal multi-agency working group (including NCC, NASRDA, others) to institutionalize collaboration and provide a structured advocacy platform.

12. Could NGDI provide more details about its collaboration with Grid 3?
    - What datasets or standards are shared between the two organizations, and how can these be leveraged for broadband mapping?

Response:

- Nature of Collaboration: NGDI works with Grid 3 on shared geospatial datasets, standards, and methodologies.
- **Shared Resources for Broadband Mapping:**
  - Datasets: Addresses, Land use and land cover, Settlement boundaries, administrative boundaries, population distribution estimates, building footprints, and road networks.
  - Standards: Common use of WGS84 and alignment with NGDI metadata standards.
- Application to Broadband:
  - Gap Analysis: Use Grid 3 settlement data to identify unserved/underserved populations.
  - Demand Forecasting: Use population estimates for capacity planning.
  - Infrastructure Planning: Use road networks for fiber route optimization and settlement data for tower placement planning.
  - Integration: Grid 3 data can be accessed via the NGDI Clearinghouse and combined with NCC's infrastructure data for comprehensive analysis.

5. Geospatial Data and Applications

13. What are NGDI's main deliverables in terms of geospatial data?
    - Does NGDI produce maps, datasets, or services that could directly support broadband mapping?

Response:

NGDI's core deliverables are coordination frameworks, standardized datasets, and access services.

- **Deliverables that Support Broadband Mapping:**
  - National Fundamental Datasets: Authoritative layers defined in the Bill, including:
  - Administrative Boundaries (from OSGOF/NBC)
  - Landuse and Land cover (NASRDA)
  - Settlement Locations (from NPC/Grid 3)
  - Addresses (NIPOST)
  - Transportation Networks (from Fed. Min. of Transport)
  - Population Distribution (from NPC/NBS)
  - Standardized Base Maps: Consistent national base layers.
  - Metadata & Discovery Services: The Clearinghouse catalog for finding available data.
  - Access Services: API and OGC service endpoints (WMS, WFS) for programmatic access to the above datasets.

Key Point: NGDI coordinates, supports with trainings and provides access to authoritative fundamental datasets, and also coordinates the application in specific thematic projects such as the broadband mapping, bringing the right stakeholdes together and ensuring interoperability and synergy. NCC (or other agencies) would use these layers to create specific thematic maps like broadband coverage.

14. Are there any ongoing projects within NGDI that align with the goals of broadband mapping (e.g., national address data, utility mapping)?

NGDI Metadata Portal Deployment:

- Centralized metadata catalog for discovering infrastructure datasets.
- API integration for real-time data sync.
- Dedicated schema for databases such as NCC broadband data (fiber, towers, coverage).
- National Fundamental Datasets Program: Ongoing work to standardize administrative boundaries and develop address/location frameworks.
- Utility Mapping
- Environmental Health Surveillance
- Health optimization
- Data Integration: Leveraging datasets from the custodial agencies e.g NASRDA's Earth Observation satellites for settlement identification and infrastructure monitoring, useful for verifying coverage and planning.

15. How does NGDI handle data accuracy and validation for national projects?
    - Are there specific methodologies or tools used to ensure data quality?

Response:

- NGDI ensures data quality through a standards-based framework:
- Mandated Quality Elements: The Bill (Part 2, Section 2(3)d) requires metadata to include Positional Accuracy, Attribute Accuracy, Temporal Accuracy, Lineage, Completeness, and Logical Consistency.
- Validation Processes: Includes consistency checks, reference system harmonization, and review against national/international standards.
- Tools: Uses established GIS tools (PostGIS, GeoServer, GDAL/OGR) and automated workflows for validation.
- Conformance Certification: The NGDI Secretariat issues a certificate to data producers whose metadata meets national standards (Bill Part 2, Section 2(3)h).
- Accountability: Data custodians are accountable for dataset integrity, and a user feedback loop exists to report and rectify quality issues.

6. Alignment with Broadband Mapping

16. How can NGDI's expertise in geospatial data directly support broadband mapping?
    - Are there specific datasets (e.g., administrative boundaries, population density, utility data) that NGDI recommends prioritizing for this project?

Response:

NGDI can directly support broadband mapping by providing authoritative national datasets, standards, and coordination expertise.

Priority Datasets Recommended:

- Tier 1 - Essential: Administrative Boundaries (for regulatory reporting), Land use and Land Cover (plan broadband rollout and model signal coverage across different terrains), Addresses (locate households, measure service coverage, and identify unserved areas) Settlement Locations (for gap analysis), Population Distribution (for demand forecasting).
- Tier 2 - Important: Transportation Networks (for fiber route planning), Terrain & Elevation (for wireless propagation modeling).

- Tier 3 - Valuable: Existing Utility Infrastructure (for co-location), Land Use/Land Cover (for permitting), Building Footprints (for customer density estimates).

NGDI's Role: Provide these datasets in a standardized (WGS84, ISO 19115), accessible manner (via APIs/OGC services) and facilitate the necessary inter-agency coordination to acquire them.

17. Are there any gaps or challenges NGDI foresees in aligning its geospatial data with the requirements of broadband mapping?
    - If so, what support is needed to address these gaps?

Response:

Identified Challenges:

- Data Gaps & Inconsistent Quality: Incomplete or varying quality data across states and regions.
- Inconsistent Reference Systems: Legacy data not in WGS84.
- Limited Institutional Coordination: No legal mandate for data sharing (Bill not enacted), leading to ad-hoc, slow processes.
- Data Currency: Some foundational datasets are not regularly updated.
- Technical Capacity: Some agencies (including potential partners) may lack GIS expertise.

Support Needed:

- Urgent: Enactment of the NGDI Bill to provide a legal mandate for coordination and enforcement.
- Formal Collaboration: MOUs between NCC and data custodian agencies.
- Funding & Capacity Building: For systematic data quality improvement, legacy data transformation, and training.
- Joint Advocacy: NCC's support in advocating for the policy is crucial to overcoming these systemic gaps.

18. How can NGDI ensure that its geospatial data and standards are interoperable with NCC's systems and other stakeholders involved in broadband mapping?

Response:

Interoperability would be ensured through a multi-pronged strategy:

- Common Standards: Enforcing the use of WGS84 and ISO 19115 metadata.
- API-Based Data Exchange: Implementing bi-directional API integration between NCC systems and the NGDI clearinghouse, using OGC API - Features and RESTful protocols.
- Formalized Collaboration Framework: Signing an MOU that outlines data sharing, technical standards, quality assurance, and governance (e.g., through a joint technical working group).
- Shared Data Model: Adopting a standardized schema for broadband infrastructure data (e.g., for fiber routes, towers, coverage polygons).
- Capacity Building: Joint training programs and technical documentation.

7. Advocacy and Future Collaboration

19. How can the broadband mapping project be used to amplify advocacy for the NGDI policy?
    - Are there specific milestones or deliverables that could demonstrate the importance of having a finalized NGDI policy?

Response:

The broadband mapping project is a powerful practical use-case for advocacy.

Key Demonstrative Milestones:

- Harmonized National Map: Producing the first comprehensive national broadband coverage map by combining NCC data with NGDI's fundamental datasets (admin boundaries, settlements). This demonstrates NGDI's value in enabling integration.
- Interoperable Systems: Showcasing real-time API integration between NCC and NGDI systems as proof that the framework works.
- Cost-Saving Evidence: Documenting the elimination of duplicate data collection costs and time saved in data discovery.
- Multi-Agency Success: Highlighting successful data integration across NGDI stakeholders to solve a national problem, proving the need for a mandated coordination framework.
- Advocacy Deliverables: A joint Policy Brief, and a published Case Study can be presented to the FEC, National Assembly, and the public to showcase these successes and argue for the urgent enactment of the NGDI Act.

20. Would NGDI recommend establishing a formal working group with NCC, NASRDA, and other stakeholders to ensure consistent collaboration on broadband mapping and related projects?

Response:

Strong Recommendation: YES.

- Rationale: Historical evidence (e.g., the 2009 pilot fade-out) shows that voluntary, ad-hoc collaboration is unsustainable. A formal group institutionalizes collaboration, ensures consistent standards, reduces duplication, and provides a structured platform.
- Proposed Structure: A *"Geospatial/NGDI Working Group for the Broadband Mapping"* with core members from NCC, NASRDA (NGDI Secretariat), NIPOST, OSGOF, NBS, NPC, Grid 3, etc.. It would operate under the auspices of the NGDI Committee.
- Functions: Technical coordination, standards development, project management, and stakeholder engagement specifically for broadband mapping.
- Outcome: This group would be the practical mechanism to execute the collaboration outlined in the NGDI framework and MOU, ensuring the broadband mapping project's success and its use as an advocacy tool.

8. Reference Systems and Standardization

21. Is there an initiative to standardize the use of WGS84 or another reference system across all states and agencies in Nigeria?
    - If not, what steps could be taken to encourage uniformity in geospatial data collection and usage?

Response:

Current Status: While WGS84 is widely recommended and used (especially in new projects), there is no fully enforced nationwide mandate requiring all states and agencies to adopt it.

Steps to Achieve Uniformity:

- Policy and Legal Framework: The first step is to finalize and enact the NGDI Bill, which should explicitly mandate WGS84 as the national standard. A pre-enactment FEC directive could also be pursued.

