International Telecommunication Union
Development Sector

Africa-BB-Maps Regional Event & Baseline Assessment Report

June 2025

ACKNOWLEDGEMENT

The "Africa-BB-Maps Regional Event - Assessment Report" was developed by the International Telecommunications Union (ITU) Africa Broadband Mapping System (Africa-BB-Maps) project team, in close collaboration with the ITU Regional office for Africa and the ITU Office for Europe.

Special recognition is given to the key contributors from the participating countries of the series of case studies from African (Benin, Botswana, Burundi, Côte d'Ivoire, Ethiopia, Kenya, Malawi, Nigeria, Uganda, Zambia, Zimbabwe) and European (Croatia, Cyprus, Denmark, France, Italy, Lithuania, Poland) countries. Their detailed case studies and thorough analysis have provided a comprehensive understanding of the broadband mapping efforts and challenges in their respective regions.

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1. Introduction and General Overview

The Africa-BB-Maps Regional Event, held on 26-27 March 2025 in Abidjan, Côte d'Ivoire, represented the first milestone toward the implementation of Africa-BB-Maps. This event was co-organized by the ITU Telecommunication Development Bureau (BDT) and ARTCI of Côte d'Ivoire, bringing together the eleven beneficiary countries, committed to advancing digital infrastructure mapping at the national level. The gathering launched the implementation phase of the project, a four-year, €15 million initiative designed to establish or strengthen national broadband mapping systems in eleven African countries in Sub-Sahara, necessary to identify connectivity gaps, inform policy decisions, and attract targeted investments.

This regional event brought together 75 participants, both onsite and remotely, including national regulatory authorities (NRAs) from both Africa and Europe, policymakers, technical experts, and representatives from international organizations. The event's primary objectives were to share best practices from Africa and Europe in the field of broadband mapping, assess the current state of mapping efforts in the African beneficiary countries, introduce ITU's suite of tools and services, and facilitate co-creation sessions to start pinpointing what would be necessary for the upcoming national event discourse and rollouts. Beyond these technical aims, the event served as a critical platform for initiating the first African European network of broadband mapping system experts between the African and European NRAs, setting the stage for sustained collaboration over the next three years across Europe and Africa.

Figure 1: Official group photograph (Source: the Africa-BB-Maps project team)

Spanning two days, the agenda was structured to progress from high-level vision-setting to national case studies. It commenced with an opening ceremony featuring representatives from the Host country's ministry and the national regulatory authority, the European Union (EU), and the ITU. This was followed by sessions that contextualized broadband mapping's role in digital transformation, detailed the Africa-BB-Maps project, and explored 19 case studies from both the African and European continents. The second day focused on practical tools developed by the ITU and proposed collaborative planning for the national rollouts.

This report captures and summarizes each session, presenting the essential points and narratives that reflected each intervention and insights. Through this account, readers will gain a deep understanding of the roll out of this Regional Event that launched Africa-BB-Maps.

2. Opening Ceremony

Title	Opening Ceremony
Objective	To officially launch the Africa-BB-Maps Regional Event, set the tone with high-level remarks, and emphasize the collaborative spirit and significance of broadband mapping for Africa's digital transformation.
Key Participants	Mr. Guy Michel Kouakou (Master of Ceremonies, ARTCI), Mr. Lakoun Outtara (ARTCI), Mr. Hans Christian Stausbøll (European Commission), Mr. Cosmas Luckyson Zavazava (ITU), Mr. Ekissi Narcisse (Ministry of Digital Transition and Digitalisation of Côte d'Ivoire).

The Africa-BB-Maps Regional Event started with the opening ceremony that set the collaborative tone for the two days ahead. The session was moderated by Mr. Guy Michel Kouakou, Director of Telecommunications Regulations at ARTCI Côte d'Ivoire. The ceremony featured a series of high-level interventions, each underscoring the event's importance and the broader implications of the Africa-BB-Maps project.

Mr. Lakoun Outtara, Director General of ARTCI, opened the proceedings with his welcome, expressing Côte d'Ivoire's honour in hosting this event. He spoke of the nation's ambition as a digital hub in West Africa and its commitment to leveraging broadband mapping to enhance connectivity, stimulate economic growth, and improve quality of life. His address highlighted the practical stakes of the initiative, framing it as a catalyst for national and regional development, and his pride in ARTCI's partnership with ITU and the EU.

This was followed by the video-intervention of Mr. Hans Christian Stausbøll, Acting Director for Africa at the European Commission's DG INTPA, took the floor, introduced by Ms. Laura Desmoulin of the EU Delegation in Côte d'Ivoire. Mr Stausbøll elaborated on the European Union's strategic investment in the Africa-BB-Maps project, placing it within the Global Gateway initiative's strategy to foster sustainable infrastructure worldwide. His remarks emphasized the EU's commitment to connectivity as a cornerstone of socio-economic progress, noting that the €15 million investment reflects a long-term partnership between the ITU and EU for Africa, aiming at empowering African member states to bridge the digital divide through data-driven solutions.

The next intervention was a keynote address from Dr. Cosmas Luckyson Zavazava, Director of the ITU's Telecommunication Development Bureau (BDT). He presented the work of ITU and ITU-D on how to achieve universal meaningful connectivity, using the example of Africa-BB-Maps as a project that helps to achieve that. He stressed that broadband mapping is not merely a technical exercise but a transformative tool for policymakers, investors, and communities, enabling them to address disparities and unlock digital potential. His call to action highlighted that Africa-BB-Maps starts with eleven beneficiary countries, but upon completion of this first series, aims at opening to other countries in Africa and beyond.

The last high-level intervention was delivered by Mr Ekissi Narcisse, the chief of staff of the Ministry of Digital Transition and Digitalisation, representing the Office of Mr. Kalil Konate, Côte d'Ivoire's Minister for the Digital Transition and Digitalisation. This intervention outlined his government's digital agenda, emphasizing broadband mapping's role in ensuring equitable access and resilient infrastructure in Cote d'Ivoire. He reaffirmed Côte d'Ivoire's commitment to lead by example, recognising Africa-BB-Maps as an important project that can play a key role to advance digital transformation at both the national and regional levels, by creating bridges and establishing collaboration across the countries in the region.

Following the opening ceremony, all participants gathered for the official group photo. A coffee break followed, providing space for informal exchanges—an essential element in fostering the cross-continental network of broadband mapping experts that Africa-BB-Maps aims to build between Europe and Africa. This opening ceremony not only marked the formal launch of the Africa-BB-Maps initiative but also reestablished the commitment among all stakeholders to work towards the implementation of Africa-BB-Maps.

Figure 2: Opening Ceremony Photograph (Source: the ITU project team)

3. The Role of Broadband Mapping for Universal Meaningful Connectivity and Digital Transformation

Title	**Setting the Stage: The Role of Broadband Mapping for Universal Meaningful Connectivity and Digital Transformation**
Objective	To provide a strategic overview of broadband mapping's importance in achieving connectivity goals and driving digital transformation, drawing on global and regional perspectives.
Key Participants	Moderator: Mr. Guy Michel Kouakou (ARTCI); Speakers: Mr. Jaroslaw Ponder (ITU Europe), Mr. Emmanuel Manasseh (ITU Africa), Mr. Tonko Obuljen (BEREC).

Figure 3: Speakers of setting the stage (Source: the ITU project team)

The first session of the Africa-BB-Maps Regional Event, moderated by Mr. Guy Michel Kouakou of ARTCI, introduced the core theme of broadband mapping. It aimed to define a shared reference for the discussions ahead, focusing on the role of mapping in supporting connectivity and digital infrastructure planning. Three speakers were invited to share their insights: Mr. Jaroslaw Ponder (ITU Europe), Mr. Emmanuel Manasseh (ITU Africa), and Mr. Tonko Obuljen (BEREC).

Mr. Jaroslaw Ponder, Head of the ITU Office for Europe, delivered the first presentation, outlining the European experience in this area. He began by showing the progress of internet use in Europe. As of 2024, 91% of individuals use the internet, compared to the global average of 68%. Urban areas in Europe reach 93% usage, while rural areas reach 86%, indicating a smaller divide than global figures. Mobile broadband subscriptions exceed 112 per 100 inhabitants, with fixed broadband at 37 per 100—higher than global averages. The data also revealed variation between countries. Northern and Western European countries show higher connectivity levels, while some Eastern and Southeastern countries are still progressing.

Mr. Ponder described how Europe's approach evolved through a mix of regulation, planning, and data collection. Broadband mapping started as a tool to monitor infrastructure but now supports broader objectives across the European NRAs. It helps identify underserved areas, guides investments, and promotes market transparency. He presented coverage data showing that 97% of Europe's population lives within 50 km of a fibre node, and 88% within 25 km.

He then outlined Europe's regulatory framework. The European Union and BEREC play key roles in standardizing rules and supporting implementation across member states. Key legislative milestones include the 2013 EU Guidelines on State Aid for Broadband, the 2014 Broadband Cost Reduction Directive, the 2018 European Electronic Communications Code (EECC), and the 2024 Gigabit Infrastructure Act. Each policy includes provisions related to broadband mapping and data use.

Particular attention was given to Article 22 of the EECC, which mandates national surveys of broadband coverage and projections for Very-High-Capacity Networks (VHCN). These surveys must be updated every three years. BEREC's guidelines support this work by specifying methods, data sources, frequency, and confidentiality measures.

The presentation continued with highlights on the mobile network coverage. In the European region, 5G is expanding quickly, particularly in urban areas, while rural areas still rely more on 4G. The European region has reached 99% coverage with at least 4G. The difference between urban and rural 5G availability was noted, with rural Europe at 46%, compared to 81% in urban areas.

The Gigabit Infrastructure Act, which is due to come into force in November 2025, aims to remove administrative barriers. It introduces single information points for civil works and requires no national transposition, making it directly applicable across EU member states. BEREC is assigned to coordinate implementation and issue guidelines.

Mr. Ponder then focused on concrete examples of technical assistance delivered by the ITU Office for Europe: over the past five years, the ITU Office for Europe has supported Albania, Moldova, and Bosnia and Herzegovina at various phases of broadband mapping systems development. These examples illustrate how ITU's broader series of policy analysis is complemented by practical work, across the Europe region and beyond.

To close, Mr. Ponder referenced the 2024 Compendium of Case Studies from the EMERG and EaPeReg regions. It collects examples from 18 countries and offers documentation of methods and lessons learned. These resources are meant to support other regions in building or improving their mapping systems.

The session linked Europe's broadband outcomes to its regulatory and technical strategies, showing how structured mapping practices can support national and regional connectivity goals. While acknowledging different contexts, the presentation offered data, policy instruments, and implementation tools that can inform planning in Africa and elsewhere.

Dr. Emmanuel Manasseh, ITU Regional Director for Africa, followed with a focused overview of the broadband landscape in Sub-Saharan Africa, linking regional challenges to the strategic aims of the Africa-BB-Maps project. His remarks addressed both progress and persistent obstacles in the region's digital transformation, emphasizing the structural role of broadband mapping in enabling effective policymaking.

He began by noting the substantial growth in mobile broadband coverage over the last decade, which has extended access to millions of people. However, this expansion remains uneven. Large gaps persist between urban and rural areas, where coverage is often incomplete or non-existent. Even in covered regions, affordability and service quality are inconsistent, limiting the actual use of available networks. These disparities are not always visible through high-level statistics, which tend to average out differences. To address this, Dr. Manasseh positioned broadband mapping as an essential tool to make gaps visible, quantify underserved populations, and help governments prioritize infrastructure investments.

The Africa-BB-Maps project was presented as a direct response to these needs. It also outlined the project's dual objectives: first, to implement eleven broadband mapping systems in each beneficiary country, and second to promote stakeholder engagement and structured feedback loops, which in return would help to create a regional knowledge-sharing space for mapping methodologies, tools, and lessons learned. These activities aim to support countries in generating accurate and usable data that can inform regulation, investment planning, and public-private coordination.

He then continued with a question "Can a map tell the story?" to introduce the function of mapping in revealing infrastructure gaps that are otherwise difficult to detect. Broadband maps allow planners to avoid redundant investments, improve the allocation of public funds, and identify priority zones. They also serve as a basis for more targeted policies, moving away from generalized strategies that may not address specific local needs.

Dr. Manasseh referred to mapping as a public good that should be regionally integrated. This framing emphasizes the role of shared standards, interoperability, and collaborative platforms. He concluded by noting that Sub-Saharan Africa continues to have the widest digital coverage gap globally. Africa-BB-Maps, by building validated and accessible mapping data from the national regulatory authorities, seeks to shift this trend by empowering national and regional actors to design more informed and inclusive digital strategies. His intervention linked high-level policy objectives with technical implementation, reinforcing the idea that data visibility directly translates into policy effectiveness.

The final speaker of the session, Mr. Tonko Obuljen, Vice Chair of the Body of European Regulators for Electronic Communications (BEREC), concluded the panel by offering a regulatory perspective grounded in European practice. His remarks brought a structured and institutional lens to the discussion, highlighting how sound regulatory frameworks can enable effective broadband mapping while supporting innovation and accountability.

Mr. Obuljen began by outlining BEREC's central guiding principle: harmonization. Across the European internal market, regulators apply standardized methodologies for data collection, network characterization, and coverage verification. This common approach ensures that mapping outputs are consistent and comparable across borders, enabling coordinated policy responses and regional oversight.

Mr. Obuljen explained that in Europe, operators are legally mandated to report network data at regular intervals. Compliance is not optional—non-adherence triggers penalties, and all submitted data undergoes verification. These mechanisms, he noted, foster a system where regulatory obligations are clear and consistently enforced. Crucially, much of the resulting data is made publicly accessible, enhancing transparency and allowing civil society, market actors, and policymakers to monitor progress and identify service gaps.

Mr. Obuljen emphasized that this model should not be seen as a rigid template, but rather as an example of how regulation can create space for technical advancement. By establishing legal clarity and institutional capacity, European regulators have been able to support new innovations such as 5G coverage mapping and the integration of geospatial forecasting tools—without compromising trust or oversight.

In his concluding remarks, Mr. Obuljen stressed that for broadband mapping to be truly effective, it must be both technically robust and institutionally anchored. The European experience, he suggested, offers valuable lessons for African regulators aiming to institutionalize broadband mapping: particularly the importance of regulatory rigor, operational discipline, and public transparency. Balancing innovation with legal structure, and flexibility with enforcement, is essential to building systems that deliver long-term value and stakeholder trust.

4. Africa-BB-Maps project objectives and expected outcomes

Title	SESSION1: Presentation of the Africa-BB-Maps project objectives and expected outcomes
Objective	To outline the Africa-BB-Maps project's goals, structure, and anticipated impacts, providing a roadmap for its implementation in beneficiary countries.
Key Participants	Moderator: Mr. Emmanuel Manasseh (ITU Africa); Speakers: • Ms. Halima Letamo (ITU Area Rep. for Southern Africa), • Mr. Elind Sulmina (ITU, Africa-BB-Maps).

Figure 4: Speakers of session 1 (Source: the ITU project team)

The session moderated by Emmanuel Manasseh introduced the Africa-BB-Maps project in depth, with Halima Letamo and Elind Sulmina presenting its structure, methodology, and intended outcomes. The presentation aimed to clarify the project's operational logic, institutional partnerships, and technical roadmap, reinforcing its alignment with Africa's broader digital transformation agenda.

Ms. Letamo framed the initiative within the ITU's efforts to strengthen national regulatory frameworks through structured broadband mapping. The project is funded by a €15 million EU investment and implemented by ITU as the technical agency over a four-year period and targets eleven Sub-Saharan countries: Benin, Botswana, Burundi, Côte d'Ivoire, Ethiopia, Kenya, Malawi, Nigeria, Uganda, Zambia, and Zimbabwe. The selection was based on institutional proactive interest expressed during the ITU call at the Global Symposium for Regulators in 2022, geographical distribution, and alignment with the EU's Global Gateway investment strategy. The three primary objectives are: developing or strenghtening national mapping systems that integrate infrastructure and service mapping, investment an demand mapping would be a plus; reinforcing the capacity of national regulatory authorities; and promoting the use of data for investment and policy formulation.

Mr. Sulmina provided a detailed explanation of the implementation methodology, structured into three progressive stages (initial, medium, and advanced) across an eight-step framework. Each country begins with a baseline assessment to identify policy, regulatory, and technical gaps. This is followed by designing, updating, or strengthening new or already established mapping systems tailored to national needs. These mapping systems include data integration across three layers: physical infrastructure (e.g. fibre, towers), service availability (e.g. coverage, technology), and quality metrics (e.g. speed, latency). International and European expert teams—comprising legal, policy, and engineering profiles—will compose the ITU Teams of experts who will support the project throughout its lifecycle.

Capacity building is integrated into all phases, starting with basic training and progressing to advanced certification via the ITU Academy. Technical support extends from design of technical specifications, procurement of hardware and software, installation to post-implementation assistance. In parallel, the project will promote knowledge exchange through national and regional communities of practice, culminating in peer learning and trend monitoring across the region.

The expected outputs fall into three categories: policy and regulatory support, open-source and open data mapping solutions, and structured technical assistance. The 2025–2028 timeline foresees baseline work and assessments in the first year and planned procurement for those countries at the advanced stage, mapping system setup in the second, training and refinement in the third, and final consolidation in the fourth.

The session emphasized that Africa-BB-Maps is not limited to technical delivery. It seeks national ownership, to enhance regulatory agility, improve transparency, and build conditions for targeted public and private investment. National ownership is a core feature of the model, balanced with regional harmonization to enable future integration of cross-border connectivity strategies. Questions from participants addressed practical concerns such as limited capacity and resistance from operators. The ITU project team explained how the project's flexible and modular design, combined with support from ITU regional and global service, would allow adaptation to different national contexts.

5. Best practices & Case studies of broadband mapping in Slovenia, France, Italy, and Poland

Title	SESSION2: Best practices & Case studies of broadband mapping in Europe (1)
Objective	To share detailed case studies from European countries highlighting diverse approaches to broadband mapping.
Key Participants	Moderator: Mr. Jaroslaw Ponder (ITU Europe); Speakers: • Slovenia (Mr. Marko Simoncic, Mr. Gregor Baliž), • France (Mr. Antoine Samba), • Italy (Mr. Aldo Milan), • Poland (Mr. Marcin Adamowicz).

Moderated by Mr. Jaroslaw Ponder, this session offered the audience with the first series of case studies from the European Countries participating to the Regional Event, featuring detailed case studies from Slovenia, France, Italy, and Poland. Each presentation provided a narrative of strategies, challenges, and outcomes, offering the audience a clear understanding of the work carried out at the national level in each European country to arrive today to a successful broadband mapping system capable of continuously producing public available validated data.

Figure 5: Beginning of session 2 in Abidjan, Côte d'Ivoire (Source: the ITU project team)

The presentation by Mr. Marko Simončič and Mr. Gregor Baliž from Slovenia's Agency for Communication Networks and Services (AKOS) provided a detailed account of the country's broadband mapping system. Their intervention highlighted how regulatory obligations, technological integration, and public transparency have been combined into a structured, enforceable, and widely accessible national platform, serving Slovenia's 2.1 million citizens.

They began by situating Slovenia's system within its legal and institutional framework. Under the Electronic Communications Act, all Slovenian and international telecom operators are required to submit quarterly updates detailing their infrastructure and service coverage. The scope of reporting includes fibre lines, mobile base stations, bandwidth speeds, and technology types. Non-compliance leads to significant penalties ranging from €50,000 to €400,000, depending on company size, and AKOS supervises enforcement. This framework has led to high reporting compliance and strong data consistency.

At the operational level, Slovenia's geoportal, launched in 2019 and enhanced in 2023 with a mobile interface, serves as the public face of their national broadband mapping system. It integrates over 110 data layers, covering fixed and mobile infrastructure, postal and railway networks, as well as broadband service availability and user demand. The platform is built with real-time and daily updates, and it is open to all users, including citizens, regulators, and operators. It also offers public APIs and analytical tools, enabling use by various government agencies and private actors.

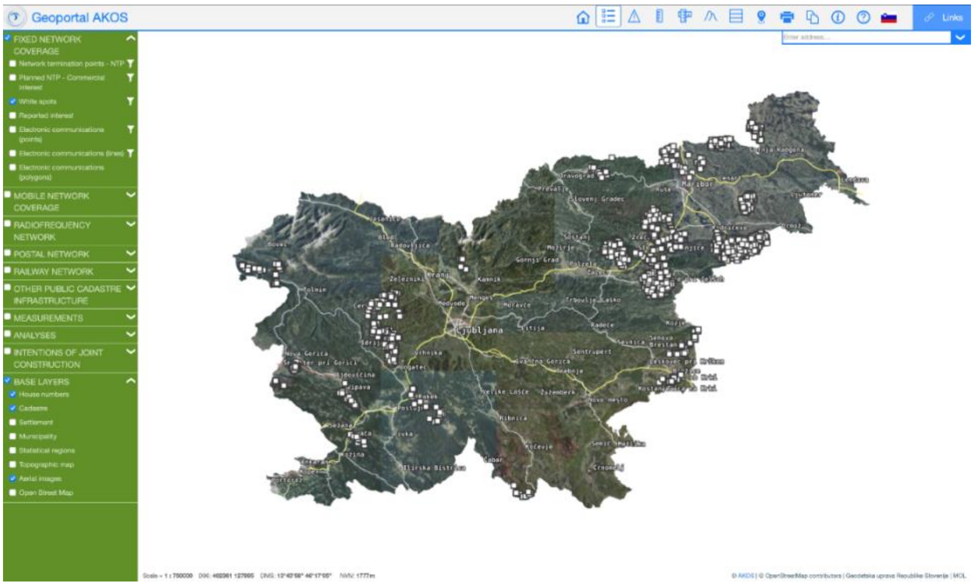

Figure 6: Map of fixed network whitespaces on AKOS' geoportal (Source: https://gis.akos-rs.si/)

One of the key elements discussed was the inclusion of crowdsourced data. Users can submit service quality reports through a mobile app, which are cross validated against operator submissions. This two-way data input strengthens accuracy and public trust, while providing a mechanism for direct feedback on service performance.