- Technical Support: The NGDI Secretariat (NASRDA) should be supported to conduct trainings on transformation tools, parameters, and consequently offer a conversion service for legacy data.
- Capacity Building: The NGDI Secretariat should be supported to conduct national training programs for state and federal Geospatial officers on WGS84 and transformation techniques.
- Incentives and Enforcement: Link compliance to budget approvals and clearinghouse access. Create a compliance dashboard.

22. How does NGDI handle legacy data collected using local or regional reference systems?
    - Are there any plans to convert older datasets to a standardized system?

Response:

- Current Approach: Legacy data is handled through on-demand reprojection and transformation into WGS84, typically when needed for a specific project.
- Tools: Standard GIS tools (PostGIS, GDAL/OGR) are used for these conversions.
- Systematic Plans: There is an acknowledged intention for progressive harmonization as part of national data integration. A systematic, funded national program would be needed for comprehensive conversion.
- Recommendation: The enactment of the NGDI Act and the operationalization of the NGDI Fund would provide the mandate and resources needed for a coordinated national legacy data transformation program.

9. Next Steps

23. Can NGDI provide the requested draft policy document, standards, and guidelines?
    - Could you also share any relevant documents related to the Grade 3 project and its geospatial data infrastructure?

Response:

Documents Provided:

- National Geoinformation Policy (Updated March 2024).
- Draft NGDI Bill (May 2024).
- Workshop Report (March 2024). Includes historical summary.

24. What are NGDI's expectations or recommendations for the next steps in this collaboration?
    - Are there specific areas where NGDI would like support from NCC or ITU experts?

Response:

NGDI's Recommendations for Immediate Next Steps:

- Formalize the Partnership: Draft and sign a Memorandum of Understanding (MOU) between NCC and NASRDA to establish the framework for data sharing, technical integration, and collaboration.
- Establish the Working Group: Constitute the formal joint technical working group (as recommended in Q20) to begin detailed work on broadband mapping alignment.
- Joint Advocacy Action: Collaborate immediately on a joint advocacy strategy to present the broadband mapping use-case to the FEC and key National Assembly committees, urging the approval of the NGDI Policy and transmission of the NGDI Bill.
- Begin Technical Alignment: Start the process of aligning NCC's broadband data standards with NGDI specifications (WGS84, ISO 19115 metadata) and scoping the API integration.

- Leverage ITU Expertise: Engage ITU experts to provide guidance on international best practices for broadband mapping and to lend weight to the advocacy for a robust national geospatial policy framework.

Follow-up questions for NPC — Questions & Responses

FOLLOW-UP QUESTIONS FOR NATIONAL POPULATION COMMISSION

1. Data and Availability

· Could NPC provide a detailed list of available datasets along with descriptions (e.g., demographic data, buildings, locations, roads, administrative boundaries)?

- Enumeration areas
- Buildings
- Ward Boundaries
- Settlements/localities
- Demography data(projected population data)

· Are building and address datasets available in GIS formats (e.g., shapefile, GeoJSON)? If so, what are the limitations for sharing them?

- Yes available in Shapefiles, file geodatabase and APIs

· Is there a schedule for updating datasets, such as those related to buildings or demographics? How frequently are these updates made?

– No schdduled update at the moment however, the only envisaged update is the Household listing exercise prior to census.

2. Standards and Data Formats

· Does NPC already have established standards or data formats that could be useful for broadband mapping projects (e.g., standards for addresses, building classifications)?

- NPC data standard formats will be shared via APIs and SDKs

· Could NPC share details regarding the methodology for building classification (e.g., how residential, commercial, or public infrastructure buildings are categorized)?

- Building Classification was done On-field by observation and identification by data collectors

· What are the details of the six urbanization classes mentioned during the meeting? Is there documentation describing these classifications?

Yes. However, official documentation is yet to be gazetted.

- Urban - urban
- Urban
- Urban-rural
- Rural - urban

- Rural
- Rural - Rural

3. Collaboration with Other Institutions

· What does NPC's current collaboration look like with other institutions, such as Nipost, ALGON, or INEC, in terms of geospatial data? Are there formal protocols for collaboration that could be shared?

Collaboration is based on inter-agency agreements tailored to the specific requirements of a project.

· What are the main challenges NPC faces in data exchange with other institutions? What are potential ways to address these challenges?

Inconsistent data format

· Could NPC help establish contact with the National Addressing Council or other key entities relevant to the broadband mapping project?

No

4. Legal Regulations

· Could NPC share the full text of the legal act (National Population Commission Act) governing its operations? Are there additional regulations defining the scope and structure of collected data?

Legal act available on National Population Commission

· Are there legal or procedural restrictions on sharing data with other institutions or projects, such as broadband mapping?

Legal and procedural restrictions primarily prevent sharing direct individual identifiers, such as names, ensuring compliance with data privacy laws.

5. Address and Building Data

· Could NPC provide more information about its collaboration with Nypost on address standardization? What is the current status of the national addressing system project?

- NPC/Nipost collaboration was initiated to help develop and roll out a national postcode for the nation. Collaboration is still ongoing

· Do the building datasets include detailed attributes, such as building type (residential, commercial), number of residents, or construction year?

- NPC residential types are basically classified into residential, non-residential, and institutional (hotels, prisons, etc.).

· Are there plans to update address and building data in the near future? If so, what is the timeline?

Yes, the timeline isn't defined yet

6. Urbanization Classification

· Could NPC provide detailed criteria used for urbanization classification (e.g., six urbanization classes)? What data is considered in this classification (e.g., infrastructure, population, service availability)?

- (population, conurbation, socioeconomic infrastructure)

· Are there maps or spatial data showing the country's division based on these urbanization classes?

- Not yet, but it can be created

7. Collaboration Possibilities

· What are the conditions for collaborating with NPC on data sharing? Does NPC require a Memorandum of Understanding (MOU) before initiating collaboration?

Yes

· Could NPC suggest specific steps to improve collaboration between NPC and NCC within the broadband mapping project?

- Official MOU

8. Technical Challenges and Support

· Could NPC suggest tools or platforms for data exchange (e.g., APIs, geospatial data portals)?

Enumpad Mobile Application (geospatial tool for data collection)

APIs and SDKs

· What are the main technical challenges NPC faces in managing large geospatial datasets?

- Super workstations and training gaps

9. Future Meetings and Needs

- Does NPC see the need for additional workshops or meetings to discuss specific technical or legal aspects of the project? Yes
- What are NPC's expectations for future actions within the broadband mapping project?
- utilize the existing Enumeration Area (EA) baseline data and the EnumPad platform to efficiently and securely provide the foundational geographic framework required by the project.

Follow-up questions for NCC — Questions & Responses

Follow-Up Questions for NCC – Broadband Mapping Project

Purpose: To clarify details discussed during the meeting and obtain templates and technical information necessary to finalize recommendations for the Broadband Mapping project.

1. Detailed Follow-Up Questions

Templates & Formats

1. Could you share the current data templates used in the Obligation Management System (OMS) for:

- – Mobile coverage (base stations): Coverage Prediction Data threshold of RSS= -95 (subject to review). File format: ESRI Shapefile; others may be considered
- – Microwave links: See Attached.
- – Fiber routes:
  - Geometric route map data (Kmz format with no specific adopted schema)
  - Attributes template is for collecting already aggregated datasets(see attached)

2. Please indicate which templates are production-ready and which are in beta: The Microwave Links Data is Production ready while the Base Station Data is still at beta level
3. Is there a validation guide or constraints list for these templates (e.g., allowed values, naming conventions)?: Yes, there is a validation guide for the Microwave Links (see attached), others are still being worked on

Reporting Process

- Could you confirm the reporting frequency for:
  - – Mobile coverage (quarterly): Correct
  - – Microwave links (biannual): Correct
  - – Fiber deployments (pre-, during, and post-deployment) Correct

4. Could you provide a table summarizing SLA for reporting (data type → frequency → deadline → responsible department)?: The highest level of legal instrument that

empowers the Commission to collect accurate and timely data is the NCA 2003. Empowered by this ACT, the Commission request for and receive data through various means including:

a. Frequency Assignment Letters where clauses are included to indicate the manner of data requirements, its frequency / timelines
b. Directives via formal official correspondence where specific details of the data requirements are usually stated.

OMS Details

5. Could you share a description of the OMS workflow (data upload process, validation steps)?:

- It is important to note that the at the moment, the OMS only accepts tabular data, traditional geospatial formats such as shapefile, kmz/kml etc are not compartible.
    a. All Licensees are required to be on-boarded in the Commission's e-services platform to be able to access the OMS platform
    b. Relevant templates should be visible to the licensee, depending on the license holdings.
    c. On accessing the platform, they are meant to download the template and read instructions and then attempt to migrate legacy data to fit the template
    d. On completion of the form, the licensee will attempt to upload the completed
    e. Where any record is short of the required constraint set, the upload will not be complete but rather an error report will be produced in other to guide the completion of the form
    f. The process for completing the form is recursive; until all set rules are addressed before successful upload is possible.

6. Does OMS support API integration (REST, OGC WMS/WFS)?:
    a. At the moment the system does not support API Integration.
7. If available, please share screenshots or a diagram of OMS architecture.:
    a. N/A

Registration Data

- Could you provide the schema for user/CPE registration (list of attributes, data types)?

User/CPE registration schema

In Nigeria, user and CPE registration is primarily managed by licensed operators under existing KYC and QoS frameworks. For broadband mapping purposes, NCC plans to rely on

a pseudonymised CPE dataset rather than raw customer records. The core attributes captured include:

- a CPE identifier and operator ID,
- service and technology parameters (access technology, speed tier, plan type),
- premises type (household, school, health facility, public institution, enterprise), and
- geospatial location expressed either as precise coordinates or aggregated to a standard mapping grid / administrative unit.
  Personally identifiable information (names, national IDs, phone numbers) remains exclusively with operators and is not shared for the sake of mapping.

- How is this registration data linked to infrastructure data (e.g., fiber route points A–B)?

NCC's broadband mapping model links this registration data to infrastructure layers through:

- **topology references** (the serving access node or base station, and associated backhaul segment IDs where available); and
- **geospatial overlays**, where CPE locations (or aggregated grid cells) are intersected with fiber routes, access network nodes, and coverage polygons.
  This allows us to analyse, for example, how many connected premises are served along each backbone or backhaul segment, and to identify unserved or underserved grid cells even where infrastructure exists.

Address & Geolocation

8. Which address datasets are currently available to NCC (NGDI, NIPOST, ALGON)?:
   a. No address dataset from the above entities is currently available with NCC. Based on information gotten from some of the stakeholders, There is an existing inter-agency committee that is looking at building, reviewing and enabling the National Addressing System
9. What address attributes are required in current templates (state, city, street, building number, coordinates)?:
   a. In most of the templates, especially the Microwave Links template, there are columns for State, Local Government and Address. The address then requires a detailed description of the location to the nearest city, area, street, house number and landmark as relevant.

10. Could you share an example of an address record used in reporting?

Below is a typical site address reporting for a reported Site "A" of a microwave link

a. State: Lagos
b. Local Government Area: Alimosho
c. Address: 10, Madam Olaosun Okesola street off Mudashiru by Mingles B/Stop, Ejigbo
d. Latitude: 6.557811
e. Longitude: 3.292911

Security & Access

- Is there a draft classification matrix for tiered access (public vs restricted data)?:
- At the moment, we have a mobile coverage map that is publicly accessible and shows where networks are, what generations of mobile technology are available, and how they are performing.

  Accessible here: https://ncc.gov.ng/coverage-map

  Internally, we have more detailed information such as locations of base stations, national coverage by all operators, etc. which are only for internal use and not public access.

  - There is currently no classification matrix for tiered access specific to geospatial data.
  - However, there is a need for clear guidelines with matrix that define levels of access for each data class.

11. Will data hosting be local (data sovereignty)?

- The Commission's decision of hosting may be a function of the circumstances; however, it may prefer local hosting for security guarantee and data control

Organisational Questions

12. Could you confirm which NCC departments collect which datasets (e.g., Spectrum, Standards, Cybersecurity, Policy, USPF, Digital Economy)?
    a. The above-mentioned all collect data to address needs of the business
13. In how many systems are these datasets currently collected (OMS or other platforms)?
    a. OMS: Mainly tabular data
    b. FTP
    c. Teams Channels: Tabular and geospatial data
    d. Email reporting: mostly intermittent data need.

14. Is there a designated unit or coordinator responsible for harmonising data collection across departments?
    a. None for now
15. Could you share the process for inter-departmental data exchange and validation?

Currently, traditional methods are employed for data sharing such as:

    a. Email exchanges
    b. Memory drives
    c. Teams Channels

Data Standardisation

16. How does NCC currently standardise data across departments (naming conventions, schemas, validation rules)?
    a. Data standardization is yet to be fully operationalized, however the OMS is seen as a potential to introduce some level of standardization.
    b. In the OMS, the address data such as State and LGA in some of the templates are near standardized as operators are enforced by the constraint to report only states and LGAs in Nigeria. This might eventually be the standard for reporting states and LGA.
    c. The OMS also enforces certain reporting requirements of other key records such as frequency bands, Frequency Bandwidths, Data rate etc.
    d. Validations are done per department protocols and business rules (Still at early stage) . For example, data received from operators can be validated to reveal For example, data received from operators can be validated to reveal site locations with coordinate accuracy issues using the State, LGA columns to validate the lat/long location.
    e. Much of validation is done semi-automated
    f. Schemas are not very standardized (no existing standards adopted)
17. Are there existing internal guidelines or manuals for data formatting and validation?
    a. None for now
18. Is there a plan to adopt a unified schema or OGC standards for geospatial data?:
    a. NCC being a world class organization will be ready to adopt best practices, including the OGC standards especially if it does not jeopardize the security of its data.
19. Could you share any draft or example of these standardisation rules?
    a. We do not have any example but we will be happy to learn and adopt one.

2. Checklist of Materials Requested from NCC

- OMS templates (Excel, KMZ) and validation guides.
- SLA reporting table (data type, frequency, deadlines).
- OMS workflow description and API integration details.
- Information for CPE/user registration.
- Information on available address datasets and required attributes.

Follow-up questions for Globacom — Questions & Responses

Questionnaire for Mobile Networks Operators

Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national mobile networks infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Data Standards, Coverage Modelling & Templates

A1. Coverage modelling responsibility

1. Under what conditions would you consider it acceptable for the regulator (e.g. NCC) to centrally run the radio-coverage prediction (using your site parameters)?
    - Please specify any conditions on propagation models, clutter classes, antenna heights, reception thresholds, etc.

Globacom would consider it acceptable under the following conditions:

- Use of standardized and industry-accepted propagation models (e.g., COST-231 Hata, Walfisch-Ikegami, etc.).
- Harmonized clutter classes that accurately represent Nigerian urban, suburban and rural morphologies.
- Clear definition of receiver thresholds, including indoor/outdoor assumptions and penetration losses.
- Use of antenna heights, azimuths, downtilts and other site parameters as shared by operators without alteration.
- Transparent documentation of modelling parameters, model versions and software used.
- Opportunity for operators to validate and comment on model outputs before publication.

2. Do you have any technical or business objections to the regulator owning the radio-coverage model while your organisation provides only the input parameters (site data, technical parameters)?
    - ☐ No significant objections
    - ☐ Some concerns – please explain:

Our concerns are as below.

- Operators must be assured that their commercial planning strategies are not reverse-engineered from modelling outputs.
- Raw files from modelling outputs must only be shared with concerned operators to avoid reproducibility.
- Final coverage outputs should reflect realistic field conditions and operator review should be mandatory before release.

A2. Granularity of standardisation

3. Which parameters do you believe must be **strictly harmonised** across all operators to ensure truly comparable coverage results?
(e.g. propagation model type, clutter classes, receiver thresholds, map resolution, indoor/outdoor assumptions, etc.)

- Propagation model type and version
- Clutter classes and land-use categories
- Receiver sensitivity/threshold levels
- Penetration loss assumptions (indoor/outdoor)
- Map resolution (e.g., 20–50 m raster grid)
- Reference terminal height (e.g., 1.5 m for handheld)
- Time/fading margins and confidence levels

4. Which parameters could remain operator-specific without harming comparability?

- Transmit power per sector
- Tilt (mechanical/electrical)
- Antenna type and vendor
- Load-dependent parameters
- Proprietary optimization strategies

A3. Standard templates & metadata

5. For a **standard BTS/site template**, which 5–10 fields do you consider essential?

- Site ID / Name
- Latitude / Longitude

- Technology (2G/3G/4G/5G/FWA) per sector
- Carrier frequencies + bandwidth
- Antenna height, tilt, azimuth
- Tx power / eNodeB parameters
- Backhaul type (microwave/fiber)

6. For a **standard fibre network template**, which 5–10 fields do you consider essential?

- Cable route description: Detailed "As Built Drawing" showing start and end points, important landmarks and route summary.
- Fiber cable specifications: Type (single mode/multi-mode) , fiber count, sheet materials etc.
- Ducts/Trench Details: Ducts size, no of ducts, trench depth.
- Splice/Joint Information: Splice point I.D, enclosure type, coordinates, splice loss, fiber pairing.
- OTDR/Power Meter Test Results: Wavelengths tested, events losses, link loss

7. For **coverage layers (2G/3G/4G/5G/FWA)**, which key attributes and metadata should always be included (e.g. date of simulation, software used, model version)?

- Simulation date
- Propagation model + version
- Software/tool used
- Resolution (raster/hex grid size)
- Indoor/outdoor assumptions
- Tx parameters used
- Confidence level (e.g., 75/90%)

A4. Frequency of updates

8. How often would it be realistic for your organisation to provide updates for:
   - BTS / POP locations:
     [e.g. monthly / quarterly / other]
   - Fibre network changes:
     [e.g. monthly / quarterly / other]
   - Coverage layers (2G/3G/4G/5G/FWA):
     [e.g. monthly / quarterly / other]

- BTS / POP locations:
  Quarterly. Major changes (new site deployments) could be reported monthly.
- Fiber network changes:
  Monthly
- Coverage layers:
  Bi-annually (twice per year), as these require high computation and validation

9. Should reporting frequency differ for:
   - Urban vs rural areas?
   - Fixed vs mobile networks?
     Please explain.

No, reporting frequency should remain the same for all

B. Data Exchange, Automation & Validation

B1. Current level of automation

10. Roughly what share of your current data flows to the regulator is automated (0–100%) for:

- Infrastructure data (sites, fibre, POPs): ___ % Manual
- Coverage data: ___ % Manual
- QoS / KPI data: ___ % 50%

11. Where do manual steps currently create the biggest risks of error or delay?

- Human error

B2. APIs & integration model

12. Does your organisation already use APIs or database interfaces for GIS/network data internally or with partners?

- ☐ Yes
- ☐ No
- If yes, please briefly describe.