The system is designed to manage four types of mapping: infrastructure, service, investment, and demand. Infrastructure mapping focuses on fixed broadband assets, including fibre and copper lines. Service mapping captures the retail layer—prices, service types, and availability. Investment mapping documents both planned and completed rollouts, identifies funding sources, and flags areas targeted for joint construction. Demand mapping incorporates data from users, including complaints, coverage issues, and interest in new services. These layers collectively provide a full view of the broadband ecosystem, allowing for data-informed regulation, subsidy planning, and market supervision.

In describing the system's evolution, Mr. Simončič noted that earlier versions relied on manual reporting and had challenges related to format harmonization and operator cooperation. These issues were addressed through step-by-step upgrades and AKOS-led technical support. Automation introduced in 2020 improved reporting speed and reduced human error. For rural areas, where coverage validation is more complex due to terrain, AKOS partnered with municipalities to verify data and extend reach.

5.1. France

5.1.1. FRATEL

Mr. Antoine Samba delivered a presentation from the Francophone network of telecommunications regulators (FRATEL) on a regional approach to mobile service regulation based on data collection, visualization, and public access in the field of broadband mapping. Framed around a tool co-developed by FRATEL and Qosi with funding from the Agence Française de Développement, the intervention positioned data-driven regulation as a method to complement existing oversight mechanisms.

The initiative began in 2019 with the publication of best practices for visualizing mobile network coverage and quality of service (QoS). The underlying objective was to provide users with accurate, practical information while supporting national regulators in improving oversight. This model aims to align consumer transparency, public policy planning, and market regulation through a common digital tool.

The development of the platform was structured around three design questions: what metrics to measure, for what policy or market objective, and how to present the data. These questions guided the technical scope and interface design. The tool itself—hosted online—aggregates coverage and performance data, offering access to both regulatory bodies and the general public. Pilot countries include Cameroon, Côte d'Ivoire, Guinea, Madagascar, Congo, Senegal, and Togo. Deployment was planned for 2024, with several countries already showing preliminary impacts.

In Côte d'Ivoire, a national mobile coverage site was launched. Madagascar used the platform as a basis for issuing a call for tenders to conduct new measurement campaigns. Cameroon is assessing the feasibility of a nationwide platform. Senegal, where the tool is publicly available, experienced increased attention from mobile operators toward service quality. Togo integrated the platform into its regulatory strategy, using it to inform decisions and stakeholder dialogue.

Despite positive outcomes, several challenges remain. The participating regulators operate with varying levels of technical capacity, and many rely on external support to manage mapping tools or conduct data analysis. Funding cycles also present constraints, particularly with AFD financing set to end in 2024. This shift will require each authority to secure its own funding to maintain and expand platform use. The presentation underscored the importance of ongoing training and the need for institutional independence in managing and using broadband data.

Looking ahead, the project will focus on knowledge exchange among FRATEL members and continued support from the network's executive secretariat. Training activities will continue, and emphasis will be placed on integrating these tools into national regulatory practices beyond the pilot phase.

5.1.2. ARCEP

Mr. Antoine Samba continued by presenting ARCEP France's work on broadband mapping system as an example of regulation built on data-driven enforcement: serving more than 66 million citizens, the French model operates on the principle that public access to precise information can influence operator behaviour, guide investment, and support more informed policymaking. Instead of prescribing detailed rules, ARCEP's approach uses data to expose gaps, compare performance, and create incentives for improvement.

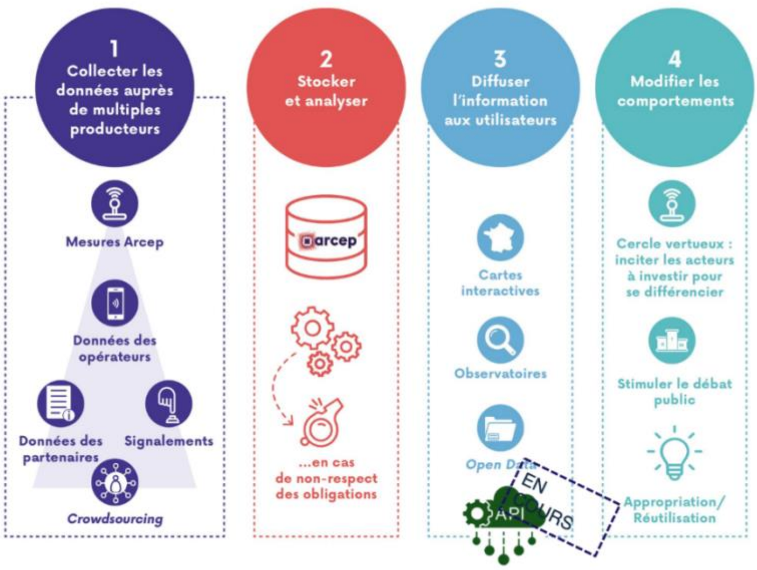

Figure 7: ARCEP's "data-driven regulation" framework (Source: ARCEP presenter's Slides)

He described the system's two main platforms: *monreseaumobile.fr*, launched in 2017 for mobile coverage, followed by *cartefibre.arcep.fr* for fixed fibre deployments. These tools provide users with interactive, address-level visibility into service availability and performance. For example, mobile users can verify 4G or 5G coverage at specific locations, while fixed-line users can check fibre access and available speeds per address or municipality.

These platforms are updated quarterly with operator-submitted data, which includes infrastructure location, service coverage, and quality indicators. ARCEP processes and verifies these inputs, applying both internal analysis and public feedback mechanisms, including field audits and crowdsourced speed test reports.

The regulatory function of the platforms is embedded in their design. By making performance public, ARCEP encourages investment through reputational pressure. The model assumes that consumers, local authorities, and competitors will use the data to push for better services, which in turn motivates operators to expand or improve coverage. This cycle—investment, innovation, improved service, user feedback, and further investment—is central to France's "data as regulation" concept.

Mr. Samba illustrated how transparency has practical outcomes. The system includes policy tracking tools like the *New Deal Mobile* dashboard, which monitors compliance with 4G deployment obligations by region and operator. Public access is supported by open APIs and downloadable datasets, which allow third parties to build their own analysis or services. Some operators even use publicly available data to promote their networks.

In closing, he framed France's strategy as indirect but effective: rather than relying on sanctions, ARCEP relies on legal obligations and cooperation between ARCEP, operators and civil society. The data-driven approach makes market performance visible and comparable, creating space for intervention without heavy-handed enforcement.

5.2. Italy

Mr. Aldo Milan from Italy's communications regulator, AGCOM, presented the country's broadband mapping system as a tool designed to address both the technical and policy dimensions of connectivity. Broadband map enables fine-grained monitoring of infrastructure, service availability, and speed estimates at the level of individual buildings, supporting a wide range of regulatory, planning, and market functions.

Mr. Milan opened by framing the national context. Italy's 59 million inhabitants are spread across a complex geography that includes dense metropolitan areas and remote rural zones. AGCOM launched broadband maps in 2015 to provide policymakers, regulators, and users with a consistent, address-level picture of connectivity. The system integrates operator-submitted data with modelled performance metrics, underpinned by a geocoding framework that links spatial coordinates with formal addresses.

He described the system's architecture as a modular combination of commercial and open-source components, layered across application, platform, and infrastructure levels. It includes ESRI's ArcGIS for spatial mapping, AWS cloud services for processing and storage, custom-built Android apps for mobile access, and PostgreSQL/PostGIS for open-source spatial data handling. This structure allows AGCOM to update or adapt specific parts of the system without replacing the whole architecture—a strategy that has reduced long-term costs and enhanced flexibility.

A central design element is the geolocation system, which uses both spatial grid-coding and toponymic address coding. This dual system allows the Italian BBmap to align technical infrastructure maps with administrative and retail service data. Mr. Milan traced the evolution of this framework, starting with simple address-to-coordinate conversion, then adding unique address codes to reduce disputes in regulated markets and finally developing a full grid-based overlay to support national voucher schemes and infrastructure subsidy programs.

He made a clear distinction between two data layers: infrastructure mapping and service mapping. Infrastructure data (such as manholes, ducts, and fibre backbone routes) is treated as sensitive and only used for internal planning and regulatory oversight. Service data—such as available technologies, speeds, and retail pricing—is published through a public-facing interface. This distinction ensures that operators' commercially sensitive information is protected, while consumers and local governments still benefit from transparency.

The Italian broadband mapping system's ability to estimate available speeds is tailored to access technology. For FTTC (VDSL), models account for distance from the street cabinet and signal attenuation. For FTTH (GPON), the system uses shared capacity models that factor in user load on the same splitter. For 5G, simulations combine signal strength, congestion, and device density to estimate performance in real-world conditions. Mr. Milan emphasized that this modelling is essential: not only for consumer information, but also for assessing whether areas meet the thresholds required for subsidy eligibility or regulatory obligations.

The Italian broadband mapping system supports three main functions. For regulation, it identifies underserved areas, monitors compliance with rollout targets (especially in the context of copper switch-off by 2030), and guides universal service assessments. For planning, it assists municipalities in aligning digital infrastructure projects with actual needs, promoting coordination and shared investments. For market transparency, it informs consumers about the services available at their address and enables comparison of offers, promoting fair competition.

5.3. Poland

Mr. Marcin Adamowicz of Poland's Office of Electronic Communications (UKE) concluded the session with a comprehensive presentation of Poland's broadband infrastructure mapping system, placing emphasis on rural connectivity. In a country of 38 million where approximately 40% of the population resides in rural areas, bridging the digital divide was a challenge. Poland's mapping efforts, launched in 2010 and systematically upgraded, are positioned as a an instrument for guiding both public and private broadband deployment, with a strong focus on underserved zones.

Poland's broadband mapping is supported by two key entities: the Ministry of Digital Affairs, which manages the SIDUSIS platform for fixed-line coverage visualization, and UKE, the national regulatory authority responsible for the broader telecommunication register and the "PIT" (Information Point on Telecommunications) data collection system. These institutions operate under a shared legal framework but manage different databases. UKE is formally independent and supervised by the Minister, though its coordination with the Ministry ensures consistency across regulatory and strategic planning efforts.

SIDUSIS collects operator-reported data at the address level and makes it available to the public through the portal internet.gov.pl. Operators declare their coverage and service parameters, which are visualized through interactive maps. A national heatmap showing households passed by networks offering speeds of at least 300 Mbps illustrates the spatial variation in connectivity. This system supports transparency, providing data to citizens, policymakers, and private stakeholders alike. This system also enables, for example, the identification of "white areas" - i.e. areas with no access to NGA (Next Generation Access) networks offering speeds above 30 Mbps.

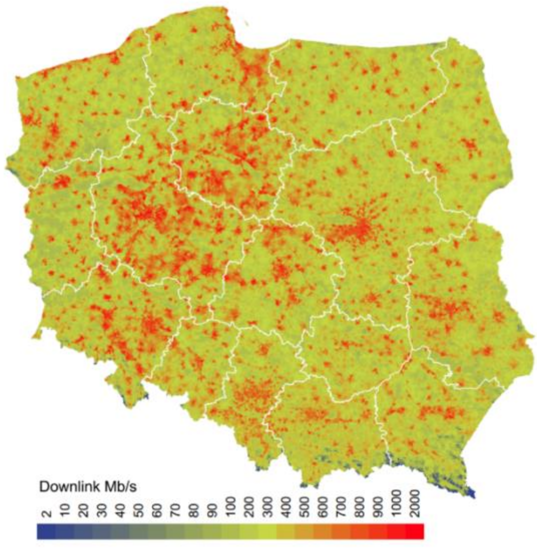

Figure 8: Map showing the downlink speeds in Poland (Source: Poland's presenter's Slides)

UKE's responsibilities are anchored in Poland's updated telecommunications legislation, notably the law of 12 July 2024 and Articles 29c and 29d of the "Mega Act." This legislation defines the scope of the telecommunication register, including technical infrastructure, technical channels, road lane occupying fees, and reporting obligations. The registry must be kept current, with some data (such as road lane fees) updated continuously and others, like infrastructure rollout plans, on an annual basis. More than 4,000 entities that own telecommunication infrastructure or provide internet access service are subject to registration. Operators must submit applications electronically, with UKE providing confirmation within 10 working days.

The telecommunication register serves as a compliance database but also as a strategic platform. It records media types, technologies, operator identities, network ranges, and future investment plans. This data is visualized in geospatial formats through an online portal (PIT), where users can filter by infrastructure type, and operator. It supports investment coordination, market analysis, and public subsidy planning.

Mr. Adamowicz also discussed the MKP tool (Network Planning and Cost Estimation Application), developed by UKE to simulate fibre network deployments and estimate both investment and operational costs. The tool integrates directly with the telecom register and allows users to model various rollout scenarios, considering technology types, route planning, user density, and cost structures. Planners can compare multiple scenarios side-by-side, calculate materials and labour costs, and simulate the financial outcomes of different infrastructure strategies. This is especially valuable for municipalities planning public-funded interventions or for operators conducting business case analyses.

While the mapping system offers high-resolution data and powerful planning tools, challenges persist. These include inconsistent data submissions, excessive technical detail, gaps in operator reporting, and limited proficiency with GIS vector data formats.

Despite these challenges, the system has demonstrated measurable impact. Broadband mapping tools, integrated with public data and decision-making frameworks, have helped direct EU and state aid where needed most, identify overlapping infrastructure, and supported regulatory enforcement, such as overseeing the implementation of the EU Gigabit Infrastructure Act, the SMP (Significant Market Power) designations at the local level, as well as supporting the wholesale broadband market.

6. Posture of broadband mapping in Côte d'Ivoire, Zambia, Uganda, Botswana, Zimbabwe, Kenya

Title	SESSION 3: Posture of broadband mapping in the beneficiary countries (1)
Objective	To present the current state of broadband mapping in six African beneficiary countries, highlighting progress, challenges, and needs to inform the Africa-BB-Maps project.
Key Participants	Moderator: Emmanuel Manasseh (ITU Africa) Speakers: • Côte d'Ivoire (Paule Renée Lasme), • Zambia (Oswald Kooma), • Uganda (Rebecca Mukite), • Botswana (Tebogo Ketshabile), • Zimbabwe (David Madondo), • Kenya (Paul Kiage).

Figure 9: Speakers of session 3 (Source: the ITU project team)

Moderated by Mr. Emmanuel Manasseh, the session on the posture of broadband mapping systems in Africa shifted focus to the continent's implementation realities, with six beneficiary countries sharing insights from their national experiences: Côte d'Ivoire, Zambia, Uganda, Botswana, Zimbabwe, and Kenya.

After each country's presentation, an excerpt from the survey results specific to the country is presented graphically. For more details on the maturity matrix, see Annex 1.

6.1. Côte d'Ivoire

Côte d'Ivoire's presentation, delivered by Ms. Paule-Renée Lasme, Head of the Market Regulation Department at ARTCI, centred on the country's broadband mapping platform, *cartodonnees.artci.ci*. The presentation traced the development, functionalities, and perspectives of the platform within the framework of ARTCI's regulatory strategy and the broader Africa-BB-Maps initiative.

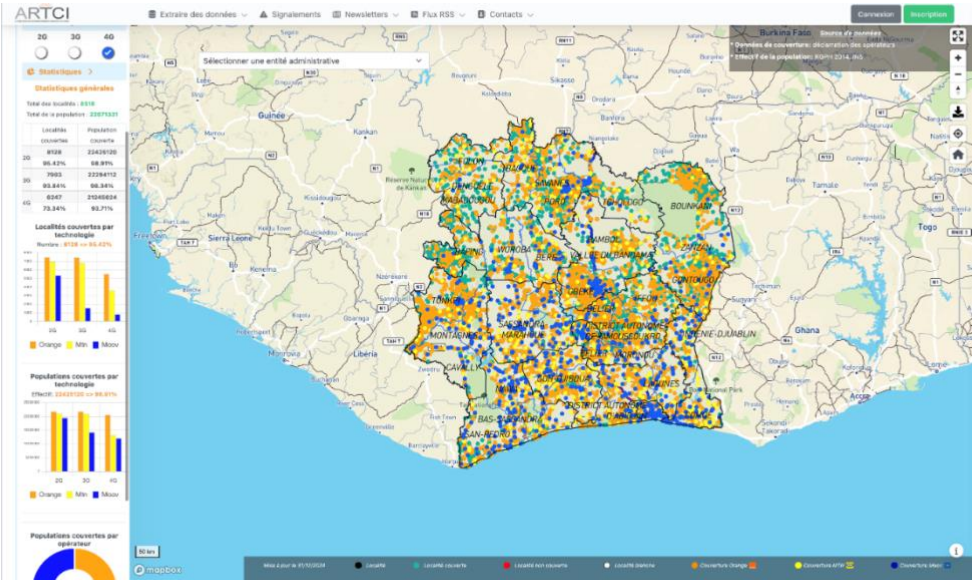

Figure 10: Mobile broadband coverage of the three national operators in Côte d'Ivoire (Orange, Mtn, Moov) (Source: https://cartodonnees.artci.ci/)

The platform, launched by ARTCI in 2023 for Côte d'Ivoire's 31.9 million citizens, responds to specific regulatory challenges faced in Côte d'Ivoire's telecommunications sector. The need for such a system arose from the difficulty of analysing large volumes of fragmented data, and the limited engagement of stakeholders in the regulatory process. ARTCI thus noted that at the time, understanding and interpreting broadband development data was a challenge. These obstacles shaped the decision to institutionalize a centralized and accessible mapping tool to consolidate, analyse, and disseminate broadband infrastructure and service information.

The logic underpinning Côte d'Ivoire's broadband regulation is the same as presented by the FRATEL and ARCEP representative from France (data-driven regulation). It is centred on a structured data cycle: collection, analysis, dissemination, and behavioural influence. The presentation outlined how data is gathered through four main sources: regulator-led measurements, operator-submitted data, contributions from technical partners, and user-driven crowdsourcing. Once collected, data is analysed and integrated into regulatory assessments, with specific attention to operator compliance and performance gaps. ARTCI then publishes the processed data via an open-access interface, supported by observatories, interactive maps, and APIs. This transparency aims to produce a regulatory environment where operator behaviour can be shaped by public visibility, institutional accountability, and user feedback.

Looking ahead, ARTCI outlined several planned improvements. The observatory will be expanded to include fixed broadband coverage, and commercial service offers from providers. Côte d'Ivoire's *cartodonnees.artci.ci* is currently a critical instrument for national broadband planning, regulatory enforcement, and data transparency. The system is rooted in a regulatory logic that prioritizes evidence-based policy, cross-referenced validation, and open access to information.

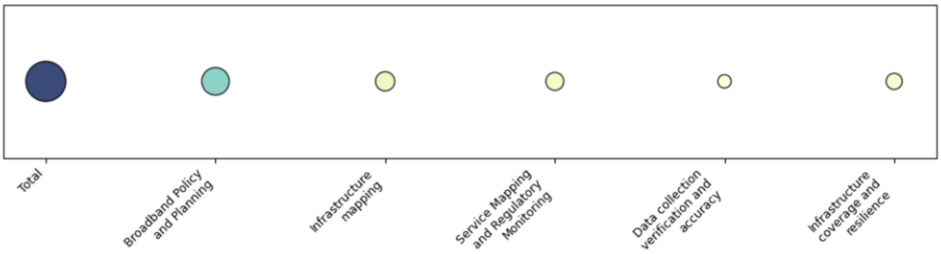

Figure 11: Overview of the survey answers of Côte d'Ivoire, area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

6.2. Zambia

Mr. Oswald Kooma, representing the Zambia Information and Communications Technology Authority (ZICTA), presented Zambia's current efforts to increase broadband penetration, with a national target of 70% by 2025 and 80% by 2030.

The presentation began by establishing Zambia's national context: a landlocked country of approximately 20 million people, spanning over 750,000 square kilometres, with economic activities concentrated in mining, agriculture, and tourism. Broadband delivery is supported through a mix of mobile broadband, fibre networks, fixed wireless, and satellite. Illustrative maps from the presentation highlighted mobile broadband's spatial footprint and the layout of existing fibre infrastructure.

Mr. Kooma then introduced Zambia's legal and regulatory frameworks governing broadband and ICT development. These include foundational acts such as the ICT Act and the Electronic Communications and Transactions Act (both enacted in 2009), supplemented by targeted regulations and guidelines such as the ICT (Universal Access) Regulations of 2012 and the newly introduced Quality of Service Guidelines (2024). The presence of consumer protection guidelines and a formal code of conduct for ICT service providers underscores Zambia's dual emphasis on user rights and regulatory discipline. Licensing rules and installation standards provide the operational scaffolding for the rollout of broadband services.