Yes, we use internal APIs and GIS platforms to manage our network inventory, coverage /capacity heatmap, Population density , OSM Building, and open source Standard GIS tools with GeoJSON STRM, OSM compatibility,

13. For future broadband mapping, which model would you prefer:
- ☐ Pull model – the regulator queries your API
- ☐ Push model – you push standardised datasets to a secure portal or endpoint
- ☐ Hybrid – please specify:

Globacom prefers the Push Model because it gives us better control over data quality, timing, security, and compliance, while still enabling the regulator to receive accurate and up-to-date datasets.

However, A limited "pull" capability via API could be enabled for the regulator to query the status of specific, agreed-upon datasets in near-real-time.

14. Under what technical or security conditions would you be willing to expose an API or automated interface to the regulator (e.g. authentication, encryption, logging, SLAs)?

Strong Authentication, End-to-End Encryption, SLA's and Data protection

B3. Portal constraints & validation rules

15. Which automatic checks or business rules would you like the upload portal to perform (e.g. value ranges, mandatory fields, band checks, topology validation)?

- Mandatory fields not empty
- GPS coordinate validation
- Frequency-band consistency checks
- Antenna height / power range checks
- Duplicate site ID / sector ID detection
- Logical links (e.g., a fiber segment must connect to valid POPs and forming a complete Path).
- Boundary rules for Coordinates falling within the national /State boundaries check.
- Date format consistency
- Model version compatibility

16. Are there examples from your internal tools that could be mirrored (e.g. validation rules that work well for you today)?

No internal tool can be mirrored.

B4. Joint validation processes

17. What kind of validation workflow do you consider appropriate between regulator and operators?(e.g. draft results shared for comments, technical working group, defined response timelines, etc.)

- Regulator shares draft outputs before publication
- Operators review within an agreed timeframe (e.g., 10–15 working days)
- Technical working group sessions for dispute resolution
- Final harmonization before public release

18. How often should validation rules and parameters be jointly reviewed (e.g. annually, every 2 years)?

- Annually, with provision for urgent updates if required.

C. Openness, Confidentiality & Use of Data

C1. Sensitive vs non-sensitive data

19. Please list 3–5 data items you consider clearly **non-sensitive** and suitable for open or wide sharing (possibly in aggregated form).

1. Aggregated coverage maps
2. High-level fiber presence (no exact coordinates)
3. Population coverage statistics
4. Technology availability maps

20. Please list 3–5 data items you consider **sensitive** and only shareable under strict conditions (e.g. NDPA constraints, NDAs).

1. Exact site coordinates
2. Detailed fibre routes
3. Traffic volumes per site/sector
4. Subscriber distribution per grid
5. Vendor-specific configuration parameters
6. Future rollout /AOP plans for specific area.

C2. Tiered access model

21. Would you support a **tiered access model** (public view / professional view / regulator-only view)?

- ☐ Yes
- ☐ No
- Comments:

Yes. A tiered model ensures complete transparency with security and confidentiality, and is considered a best practice ensuring access of only Non sensitive data.

22. In such a model, which datasets or attributes should be:

- Publicly visible:
  - National/state coverage maps (aggregated)
  - Population coverage gaps
  - Broadband availability indicators
- Visible to trusted institutional users (government, donors, research):
  - Higher-resolution coverage
  - High-level fibre maps
  - Anonymous traffic layers
  - Cluster-level QoS summaries
- Regulator-only:
  - Detailed site coordinates
  - Precise fiber routes
  - Subscriber/traffic data
  - Full KPI datasets
  - Raw simulation parameters

C3. Anonymisation & aggregation

23. For data relating to subscribers or traffic volumes, what anonymisation or aggregation rules (e.g. minimum number of subscribers per grid cell) would you consider sufficient to protect commercial interests and comply with data protection rules?

- Aggregated to a minimum geographic unit (e.g., a hex grid / or a square grid with a population > 200).
- a minimum subscriber threshold can be >100 per operator in the unit, before being displayed.
- Released with a time lag (e.g., one quarter) to avoid any competitive advantage by competitor.

C4. Expected benefits of openness

24. From your perspective, what concrete benefits would you expect from better broadband mapping and (where appropriate) more open data?
(e.g. less duplication of civil works, easier wayleave negotiations, better targeting of USF/state projects, more informed investors, improved planning)

- Improved network planning and cross-industry collaboration
- Faster identification of underserved areas
- Reduced duplication of fiber trenching and civil works
- Better alignment of USPF/state broadband interventions
- More informed investment decisions

D. Costs, Capacity, Incentives & Governance

D1. Cost drivers

25. Where do you expect the main **costs** of participating in the Broadband Mapping System to arise (staff time, software licences, data cleansing, integration work, security reviews, etc.)?

- Staff time for data preparation
- Integration effort for APIs
- Software licences (GIS, OSS tools)
- Data cleaning and harmonisation
- Security & compliance reviews

26. What types of support from the regulator or ITU (tools, scripts, guidelines, templates) would most reduce these costs for you?

- Standard templates & scripts
- Data-validation tools
- Clear modelling guidelines
- Training on new standards
- Support for API tools
- Accurate and High resolution dataset availability

- Clear, detailed technical guidelines and data dictionaries.
- Provision of a test environment for API integration.

D2. Capacity building

27. What specific skills or training would you like to see offered to your teams to align with future data standards (e.g. GIS, metadata management, API design, anonymisation techniques)?

- GIS and spatial data modelling
- Metadata and documentation standards
- API development and integration
- Data anonymization and privacy techniques
- Coverage-modelling best practices

D3. Incentives & compliance

28. Which **non-financial incentives** could motivate consistent, high-quality reporting (e.g. better access to public datasets, fast-track permits, public recognition as a compliant operator)?

- Priority access to public infrastructure datasets
- Fast-track permitting and approvals
- Reduced audit frequency for compliant operators

29. Do you see a role for **light penalties or performance indicators** (e.g. timeliness/completeness scores) if operators repeatedly fail to submit required data?
- ☐ Yes
- ☐ No
- Please elaborate.

We do not support penalties because the system is still new, most delays are due to technical issues rather than unwillingness, and collaboration with proper tools and guidance will improve data quality more effectively than punishment.
The Commission should help the MNOs to improve on the various QoS KPIs,not through penalty but by close collaborations.

D4. Long-term governance role

30. How would you like operators to be involved in the long-term governance of the Broadband Mapping System?
(e.g. permanent technical working group, annual review of standards, advisory

board)

We suggest establishing a permanent technical working group with an annual review of standards, templates and APIs.

31. Once the system is operational, how often should structured operator–regulator meetings on broadband mapping be held?
    - ☐ Quarterly
    - ☐ Twice per year
    - ☐ Once per year
    - ☐ Other – please specify:

Twice per year.

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria

Follow-up questions for MTN — Questions & Responses

MTM Questionnaire for Mobile Networks Operators

Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national mobile networks infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Data Standards, Coverage Modelling & Templates

A1. Coverage modelling responsibility

1. Under what conditions would you consider it acceptable for the regulator (e.g. NCC) to centrally run the radio-coverage prediction (using your site parameters)?
    a. Please specify any conditions on propagation models, clutter classes, antenna heights, reception thresholds, etc.
        - The radio-coverage prediction and simulation should be the sole responsibility of the MNOs. NCC should only standardize the coverage data reporting.

2. Do you have any technical or business objections to the regulator owning the radio-coverage model while your organisation provides only the input parameters (site data, technical parameters)?
    a. ☐ No significant objections
        - ☐ Some concerns – please explain: It is the responsibility of the MNOs to own radio-coverage model for coverage simulation. The MNOs can only provide physical site data parameters coverage data according to standardized specification.

A2. Granularity of standardisation

3. Which parameters do you believe must be strictly harmonised across all operators to ensure truly comparable coverage results?
   (e.g. propagation model type, clutter classes, receiver thresholds, map resolution, indoor/outdoor assumptions, etc.)
    - Receiver Threshold
4. Which parameters could remain operator-specific without harming comparability?
    - Indoor/outdoor assumptions
    - Propagation Models
    - Map resolution

- Clutter classes

A3. Standard templates & metadata

5. For a standard BTS/site template, which 5–10 fields do you consider essential?
   - SiteID
   - Long/Lat
   - City
   - LGA
   - State
   - Georegion
   - Clutter Type
   - Technology

6. For a standard fibre network template, which 5–10 fields do you consider essential?

7. For coverage layers (2G/3G/4G/5G/FWA), which key attributes and metadata should always be included (e.g. date of simulation, software used, model version)?
   - Date of simulation
   - Software used
   - Propagation model
   - File Format
   - Signal threshold
   - Indoor/Outdoor Assumption

A4. Frequency of updates

8. How often would it be realistic for your organisation to provide updates for:

- BTS / POP locations:
  [e.g. monthly / quarterly / other]
- Fibre network changes:
  [e.g. monthly / quarterly / other]
- Coverage layers (2G/3G/4G/5G/FWA):
  [e.g. monthly / quarterly / other]

9. Should reporting frequency differ for:
   - Urban vs rural areas? No
   - Fixed vs mobile networks? No
     Please explain. The reporting frequency should be unified. Quarterly is preferable

B. Data Exchange, Automation & Validation

B1. Current level of automation

10. Roughly what share of your current data flows to the regulator is automated (0–100%) for:

Infrastructure data (sites, fibre, POPs): _50__ %

- Coverage data: _70__ %
- QoS / KPI data: ___ %

11. Where do manual steps currently create the biggest risks of error or delay?

B2. APIs & integration model

12. Does your organisation already use APIs or database interfaces for GIS/network data internally or with partners?

- ☐ Yes
- ☐ No
- If yes, please briefly describe.

13. For future broadband mapping, which model would you prefer:

- ☐ Pull model – the regulator queries your API
- ☐ Push model – you push standardised datasets to a secure portal or endpoint

14. ☐ Hybrid – please specify:

Under what technical or security conditions would you be willing to expose an API or automated interface to the regulator (e.g. authentication, encryption, logging, SLAs)?

Encryption

B3. Portal constraints & validation rules

15. Which automatic checks or business rules would you like the upload portal to perform (e.g. value ranges, mandatory fields, band checks, topology validation)?

- mandatory fields

16. Are there examples from your internal tools that could be mirrored (e.g. validation rules that work well for you today)?

No

B4. Joint validation processes

17. What kind of validation workflow do you consider appropriate between regulator and operators?(e.g. draft results shared for comments, technical working group, defined response timelines, etc.)

- Defined response timelines
- Technical working group

18. How often should validation rules and parameters be jointly reviewed (e.g. annually, every 2 years)?

- 5 years

C. Openness, Confidentiality & Use of Data

C1. Sensitive vs non-sensitive data
Please list 3–5 data items you consider clearly non-sensitive and suitable for open or wide sharing (possibly in aggregated form).

- Site location
- State
- Technology

20. Please list 3–5 data items you consider sensitive and only shareable under strict conditions (e.g. NDPA constraints, NDAs).
    - Tower owner
    - Tower height
    - Site ID

C2. Tiered access model

21. Would you support a tiered access model (public view / professional view / regulator-only view)?

- ☐ Yes
- ☐ No
- Comments: Regulator-only view

22. In such a model, which datasets or attributes should be:

- Publicly visible:
    - Site location
    - State
- Technology
  Visible to trusted institutional users (government, donors, research):
    - Tower owner
    - Tower height
    - Site ID

- Regulator-only:
    - Site ID
    - Long/Lat
    - City
    - LGA
    - State
    - Georegion
    - Clutter Type
    - Tech

C3. Anonymisation & aggregation

23. For data relating to subscribers or traffic volumes, what anonymisation or aggregation rules (e.g. minimum number of subscribers per grid cell) would you consider sufficient to protect commercial interests and comply with data protection rules?

C4. Expected benefits of openness

24. From your perspective, what concrete benefits would you expect from better broadband mapping and (where appropriate) more open data?
(e.g. less duplication of civil works, easier wayleave negotiations, better targeting of USF/state projects, more informed investors, improved planning)

- Less duplication of civil works,
- Easier wayleave negotiations,
- Better targeting of USF/state projects,
- More informed investors,
- Improved planning

D. Costs, Capacity, Incentives & Governance

D1. Cost drivers

25. Where do you expect the main costs of participating in the Broadband Mapping System to arise (staff time, software licences, data cleansing, integration work, security reviews, etc.)?
    - Software licensing,
    - Integration work,
26. Security reviews.
    What types of support from the regulator or ITU (tools, scripts, guidelines, templates) would most reduce these costs for you?
    - Standardized Template

D2. Capacity building

27. What specific skills or training would you like to see offered to your teams to align with future data standards (e.g. GIS, metadata management, API design, anonymisation techniques)?
Standard templates,

- clear guidelines,
- Training in GIS and API design.

D3. Incentives & compliance

28. Which non-financial incentives could motivate consistent, high-quality reporting (e.g. better access to public datasets, fast-track permits, public recognition as a compliant operator)?

- Fast-track permits,
- Public recognition,
- Improved access to datasets.

29. Do you see a role for light penalties or performance indicators (e.g. timeliness/completeness scores) if operators repeatedly fail to submit required data?

- ☐ Yes
- ☐ No
- Please elaborate.

The focus should remain on collaboration, clarity of requirements, and improving the data submission process.

D4. Long-term governance role

30. How would you like operators to be involved in the long-term governance of the Broadband Mapping System?
(e.g. permanent technical working group, annual review of standards, advisory board)

- Annual review of standards

31. Once the system is operational, how often should structured operator–regulator meetings on broadband mapping be held?

- ☐ Quarterly
- ☐ Twice per year
- ☐ Once per year
- ☐ Other – please specify:

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria

Follow-up questions for Galaxy — Questions & Responses

Questionnaire for Backbone, Fibre and Tower Operators - Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national backbone and passive infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Network Inventory, Standards & Level of Detail

A1. Existing GIS inventory

1. Which main infrastructure elements are currently maintained in your GIS / mapping systems?
   a. ☐ Long-haul / backbone fibre routes
   b. ☐ Metro fibre routes
   c. ☐ Aerial fibre on transmission lines
   d. ☐ Distribution / access fibre
   e. ☐ POPs / backbone nodes / data centres
   f. ☐ Towers / sites (for tower companies)
   g. ☐ Manholes / handholes / joints
   h. ☐ Other (please specify):

2. In which formats can you currently export these datasets for NCC (e.g. KMZ/KML, Shapefile, GeoPackage, CSV, JSON)? KMZ

A2. Standardisation of attributes

3. For backbone and metro fibre routes, which 10–15 attributes should in your view be *mandatory* in a national standard schema (e.g. route ID, cable type, fibre count, status, owner, installation method, aerial/duct, construction year)?

   A. Route ID
   B. Segment Type
   C. Owner/Operator
   D. Geometry (LineString)
   E. Accuracy/Survey Method
   F. Elevation metadata (optional)

G. Installation method
H. Duct/structure details
I. Fibre cable type
J. Commissioned date
K. Depth/Height
L. Start asset ID
M. End asset ID
N. Fibre count & availability
O. Protection class

4. For POPs, nodes and data centres, which key attributes are essential (e.g. type of site, redundancy level, power backup, interconnection role)?

   Type of site

   Power sources

5. For towers and co-location sites (where applicable), which attributes are essential for broadband mapping purposes (e.g. height, load, available space, power characteristics, fibre presence)?

   Height

   Power characteristics

   Fibre presence

6. At what spatial resolution do you currently maintain your fibre and tower data (e.g. exact geometry of routes, link segments between manholes, only node-to-node lines, approximate routes)?

   Link segments between manholes

B. Power Infrastructure, Aerial Fibre & Other Layers

B1. Use of transmission and distribution lines

7. To what extent does your network rely on:
   - Transmission lines (e.g. 330/132 kV)
   - Distribution lines (11/33 kV)

   Please describe typical use and coverage.

8. For aerial fibre on power lines, what information do you currently have (and in what format) about the underlying power infrastructure (e.g. tower positions, line IDs, voltage level)? N/A

9. What data about distribution lines from DISCOs would be most useful for you and for a national broadband map (e.g. routes, substation locations, voltage levels), and in what format? N/A

B2. Other layers relevant for planning

10. Which external datasets, if integrated with the broadband map, would most improve your planning (e.g. roads, rail, rights-of-way, flood zones, industrial zones, government facilities)?

    Roads

    Rights of way

    Government facilities

11. Are there specific construction permit / wayleave processes where a centralised broadband map would help you reduce delays or cable cuts?

C. Data Exchange, Automation & Validation

C1. Frequency and timeliness

12. Today, how often do you realistically update and send backbone / metro fibre data to NCC?
    a. ☐ Monthly
    b. ☐ Quarterly
    c. ☐ Annually
    d. ☐ On request only
    e. Comments:

13. What reporting frequency would be feasible for you in a future system for:
    a. Backbone routes: *[e.g. monthly / quarterly]* Biannually
    b. Metro routes: *[e.g. monthly / quarterly]* Biannually
    c. POPs / nodes: *[e.g. when changes occur / quarterly]* Biannually
    d. Towers / sites: *[e.g. quarterly / annually]* Biannually

C2. Automation and interfaces

Roughly what share of your current submissions to NCC are:

    a. Generated automatically from your systems: __40_ %
    b. Manually prepared or edited (Excel, KMZ, etc.): _60__ %

15. Do you have internal APIs or automated exports for GIS/network data?
    a. ☐ Yes
    b. ☐ No
    c. If yes, please describe briefly the main tools and technologies (e.g. ArcGIS Server, PostGIS, web services, custom APIs).

16. For future broadband mapping, which model would you prefer for data exchange with NCC?
    a. ☐ You Push data to a secure portal / SFTP / API endpoint
    b. ☐ NCC Pulls from your API/web services

c. ☐ Hybrid model – please describe:

17. What main technical or security conditions would you require for an automated interface (e.g. VPN, mutual TLS, token-based authentication, IP whitelisting, logging and audit trails)?

    Token-based authentication, logging and audit trails

C3. Validation and quality control

18. Which automatic checks would you want the NCC portal to perform at upload time (e.g. geometry validity, duplicates, attribute ranges, mandatory fields, topology checks such as fibre routes connecting valid nodes)?
    A. Schema validation
    B. Mandatory fields present
    C. Coordinates inside national boundaries
    D. Route continuity
    E. Duplicate/overlapping segment detection

19. How should discrepancies be handled (e.g. conflicting routes between operators, gaps at borders between datasets)? What validation workflow do you find acceptable (draft map, comment period, joint technical session)?