At the strategic level, Zambia's broadband penetration roadmap is as follows: 55.5% in 2022, 70% by 2025, and 80% by 2030. The pathway to achieving these milestones relies on four policy levers: implementation of a national 5G roadmap, release of sub-1GHz spectrum to enhance rural penetration, deployment of the Universal Access strategy, and the imposition of coverage obligations tied to high-value spectrum licenses. These mechanisms represent a hybrid model of regulation and market incentive, seeking to align commercial interests with public policy goals.

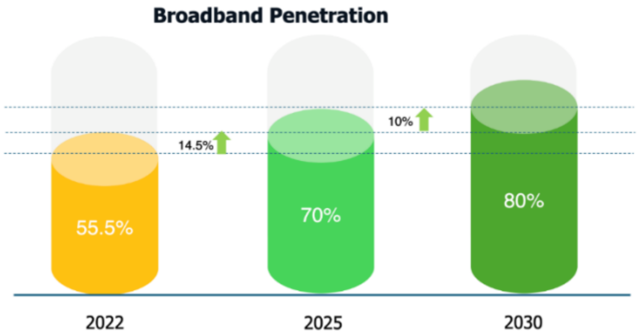

Figure 12: Zambia's broadband penetration objective (Source: Zambia's presenter's Slides)

Turning to infrastructure coverage, Mr. Kooma explained the structure of Zambia's broadband data management. Operators are required to submit data regularly—quarterly or annually—via standard templates developed through stakeholder consultation. These data submissions include mobile broadband network information, coverage footprints, and quality of service metrics. ZICTA supplements operator data with independent drive-test measurements to verify accuracy. However, penalties for non-compliance are noted but not elaborated, suggesting an area for further enforcement. While partial statistical information is published on ZICTA's website, coverage maps are not yet publicly available. The statistics are not independently verified. Work is underway to publish mobile coverage maps online.

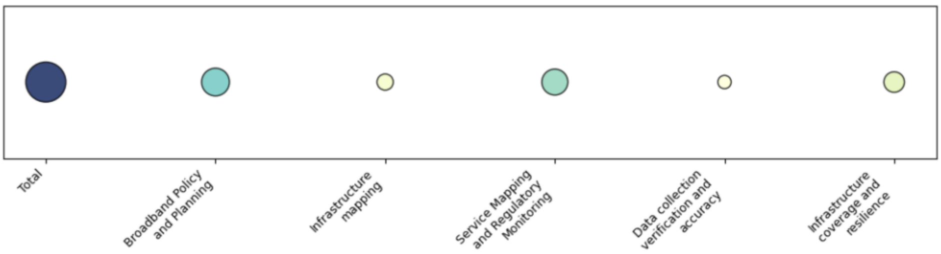

Figure 13: Overview of the survey answers of Zambia area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

6.3. Uganda

Uganda's case, presented by Ms. Rebecca Mukite from the Uganda Communications Commission (UCC) illustrated both institutional maturity and operational hurdles. With a current broadband penetration rate of 64% and a population of over 51 million, Uganda's focus is on increasing coverage and digital skills among the population, data format harmonization, and map analysis capacity building.

The presentation began with contextual framing. Uganda is a landlocked country in East Africa, with agriculture as the primary economic activity. Broadband technologies in use include mobile (3G, 4G, 5G), fibre, fixed wireless access, and satellite. ArcGIS mapping is used for operator usage. Those maps are not fully public but can be available through operator's websites and reports.

The policy framework was outlined with key frameworks including the National Broadband Policy (2018), the Uganda Communications Act (2013), and the Digital Transformation Roadmap (2023/2024–2027/2028). Operationally, Uganda separates licenses for infrastructure and service provision (2020), promotes infrastructure sharing (2021), and monitors quality of service (QoS) under benchmarks established in 2007. The recent coverage obligation monitoring framework (2024) and cybersecurity strategy (2022–2027) reflect Uganda's intent to maintain pace with digital policy advancements.

Mapping and data collection efforts combine operator submissions and quarterly QoS testing. Mapping granularity reaches the sub-county and, for select parameters, the village level. Core indicators include signal strength, technology type, latency, speed, and population coverage. Tools such as GIS dashboards and APIs support analysis and internal reporting, but technical capacity remains limited.

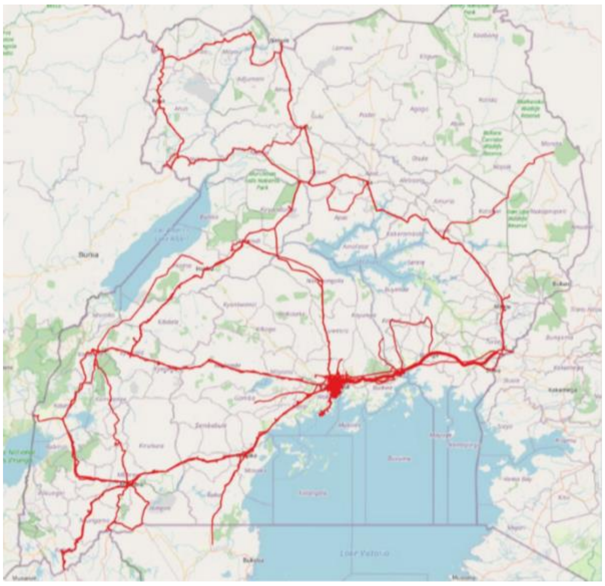

Figure 14: Map produced by Uganda, using *ArcGIS for its mapping efforts (Source: Uganda presenter's Slides)*

A key part of the presentation focused on enforcement and data standardization challenges. Operator data is often incomplete or delayed. Formats vary widely, making integration difficult. Coverage statistics are not verified independently, but QoS performance indicators are monitored independently. While there are penalties for non-compliance with data submission requirements, they are not currently enforced.

Despite these gaps, Uganda is preparing a series of structural improvements. A public-facing National Broadband Mapping Portal is planned in Uganda's Broadband Blueprint. It should provide layered access to coverage, infrastructure, and demand data. The objective is to follow international standards in mapping and to allow public access for greater transparency.

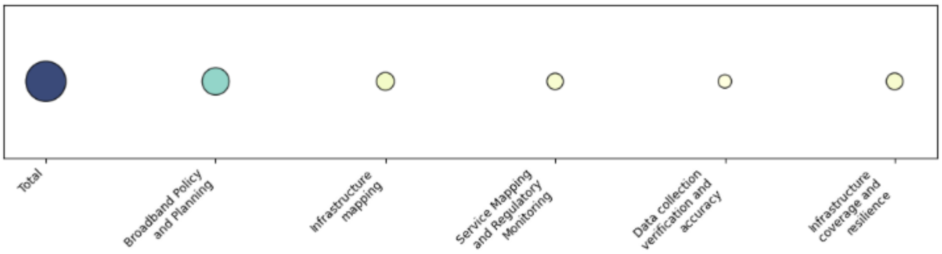

Figure 15: Overview of the survey answers of Uganda area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

6.4. Botswana

Botswana's broadband journey is based on a solid policy environment and connectivity achievements, yet its mapping systems remain at an early stage of development. With a population of 2.5 million (2024) spread across 581,730 square kilometres, broadband access spans mobile, fibre, wireless, and satellite technologies—collectively covering over 98% of the population. While this signals significant progress in infrastructure rollout, Botswana does not have any specific policy provisions for broadband mapping.

Broadband penetration officially stands at 129% according to the country's presentation, a figure that likely reflects SIM-based subscriptions rather than unique users. This is corroborated by a high mobile service adoption (112% of the population, according to ITU statistics) and multi-SIM usage.

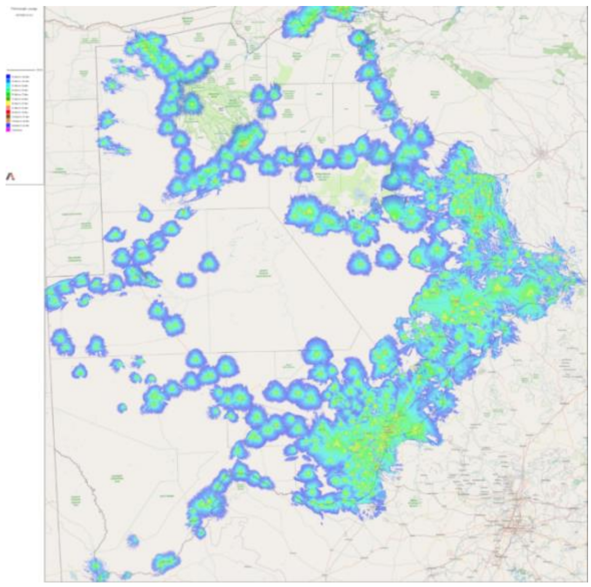

Figure 16: Mobile broadband coverage in Botswana (Source: BOCRA presenter's Slides)

The current policy framework is built on instruments such as the National Broadband Strategy (2018), the National ICT Policy, and the Communications Regulatory Act (2012), all of which empower the Botswana Communications Regulatory Authority (BOCRA) to drive connectivity. BOCRA oversees the Universal Access and Services Fund (UASF), which subsidizes broadband rollout in rural and underserved areas. Complementing this, the SmartBots initiative promotes digital access in public facilities such as clinics, schools, and tribal administration offices. However, despite these advances, Botswana does not yet have specific policy provisions or operational mechanisms for broadband mapping.

Some coverage maps are made available in BOCRA's Annual Reports. Additionally, BOCRA collects data from various sources to develop coverage maps for internal use. It collects data from its licensees, and from Internet Service Providers on a case-by-case basis, when necessary. While ISPs are required to submit broadband coverage and Quality of Service data, there are no penalties for non-compliance and enforcement is not strict.

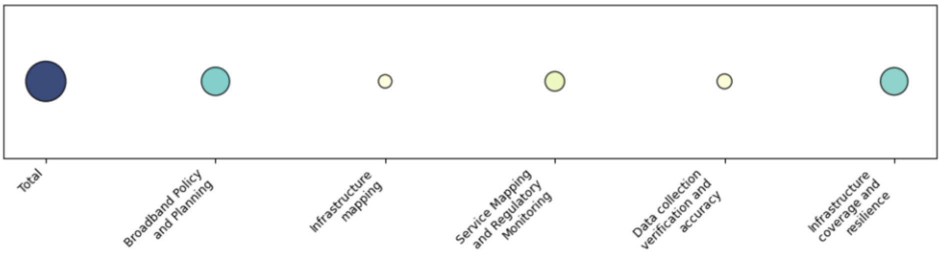

Figure 17: Overview of the survey answers of Botswana area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

6.5. Zimbabwe

Mr David Madondo delivered the presentation for Zimbabwe. With a population of 16.6 million (2024) and a GDP per capita of USD 2,156.03 (2023), mobile access stands at 98.6%, and internet user penetration at 83.52%. Moreover, according to ITU statistics, 86.8% of the population is covered by at least 3G. These statistics reveal an important uptake of digital services relative to the country's economic standing, indicating increased investment in mobile infrastructure, coupled with commitment to national digital inclusion goals.

Zimbabwe's broadband ecosystem is characterized by the deployment of diverse access technologies including 3G, 4G, 5G, fibre, and satellite. The national broadband plan, aligned with the SADC definition of broadband (internet speed of at least 1 Mbps), outlines five goals designed to ensure universal access.

Available data according to the presentation shows however spatial disparities. Extensive fibre backbone coverage is present in the east, centre, and southern regions of the country, with further expansion planned to bridge gaps in the west. Moreover, current 5G coverage remains limited to a handful of urban areas. Meanwhile, 3G coverage is near universal (86.8% of the population covered), forming the basic connectivity layer nationwide. In contrast, 4G remains highly clustered around semi-urban areas with 44.7% of the population covered by LTE/WiMAX.

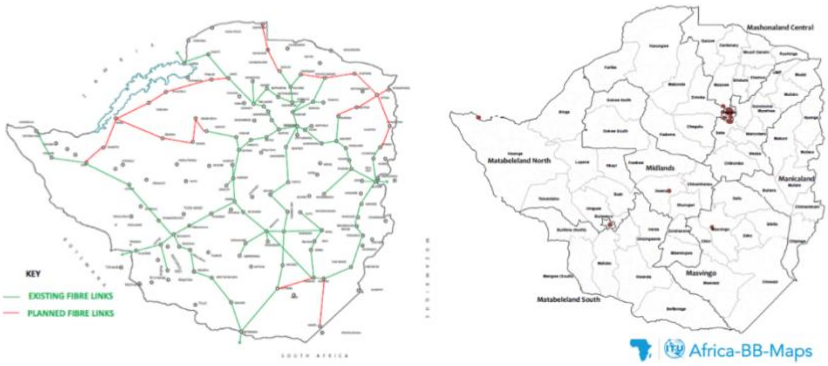

Figure 18: Fibre Backbone and 5G coverage built in Zimbabwe (Source: Zimbabwe presenter's Slides)

On the policy front, Zimbabwe operates under a legislative framework anchored in the Postal and Telecommunications Act, which empowers the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ) to oversee the sector. The Converged Licensing Framework introduced by Statutory Instrument 12 of 2021 provides technology-neutral licensing. Additionally, the National Broadband Plan is presented as a living document, accompanied by Zimbabwe's National Development Strategy 1 (NDS1) which requires monitoring and evaluation of broadband networks.

One initiative is Zimbabwe's participation in the Giga programme, launched through a Memorandum of Understanding with UNICEF in 2021. This project aims to provide schools with internet connectivity. This initiative was implemented thanks to a collaboration between the ITU and the government of Zimbabwe, based on existing data collected by the POTRAZ.

Zimbabwe's broadband mapping capabilities are built upon a multi-source data ecosystem. POTRAZ collects information through biannual Regulatory Reports submitted by operators, quarterly reports surveys, and an automated QoS Monitoring System. Other data may be requested by POTRAZ on a case-by-case basis. Coverage data is not currently publicly available, but POTRAZ is developing a Mobile application that aims to provide information on network coverage data and QoS indicators at the district and province level.

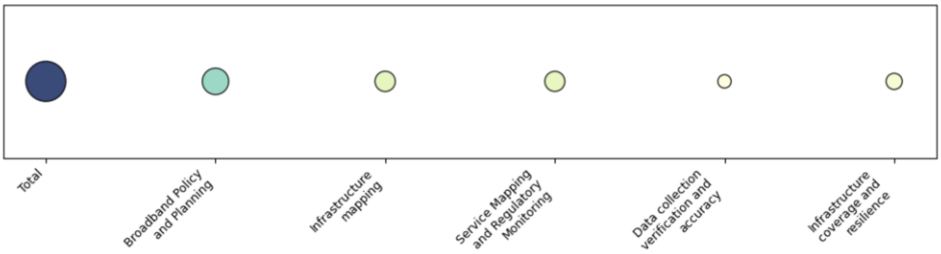

Figure 19: Overview of the survey answers of Zimbabwe area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

6.6. Kenya

Kenya stands at the forefront of East Africa's digital transformation, thanks to strong demographic, geographic, and institutional foundations. With a population of 56 million (2024) the nation's approach to broadband infrastructure reflects a commitment to structured policy, technological investment, and cross-sector coordination.

Mr Paul Kiage from the Communications Authority (CA)presented the case study from Kenya. The country's broadband development is guided by the National Broadband Strategy (NBS) 2018–2023, implemented by CA. This roadmap prioritizes affordable internet access, digital inclusion, and effective spectrum management. The government has adopted tax relief measures and funding programs to incentivize broadband expansion, particularly in underserved and rural areas. Additional submarine cables improve international connectivity, with Kenya being a major landing point for multiple submarine cables (TEAMS, SEACOM, PEACE, Eassy, DARE, LION2, and Z Africa), showing both government initiatives and public-private partnerships to implement this strategy.

Kenya's broadband penetration targets aim to grow from 44% to 80% by 2030. Official maps presented show near-parity between voice (2G) and broadband (3G/4G) coverage at over 96% of the population. However, land area coverage presents a more nuanced story: despite the population coverage leap from 78% in 2016 to over 96% in 2024, the geographic footprint expanded from only 17% to just over 56%. This discrepancy indicates a rural-urban divide, with most investments concentrated in densely populated zones.

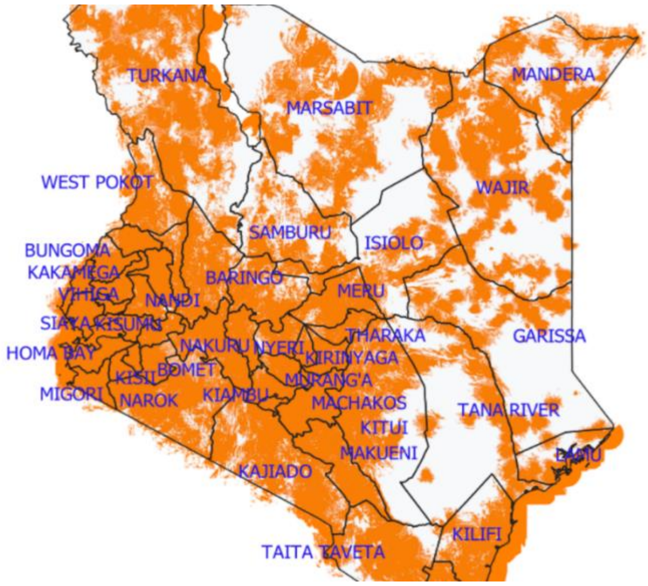

Figure 20: Broadband (3G/4G) Coverage
96.3% of the population and 56.3% of the Geo-Area are covered
(Source: Map provided by the CA)

Domestically, the broadband map reveals a dense layering of fibre optic infrastructure from both public and private entities. Mapping is central to Kenya's strategy for equitable broadband rollout. The CA uses regulatory reporting from ISPs, field surveys by government agencies, and geospatial technologies for mapping. It collects data on a quarterly basis from licensees (ISPs are legally required to submit data, with non-compliance leading to penalties). This information is validated through field surveys and geospatial analysis. The data are integrated with infrastructure and coverage data, as well as information on underserved areas. Key infrastructure such as schools or hospitals is considered. These efforts are aided by partnerships with the World Bank, ITU and Smart Africa Alliance.

The CA manages a geoportal system and a GIS system, allowing the agency to map broadband coverage, broadcasting and Postal infrastructure. However, the CA has few GIS experts and lacks a dedicated GIS department to manage the system. Moreover, the Authority lacks licenses for the system, which means that access is restricted to a limited number of staff. The portal is partially accessible to the public via reports and government portals. Detailed infrastructure maps are made available to government agencies, ISPs and research institutions and managed by the CA, but limited resources imply limited updates and data accuracy concerns.

Kenya's Universal Access Baseline (2016) provided the following results: while 94.4% of the population had 2G access, only 78% had 3G, and geographic coverage was uneven. As of 2024, broadband access has significantly improved in terms of population reach (3G/4G Coverage stands at 96.3% of the population), but vast rural areas still face connectivity challenges.

Kenya's objective is not only in its technical capacity, but in its ability to coordinate actors, standardize inputs, and elevate broadband mapping from a regulatory tool to a development engine.

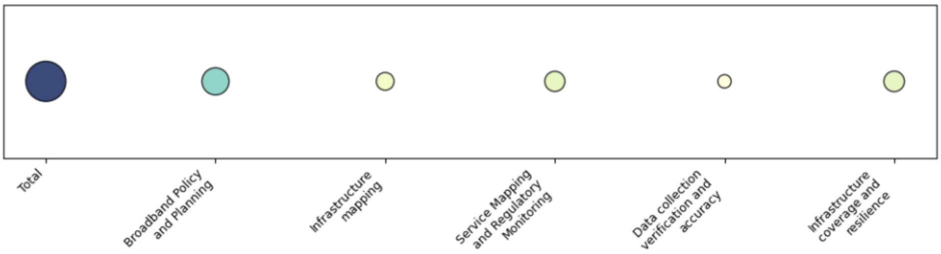

Figure 21: Overview of the survey answers of Kenya area by area.
The bigger the circle, the more advanced the country is in the related area.
(Source: Graph created by the Africa-BB-Maps project team)

7. Best practices & Case studies of broadband mapping in Lithuania, Denmark, Croatia, Cyprus

Title	SESSION 4: Best practices & Case studies of broadband mapping in Europe (2)
Objective	To continue exploring European broadband mapping policies, offering additional models to enrich discussions.
Key Participants	Moderator: Mr. Marko Simoncic (AKOS Slovenia) Speakers: • Lithuania (Mr. Vaidotas Radzevičius), • Denmark (Mr. Rune Skov Maigaard), • Croatia (Mr. Vladimir Duković), • Cyprus (Mr. Marios Ioannides).

Figure 22: Speakers of session 4 (Source: the ITU project team)

Moderated by Mr. Marko Simoncic, this session built on the precedent European showcase, featuring Lithuania, Denmark, Croatia, and Cyprus. Each case study offered unique lessons, deepening the event's knowledge base.

7.1. Lithuania

Mr. Vaidotas Radzevičius presented how the Communications Regulatory Authority of the Republic of Lithuania (RRT) implemented article 22 of the European Electronic Communications Code (EECC). This piece of law mandates competent authorities to "conduct a geographical survey of the reach of electronic communications networks".

Lithuania is populated by 2.9 million people. The strategy to determine broadband coverage began in May 2023 with a definition of its methodology and ended in January 2024 with the publication of the results. During this period, RTT led data collection and verification, evaluated network coverage and conducted a public consultation on the results before the final publication.