    Joint technical session

D. Openness, Security & Use of Backbone Data

D1. Public vs restricted views

20. For backbone and metro infrastructure, which elements could be shown in a public map without creating significant security or commercial risks (e.g. approximate corridors, presence of fibre in an area without exact route)? Presence of fibre in an area without exact route

21. Which data should be visible only to a restricted community of operators and public institutions (e.g. exact geometry of routes, manhole positions, spare duct capacity)? All of the Above, including approved access to researchers

22. Which elements should remain regulator-only (if any)?
    D2. Open access and co-investment

23. How do you currently handle requests from other operators to use your fibre or tower infrastructure (e.g. bilateral negotiations, standard offers, long-term IRUs)? Bilateral negotiations

24. In your view, how could a national broadband map support:
    a. Co-investment and sharing of ducts, towers, and rights-of-way? Yes
    b. Reduction of unnecessary route duplication? Yes

c. Protection of critical infrastructure (avoiding accidental cuts)? Yes

25. Would you support a model where backbone players see each other's precise infrastructure in a restricted, login-protected view (while the public sees only aggregated information)?
    a. ☐ Yes
    b. ☐ No
    c. ☐ Yes, under conditions (please specify):

E. Costs, Capacity, Incentives & Governance

E1. Costs and support needs

26. Where do you expect the main costs for your organisation to participate in the future Broadband Mapping System:
    a. Data cleaning and harmonisation
    b. System integration / APIs
    c. Additional licences / tools
    d. Staff time for updates and validation meetings
    e. Other (please specify)

27. What specific support from NCC / ITU (templates, example scripts, training, reference implementations) would most reduce these costs?

E2. Capacity and training

28. What additional skills or training would be useful for your teams (GIS specialists, planners, IT staff) to fully align with the planned standards (e.g. spatial databases, metadata management, API design, data protection & security for infrastructure mapping)?
    API design

    Data protection & security for infrastructure mapping

E3. Incentives and governance

Which incentives would motivate you to provide timely, accurate and detailed data (e.g. access to enriched national datasets, visibility as a compliant/open-access operator, faster permit processing)?

Access to enriched national datasets

30. How would you like backbone, fibre and tower operators to be represented in the governance of the Broadband Mapping System (e.g. permanent technical working group, backbone sub-group, annual joint review of standards)?

    Annual joint review of standards

31. From your perspective, how often should structured NCC-industry meetings on broadband mapping (specifically including backbone / fibre issues) be held once the system is operational?

a. ☐ Quarterly
b. ☐ Twice per year
c. ☐ Once per year
d. ☐ Other – please specify:

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria.

Follow-up questions for FoB — Questions & Responses

Questionnaire for Backbone, Fibre and Tower Operators - Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national backbone and passive infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Network Inventory, Standards & Level of Detail

A1. Existing GIS inventory

1. Which main infrastructure elements are currently maintained in your GIS / mapping systems?
   - ☐ Long-haul / backbone fibre routes
   - ☐ Metro fibre routes
   - ☐ Aerial fibre on transmission lines
   - ☐ Distribution / access fibre
   - ☐ POPs / backbone nodes / data centres
   - ☐ Towers / sites (for tower companies)
   - ☐ Manholes / handholes / joints
   - ☐ Other (please specify):

2. In which formats can you currently export these datasets for NCC (e.g. KMZ/KML, Shapefile, GeoPackage, CSV, JSON)? KMZ/KML

A2. Standardisation of attributes

3. For **backbone and metro fibre routes**, which 10–15 attributes should in your view be *mandatory* in a national standard schema (e.g. route ID, cable type, fibre count, status, owner, installation method, aerial/duct, construction year)?
   1. Route ID 2. Cable Capacity 3. Cable Configuration 4. Handhole Tagging 5. Splice point tagging 6. Duct access capacity 7. Deployment method 8. Construction year 9. Status 10. Owner

4. For **POPs, nodes and data centres**, which key attributes are essential (e.g. type of site, redundancy level, power backup, interconnection role)? 1. Power backup 2. Redundant fiber route

5. For **towers and co-location sites** (where applicable), which attributes are essential for broadband mapping purposes (e.g. height, load, available space, power characteristics, fibre presence)? height, load, available space, power characteristics, fibre presence)?

6. At what **spatial resolution** do you currently maintain your fibre and tower data (e.g. exact geometry of routes, link segments between manholes, only node-to-node lines, approximate routes)? exact geometry of routes, link segments between manholes,

B. Power Infrastructure, Aerial Fibre & Other Layers

B1. Use of transmission and distribution lines

7. To what extent does your network rely on:
   - Transmission lines (e.g. 330/132 kV)
   - Distribution lines (11/33 kV)

   Please describe typical use and coverage.

   - NO

8. For aerial fibre on power lines, what information do you currently have (and in what format) about the underlying power infrastructure (e.g. tower positions, line IDs, voltage level)? N/A

9. What data about **distribution lines** from DISCOs would be most useful for you and for a national broadband map (e.g. routes, substation locations, voltage levels), and in what format? N/A

B2. Other layers relevant for planning

10. Which external datasets, if integrated with the broadband map, would most improve your planning (e.g. roads, rail, rights-of-way, flood zones, industrial zones, government facilities)? All the above

11. Are there specific **construction permit / wayleave** processes where a centralised broadband map would help you reduce delays or cable cuts? Yes

C. Data Exchange, Automation & Validation

C1. Frequency and timeliness

12. Today, how often do you realistically update and send backbone / metro fibre data to NCC?
    - ☐ Monthly
    - ☐ Quarterly
    - ☐ Annually
    - ☐ On request only
    - Comments:

13. What reporting frequency would be **feasible** for you in a future system for:
    - Backbone routes: *[e.g. monthly / quarterly]*
    - Metro routes: *[e.g. monthly / quarterly]*
    - POPs / nodes: *[e.g. when changes occur / quarterly]*
    - Towers / sites: *[e.g. quarterly / annually]*

C2. Automation and interfaces

14. Roughly what share of your current submissions to NCC are:
    - Generated automatically from your systems: _50__ %
    - Manually prepared or edited (Excel, KMZ, etc.): _50__ %

15. Do you have internal **APIs or automated exports** for GIS/network data?
    - ☐ Yes
    - ☐ No
    - If yes, please describe briefly the main tools and technologies (e.g. ArcGIS Server, PostGIS, web services, custom APIs). , PostGIS, web services, custom APIs

16. For future broadband mapping, which model would you prefer for data exchange with NCC?
    - ☐ You Push data to a secure portal / SFTP / API endpoint
    - ☐ NCC Pulls from your API/web services
    - ☐ Hybrid model – please describe:

17. What main **technical or security conditions** would you require for an automated interface (e.g. VPN, mutual TLS, token-based authentication, IP whitelisting, logging and audit trails)?

C3. Validation and quality control

18. Which **automatic checks** would you want the NCC portal to perform at upload time (e.g. geometry validity, duplicates, attribute ranges, mandatory fields,

topology checks such as fibre routes connecting valid nodes)?
geometry validity, duplicates

19. How should discrepancies be handled (e.g. conflicting routes between operators, gaps at borders between datasets)? What validation workflow do you find acceptable (draft map, comment period, joint technical session)? joint technical session

D. Openness, Security & Use of Backbone Data

D1. Public vs restricted views

20. For backbone and metro infrastructure, which elements could be shown in a **public map** without creating significant security or commercial risks (e.g. approximate corridors, presence of fibre in an area without exact route)? presence of fibre in an area without exact route)

21. Which data should be visible only to a **restricted community of operators and public institutions** (e.g. exact geometry of routes, manhole positions, spare duct capacity)? exact geometry of routes, manhole positions

22. Which elements should remain **regulator-only** (if any)?

D2. Open access and co-investment

23. How do you currently handle **requests from other operators** to use your fibre or tower infrastructure (e.g. bilateral negotiations, standard offers, long-term IRUs)? standard offers

24. In your view, how could a national broadband map support:
    - Co-investment and sharing of ducts, towers, and rights-of-way?
      A national broadband map can support co-investment and sharing of ducts, towers, and rights-of-way in several ways:

      1. Increased Transparency: By providing a centralized platform for infrastructure data, a national broadband map can help identify existing infrastructure, reducing duplication of efforts and costs.

      2. Improved Planning: The map can facilitate planning and coordination among stakeholders, enabling more efficient deployment of broadband infrastructure.

      3. Sharing of Infrastructure: By identifying available ducts, towers, and rights-of-way, the map can enable sharing and co-location, reducing the need for new infrastructure.

4. Cost Savings: It leads to significant cost savings for network operators and governments.

5. Increased Investment: It attracts investors by providing a clear understanding of existing infrastructure and potential opportunities.

6. Streamlined Permitting: it enhances by identifying existing infrastructure and rights-of-way.

7. Enhanced Collaboration: The map can foster collaboration among stakeholders, including network operators, governments, and infrastructure providers.

- Reduction of unnecessary route duplication?
- Protection of critical infrastructure (avoiding accidental cuts)?

25. Would you support a model where **backbone players see each other's precise infrastructure** in a restricted, login-protected view (while the public sees only aggregated information)?
    - ☐ Yes
    - ☐ No
    - ☐ Yes, under conditions (please specify): Competitions do not take advantage negatively

E. Costs, Capacity, Incentives & Governance

E1. Costs and support needs

26. Where do you expect the main **costs** for your organisation to participate in the future Broadband Mapping System:
    - Data cleaning and harmonisation
    - System integration / APIs
    - Additional licences / tools
    - Staff time for updates and validation meetings
    - Other (please specify)

27. What specific support from NCC / ITU (templates, example scripts, training, reference implementations) would most reduce these costs? Absorption of cost of data management, License fees relieve /reduction and sponsorship of staff operational cost for meetings

E2. Capacity and training

28. What additional skills or training would be useful for your teams (GIS specialists, planners, IT staff) to fully align with the planned standards (e.g. spatial databases, metadata management, API design, data protection & security for

infrastructure mapping)? API design, data protection & security for infrastructure mapping

E3. Incentives and governance

29. Which **incentives** would motivate you to provide timely, accurate and detailed data (e.g. access to enriched national datasets, visibility as a compliant/open-access operator, faster permit processing)? Access to enriched national datasets, visibility as a compliant/open-access operator, faster permit processing

30. How would you like backbone, fibre and tower operators to be represented in the **governance** of the Broadband Mapping System (e.g. permanent technical working group, backbone sub-group, annual joint review of standards)? permanent technical working group

31. From your perspective, how often should structured NCC-industry meetings on broadband mapping (specifically including backbone / fibre issues) be held once the system is operational?
    - ☐ Quarterly
    - ☐ Twice per year
    - ☐ Once per year
    - ☐ Other – please specify:

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria.

Follow-up questions for Phase3 Telecom — Questions & Responses

Questionnaire for Backbone, Fibre and Tower Operators - Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national backbone and passive infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Network Inventory, Standards & Level of Detail

A1. Existing GIS inventory

3. Which main infrastructure elements are currently maintained in your GIS / mapping systems?
   a. ☐ Long-haul / backbone fibre routes
   b. ☐ Metro fibre routes
   c. ☐ Aerial fibre on transmission lines
   d. ☐ Distribution / access fibre
   e. ☐ POPs / backbone nodes / data centres
   f. ☐ Towers / sites (for tower companies)
   g. ☐ Manholes / handholes / joints
   h. ☐ Other (please specify):

4. In which formats can you currently export these datasets for NCC (e.g. KMZ/KML, Shapefile, GeoPackage, CSV, JSON)? **We can provide the data in any of the formats mentioned in the list.**

A2. Standardisation of attributes

7. For **backbone and metro fibre routes**, which 10–15 attributes should in your view be *mandatory* in a national standard schema (e.g. route ID, cable type, fibre count, status, owner, installation method, aerial/duct, construction year)?: **Route ID, Cable Type, Fibre Type, Installation Method, Year of Construction**

8. For **POPs, nodes and data centres**, which key attributes are essential (e.g. type of site, redundancy level, power backup, interconnection role)? **Pop Geo Location Data, Type of Power, Power Status and Availability, Total number of Racks, Pop Type(Indoor/Outdoor)**

9. For **towers and co-location sites** (where applicable), which attributes are essential for broadband mapping purposes (e.g. height, load, available space, power

characteristics, fibre presence)?**NA**

10. At what **spatial resolution** do you currently maintain your fibre and tower data (e.g. exact geometry of routes, link segments between manholes, only node-to-node lines, approximate routes)? **Exact geometry of routes**

B. Power Infrastructure, Aerial Fibre & Other Layers

B1. Use of transmission and distribution lines

10. To what extent does your network rely on:
    - o **Transmission lines (e.g. 330/132 kV)**
    - o Distribution lines (11/33 kV)

      Please describe typical use and coverage.

11. For aerial fibre on power lines, what information do you currently have (and in what format) about the underlying power infrastructure (e.g. tower positions, line IDs, voltage level)? **line IDs, voltage level**

12. What data about **distribution lines** from DISCOs would be most useful for you and for a national broadband map (e.g. routes, substation locations, voltage levels), and in what format?**NA**

B2. Other layers relevant for planning

12. Which external datasets, if integrated with the broadband map, would most improve your planning (e.g. roads, rail, rights-of-way, flood zones, industrial zones, government facilities)?**Duct Infrastructure Route, Right of way Details, Distribution Lines/Poles details**

13. Are there specific **construction permit / wayleave** processes where a centralised broadband map would help you reduce delays or cable cuts? **Not in Place, centralised broadband map really help**

C. Data Exchange, Automation & Validation

C1. Frequency and timeliness

14. Today, how often do you realistically update and send backbone / metro fibre data to NCC?
    a. ☐ Monthly
    b. ☐ **Quarterly**
    c. ☐ Annually
    d. ☐ On request only
    e. Comments:

15. What reporting frequency would be **feasible** for you in a future system for:
    - ***a.*** **Backbone routes: *[e.g. monthly / quarterly]***

b. Metro routes: *[e.g. monthly / quarterly]*
c. POPs / nodes: *[e.g. when changes occur / quarterly]*
d. Towers / sites: *[e.g. quarterly / annually]*

C2. Automation and interfaces

18. Roughly what share of your current submissions to NCC are:
    a. Generated automatically from your systems: **80 %**
    b. Manually prepared or edited (Excel, KMZ, etc.): **20 %**

19. Do you have internal **APIs or automated exports** for GIS/network data?
    a. ☐ **Yes**
    b. ☐ No
    c. If yes, please describe briefly the main tools and technologies (e.g. ArcGIS Server, PostGIS, web services, custom APIs).**ArcGIS, QGIS, Webservices**

20. For future broadband mapping, which model would you prefer for data exchange with NCC?
    a. ☐ **You Push data to a secure portal / SFTP / API endpoint**
    b. ☐ NCC Pulls from your API/web services
    c. ☐ Hybrid model – please describe:

21. What main **technical or security conditions** would you require for an automated interface (e.g. VPN, mutual TLS, token-based authentication, IP whitelisting, logging and audit trails)? **Token-based authentication, IP whitelisting, logging and audit trails**

C3. Validation and quality control

20. Which **automatic checks** would you want the NCC portal to perform at upload time (e.g. geometry validity, duplicates, attribute ranges, mandatory fields, topology checks such as fibre routes connecting valid nodes)? **Geometry validity, duplicates, attribute ranges, mandatory fields, topology checks**

21. How should discrepancies be handled (e.g. conflicting routes between operators, gaps at borders between datasets)? What validation workflow do you find acceptable (draft map, comment period, joint technical session)? **joint technical session**

D. Openness, Security & Use of Backbone Data

D1. Public vs restricted views

23. For backbone and metro infrastructure, which elements could be shown in a **public map** without creating significant security or commercial risks (e.g. approximate corridors, presence of fibre in an area without exact route)? **Presence of fibre in an area with exact route with type of Infrastructure (Aerial/Terrestrial) and Presence of Pop with Exact Geo location details**

24. Which data should be visible only to a **restricted community of operators and public institutions** (e.g. exact geometry of routes, manhole positions, spare duct capacity)? **Exact geometry of routes, Manhole positions, spare duct capacity, Fibre Type/Specification, Deployed Infrastructure type**

25. Which elements should remain **regulator-only** (if any)?**Type of Customers on the live fibre route**

D2. Open access and co-investment

26. How do you currently handle **requests from other operators** to use your fibre or tower infrastructure (e.g. bilateral negotiations, standard offers, long-term IRUs)? **long-term IRUs, bilateral negotiations**

27. In your view, how could a national broadband map support:
    a. **Co-investment and sharing of ducts, towers, and rights-of-way**
    b. **Reduction of unnecessary route duplication**
    c. **Protection of critical infrastructure (avoiding accidental cuts)**

28. Would you support a model where **backbone players see each other's precise infrastructure** in a restricted, login-protected view (while the public sees only aggregated information)?
    a. ☐ **Yes**
    b. ☐ No
    c. ☐ Yes, under conditions (please specify):

E. Costs, Capacity, Incentives & Governance

E1. Costs and support needs

28. Where do you expect the main **costs** for your organisation to participate in the future Broadband Mapping System:
    a. **Data cleaning and harmonisation**
    b. **System integration / APIs**
    c. Additional licences / tools
    d. **Staff time for updates and validation meetings**
    e. Other (please specify)

29. What specific support from NCC / ITU (templates, example scripts, training, reference implementations) would most reduce these costs? **Templates and Training**

E2. Capacity and training

29. What additional skills or training would be useful for your teams (GIS specialists, planners, IT staff) to fully align with the planned standards (e.g. spatial databases, metadata management, API design, data protection & security for infrastructure mapping)? **API design, data protection & security for infrastructure mapping**

E3. Incentives and governance

32. Which **incentives** would motivate you to provide timely, accurate and detailed data (e.g. access to enriched national datasets, visibility as a compliant/open-access operator, faster permit processing**)? access to enriched national datasets, visibility as a compliant/open-access operator**

33. How would you like backbone, fibre and tower operators to be represented in the **governance** of the Broadband Mapping System (e.g. permanent technical working group, backbone sub-group, annual joint review of standards)? **permanent technical working group and annual joint review of standards**

34. From your perspective, how often should structured NCC-industry meetings on broadband mapping (specifically including backbone / fibre issues) be held once the system is operational?
    a. ☐ **Quarterly**
    b. ☐ Twice per year
    c. ☐ Once per year
    d. ☐ Other – please specify:

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria.