Regarding methodology, RRT collected present data as well as forecasts. For mobile network, it use principles of data transmission speed calculation via propagation modelling to map mobile broadband penetration to a 60x60 meters grid. For fixed network, data collection was carried out at the address level. As for the source of these data, fixed communication network data were collected from public electronic communication service providers (total of 65 different operators) as well as already-available data obtained by RRT during other studies. Mobile Broadband coverage is estimated mathematically using HTZ Communications software thanks to technical information provided by 3 operators of mobile networks. Some data (household numbers, locations and distribution) were gathered from the national real estate register. Finally, the mapping was conducted using ESRI ArcGIS Pro software.

Thanks to this data, RRT was able to elaborate maps to visualize the percentage of covered households, the exact locations (addresses) of fixed connections as well as estimate the expected download speed in mobile networks across the country. The maps allow for a visualization across different scales (from a 60x60 grid to the county level for mobile broadband).

This data collection and visualization brought valuable insights to RRT. At the National level, 97% of households are covered with speeds up to 30 Mb/s - VHCN. At the county level, 9 out of 10 households are covered by VHCN. At the municipality level, 3 households out of 4 have at least 30Mb/s data transfer, and 1 out of 2 have at least 100 Mb/s.

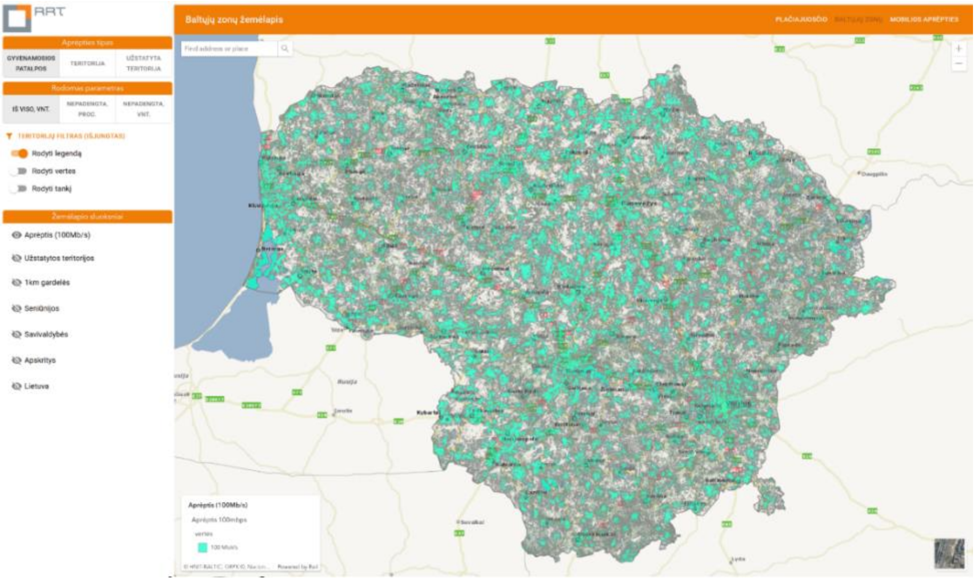

Figure 23: Analysis of white spaces in Lithuania
A 2024 broadband survey showed that 59.3% of Lithuania's territory is within White Spaces, while 17.2% of living quarters (residential buildings) are within White Spaces.
(Source: Lithuania presenter's Slides)

The presentation continued by highlighting how the data collection effort allowed RRT to identify white spaces (households where 100 Mb/s data transfer speeds are not available). Results in 2024 showed that 59.3% of Lithuania's territory and 17.2% of residential areas are within White Spaces. Mapping allows to identify areas that should be prioritized, driving future broadband development policies (both mobile and fixed), and efficiently allocating fundings.

7.2. Denmark

With a population of 6 million and 96.9% of households with internet access, Denmark presents a case where mapping serves both administrative planning and public engagement. Like Lithuania, mapping allows for the identification of coverage gaps and drives policies targeting areas with limited coverage, through the Danish state's aid program. Mr. Rune Skov Maigaard from DGIST led the presentation.

Mr. Rune Skov Maigaard presented Tjekditnet.dk, an online portal that allows users to search for any address in Denmark and view information on available broadband technologies, connection speeds, and service providers. The interface offers several filters: users can select between fixed broadband, mobile broadband, and voice services, as well as set minimum speed thresholds, such as 100/30 Mbit/s. It also differentiates by building types, allowing specific searches for residential or business premises.

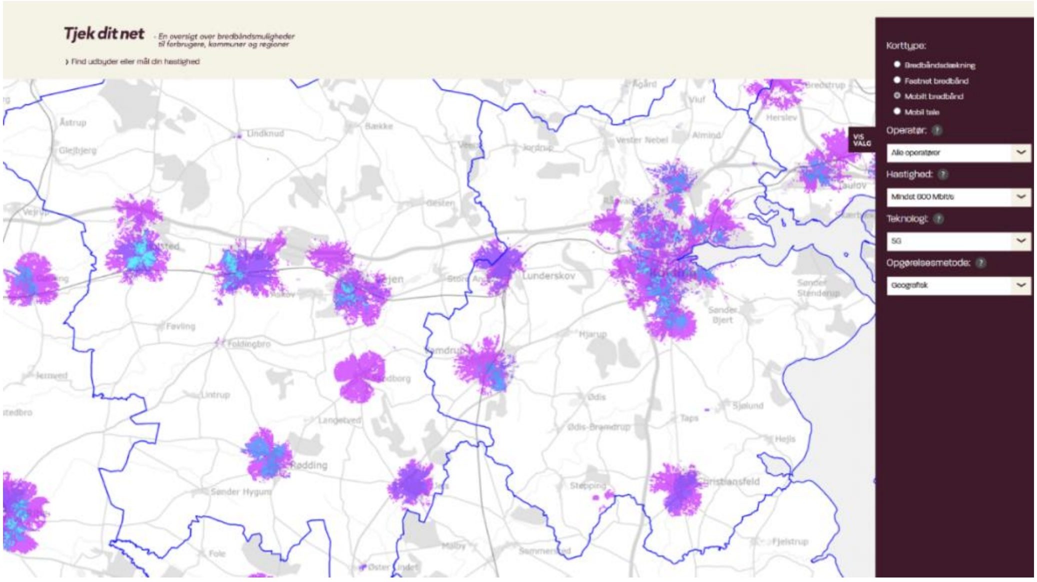

Figure 24: Broadband mapping of *Tjekditnet.dk*
Tjekditnet.dk allows, for example, to visualize geographic coverage of mobile broadband
(Source: Presenter's Slides)

This public-facing tool is underpinned by a structured data acquisition process. Twice a year, broadband providers are required to submit coverage data to the government as mandated by the National telecommunication legislation.

In parallel with the fixed broadband data, Denmark also collects mobile broadband coverage information. Unlike fixed broadband, which is centrally verified, mobile coverage is modelled by operators themselves. These models rely on terrain and surface data, supported by input from on-site measurements. External data sources, such as OpenStreetMap, Copernicus, and the Shuttle Radar Topography Mission, are also used to refine models and estimate coverage areas. This separation between fixed and mobile mapping methods reflects a dual structure: one rooted in government validation and the other in operator-based modelling, both contributing to the same national map.

The map produced through this system is pixel-based and address-specific. It presents users with colour-coded coverage information and offers interactive layers that can be adjusted according to selected criteria. The information is published not only through the consumer interface but also via open data portals and an API, where municipalities, researchers, journalists, and civil society organizations can download raw datasets in CSV or JSON format. This level of data accessibility supports a broader ecosystem of digital planning, public accountability, and third-party analysis. It is a win-win situation for all parties, since the data publicly released allows operators to plan their commercial rollouts.

The use of broadband mapping in Denmark is multifaceted. First, it enables systematic monitoring of national connectivity goals. Authorities can compare coverage levels over time, tracking progress against benchmarks set in policy frameworks. Second, it provides evidence to identify geographic areas that fall below acceptable thresholds of coverage, informing political decisions and guiding public funding mechanisms. Third, it supports regulation by allowing authorities to assess whether providers are meeting their obligations. Fourth, it empowers citizens by giving them the means to understand their connectivity options and, where necessary, question service levels or lobby for improvements. Denmark also uses broadband mapping as the foundation for its state aid program. Areas identified through the mapping system as underserved or unserved are eligible for government-supported infrastructure investment.

At the core of this mapping initiative is the principle of institutional integration. By linking broadband data with other public registers, Denmark ensures that coverage data aligns with actual infrastructure, buildings, and populations. This enables more precise planning and avoids the misallocation of resources. The use of a unified address system further ensures consistency across government datasets, improving the quality of broadband mapping outputs.

Denmark's broadband mapping system serves multiple objectives. It supports public policy, guides infrastructure investment, enables regulatory compliance, informs consumers, and promotes open data usage. Its design is based on systematic data collection, centralized validation for fixed broadband, and operator-led modelling for mobile networks. Through regular updates, verified inputs, and public access, the system provides a scalable example of how national governments can manage broadband development with precision and accountability.

7.3. Croatia

Croatia, with its 3.9 million inhabitants, has developed a broadband mapping system anchored in legal mandates, spatial data integration and cross-sector collaboration. Managed by HAKOM, the Croatian Regulatory Authority for Network Industries, the system supports broadband infrastructure planning, coverage verification, and investment targeting. Built according to EU legal frameworks (Article 22 EECC), it combines infrastructure and service-level data collection. It is supported by public-facing platforms such as HAKOMetar and institutional databases like the Infrastructure Cadastre System (ISKD).

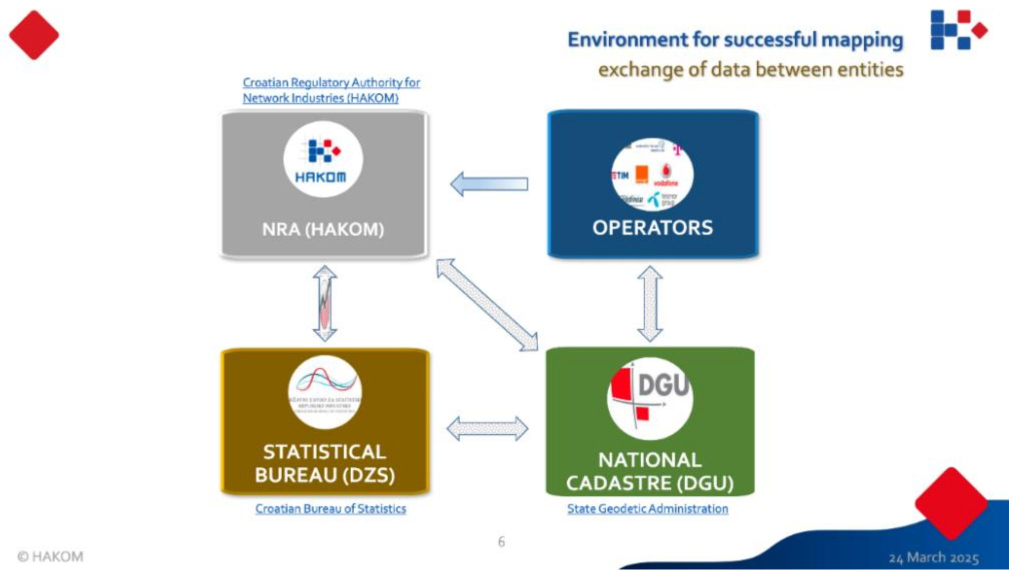

Figure 25: Croatia's entities ecosystem for broadband mapping (Source: Croatia's presenter's Slides)

Croatia's approach is shaped by its obligations under the European Electronic Communications Code (EECC) and the Broadband Cost Reduction Directive. Article 22 of the EECC mandates NRAs to conduct nationwide broadband network surveys and update them every three years. This legal requirement is foundational to Croatia's mapping of both physical infrastructure and service availability. Data is collected for several regulatory purposes: market analysis, spectrum license verification, public funding eligibility, investment forecasting, Digital Decade targets' progress monitoring, and transparency. These legal bases define the structure and purpose of Croatia's mapping system and ensure its compliance with EU standards.

Croatia distinguishes between two core mapping dimensions: physical infrastructure and broadband coverage. Infrastructure mapping refers to the physical components of broadband networks—ducts, antenna poles, nodes, manholes, cables—submitted by both telecom and non-telecom operators. These include energy, water, and transport infrastructure managers. Data geometry includes points (e.g. infrastructure route) and lines (e.g. node locations). The State Geodetic Administration (DGU) functions as the Single Information Point for this data. All mandated entities must submit through the SKI portal, with dispute resolution handled by HAKOM.

Broadband coverage monitoring is based on quarterly reporting by all broadband providers. Mapping for mobile networks is polygon-based, and points-based for fixed networks (addresses). The objective is to provide an analysis of broadband coverage and take-up, taking into account future investments in broadband deployment. The HAKOMetar platform provides public and stakeholder access. This layer supports regulatory enforcement, state aid planning, and broadband gap analysis.

Croatia's mapping workflow begins with operator data collection in standard formats (.xls, .csv, .txt), followed by integration into SQL databases, conversion into GIS-compatible formats (ArcGIS), and import into analytical tools (Power BI for reporting, ArcMap for visualization). This structure supports automation, ensures consistency, and minimizes data processing errors. It also allows both internal analysis and public dissemination.

Croatia's mapping system includes a public GIS portal, HAKOM e-maps. It offers thematic viewers for mobile network plans, broadband access, infrastructure build intentions, radio base stations, and electromagnetic field measurements. These tools support policy transparency, empower local governments, and guide public and private sector planning. Of note is the portal for publishing intended fibre deployments—a tool supporting EU compliance and funding visibility. All maps are searchable by location, technology, and provider.

Coverage maps allow users to see the number of operators in a given area and differentiate speed levels. Historical data is also available, allowing tracking of network rollout over time. Areas are colour-coded by operator count (1, 2, or 3+), speed class (2–30 Mbps, 30–100 Mbps), and coverage gaps. This supports state aid eligibility checks, investment coordination, and policy monitoring. Data is segmented by quarter, supporting progress analysis aligned with Digital Decade milestones.

Croatia has also developed mapping tools for broadband take-up. These visualize subscription levels by speed tier and area, enabling policymakers to identify usage trends and digital inclusion gaps. The take-up viewer guides targeted interventions such as digital literacy programs or demand-side subsidies. This is important for regions where networks exist, but usage remains low.

Quality of service (QoS) data is crowdsourced through the HAKOMetar app. It captures real-time speed tests from end users across Wi-Fi, Ethernet, and mobile networks. Measurements include download/upload speeds, ping, signal power, and packet loss. Results are visualized on interactive heatmaps, reflecting actual user experience. This data is processed through dashboards, supporting network performance benchmarking, consumer protection, and infrastructure auditing. Over 10 million measurements have been collected, providing a statistically robust dataset for regulation and planning.

HAKOM's internal dashboards allow disaggregation by ISP, platform (Android, iOS, Windows), location, and time. These tools convert user measurements into actionable intelligence, identifying network congestion, underperformance, or regional disparities. They supplement provider-submitted data with independent verification, strengthening the evidence base for regulatory decisions and investment planning.

At the infrastructure level, Croatia's State Geodetic Administration (DGU) developed the Infrastructure Cadastre System (SKI), integrating broadband with other utility networks (gas, water, electricity, heating). The system is built following Directive 2014/61/EU. It includes location, ownership, and use of infrastructure. SKI allows digital submission of geodetic studies for review and confirmation by the competent cadastral office. It also offers the possibility to search, receive and distribute information about current or planned civil works, as well as metadata search. This ensures availability and efficiency in managing cadastral affairs.

Croatia's final lessons stress the need for legal clarity, data quality, and stakeholder cooperation. HAKOM advises starting with available data and building incrementally and with patience. The process of standardizing submissions across operators can take a year or more. Openness to best practices, use of official data, and integration of statistical sources from National Statistical Bureaus are essential. Mapping must be future proofed to adapt to evolving technologies.

7.4. Cyprus

Cyprus's broadband mapping system, presented by Mr. Marios Ioannides of OCECPR, offers an example of how nations can develop structured, multi-use mapping platforms to serve policy, infrastructure, and public transparency goals. With a population of approximately 920 000 (ITU, 2023), 91.2% of Cyprus' population uses the internet. The country has very recently moved from a basic operator-driven reporting model to a more granular, centralized interactive system. This "unified portal" was completed in March 2025.

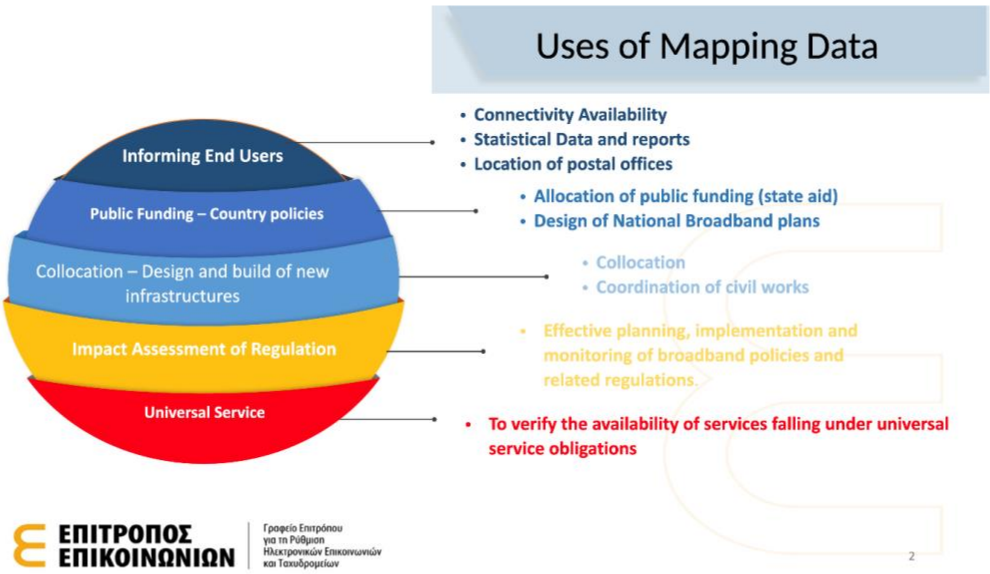

Figure 26: Uses of broadband mapping data in Cyprus (Source: Cyprus presenter's Slides)

The foundation of Cyprus's system lies in the multipurpose utility of broadband mapping. As depicted in the use-case diagram above, data collected from broadband coverage maps serves a layered set of functions. At the top are public transparency needs—users rely on the system to assess network availability, performance, and provider options. In the middle layers are regulatory and strategic tools: public funding decisions, broadband gap identification, civil works coordination, and collocation planning. At the base are monitoring tools for regulatory enforcement, including compliance with universal service obligations. These stacked functions highlight the systemic importance of broadband mapping for national digital strategies, especially in aligning funding with measurable impact. Cyprus aims to be fully covered in fibre technology by next year through ad-hoc funding thanks to the state aid plan.

At the operational level, Cyprus organizes its broadband data ecosystem into six integrated elements. First, multiple sources of information feed the system: telecom operators, other infrastructure entities (e.g. utilities), and public authorities. Second, data categories cover physical infrastructure, network surveys mandated by Article 22 of the EECC, and planned civil works. Third, data formats range from geospatial files to Excel spreadsheets, with spatial references for GIS interoperability. Fourth, submission procedures are streamlined through email or web interfaces. Data can even be uploaded directly to the servers, with defined reporting intervals (every three months). Fifth, access levels are clearly segmented into public, restricted, and internal use, ensuring both transparency and security. Sixth, information is processed and published in various formats—interactive maps, reports, and raw data files.

The public-facing portal is the central pillar of Cyprus's mapping model. Managed by OCECPR, it gives users direct access to fixed broadband, mobile broadband, and postal service coverage through three thematic modules. The fixed broadband map displays data at address level, segmented by provider and speed tiers (e.g., 100 Mbps, 500 Mbps, 1 Gbps). Users can search by location, compare providers, and assess technology types like FTTH or cable. Mobile broadband availability is shown through a grid-based heatmap, with colour codes reflecting real download speed ranges from 2 Mbps up to 1 Gbps and beyond. Since the platform was 3 weeks old at the time of the presentation, some mobile operators had not participated in the first survey. It is expected that, given the win-win situation for operators to submit quality data to the system, all operators will participate to the next surveys that happen every three months. Together, these interfaces help households and businesses make informed connectivity decisions.

At the regulatory level, Cyprus uses broadband maps to guide state aid decisions, plan national broadband expansions, and avoid infrastructure duplication. The portal supports this by flagging underserved areas, overlapping infrastructure, and planned civil works. A restricted-access technical works module lets authorized stakeholders plan, draw, and annotate civil works proposals directly on the map interface using point, line, or polygon tools. The platform, intended for internal use, provides information on sewer, drainage, electricity, and water networks and helps infrastructure planners contact the right authorities to get the relevant authorizations. These spatial planning functions are crucial for synchronizing network deployments across operators and minimizing roadworks or cable conflicts. This also aligns with EU principles for efficient use of public funds and cross-sector infrastructure coordination.

From a policy planning standpoint, Cyprus's mapping system is increasingly tied to public funding streams. The portal is supported by the EU Recovery and Resilience Plan under the "Cyprus Tomorrow" initiative. Mapping data is used to assess where state aid is needed, how to track progress, and whether connectivity obligations are met. This linkage between data and funding creates a direct feedback loop: public money is allocated based on gaps shown on the map, and outcomes are verified through live data updates.