Follow-up questions for IHS — Questions & Responses

Questionnaire for Backbone, Fibre and Tower Operators - Follow-up to Africa BB Maps (Nigeria)

Thank you again for your active participation in the 25 November follow-up meeting on Africa Broadband Mapping in Nigeria.

Your organisation plays a key role in national backbone and passive infrastructure, and your input is crucial for designing realistic standards, data-sharing models and governance arrangements.

We kindly ask you to answer the questions below as they relate to your organisation.

A. Network Inventory, Standards s Level of Detail

A1. Existing GIS inventory

1. Which main infrastructure elements are currently maintained in your GIS / mapping systems?
   - ☑ Long-haul / backbone fibre routes
   - ☑ Metro fibre routes
   - ☑ Aerial fibre on transmission lines
   - ☐ Distribution / access fibre
   - ☐ POPs / backbone nodes / data centres
   - ☑ Towers / sites (for tower companies)
   - ☑ Manholes / handholes / joints
   - ☐ Other (please specify):

2. In which formats can you currently export these datasets for NCC (e.g. KMZ/KML, Shapefile, GeoPackage, CSV, JSON)?
   - KMZ/KML/CSV

A2. Standardisation of attributes

3. For **backbone and metro fibre routes**, which 10–15 attributes should in your view be *mandatory* in a national standard schema (e.g. route ID, cable type, fibre count, status, owner, installation method, aerial/duct, construction year)?
   - Fibre type (SMF, MMF)
   - Cable capacity (24F, 48F, 96F, 144F)
   - Installation method (duct, direct buried, aerial)
   - Duct type (PVC, HDPE),
   - Number of Ducts
   - Category(Backbone or Metro)
   - Cable route
   - Cable length
   - Manhole coordinates

4. For **POPs, nodes and data centres**, which key attributes are essential (e.g. type of site, redundancy level, power backup, interconnection role)?
   - N/A

5. For **towers and co-location sites** (where applicable), which attributes are essential for broadband mapping purposes (e.g. height, load, available space, power characteristics, fibre presence)?
   - Site ID / name, Site address
   - Latitude / longitude
   - Site type (Greenfield, Rooftop, IBS)
   - Tower type
   - Tower height (m)
   - Power source (grid, diesel, hybrid, solar)
   - Fibre connected site
   - Equipment cabinet type (indoor/outdoor)

6. At what **spatial resolution** do you currently maintain your fibre and tower data (e.g. exact geometry of routes, link segments between manholes, only node-to-node lines, approximate routes)?
   - Approximate geometry of routes, Manholes and towers

B. Power Infrastructure, Aerial Fibre s Other Layers

B1. Use of transmission and distribution lines

7. To what extent does your network rely on:
   - ○ Transmission lines (e.g. 330/132 kV)
   - ✓ Distribution lines (11/33 kV)

   Please describe typical use and coverage.

8. For aerial fibre on power lines, what information do you currently have (and in what format) about the underlying power infrastructure (e.g. tower positions, line IDs, voltage level)?
   - voltage level
   - Pole coordinates
9. What data about **distribution lines** from DISCOs would be most useful for you and for a national broadband map (e.g. routes, substation locations, voltage levels), and in what format?
   - Power routes
   - substation locations
   - voltage level
   - Pole coordinates

B2. Other layers relevant for planning

10. Which external datasets, if integrated with the broadband map, would most improve your planning (e.g. roads, rail, rights-of-way, flood zones, industrial zones, government facilities)?
    - Locations of government offices/facilities, schools, hospitals, industrial zones, residential areas
    - Roads/rail tracks/Oil pipelines routes

11. Are there specific **construction permit / wayleave** processes where a centralised broadband map would help you reduce delays or cable cuts?
    - A consolidated RoW registry integrated with a centralised BB map would be very helpful.
    - This would enable relevant agencies evaluate impact on impending construction projects and mitigate possible outages. All infrastructure owners can also be auto notified of planned activities and likely disruption of services

C. Data Exchange, Automation s Validation

C1. Frequency and timeliness

12. Today, how often do you realistically update and send backbone / metro fibre data to NCC?
    - ☑ Monthly
    - ☐ Quarterly
    - ☐ Annually
    - ☐ On request only
    - Comments:

13. What reporting frequency would be **feasible** for you in a future system for:
    - Backbone routes: *[e.g. monthly / quarterly]*
    - Metro routes: *[e.g. monthly / quarterly]*
    - POPs / nodes: *[e.g. when changes occur / quarterly]*
      N/A
    - Towers / sites: *[e.g. quarterly / annually]*

C2. Automation and interfaces

14. Roughly what share of your current submissions to NCC are:
    - Generated automatically from your systems: 0 %
    - Manually prepared or edited (Excel, KMZ, etc.):100 %

15. Do you have internal **APIs or automated exports** for GIS/network data?
    - ☐ Yes
    - ☑ No
    - If yes, please describe briefly the main tools and technologies (e.g. ArcGIS Server, PostGIS, web services, custom APIs).

16. For future broadband mapping, which model would you prefer for data exchange with NCC?
    - ☑ You Push data to a secure portal / SFTP / API endpoint
    - ☐ NCC Pulls from your API/web services
    - ☐ Hybrid model – please describe:

17. What main **technical or security conditions** would you require for an automated interface (e.g. VPN, mutual TLS, token-based authentication, IP whitelisting, logging and audit trails)?
    - VPN, Token based authentication, logging and audit trails

C3. Validation and quality control

18. Which **automatic checks** would you want the NCC portal to perform at upload time (e.g. geometry validity, duplicates, attribute ranges, mandatory fields, topology checks such as fibre routes connecting valid nodes)?
    - geometry validity, duplicates, attribute ranges, mandatory fields

19. How should discrepancies be handled (e.g. conflicting routes between operators, gaps at borders between datasets)? What validation workflow do you find acceptable (draft map, comment period, joint technical session)?
    - Joint Technical Session

D. Openness, Security s Use of Backbone Data

D1. Public vs restricted views

20. For backbone and metro infrastructure, which elements could be shown in a **public map** without creating significant security or commercial risks (e.g. approximate corridors, presence of fibre in an area without exact route)?
    - Presence of Fiber in an area, routes without ownership information

21. Which data should be visible only to a **restricted community of operators and public institutions** (e.g. exact geometry of routes, manhole positions, spare duct capacity)?
    - geometry of routes / without ownership information

22. Which elements should remain **regulator-only** (if any)?
    - All submitted data

D2. Open access and co-investment

23. How do you currently handle **requests from other operators** to use your fibre or tower infrastructure (e.g. bilateral negotiations, standard offers, long-term IRUs)?
    - Longterm IRUs

24. In your view, how could a national broadband map support:
    - Co-investment and sharing of ducts, towers, and rights-of-way?
    - Can foster partnership/collaboration to leverage infra and guide informed decision for shared costing on new deployments
    - Reduction of unnecessary route duplication?
    - Visibility in existing infrastructure would encourage sharing/reuse and avoid parallel builds. Allows CAPEX to be invested in other areas without existing infrastructure
    - Protection of critical infrastructure (avoiding accidental cuts)?
    - Provides visibility into locations of critical infrastructure and the deployment of appropriate security interventions. Also allow construction factor in critical infrastructure when planned projects and limit accidental cuts

25. Would you support a model where **backbone players see each other's precise infrastructure** in a restricted, login-protected view (while the public sees only aggregated information)?
    - ☑ Yes
    - ☐ No
    - ☐ Yes, under conditions (please specify):

E. Costs, Capacity, Incentives s Governance

E1. Costs and support needs

26. Where do you expect the main **costs** for your organisation to participate in the future Broadband Mapping System:
    - ✓ Data cleaning and harmonisation
    - ○ System integration / APIs
    - ○ Additional licences / tools
    - ✓ Staff time for updates and validation meetings
    - ○ Other (please specify)

27. What specific support from NCC / ITU (templates, example scripts, training, reference implementations) would most reduce these costs?
    - Manpower development/training, regulatory frameworks and IT

E2. Capacity and training

28. What additional skills or training would be useful for your teams (GIS specialists, planners, IT staff) to fully align with the planned standards (e.g. spatial databases, metadata management, API design, data protection C security for infrastructure mapping)?

- GIS training, metadata management , data protection C security for infrastructure mapping training

E3. Incentives and governance

29. Which **incentives** would motivate you to provide timely, accurate and detailed data (e.g. access to enriched national datasets, visibility as a compliant/open-access operator, faster permit processing)?
    - access to enriched national datasets
    - visibility as a compliant/open- access operator

30. How would you like backbone, fibre and tower operators to be represented in the **governance** of the Broadband Mapping System (e.g. permanent technical working group, backbone sub-group, annual joint review of standards)?
    - Permanent Technical Working group
    - annual joint review of standards

31. From your perspective, how often should structured NCC-industry meetings on broadband mapping (specifically including backbone / fibre issues) be held once the system is operational?
    - ☑ Quarterly
    - ☐ Twice per year
    - ☐ Once per year
    - ☐ Other – please specify:

Thank you very much for your time and contribution.

Your responses will directly inform the ITU policy report and recommendations on broadband mapping, data governance and infrastructure sharing for Nigeria.