The Cypriot experience reinforces three core lessons for Africa-BB-Maps participants. First, even small countries can build robust broadband mapping systems. Second, cooperation is key to the success of broadband mapping initiatives. Third, integrating mapping with public planning, civil works coordination, and funding transparency turns a technical system into a governance tool. Cyprus's approach demonstrates that mapping is not a side project—it is foundational to inclusive digital development and can be scaled to meet the needs of larger or more complex geographies over time.

8. Posture of broadband mapping in Burundi, Malawi, Nigeria, Benin, Ethiopia

Title	SESSION 5: Posture of broadband mapping in the beneficiary countries (2)
Objective	Give the floor to five more beneficiary countries, deepening the understanding of regional needs and opportunities.
Key Participants	Moderator: Mr. Umar S. Abdullahi (NCC Nigeria); Speakers: • Burundi (Mr. Samuel Muhizi), • Malawi (Mr. Khumbo Kasambara), • Nigeria (Mr. Emmanuel Avula), • Benin (Mr. Samuel Akpan), • Ethiopia (Mr. Asegdew Fitawok).

Figure 27: Speakers of session 5 (Source: the ITU project team)

Figure 28: Beginning of session 5 in Abidjan, Côte d'Ivoire (Source: the ITU project team)

Moderated by Mr. Umar S. Abdullahi, this session continued the second round of presentations by the African countries. After the presentation, an excerpt from the survey results specific to the country is presented graphically. For more details on the maturity matrix, see Annex 1.

8.1. Burundi

Burundi, a landlocked country in East Africa, borders the Democratic Republic of Congo, Rwanda, and Tanzania, with a shoreline on Lake Tanganyika. Its population is estimated at around 14 million in 2024 according to ITU statistics, with Gitega as the political capital and Bujumbura remaining the economic hub. The broadband mapping landscape in Burundi is still in its early stages. The presentation delivered by Dr. Samuel Muhizi, Director General of ARCT, during the Africa-BB-Maps regional event, presents the first coordinated effort to assess the state of broadband infrastructure, institutional roles, and data systems in the country.

The institutional structure of Burundi's digital ecosystem involves multiple actors. The ICT Ministry, ARCT (the national regulatory authority), SETIC, and FSU collectively oversee policy, regulation, infrastructure, and service financing. The national digital strategy encompasses five pillars: infrastructure (last mile, backbone, rural), skills (technical institutes and digital hubs), digital solutions (e-health, e-immigration), financial services (mobile money, e-banking), and entrepreneurship support mechanisms.

Mobile broadband remains the dominant access technology. Three operators—Onatel, Econet-Leo, and Viettel—provide services across multiple mobile generations. Viettel leads the market, with 95% 2G, 48% 3G, and 27% 4G coverage, alongside an early deployment of 10 5G sites. Econet-Leo has a significant 2G network but only minimal 3G and 4G deployment. Onatel's coverage is lower, particularly for 4G (3.6%). Visual maps confirm that while 2G is widespread, 4G is limited to urban centers. This suggests a mobile sector still heavily reliant on legacy technologies and concentrated urban connectivity, despite early-stage 5G testing.

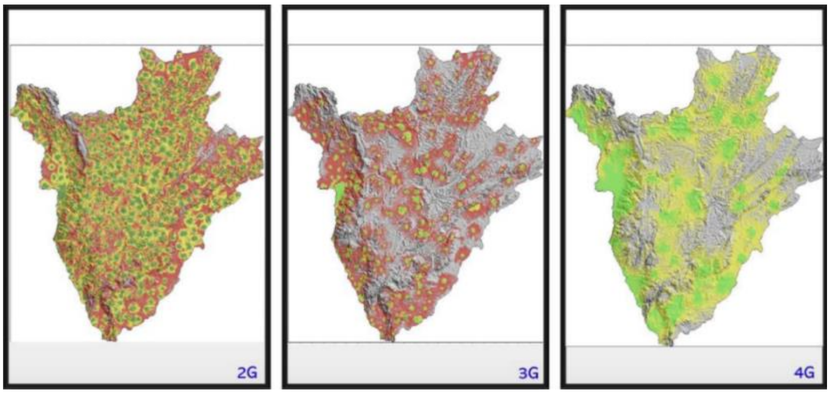

Figure 29: Lumitel (Viettel) Mobile Network coverage in *2025*
(Source: Burundi presenter's Slides)

The national fibre optic infrastructure is anchored by three operators. Viettel operates the largest backbone, totalling 3,400 km and covering all 18 provinces. The Burundi Backbone System (BBS) follows with 1,750 km, also covering the entire country. Onatel's MAN (Metropolitan Area Network) spans 350 km and is limited to Bujumbura. The backbone is structurally present, but the number of end-users is low: BBS reports only 380 fibre subscribers. This indicates that fibre is primarily being used for institutional access, inter-urban transport, and wholesale provisioning rather than residential or SME connectivity. The contrast between nationwide coverage and limited uptake reflects a significant bottleneck at the last-mile level.

Satellite broadband emerged recently with the introduction of Starlink. The system was authorized by ARCT in May 2024 and became operational by September 2024. By March 2025, over 1,200 subscribers had connected. Starlink's availability spans the entire territory, offering immediate coverage to remote areas without dependence on terrestrial infrastructure. This is important for regions where fibre and mobile remain undeployed. The satellite model complements other technologies and can serve institutions as well as underserved households. The key constraint is affordability, which will determine long-term viability.

Burundi's broadband policy framework is structured around six core areas: strategic vision, partnerships, digital governance, infrastructure, human capital, and regulation. The long-term vision projects Burundi as an emerging economy by 2040 and a developed one by 2060. This is supported by the National ICT Policy (2010–2025) and a master plan for digitizing public services (2023–2033). Infrastructure goals include digital sovereignty and cyber-resilience, while talent development targets youth, women, and general digital literacy (e.g., Girls in Tech, Code Week). Legal harmonization efforts are in progress.

The legal framework includes three primary texts: Law No. 1/22 (2024), Decree No. 100/97 (2014), and Decree No. 100/054 (2024) establishing the Universal ICT Service Fund. However, the absence of a formal broadband mapping system is explicitly acknowledged. This is a major gap in national planning. While ARCT collects operator data and performs field surveys, there is no integrated platform or institutionalized system to map, validate, or visualize broadband availability and infrastructure in real time.

Despite the structural challenges, Burundi's broadband penetration has increased. According to ARCT statistics, Internet usage rose from 7% in 2017 to over 25% in 2024 (11% in 2023 according to ITU statistics). According to the presenter, mobile penetration grew from 52% to 63.6% in the same period (ITU statistics indicate that 10.3 out of 100 people had a mobile broadband subscription in 2023). The number of Internet subscribers reached 3,28 million across 11 ISPs, while mobile users surpassed 8 million. This progress is supported by three nationwide backbones and specialized education networks such as BERNET (14 institutions) and COMGOV (100 institutions). Still, broadband remains out of reach for many, particularly in rural and low-income communities.

Burundi's strategy for the next five years includes major programs such as PAFEN, supported by the World Bank and coordinated by SETIC. PAFEN focuses on national broadband expansion, including infrastructure upgrades (e.g., towers, power systems) to support 3G, 4G, and 5G readiness. The Ministry of ICT is also deploying broadband along major roads to improve rural access. Parallel efforts target educational institutions, community centres, and rural zones with Wi-Fi through the Universal Service Fund (FSU). The extension of ONATEL's MAN Network is planned, as well as last-mile connectivity programs.

Regulatory instruments are being designed to enable infrastructure sharing. ARCT is developing a Green Infrastructure Policy that includes a reverse auction model to extend network coverage in underserved rural areas. These mechanisms reflect an emerging regulatory approach focused on cost-efficiency and market stimulation.

Data collection in Burundi occurs through multiple channels. Operators provide quarterly data to ARCT, field surveys complemented by drive tests, and online monitoring tools such as the DQoS platform. The datasets include information on infrastructure, coverage, and service quality. Reports are reviewed monthly and verified for accuracy through a dedicated platform. Obligations are clearly defined: ISPs must submit data and are subject to penalties for non-compliance (fines, restrictions on licensing). Data is also validated in coordination with third-party stakeholders. Once verified, ARCT publishes broadband coverage information to inform citizens and support planning.

The country has made early progress in consolidating infrastructure datasets. This includes fibre routes, telecom towers, and service availability. Still, Burundi lacks a centralized broadband GIS platform or mapping interface. The collected data is however made available to the public via third party-verified publications by ARCT.

Intersectoral collaboration remains essential. ARCT works with statistical agencies (INSBU), ministries, ISPs and third-party validators to consolidate inputs. INSBU's Statistical Yearbook offers a detailed view of the ICT sector. However, integration remains a work in progress. A unified, national broadband mapping platform could serve as a coordination and planning instrument for ARCT and other public actors, especially as regional harmonization efforts intensify under the Africa-BB-Maps framework.

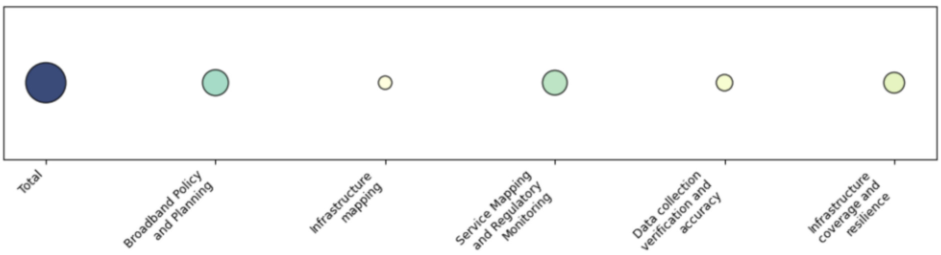

Figure 30: Overview of the survey answers of Burundi *area by area*
The bigger the circle, the more advanced the country is in the related area
(Source: Graph created by the Africa-BB-Maps project team)

8.2. Malawi

Malawi, a southeastern African country with a population of over 21 million (ITU, 2024) and one of the world's youngest demographic profiles, is undertaking efforts to expand broadband infrastructure and integrate data-driven planning. The presentation delivered by Mr. Khumbo Kasambara of MACRA at the Africa-BB-Maps Regional Event reflects Malawi's ambition to reach 80% network access by 2027, a significant leap from the current 47% mobile broadband penetration. According to ITU statistics, 88.7% of the population had access to at least 3G and 74.9% to at least LTE/WiMAX in 2023, while mobile broadband penetration stood at 40.2% of the population.

Broadband infrastructure in Malawi spans multiple technologies and delivery models. Fibre networks have been deployed in metropolitan areas and across the national backbone, including cross-border uplinks. The total fibre length is 5,585 kilometres, forming the physical foundation for fixed broadband expansion. Mobile broadband is delivered primarily through three major providers—Airtel Malawi, TNM, and Access Communications—using 3G, 4G. Satellite services, particularly Starlink, are now operational, expanding coverage to remote areas otherwise unreachable by terrestrial networks. Wireless broadband providers such as Converged Technology Networks and Inq. Digital serve companies and households, while ESCOM Fibre and Simbanet offer backbone-level services.

Figure 31: Fibre network in Malawi (*Source:* Malawi *presenter's slides*)

Malawi's broadband policies are embedded in several key national strategies. These include the Communications Act (2016), the National Broadband Strategy (2019–2023), and more recent documents such as the Digitalisation Policy (2023) and the Malawi Digital Economy Strategy 2023-2028. These frameworks are aligned with the broader Malawi 2063 vision. Public-sector efforts include the National Fibre Backbone Project, the Last Mile Rural

Connectivity initiative, and the Yathu Data program, which focuses on service provision in rural and hard-to-reach communities across Malawi.

Despite this progress, Malawi does not yet operate a centralized broadband mapping system. Instead, MACRA collects information quarterly from ISPs and Telecom providers, national field surveys conducted every 3-4 years by the government, as well as crowdsourced user complaints. Occasionally, Infrastructure audits and broadband gap studies are conducted by MACRA. These data are verified with Telcos and then integrated to National Planning. They are also used by the Ministry of Information, but this integration is not fully structured.

The regulatory framework includes license obligations for ISPs, although specific penalties for non-compliance are not fixed in the licensing terms. However, MACRA holds discretionary authority to enforce compliance and penalize data submission failures. This creates a partial enforcement environment: operators are legally obligated to submit data, but compliance depends on regulatory pressure rather than systematic fines or thresholds.

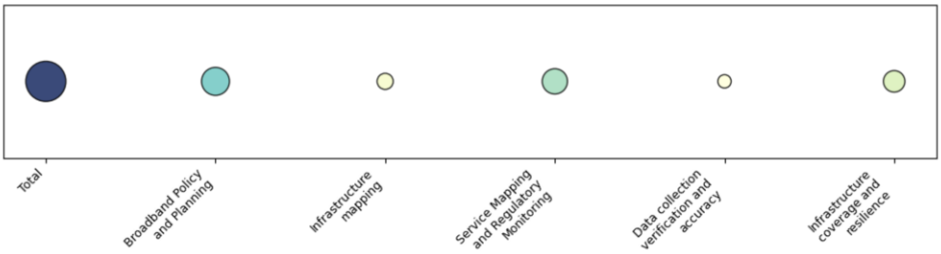

Figure 32: Overview of the survey answers of Malawi *area by area*
The bigger the circle, the more advanced the country is in the related area
(Source: Graph created by the Africa-BB-Maps project team)

8.3. Nigeria

Nigeria has developed a complex broadband ecosystem under the guidance of the Nigerian Communications Commission (NCC) and the Nigerian National Broadband Plan (NNBP). With a population exceeding 230 million (ITU, 2024) and growing demand for digital services, Nigeria's approach to broadband mapping combines internal GIS tools, data submissions from network operators and service providers, crowdsourced data and field assessments to guide investment and policy planning. Mr. Emmanuel Avula presented Nigeria's national broadband plan, supported by multiple layers of infrastructure data and a series of initiatives designed to reach 80% penetration within five years.

The Nigerian National Broadband Plan (NNBP) 2020–2025 serves as the strategic backbone of broadband expansion in the country. In the past five years, mobile broadband coverage grew from 34% to over 84%, supported by the expansion of 3G, 4G, and the early rollout of 5G in major urban zones. Current mobile broadband subscriptions exceed 98 million subscribers, representing over 58% of the market. Fibre optic deployment has similarly increased—from 40,000 km to 98,000 km of fibre in the last 5 years. This has elevated broadband penetration from 32% to 45.6% in the last 6 years. However, fixed broadband remains secondary to mobile, constrained by infrastructure costs and the population's geographic spread.

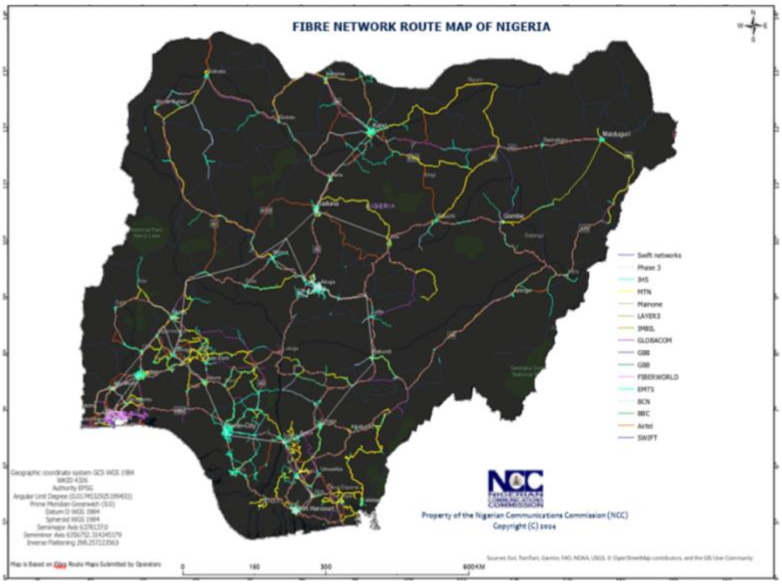

Figure 33: Fibre network map in Nigeria (Source: Nigeria presenter's Slides)

Mapping technologies and practices play a central role in this transformation. NCC maintains internal, GIS-based broadband maps to monitor coverage evolution. These maps include coverage heatmaps for 3G, 4G, and 5G networks. For instance, 3G coverage is mapped at 89%, while 4G coverage stands at 84%. 5G coverage, as of 2024, remains low at 13%, concentrated around Lagos and Abuja. These maps provide signal intensity gradations that help visualize not just coverage presence but signal strength, revealing qualitative disparities across states.

Complementing mobile coverage maps is the national fibre infrastructure layer, overseen by the Technical Standards & Network Integrity Department. NCC tracks terrestrial fibre routes across the country. The southern and eastern regions show more fibre density due to both economic activity and terrain feasibility. Areas not covered by fibre are served by microwave frequency links. These links provide critical broadband backhaul, particularly in regions where terrain is challenging and limits fibre deployment.

Another major mapping product is the Cluster of Coverage Gap Map, maintained and updated by the Nigerian Universal Service Provision Fund (USPF). This map identifies unserved and underserved areas using heatmap-style visualizations and supports the planning of rural and community-oriented projects. High-gap zones are concentrated in northern and rural states. The map is connected to a web interface that allows operators or policymakers to interactively explore regional connectivity deficits.

To ensure forward compatibility, NCC and USPF are collecting multiple types of data in standardized formats. Fibre and base station data are submitted quarterly and semi-annually by operators. Mobile coverage data, particularly prediction models, are also submitted quarterly. Crowdsourced quality-of-experience (QoE) metrics (covering download speed and latency) are being introduced via field testing. However, real-time performance measurement systems are still under development.

The spectrum of broadband infrastructure data is collected through regulatory obligations. Network licensees are required to submit coverage and QoS data under compliance with Sections 64 and 65 of the Nigerian Communications Act (NCA) 2003. Data is validated through drive tests and other field verification methods conducted by NCC. Penalties for non-compliance exist, although enforcement intensity and transparency are not detailed.

Currently, broadband data remains largely internal. Interactive coverage tools exist for institutional use, but there is no public-facing national broadband portal. Entities may request access, pending regulatory approval, but data is not yet published systematically for public consultation or third-party reuse. Plans for a public portal are under consideration.

Mapping is also operationalized in infrastructure planning. Nigeria's Project BRIDGE aims to deploy 90,000 km of fibre, while Project 774 targets broadband deployment across all 774 Local Government Areas (LGAs). These projects are mapped and monitored using the internal GIS platform to avoid duplication and ensure geographic equity. Microwave and fibre deployments are plotted alongside mobile tower infrastructure—approximately 30,000 towers as of 2024—to visualize the national digital footprint and identify rollout priorities.

Beyond the NCC, the Broadband Implementation Steering Committee (BISC) coordinates inter-agency and inter-ministerial data collection to support the NNBP's implementation. This includes harmonizing datasets from infrastructure audits, crowdsourced measurement tools, and network performance reporting. The country has also initiated MoU discussions with the Federal Ministry of Works to protect fibre assets during and after construction. Integration with national GIS platforms is expected to improve infrastructure planning and coordination.

While the current system does not integrate with non-telecom sectors such as energy, water, or urban planning, efforts to break data silos are ongoing. Multisector integration is seen as critical to creating a national spatial data infrastructure that supports economic development and digital transformation goals. Currently, however, the telecom mapping system operates independently, focused solely on broadband.

The NCC, USPF, and associated ministries are also pursuing targeted interventions through broadband gap studies, connectivity programs, and access initiatives. These include PPP-driven telecom infrastructure rollouts, provision of end-user devices in underserved areas, and subsidized services. These programs depend on mapping outputs to identify eligible zones and monitor progress.

In addition to terrestrial infrastructure, Nigeria has embraced satellite broadband for challenging regions. The Commercial Satellite Communication Guidelines encourage deployment in unserved and underserved communities, where neither fibre nor microwave infrastructure are viable.

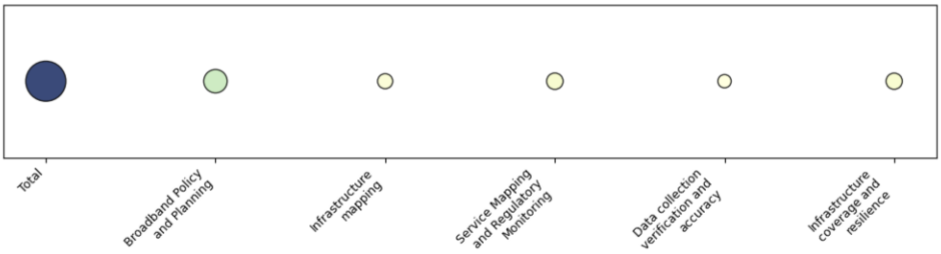

Figure 34: Overview of the survey answers of Nigeria *area by area*
The bigger the circle, the more advanced the country is in the related area
(Source: Graph created by the Africa-BB-Maps project team)

8.4. Benin

Benin has laid a solid infrastructure and policy for digital development, with increasing reliance on mapping tools to manage broadband expansion. The country, with three mobile operators, one fixed-line operator, and 26 internet service providers (as of March 2025), is investing in broadband through a mix of fibre, wireless, and satellite technologies to cover the needs of its 14.5 million inhabitants. These are supported by national policies outlined in the Government Action Program (PAG 2016–2021) and follow-up plans from 2021 to 2026. The presentation was given by Mr. Samuel Akpan from ARCEP Benin.

Under the PAG, over 2,000 kilometres of national backbone fibre have been deployed. Ongoing projects include an additional 484 kilometres of fibre and 205 kilometres of metropolitan networks, along with connectivity efforts targeting strategic sites like hospitals, social housing, and television infrastructure. The regulatory authority, ARCEP Benin, oversees this expansion, including the deployment of 1,271 mobile sites and connectivity initiatives in the Glo-Djigbé Special Economic Zone.

To manage network rollout and compliance, the regulator has implemented several key legal and operational frameworks. These include a transition since 2020 from a licensing regime to an authorization regime for fixed internet providers, with permissions now granted per commune. Mobile operators are authorized by ARCEP to deploy fibre for transmission between their own sites, and conditions for infrastructure sharing have been defined through two major decisions (2022-081 for capacity rental and 2025-011 for technical and economic sharing rules).

Central to ARCEP's efforts is a geospatial data infrastructure for broadband mapping. This includes two public portals: the *Atlas de couverture* (https://atlas.arcep.bj), which displays mobile coverage data, and *PUGIT* (https://pugit.arcep.bj), which shows infrastructure information related to non-ionizing radiation. These platforms host structured data from operators, collected using predefined templates or submitted through a dedicated platform interface. Before publication, the data undergoes validation by ARCEP.

The data collected includes detailed fields for infrastructure elements:

- Pylons**:** geolocation, type, owner, height, sharing status, power supply, and equipment installed.
- Shelters/Data rooms: surface area, shared use status, cooling systems, and equipment load.
- Fibre presence points: georeferenced access points.
- Submarine cables: details on Benin's landing points for SAT3, ACE, and West Africa cables.
- Non-ionizing radiation sources.
- Internet Exchange Point: operational status and location.
- Optical Fibre network.

Operators must report on 2G, 3G, and 4G coverage maps. These are published for public consultation, especially 4G, which is visualized on ATLAS ARCEP through colour-coded maps. Urban centres like Cotonou show dense 4G coverage, while northern areas like Atacora exhibit weaker or absent coverage.

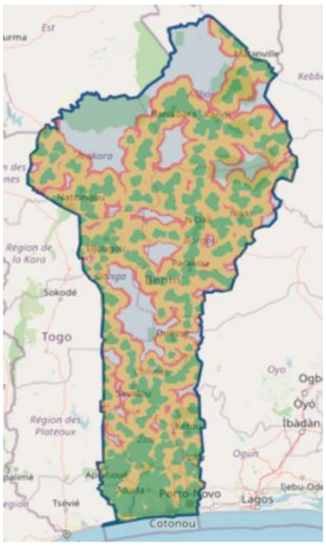

Figure 35: 4G coverage map in Benin (Source: ARCEP Benin)

However, data completeness and submission timelines remain a challenge. Operators often delay, fail to follow the submission template, or provide incomplete data. ARCEP has highlighted these as compliance issues that undermine the effectiveness of the platform. Additionally, technical problems occur in the updating process, sometimes resulting in display errors on the portals. These are flagged as structural weaknesses that must be resolved to maintain data integrity.

ARCEP also uses field audits and independent verifications to validate operator-submitted coverage data. This mixed method of self-declaration and field verification reinforces the accuracy of published data. While most information remains accessible to operators through login credentials, the platform provides public access to key information, particularly related to coverage.

In practice, ARCEP's infrastructure mapping platform allows operators to assess infrastructure availability and plan their expansion by identifying potential points for co-location or shared use. This functionality is central to cost optimization and investment planning. The public platform PUGIT also supports environmental and public health transparency by displaying electromagnetic field information, a relatively rare practice in African regulatory settings.

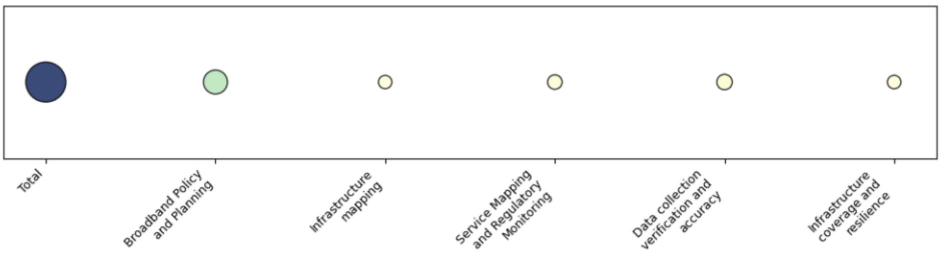

Figure 36: Overview of the survey answers of Benin *area by area*
The bigger the circle, the more advanced the country is in the related area
(Source: Graph created by the Africa-BB-Maps project team)

8.5. Ethiopia

Ethiopia, a nation of over 130 million people (ITU, 2024), is transforming its telecommunications sector following the liberalization of the market in 2019. The sector had been served only by Ethio Telecom for over 130 years, and the introduction of competition through the licensing of Safaricom Ethiopia and WebSprix represents a change. Despite this progress, broadband coverage remains limited at approximately 35% (4G coverage at mid-2024), and the development of broadband mapping systems is still at an early stage and limited to internal use. The presentation was delivered by Mr. Asegdew Fitawok.

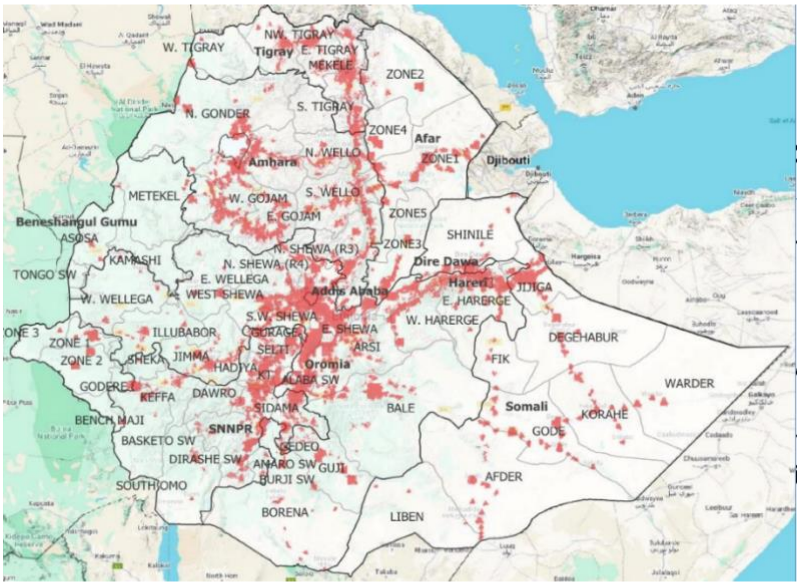

Figure 37: 4G coverage in Ethiopia, mid-2024 (Source: Ethiopia *presenter's Slides)*

Ethio Telecom currently serves 75.5 million mobile subscribers, with 43 million using mobile broadband. Safaricom Ethiopia, operating under a license commitment since 2021, has grown to 10 million subscribers, 6 million of whom are mobile internet users. Fixed broadband remains severely limited, with fewer than one million subscribers, mainly concentrated in urban areas. There are over 13,000 mobile towers deployed nationally, supported by a fibre optic backbone of more than 45,000 kilometres. The international gateway capacity stands at over 1 Tb/s for Ethio Telecom and 120 Gbps for Safaricom Ethiopia.

Despite the expansion in network infrastructure and user base, Ethiopia has not yet developed a public broadband mapping portal. Instead, the Ethiopian Communications Authority (ECA) relies on internal maps created from operator-submitted data. These maps are used for internal planning and reference purposes only. The lack of a standardized, automated system means that whenever new data is required, ECA must manually request updated information from the operators.

The absence of a broadband mapping system reflects a broader structural limitation. There is no established policy or strategy to institutionalize mapping, nor are there partnerships with other government agencies or sectors to support integrated infrastructure planning. The reason for this lack of projects is the recent liberalization of the telecommunications market, as operators were given a three-year grace period, meaning that ECA's budget is currently limited. Additionally, ECA was established 5 years ago.

The broadband data currently collected is not validated by third parties, and public access to this data remains unavailable. However, the data has been used during two national gap assessments, the first in 2021 and the second ongoing with expected completion in mid-2025.

The liberalization of Ethiopia's telecommunications market has introduced new dynamics and responsibilities. Safaricom Ethiopia's license includes specific coverage targets, and both operators—Ethio Telecom and Safaricom—are required to submit regular reports on quality of service. While the ECA collects these reports digitally, the current lack of a centralized system to manage, verify, and publish this data limits their utility.

Maps illustrating 2G and 3G coverage show that Ethio Telecom reaches 93% of the population with both technologies, though geographic coverage for 3G is more fragmented. Safaricom's rollout is progressing in line with license commitments and is expected to cover 42% of the population across 2G, 3G, and 4G by early 2025. Ethio Telecom's 4G coverage currently stands at 35%, while 5G has been commercialized in 14 cities following a pilot phase in Addis Ababa. Safaricom is preparing to launch 5G services in Addis as well. These developments reflect a growing but uneven distribution of high-speed internet access, with rural and peripheral areas still largely underserved.

The ECA manages Ethiopia's Universal Access and Service Framework, which includes a fund, strategic plan, and operational guidelines aimed at addressing the digital divide. The fund's implementation has been delayed due to a three-year grace period granted to new operators at the time of market entry. As a result, the fund has not yet begun financing infrastructure projects. These include expanding broadband infrastructure to rural and remote regions, enhancing national fibre backbones, promoting digital literacy, encouraging ICT use in health and education, and supporting community networks and local content creation.

The government's broadband strategy and National ICT policy are currently under revision. The goal for the next five years is to expand 3G and 4G coverage, especially in underserved areas. The national gap assessments conducted in 2021 and 2024 provide some insight into where infrastructure investments are most needed, but without a centralized mapping system, these insights are difficult to apply consistently across sectors.

The ECA has articulated a clear opportunity to use Africa-BB-Maps to develop a formalized, structured broadband mapping system. The current manual process is inefficient and vulnerable to data delays or inconsistencies. Automating the integration of operator data would significantly improve the frequency and quality of updates. However, Ethiopia faces several challenges in realizing this. These include the absence of a digital infrastructure for storing and managing mapping data, a shortage of skilled technical staff, and insufficient financial resources.

ECA does not yet collect broadband coverage or quality data from ISPs, as the ISP market is just beginning to emerge. WebSprix, the first ISP to receive a full license, had previously operated as a virtual ISP using Ethio Telecom's network. Future data collection protocols for ISPs have yet to be developed, but ECA plans to introduce mechanisms for regular reporting and monitoring of broadband data and quality of service once more ISPs enter the market.

Quarterly quality of service reports is submitted by operators, and Safaricom provides annual updates on its coverage obligations. These reports, while useful, are not currently verified by independent third parties. Broadband data is not publicly available, though it may be shared upon request with specific entities. The lack of public access limits transparency and reduces the ability of civil society or private actors to participate in broadband planning.

In its presentation, ECA emphasized four critical conditions for successfully developing a national broadband mapping system. First is the need for clear institutional ownership and responsibility, ensuring that mapping is not fragmented across agencies. Second is the importance of building technical capacity within the regulator and among sector stakeholders. Third is the requirement for financial investment, particularly to develop digital systems and automation tools. Fourth is the establishment of collaborative partnerships, both domestic and international, to support knowledge transfer, resource sharing, and policy alignment.

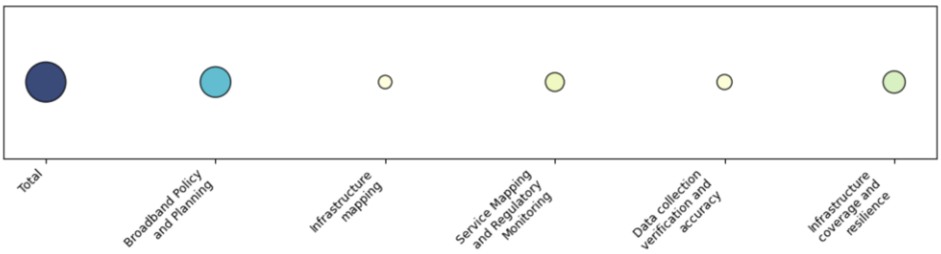

Figure 38: Overview of the survey answers of Ethiopia *area by area*
The bigger the circle, the more advanced the country is in the related area
(Source: Graph created by the Africa-BB-Maps project team)

9. ITU Products and services for Africa-BB-Maps

Title	SESSION 6: ITU Products and Services for Africa-BB-Maps
Objective	To introduce ITU's technical and institutional support for broadband mapping, equipping NRAs for implementation.
Key Participants	Moderator: Ms. Halima Letamo (ITU Area Rep. for Southern Africa) Speakers: • Ms. Halima Letamo (ITU Area Rep. for Southern Africa) • Ms. Nancy Sundberg (ITU, RME), • Mr. Sébastien Peytrignet (ITU, FNS), • Mr. David Manset (ITU, OSEE), • Mr. Elind Sulmina (ITU, Africa-BB-Maps).

Day 2 began with this session which introduced ITU's institutional and technical services that support the implementation of broadband mapping systems under the Africa-BB-Maps initiative. Interventions were provided by representatives from multiple ITU divisions, presenting tools, methodologies, and capacity-building resources relevant for national regulatory authorities (NRAs) and policy institutions across Sub-Saharan Africa.

9.1. Africa-BB-Maps and Giga

The session was delivered by Ms. Halima Letamo, who established the conceptual alignment between the Africa-BB-Maps project and Giga, the ITU-UNICEF initiative targeting global school connectivity by 2030. The presentation outlined how both initiatives, while distinct in scope, share an interoperable architecture—combining infrastructure visibility with education policy implementation.

Africa-BB-Maps is defined as a national capacity-building programme supporting NRAs in the development of harmonized broadband mapping systems. Giga was introduced as a parallel, data-driven initiative that leverages national data to then identify unconnected schools, prioritize investments, and guide national connectivity strategies in the education sector. The institutional positioning of Giga emphasized a linear process of coordination:

- Countries submit field-level data and define policy priorities;
- UNICEF contributes datasets on school infrastructure;
- ITU validates, runs analysis and develops snapshot images under forms of maps, and integrates these inputs to model investment-ready connectivity routes.

This process formalizes a new planning model based on interoperability between public service mandates (education) and technical infrastructure mandates (telecom regulation).

On the other hand, Africa-BB-Maps-specific goals were presented in three domains:

1. Establishing or upgrading national broadband mapping systems buy deploying on the ground physical hardware and software;
2. Enhancing national policymaking capacities through institutional and legal reform and promoting open-source, open-data, and public-access systems to standardize national mapping tools
3. Deliver capacity building and establishing national ownership;

These objectives were translated into operational steps: procedural documentation, phased software rollout, infrastructure requirement assessments, hardware procurement, deployment, installation, training and capacity building to ensure sustainability and long term national ownership. Countries were advised to focus on long-term sustainability, not only through technical performance but by embedding the systems within legal and institutional frameworks that guarantee continuity.

Africa-BB-Maps works at the upstream level while Giga is at the end of the pipeline, supporting the decision making of countries in the field of school connectivity.

9.2. Regulatory and Market Environment Division (RME)

The presentation delivered by Ms. Nancy Sundberg, Senior Program Officer from ITU Regulatory and Market Environment (RME), provided an overview of how regulatory maturity, infrastructure mapping, and inter-institutional cooperation shape digital connectivity in emerging and advanced telecom environments.

Broadband infrastructure mapping is not a purely technical endeavour. It is embedded in regulatory maturity, inter-agency coordination, and data governance. The evolution from G1 to G5 requires parallel advancements in infrastructure visibility and regulatory authority. Countries without obligations to map infrastructure face barriers in deploying inclusive broadband. Conversely, those advancing toward G5-level governance leverage mapping to design targeted investments, reduce rollout costs, and monitor service obligations. The presentation made clear that broadband mapping—when institutionalized, enforced, and secured—serves as a cornerstone for connectivity planning, market regulation, and equitable access.

Ms. Sundberg introduced the concept of the regulatory maturity model. This model, structured across five generations (G1–G5), reflects the progressive evolution of national ICT regulatory frameworks. Generations G1 through G4 correspond to traditional telecom regulation, while G5 represents the maturity of digital policy governance. G1 countries operate under a centralized, command-and-control framework. G2 reflects early market liberalization. G3 enables market-driven investment and competition. G4 represents integrated regulation across technology and service layers.

Beyond G4, the G5 model adds a second dimension: digital governance capacity. The model distinguishes between limited, fragmented, advanced, and leading levels of digital policy integration. At the lower end (G5 Limited), there is a lack of coordination between digital initiatives. At the top (G5 Very Advanced), governments achieve a coherent governance system, integrating infrastructure, services, and institutions through whole-of-government approaches.

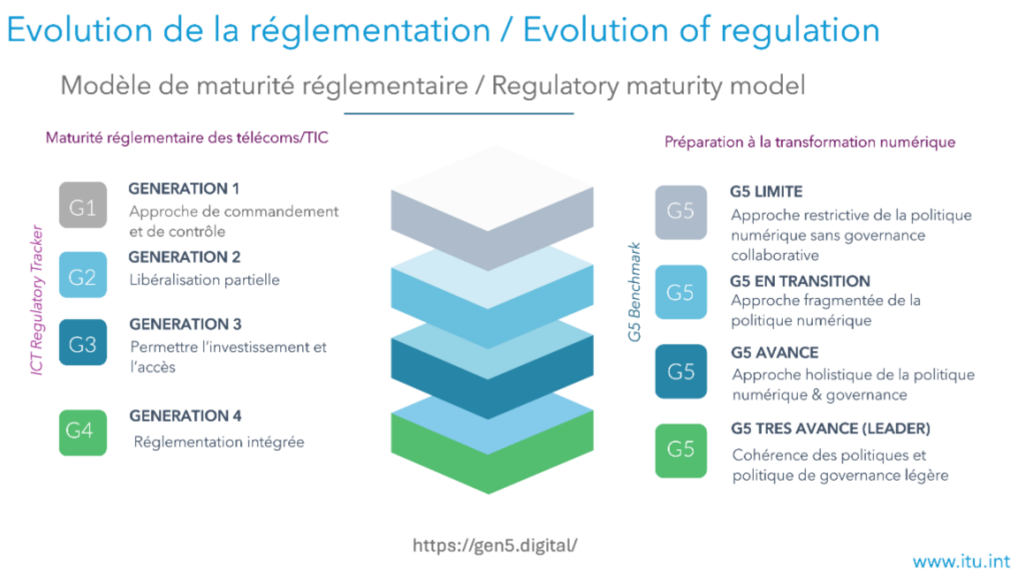

Figure 39: Regulatory maturity model (Source: the presenter's Slides)

The regional distribution of regulatory generations confirmed that most African countries are still within G2 and G3. Europe, by contrast, leads with a high number of countries reaching G4, underlining the presence of integrated regulatory institutions. Asia-Pacific and the Americas exhibit moderate maturity, mostly in G3 and some in G4. This evidences a regulatory gap between regions and underscores the necessity of capacity-building programs tailored to different maturity stages.

The regulatory obligation to map digital infrastructure is vary: ITU classified countries into three groups: those with a legal obligation to map infrastructure, those without, and those with no available data. Only 25% of African countries have enacted legislation mandating the mapping of telecom infrastructure. The majority of countries across regions, including parts of Latin America, the Middle East, and Asia, lack such legal requirements. The absence of this obligation contributes to limited visibility on infrastructure availability and creates barriers to investment and service expansion, particularly in underserved regions.

On the role of the ICT regulator has an important role to play. Key responsibilities include regular data collection from operators, enforcement of compliance with mapping obligations, and collaboration with sectoral and inter-sectoral regulators. Additional functions include managing centralized registers of telecom infrastructure, building regulatory and technical capacity, and ensuring the long-term financial sustainability of mapping systems. These responsibilities extend far beyond technical oversight and position regulators as custodians of data transparency and strategic coordination.

Different institutions collaborate with the ICT regulators. Some of them are formal, some informal, such as consumer protection agencies, postal regulators, spectrum authorities, cybersecurity agencies, and competition authorities. ITU data reveal a trend in which collaboration is strongest with institutions closely linked to digital policy, such as spectrum and data protection authorities. Collaboration with transport and energy regulators on the other hand appear more limited, despite the growing importance of infrastructure co-deployment. It appears that it exists a siloed nature of digital governance in many countries, which also means that an opportunity also exists for those to aim for integrated infrastructure planning through stronger cross-sector engagement.

More specifically, RME's intervention then presented its linkages with the strategic use of broadband infrastructure mapping. Referencing the GSR-19 best practice guidelines, it was explained how connectivity mapping is a regulatory enabler: it helps identify market gaps, facilitates evidence-based policymaking, and guides infrastructure investments. These guidelines emphasize mapping not only as a compliance tool, but as a foundation for digital growth. The use of mapping is tied to the broader principle of transforming information asymmetry into a lever for public and private investment.

GSR-21 guidelines were the first one to introduce and advocate for the use of data-driven tools such as GIS systems, machine learning, and open data schemes to identify white and grey areas—locations with partial or no service. These guidelines recommend that regulators be empowered not only to collect data but also to act on it, developing regulatory tools and financial instruments to correct market failures. This marks a significant policy evolution—from passive data collection to active, predictive regulation aimed at closing the digital divide.

Particularly, infrastructure mapping was highlighted as an enabler in the design of universal service and access projects. Information in a multi-parameter matrix on what should be mappe was presented (e.g. backhaul networks, base stations, electricity poles, water towers, roads, and topography), how each element supports planning, and its relevance for investment and funding. For example, knowing the location of electricity infrastructure allows broadband providers to co-deploy, saving on trenching and improving return on investment. Similarly, mapping community-owned land enables reduced deployment costs through leasing. The inclusion of diverse assets beyond telecom (roads, energy grids, community infrastructure) underscored the interdependency between sectors and the benefits of multi-infrastructure coordination.

Finally, and linked to the GIS system, data governance was introduced by highlighting a four-pillar framework in governance, privacy, intellectual property, and secure data sharing.

Broadband mapping requires not only technical systems and regulatory authority but also trust. As mapping involves sensitive data—such as infrastructure locations, service quality, and operator submissions—governance frameworks must ensure data integrity, privacy, and responsible sharing. Without proper legal safeguards and rights-based frameworks, infrastructure data could pose security and commercial risks.

9.3. Future Networks and Spectrum (FNS) Management Division

The presentation was delivered by Mr. Sebastien Peytrignet, Project Officer from ITU FNS, presented a toolkit developed by ITU for strategic broadband planning and connectivity analysis.

This toolkit, using geospatial analysis to provide technology assessment and cost modelling, is designed to support informed infrastructure investment. The GIS analysis process begins with connectivity demand estimation. This step identifies expected throughput needs at a given point of interest, such as a school or household. A spatial buffer is drawn around the location to approximate its catchment area. Using high-resolution population data—such as that from WorldPop—the number of people within the buffer is calculated. Multiplying this population estimate by an assumed per-capita internet usage figure yields the required throughput in Mbps. This estimate informs subsequent stages by establishing baseline demand.

The toolkit also helps to categorize broadband technologies into two classes: wired and wireless. Fibre represents the sole wired solution and is known for high bandwidth and reliability. On the wireless side, three technologies are considered. Cellular networks (3G, 4G, 5G) are widely deployed and offer scalable solutions within existing coverage. Point-to-point microwave links are a common solution too as they extend broadband to rural or hard-to-reach areas where fibre deployment is not viable. Satellite, particularly low Earth orbit systems like Starlink, provides another layer of coverage, mostly for remote locations. These four technologies are evaluated according to availability, feasibility, and cost. The analysis also integrates a mobile coverage assessment module. This component evaluates whether cellular service—3G, 4G, or 5G—reaches each point of interest. It does so either by importing operator-provided coverage maps or by using signal propagation models to simulate availability. For locations such as schools, health centres, or administrative buildings, this step determines the presence or absence of mobile broadband. The outcome directly influences which technologies remain viable for a given site.

Where coverage exists, the system performs a cellular capacity assessment. This module estimates whether current infrastructure can meet the site’s projected demand. It compares the available bandwidth (supply) against the throughput requirement calculated earlier. If the capacity is insufficient, cellular is excluded from the set of feasible solutions. This ensures that technical limitations are filtered out early in the planning process.

Fibre connectivity is approached through a routing and cost-efficiency algorithm. The tool identifies the shortest viable fibre path between each unconnected site and the existing backbone. It assumes fibre can only follow road infrastructure, which constrains the model to realistic deployment scenarios. Once a site is connected, it can serve as a hub for others nearby—supporting a phased, cost-effective expansion strategy.

Microwave link feasibility is tested through a visibility analysis. This module checks for a clear line-of-sight between the target site and potential relay towers. Obstructions such as terrain elevation or urban structures are flagged, and any link that fails this check is discarded. When feasible, microwave becomes a mid-range option, particularly in rural areas where fibre is too expensive and cellular is weak or absent.

Once technology options are filtered, the toolkit initiates cost modelling. Each solution—fibre, cellular, microwave, and satellite—is assessed on two dimensions: capital expenditure (CAPEX) and operational expenditure (OPEX). CAPEX includes hardware, trenching, tower construction, and installation. OPEX covers maintenance, licensing, and service fees over the system's lifecycle. Costs are calculated across a multi-year horizon. The model then selects the most cost-effective solution for each point, based on minimum total cost while satisfying bandwidth requirements.

A final component allows for scenario analysis. This enables planners to simulate how policy or regulatory changes would affect deployment. For instance, one scenario might limit fibre deployment to 3 kilometres from the existing grid, while another allows for 10 kilometres. Relaxing the constraint increases the number of sites eligible for fibre. This comparative function helps identify strategic levers—such as increased funding or regulatory exceptions—that can shift deployment outcomes.

All modules operate in sequence, with output from one feeding directly into the next. The workflow starts from demand estimation and moves through feasibility testing, cost modelling, and scenario testing. At each stage, non-viable options are discarded. The result is a prioritized connectivity plan grounded in geospatial data, technical feasibility, and economic constraints—ready to inform national broadband strategies.

The entire approach is based in data validation and spatial logic. Every input—be it population density, road availability, existing fibre lines, or topographical elevation—is standardized and verified before use. No decision point is treated in isolation. For example, proposed fibre routes are not selected solely based on geographic proximity; they are evaluated against road infrastructure, population served, and projected cost per megabit delivered. Similarly, satellite connectivity is not automatically assigned to remote areas. It is tested alongside microwave and cellular alternatives, with final selection based on technical feasibility and economic efficiency.

The system's modular architecture supports incremental implementation. Countries with limited data or institutional capacity can begin with basic demand estimation and progressively add more advanced components—such as fibre routing, cost modelling, or scenario testing—as capacity improves. This makes the toolkit adaptable to different regulatory maturity levels, from early-stage planners to countries with well-developed mapping systems seeking optimization.

A key distinction made within the cost model is between capital expenditures and operational expenditures. While fibre requires significant up-front investment—particularly in trenching and hardware—its operational costs are comparatively low. Satellite, conversely, may have limited installation costs but entails high recurring service fees.

Through scenario-based configurations, stakeholders can build granular deployment strategies. These outputs serve multiple purposes: justifying public investments, preparing donor submissions, negotiating infrastructure sharing agreements, or aligning rollout plans with universal service obligations. The toolkit also establishes a baseline against which future progress can be monitored and measured—allowing countries to track connectivity gains, adjust strategies, and demonstrate impact over time.

9.4. Open Source Ecosystem Enabler (OSEE)

The presentation delivered by Mr. David Manset, Senior Coordinator at the ITU, introduced the OSEE framework for helping countries to support the development, deployment, and scaling of open-source technologies in the context of Digital Public Goods (DPGs) and Digital Public Infrastructure (DPI).

The initiative is established within the global policy frameworks such as the UN Secretary-General's Roadmap on Digital Cooperation and aligns with the Sustainable Development Goals (SDGs). However, it is worth noticing that only about fifteen per cent of SDG targets are currently on track, yet global studies suggest that roughly seventy per cent could be accelerated by well-designed digital solutions. Against this backdrop, the OSEE initiative was designed to institutionalize open-source capacity at the national level through the creation of Open-Source Programme Offices (OSPOs), enabling local innovation ecosystems to scale digital public services.

DPGs and DPIs are levers for inclusive digital transformation. DPGs are defined as open-source software, data, AI models, standards, and content that conform to privacy, safety, and sustainability criteria while supporting SDG outcomes. By contrast, DPI can be referred as the foundational systems—such as digital identity, payments, and data exchange platforms—that enable the delivery of public and private services in the digital economy. The presentation emphasized that both DPGs and DPIs must be rooted in open technologies to guarantee transparency, adaptability, and interoperability.

The ecosystemic approach of the OSEE initiative is built on three pillars: thought leadership, capacity development, and sustainable support. Through this approach, ITU aims to create an enabling environment where open-source digital tools are developed, maintained, and reused across governments and institutions. The framework also supports long-term country-level investment in digital sovereignty by helping local institutions build, manage, and adapt software infrastructures.

One of the central elements introduced in the presentation is the Open-Source Ecosystem Development Matrix, a methodological framework structured across four domains—technical, organizational, institutional, and ecosystemic. Each domain includes concrete operational steps: assessment, planning, implementation, evaluation, and improvement. Within the technical domain, countries conduct needs assessments, specify software requirements, ensure code security and reusability, and develop hosting and maintenance strategies. The organizational domain focuses on managing open-source programs and assessing DPG/DPI maturity. At the institutional level, the framework evaluates public sector capacity, legal readiness, and coordination potential. The broader ecosystemic domain addresses digital governance, risk management, and national digital strategies.

This structured methodology is applied through OSPOs, which serve as in-country coordination entities. Each OSPO is hosted within a local institution—typically a ministry or national ICT agency—and staffed with national experts. They are supported by consultants and benefit from technical guidance and strategic coordination from ITU and UNDP. The model foresees a two-year operational period with the explicit goal of enabling long-term sustainability through national ownership and integration into digital governance systems.

The OSPO's functions are both managerial and strategic. They define internal open-source policies, provide guidance to agencies and stakeholders, promote inter-agency and community collaboration, and manage institutional contributions to public open-source projects. In practice, OSPOs act as interface layers between the government, the local developer ecosystem, and international networks. They also facilitate the reuse of existing digital public goods, reducing duplication and improving procurement efficiency.

As of early 2024, ITU had received 25 expressions of interest from 21 countries, covering approximately 2.2 billion people or about 28% of the world's population. Two pilot OSPOs were formally launched in Kenya and Trinidad and Tobago, with several other countries—including Cambodia, Kazakhstan, Malawi, Ghana, and Nepal—joining as affiliate OSPOs. These affiliate OSPOs adopt parts of the OSEE methodology while adapting to local institutional capacities.

The ITU OSEE roadmap laid out spans three and a half years. The first year was dedicated to laying the foundation, developing and publishing the OSEE framework. The second year (current phase) focuses on piloting activities in two countries and creating local Open-Source

Task Forces (OSTFs). The third year, beginning in Q3 2025, will aim at global expansion and knowledge sharing. In this phase, ITU will establish a knowledge Hub to aggregate lessons learned, to disseminate best practices, and to support cross-country collaboration. The long-term phase, projected for 2027 and beyond, focuses on maintaining sustainability and resilience of the OSPO network. ITU and UNDP will intend to help countries secure additional donor funding and integrate OSPO operations into national budgets, ensuring the offices remain permanent features of digital-governance architecture.

In the presentation, the OSEE was also linked to a broader UN effort "Open Source United." This inter-agency community of practice has already produced a common open-source policy framework, a unified software catalogue and a secure Git-hosting environment, all of which will be made available to national OSPOs. By federating these resources, OSEE turns open source from a collection of isolated code bases into a governance strategy for inclusive, sustainable digital transformation. Countries gain a pathway to modernise procurement, professionalise software management and share solutions across borders—laying the groundwork for digital public services that are transparent, adaptable and locally owned long after external project funding ends.

The model also considers capacity-building needs. Training programs are tailored to the roles of developers, administrators, and policymakers. These include modules on software development practices, licensing compliance, digital sovereignty, and community engagement. The goal is to professionalize the management of digital public goods and move beyond project-based development to sustainable systems.

By replicating the OSEE model, ITU intends to support the formation of a coordinated international structure. This will allow countries to benefit from shared tools, co-develop solutions, and align their digital strategies with global standards. The network is envisioned not just as a technical collaboration forum but as a policy instrument to support regional harmonization, infrastructure interoperability, and the efficient use of donor funds.

Currently OSPO's goals are summarized in: community engagement, process institutionalization, ecosystem development, and training. These goals underpin the strategic objectives of national digital transformation and inclusive digital service delivery.

The OSPOs are designed to become permanent institutional structures. To that end, they are expected to integrate into national digital strategies, secure public or donor funding, and maintain local ownership. ITU and UNDP would provide initial coordination, but countries are expected to gradually take over strategic and financial responsibility.

9.5. ITU Academy Training Centre (ACT) and Universal Meaningful Connectivity (UMC)

The presentation by Mr. Elind Sulmina, Project Officer of Africa-BB-Maps, introduced the ITU Academy and the Universal and Meaningful Connectivity (UMC) Project as components of the Africa-BB-Maps collaboration framework.

Under the Africa-BB-Maps initiative, the ITU Academy serves as the online platform for digital skills training and capacity-building offered by ITU. It is the platform where the Africa-BB-Maps team will host all its training activities. The portal offers a comprehensive list of training sessions aimed at a broad audience, including policymakers, government officials, regulators, private sector IT experts, academia, and civil society. The Academy already plays a significant role in advancing digital inclusion, with over 65,000 users—more than 70 percent of whom are based in developing countries. The training is offered in various formats, including instructor-led courses, self-paced modules, hackathons, and peer-to-peer learning sessions, ensuring both flexibility and accessibility for all participants.

The ITU Academy operates a global network of 14 certified training centres and implements a rigorous quality assurance system before, during, and after the delivery of every course. As part of its objectives under Africa-BB-Maps, capacity-building and certification training sessions are foreseen for all project beneficiaries.

UMC, on the other hand, stands to benefit directly from the improved data quality generated by Africa-BB-Maps. Its objective is to promote and measure universal and meaningful digital connectivity (UMC). The project aims to promote UMC as a policy objective, improve the quality and availability of UMC statistics, and identify promising policies for accelerating progress towards UMC. It distinguishes between the “coverage gap”—populations without access to broadband—and the “usage gap,” which refers to individuals who have access but do not use the internet effectively.

UMC measurement spans six dimensions: connection quality (e.g., speed and reliability), frequency and context of internet use, affordability (costs of data and devices), access to devices (such as smartphones and computers), digital skills and literacy (especially among disadvantaged groups), and online safety practices. These dimensions align with several Sustainable Development Goals (specifically SDGs 4.4, 5.b, 9.c.1, and 17.8.1), reinforcing the broader development implications of meaningful connectivity. The presentation warned that countries without UMC risk exacerbating digital divides, increasing economic inequality, restricting access to essential services, and weakening resilience to global shocks.

Africa-BB-Maps supports UMC by improving the quality of broadband data collected at the national level. The project addresses typical barriers to data improvement—such as fragmented information, limited staff capacity, budget constraints, and institutional inertia—by equipping regulators with the skills and tools needed to gather and clean broadband data.

With better instruments and training, regulators will be able to record accurate, up-to-date data and transmit it directly to the global dashboards managed by ITU Statistics. This process enables real-time monitoring of connectivity trends, allowing decision-makers—including ministers and development partners—to act on reliable evidence.

All the presentations converge in support of Africa-BB-Maps—bringing together RME, UMC, OSEE, the ITU Academy, FNS connectivity analysis, and Giga—into a unified framework for technical assistance, digital governance, and inclusive connectivity. These are not standalone interventions or siloed tools from ITU's global services, but complementary components that the Africa-BB-Maps project team will leverage and layer onto the concrete technical deployments delivered on the ground. Covering areas from policy and regulation to infrastructure, capacity development, and data analytics, each ITU division will continue to contribute its expertise toward the shared objective of achieving universal, meaningful, and sustainable connectivity. Within this framework, Africa-BB-Maps serves both as a technical implementation initiative and as a foundational enabler of long-term digital transformation across Sub-Saharan Africa.

10. Co-creation session & Key case study takeaways and open discussion

Title	**Co-creation session and standing coffee**
Objective	Produce a list of thoughts that stemmed from the presentations. Exchange between African and European NRAs to inspire concrete implementations.
Key Participants	• All NRAs.
Title	**SESSION 8: Key Case Study Takeaways, National Implementation Planning, and open discussion, follow up on matchmaking**
Objective	To synthesize learnings and outline national strategies.
Key Participants	Moderator: Ms. Halima Letamo (ITU). • Participants: Open Floor.

This interactive co-creation session was conducted in subgroups. Each African National Regulatory Agency (NRA) drafted a page answering three key elements. The participants exchanged with European representatives to reflect upon the different presentations that were made throughout the event. The following three questions were asked to each NRA:

- Write down something that you heard from the other presentations and that you would like to implement in your own country.
- How would you qualify the "success" of this project for your country?

- If one were to start implementing solutions with your country now, what is the first thing that you want to work collaboratively on?

Thanks to these questions and discussions, this co-creation session aims at answering the question "what is next?" and to begin a roadmap of what should come next. Defining how success is measured, what projects should be implemented is crucial to move towards concrete results in broadband mapping. In the following table, the answers of Benin, Botswana, Burundi, Côte d'Ivoire, Kenya, Malawi, Nigeria, Uganda, Zambia and Zimbabwe are presented below (Ethiopia being present remotely did not participate to the standing coffee).

Country	What inspired you from other presentations?	How do you define success on this project?	What is the first solution that you would implement?
Benin	The level of detail of Nigeria's platform, the available statistics and the reactivity of the maps.	Benin underlined their need for assistance to ensure reliable data is submitted by operators. ARCEP Benin aims to display all existing infrastructure and coverage data on a single map.	A work session to define the scope of the project and its specific objectives.
Botswana	BOCRA representatives were inspired by initiatives enabling legislation to collect up-to-date data and would like to constitute a dedicated project team including all relevant stakeholders.	Promoting Open Data to the public (e.g. via an API) Efficient identification of connectivity gaps Use of AI to show the most cost-effective options for connectivity Develop a tool optimized for both mobile and desktop access.	Bring stakeholders around the table to define what constitutes sensitive data, and what can be made available to the public. Foster a synergy of data submission formats (harmonized formats) from all stakeholders. BOCRA anticipates challenges: lack of data available in proper format, and rural areas without proper addressing systems or roads.
Burundi	Guidelines for collecting, validating, and publishing broadband maps data. Implementation of an interactive platform for public access and contribution.	Active participation of stakeholders, availability of broadband map indicators and public engagement.	Stakeholders' awareness. Capacity building for data collection. Deployment of dedicated tools and systems.
Côte d'Ivoire	Project Giga and ARCEP's "data-driven regulation" (*régulation par la donnée*) approach, as well as the feature allowing to map fibre	Proportion of the population that uses the service.	Implement QoS and QoE monitoring. Develop a mobile application.

Country	What inspired you from other presentations?	How do you define success on this project?	What is the first solution that you would implement?
	network that is planned, or under construction. Slovenia's approach with a fibre density map also interested Côte d'Ivoire's representatives.	Côte d'Ivoire sees a successful system as allowing a more inclusive regulation.	Conduct multi-dimensional analysis, including socio-economic criteria.
Kenya	Standardized data collection templates. Layering sectoral data on maps. Integrate the system to other regulatory tools. Expand data collection to include licensees and public entities. Data validation by stakeholders. System documentation.	Buy-in by stakeholders and use of broadband data in public decision making. Generally, the goal of maps is to be the single source of ICT information.	Assess what already exists (baseline data) and prepare a detailed roadmap / workplan.
Malawi	2 tools for mapping interested the delegation from Malawi: • Map box • Online data collection such as Cartodonnées, Poland's UKE. Flexible policy enabling data collection was also of interest to Malawi.	Malawi envisions a publicly accessible integrated broadband map system, that provides adequate information for digital transformation.	To kickstart the broadband maps project in Malawi, the delegation would start by raising awareness of national stakeholders via a workshop, and build capacity relevant to mapping systems, in terms of both people and infrastructure.
Nigeria	Nigeria's delegation was interested in Open data Policies, while keeping considerations to national security. Standardized geospatial data frameworks were also of interest.	Comprehensive, validated and publicly accessible broadband map capable of being integrated to other sectoral data like energy, transport, education, health, urban development and planning, etc. Enable evidence-based decisions for policy makers, private investors, etc. This would lead to targeted deployments of broadband infrastructure, and reduced overlaps. Strengthen collaboration between the regulator, telecom operators, and other stakeholders such as the Ministry of Works to minimize fibre	Technical support and capacity building on best practices for data collection, reporting, harmonization, governance and standards. High level workshop with NCC, telecom operators, the Ministry and other relevant stakeholders to align the project's scope, objectives, methodology and deliverables with National goals.

Country	What inspired you from other presentations?	How do you define success on this project?	What is the first solution that you would implement?
		cuts during construction works.	
Uganda	National definition of broadband, layered mapping (services, infrastructure, etc.), Data collection & validation and Capacity development are key takeaways of the delegation from Uganda.	Uganda would consider the project a success if it managed to create layered, validated maps that can be used for informed decision making. The objective is to create a win-win situation, embedded in multi-stakeholder collaboration.	Next steps include the alignment of objectives, capacity development, as well data collection, validation, mapping, publishing and analysis.
Zambia	Fibre infrastructure and service mapping systems from Slovenia and Côte d'Ivoire were of particular interest for Zambia.	Zambia will consider the project a success if it manages to map and publicly publish infrastructure and service maps for both fibre broadband, and mobile.	Zambia would begin the project by acquiring fibre broadband mapping tools, review the regulatory framework and conduct capacity building on the acquired systems.
Zimbabwe	Lessons learned from EU representatives' presentation include the publication of broadband maps and the BEREC guidelines (resolution of the data collected, integration of various data sources and data validation processes). The ITU presented valuable tools that could be used and the usefulness for broadband maps as a tool for data driven decision making. Finally, African NRAs provided insights on the level of granularity needed as well as challenges to mitigate (capacity building, dedicated staff).	A successful broadband mapping system for Zimbabwe would mean a publicly available broadband mapping system, providing information at the accurate granularity, with regular updates and multi-stakeholder collaboration.	Next steps for Zimbabwe involve assessing the current broadband mapping systems via a national workshop. This would help define what is needed for Zimbabwe, in relation to the best practices presented in the Africa-BB-Maps Forum. Zimbabwe's regulatory environment is deemed fairly favourable to the project.

Table 1: Answers of the participant countries to the co-creation session and standing coffee

Moderated by Ms. Halima Letamo, Session 8 further encouraged collaboration among countries, fostering the exchange of ideas and clarifying their shared expectations. This plenary also saw countries share takeaways—regulation, capacity, transparency—and strategies like training and reforms. Discussions in roundtable formats, coffee breaks and informal side events allowed for initial potential matchmaker pairings, concluding with clear commitments for the national rollout in each beneficiary country.

11. Closing ceremony and closing remarks

Title	Closing ceremony and closing remarks
Objective	To conclude the event, reinforcing commitments and gratitude.
Key Participants	• Mr. Emmanuel Manasseh (ITU Africa), • Mr. Lakoun Outtara (ARTCI).

Drawing from the event this section outlines actionable paths forward.

11.1. Recommendations

The event's discussions yielded key recommendations: regulators should strengthen legal frameworks, mandating data submission via licensing and penalties, as seen in Slovenia and Lithuania. Capacity building is urgent—NRAs need training in GIS, analytics, and enforcement to mirror gold standard expertise, such as the European one. Public transparency, inspired by France and Denmark, should be prioritized with accessible portals to boost accountability. Appropriate financing, integrating mapping into national budgets as in Poland and Croatia, ensures sustainability.

11.2. Next Steps

Immediate actions would include follow-up bilateral calls between ITU and the NRAs to discuss the outcome of the regional event, followed by an ITU introduction between EU Delegations and their respective NRAs, and trilateral meetings (NRA-ITU-EU DEL) to align teams and plan national events with each of the 11 countries. These steps, building on the event's momentum, prepare for national implementation.

11.3. Conclusion

The Africa-BB-Maps Regional Event was the first opportunity to allow the establishment of a cross-continental broadband mapping system expert network, connecting European, African and Institutional stakeholders. The event launched an initiative between Europe and Africa in the field of broadband mapping systems, fostering knowledge sharing and partnerships.

Annex 1 - Maturity Matrix Analysis

To assess the maturity level of each of the beneficiary countries of Africa-BB-Maps, a survey was conducted. This survey allowed ITU to draft a first analysis of the current state of broadband mapping in each of the beneficiary countries, based on the answers provided, on ITU statistics, and the participants' presentations. This annex details the methodology used to evaluate the survey answers, and the results obtained.

Rationale

The survey was divided in 5 sections:

1. Broadband policy and Strategic Planning (12 questions)
2. Broadband infrastructure mapping systems (5 questions)
3. Broadband service mapping and regulatory monitoring (6 questions)
4. Data collection, verification and accuracy (5 questions)
5. Infrastructure, coverage, resilience and expansion (8 questions).

Section 4 concerns only countries already with a broadband mapping system.

The survey thus counts a total of 36 questions. Each question is attributed an importance level (A, B or C) which determines its relative weight in assessing the respondent's country maturity regarding broadband mapping. In practice, this means that type A questions bring maximum 3 maturity points, type B questions maximum 2 points, and type C questions maximum 1 point.

Each question in the survey is one of two types:

- Progressive questions

Those questions measure how advanced a country is advanced in certain areas linked to broadband mapping, for example question 1: "Does your country have government initiatives or public policies related to broadband mapping?" goes from (No formal broadband mapping strategy exists" to "Yes, with a structured plan and budget": the answers are progressive.

In this type of question, the more advanced the country, the better the maturity. Each possible answer is attributed a score from 0 to the maximum allowed by the question's type (1,2 or 3 for C, B or A), with regular spacing (mathematically, $spacing = \frac{Level\ of\ answer}{Number\ of\ possible\ answers}$).

- Multiple choice questions

Some questions can have multiple answers. This is the case for example of question 2: "which types of broadband technologies are most widely deployed in your country?", where a respondent can choose multiple answers between Fibre optic, Coaxial Cable, Wireless Networks, Copper pair and satellite.

In this case, the score attributed to each answer is such that, if a respondent chooses all possible answers, it gets the maximal possible score (depending on whether the question is classified as type A, B or C). In mathematical terms, it means that $answer\ score = \frac{Max.\ possible\ score}{Number\ of\ possible\ answers}$.

This allows for an easily explainable and equitable rating of each question, to get a simple but understandable view of each country's maturity – between advanced, medium and initial stage maturity.

Analysis

With this methodological framework, the maturity level of each respondent country was assessed and is presented graphically. A section-by-section heatmap, a spider graph and plots of countries comparing their relative maturity in 2 dimensions (e.g. infrastructure mapping and service mapping) are presented.

Maturity Matrix Heatmap

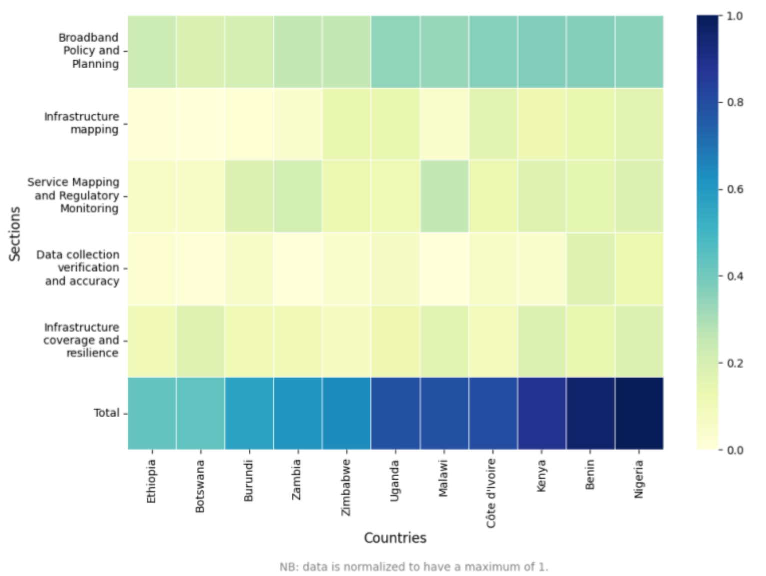

Figure 40: Maturity Matrix Heatmap, showing results by country and by survey section (Source: Graph made by project team)

ITU identifies the 4 first countries (Nigeria, Benin, Kenya, Côte d'Ivoire) as advanced. Malawi, Uganda, Zambia and Zimbabwe follow with medium maturity, and Burundi, Botswana and Ethiopia are still in initial stages.

- For example, Benin is ranked second most-mature country according to this survey and scoring framework. With the heatmap, one can understand that this higher score is partly due to its advancement in "data collection verification – and accuracy", where Benin is the most mature of the 11 countries.
- Another example: Uganda has a quite balanced score in each section, where most of its scores have a colour like the rest of the countries, except regarding "data collection verification – and accuracy" where its score is relatively higher, right behind Benin. These observations can help explain Uganda's position in the maturity spectrum.
- Botswana has a relatively high maturity regarding "Infrastructure coverage and resilience "(between 0.2 and 0.4) but has room for progress when it comes to "Data collection verification and accuracy" or "Infrastructure Mapping".

With the heatmap, the reader can quickly visualize which countries are more advanced, and which ones are still in early stages. The granularity level of the matrix (section by section) allows for better explainability of the results.

Categorized Scatter Plot of Maturity Level

The following graph is a two-dimensional plot of the participant countries' total score against their maturity level.

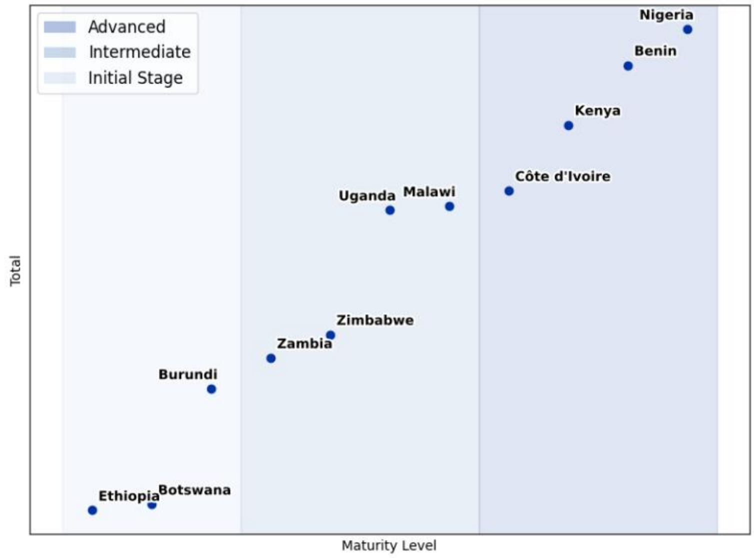

Figure 41: Maturity level plotted with the country's relative score
The more to the right and to the top, the more advanced the country is
(Source: Graph created by the Africa-BB-Maps project team)

This analysis is not intended as a performance evaluation. It is instead a reference document that supports three main functions:

- First, it provides the project team and other stakeholders with a structured snapshot of the situation across countries, identifying what capabilities exist and where key limitations persist.
- Second, it introduces a common vocabulary for understanding maturity in broadband mapping systems, so that discussions around technical assistance and investment planning can proceed on shared terms.
- Third, it enables peer comparison—not to foster competition, but to facilitate learning, adaptation, and the diffusion of practical solutions from more advanced systems to those at earlier stages of development.

In summary, the following table presents the maturity clusters identified thanks to the survey:

Nigeria	Advanced stage
Benin	Advanced stage
Kenya	Advanced stage
Côte d'Ivoire	Advanced stage
Malawi	Medium stage
Uganda	Medium stage
Zimbabwe	Medium stage
Zambia	Medium stage
Burundi	Initial stage
Botswana	Initial stage
Ethiopia	Initial stage

Table 2: Maturity levels of the 11 participant countries

Spider Graph of Maturity Matrix Survey Sections and Maturity Level

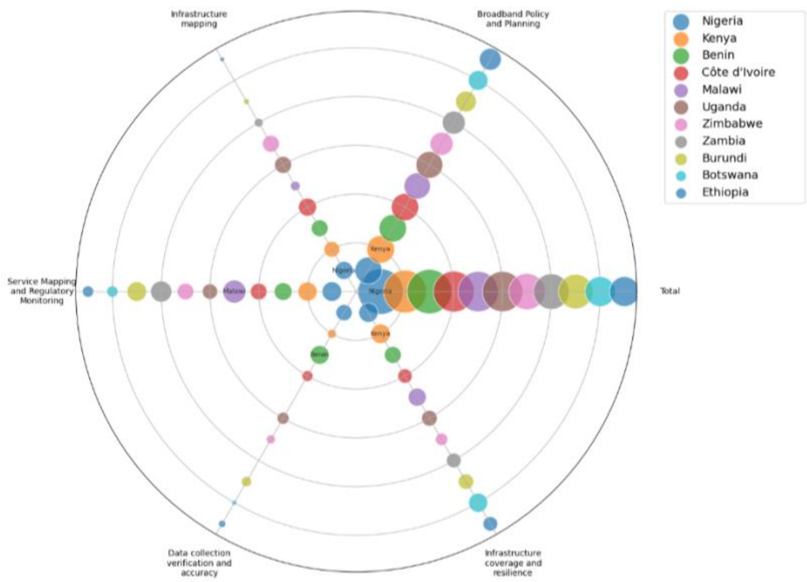

Figure 42: Spider graph of Maturity Matrix results, by country, by survey section
The bigger the circle sizes, the more advanced the country's performance in the related category. The name of the most advanced country of each category is written in the corresponding circle
(Source: Graph created by the Africa-BB-Maps project team)

This spider graph displays countries' maturity level in each of the survey's categories. The sizes of the circles are proportional to the maturity level of each country. For each section, the name of the most mature country is written in the corresponding circle (for example, the reader can see that Kenya is the most mature country in "Infrastructure coverage and resilience"). A legend allows to identify each country by its colour. It allows to identify the strengths and weaknesses of each of the respondent countries.

Here are a few examples to see how this graph can be read:

- For example, Benin's strength in "Data collection, verification and accuracy" is shown by the relatively bigger size of Benin's green circle in the bottom left line, compared to other countries;
- Kenya's advanced maturity in many of the areas evaluated through the survey is visible, as the blue circles are often the biggest of each line.
- Additionally, Burundi's strongest point is on "Broadband Policy and Planning", but can improve "Infrastructure Mapping" and "Infrastructure Coverage and Resilience", since the circles of this country in both these areas is relatively small.

Infrastructure Mapping & Service Mapping and Regulatory Monitoring

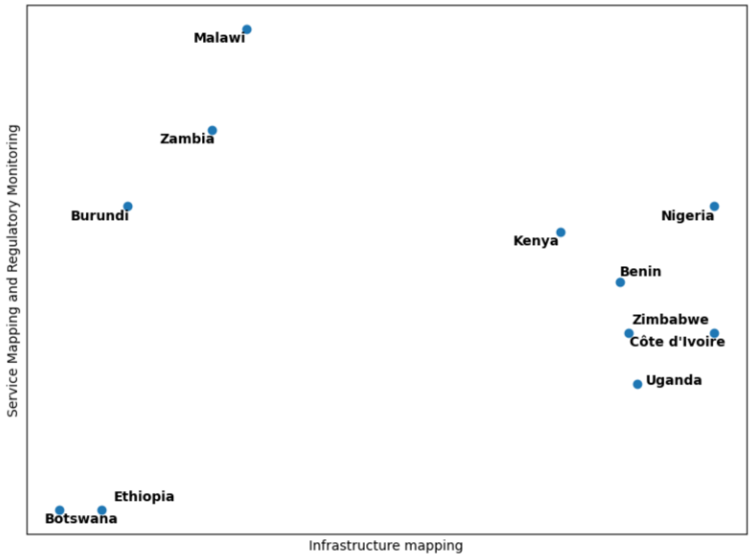

Figure 43: Countries' scores in "Infrastructure Mapping" and "Service Mapping & Regulatory Monitoring"
The more to the right and to the top, the higher the country's score is in the related axis
(Source: Graph created by the Africa-BB-Maps project team)

This 2-dimensional plot allows to evaluate the answers of the countries to the questionnaire, through the lens of Infrastructure and Service mapping. It shows three clusters:

- The most advanced countries in "Infrastructure mapping" include Kenya, Nigeria, Benin, Zimbabwe, Côte d'Ivoire and Uganda. They are however less advanced when it comes to Service Mapping and Regulatory Monitoring.
- Countries most advanced in "Service mapping and regulatory monitoring" are Malawi, Zambia and Burundi. They are however less advanced when it comes to Infrastructure mapping.
- Botswana and Ethiopia are at an initial stage in both areas.

Broadband Policy and Planning & Service Mapping and Regulatory Monitoring

Figure 44: Countries' scores in "Broadband Policy and Planning" and "Service Mapping and Regulatory Monitoring"
The more to the right and to the top, the higher the country's score is in the related axis
(Source: Graph created by the Africa-BB-Maps project team)

This 2-dimensional plot allows to evaluate the answers of the countries to the questionnaire, through the lens of Policy/Planning, and Service mapping. One can identify three clusters with overlapping members:

- The most advanced countries in "Broadband Policy and Planning" include Kenya, Nigeria, Benin, Côte d'Ivoire, Uganda and Malawi. They are however less advanced when it comes to Service Mapping and Regulatory Monitoring (except for Nigeria and Malawi).
- Countries most advanced in "Service mapping and regulatory monitoring" are Malawi, Zambia, Burundi and Nigeria. They are however less advanced when it comes to Infrastructure mapping (except for Nigeria and Malawi).
- Botswana and Ethiopia are at an initial stage in both areas. Zimbabwe is in a relatively more advanced maturity state than these two countries, but still does not belong to cluster 1 or 2.

Data Collection Verification and Accuracy & Infrastructure Coverage and Resilience

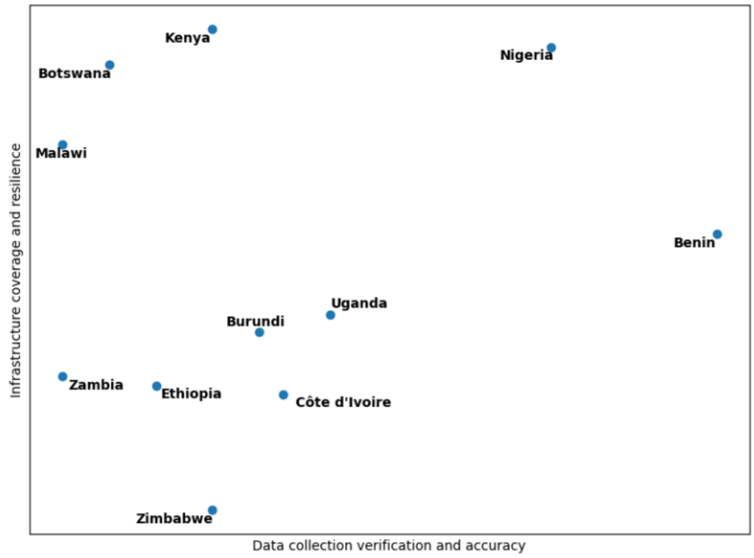

Figure 45: Countries' scores in "Data collection verification and accuracy"& "Infrastructure Coverage & resilience"
The more to the right and to the top, the higher the country's score is in the related axis
(Source: Graph created by the Africa-BB-Maps project team)

This 2-dimensional plot allows to evaluate the answers of the countries to the questionnaire, through the lens of Data collection, verification and accuracy, and Infrastructure Coverage and resilience. One can again identify three clusters:

- The most numerous cluster groups together countries with relatively low maturity levels in both sections: Zambia, Ethiopia, Zimbabwe, Burundi, Côte d'Ivoire and Uganda.
- Countries most advanced in "Data collection verification and accuracy" are Benin and Nigeria. They are also quite advanced when it comes to Infrastructure coverage and resilience (especially Nigeria).
- Malawi, Botswana and Kenya show advanced maturity in "Infrastructure coverage and resilience", while having earlier stages of development of "Data collection verification and Accuracy". Nigeria also has a relatively mature infrastructure coverage and resilience ecosystem.

Questions asked in the survey

Following are the questions asked in the survey:

Section / Question	Answer
Section 1: Broadband Policy and Strategic Planning	
Q1: 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
Q2: Which types of broadband technologies are most widely deployed in your country? (Multiple selections)	• Fibre optic; • Coaxial Cable; • Wireless networks; • Copper pair; • Satellite
Q3: What is the main objective of your broadband expansion strategy?	• Extension of fibre optic broadband; • Expansion of satellite broadband; • Development of mobile broadband (3G/4G/5G); • Other, please specify
Q4: 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; • Other, please specify
Q5: Does your country have a broadband mapping system?	• Yes, it is publicly accessible; • Yes, but it is not publicly accessible; • We collect and develop internal maps, but they do not constitute a true system; • We collect data only, without mapping; • No, and we do not collect any data
Q6: Are there policies or incentives to encourage the expansion of mobile	• Yes, with active government support;

and satellite broadband in rural areas?	• Some incentives exist, but implementation is weak; • No policies or incentives
Q7: Does your country have a broadband roadmap specifically for underserved communities?	• Yes, with active government support; • Some initiatives exist, but implementation is weak; • No initiatives
Q8: Does your agency have a dedicated division responsible for broadband infrastructure and development?	• Yes; (If yes, does it include GIS experts? Yes / No); • No
Q9: How many personnel are part of the legal and policy department?	• More than 15; • 5 to 15; • Less than 5
Q10: How many employees are part of the network and infrastructure division?	• More than 5; • Between 3 and 5; • Less than 3
Q11: Are there national broadband targets for the next 5 years?	• Yes; • No
Q12: Is broadband mapping integrated into national infrastructure projects?	• Yes; • No
Section 2: Broadband Infrastructure Mapping Systems	
Q13: 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
Q14: If yes, who manages the system?	• National Regulatory Authority (NRA); • Ministry responsible for ICT;

	• Other, please specify
Q15: Which infrastructure or coverage data are included in broadband mapping efforts? (Multiple selections)	• Backbone networks and fibre 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; • None of the above – no infrastructure data is mapped
Q16: How are broadband infrastructure mapping data collected? (Multiple selections)	• 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
Q17: Is broadband infrastructure mapping integrated with other national infrastructure planning systems?	• Yes, integrated with transport, energy, urban planning; • Some level of integration exists, but not fully structured; • Broadband infrastructure mapping is isolated
Section 3: Broadband Service Mapping and Regulatory Monitoring	
Q18: Does your agency collect broadband coverage data?	• Yes, regularly and systematically; • Occasionally, but not systematically; • No broadband coverage data is collected
Q19: How is broadband coverage data collected? (Multiple selections)	• Self-reported by Internet Service Providers (ISPs); Government-led surveys; • Crowdsourced user data (speed tests, complaints, etc.); • Field audits and independent verification

Q20: 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
Q21: Does your country publish broadband coverage data for public consultation?	• Yes, fully open and accessible; • Limited access for stakeholders only; • No public access to broadband data
Q22: 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
Q23: 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	
Q24: What methods are used to collect broadband coverage data? (Multiple selections)	• ISP reports; • Crowdsourced data; • Automated real-time data validation tools; • Independent field surveys; • Government-led audits
Q25: Does your broadband mapping system follow standardized GIS protocols (e.g., ITU recommendations)?	• Yes, fully standardized; • Partially standardized; • No standardization
Q26: How frequently are broadband coverage maps or datasets updated and verified?	• Continuously / in real-time; • Quarterly or more frequently; • Annually; • Ad hoc updates

Q27: Does your broadband mapping system systematically integrate user-reported issues and network complaints?	• Yes, with automated verification and real-time updates; • Yes, but data is verified manually and updated infrequently; • No, user feedback is not systematically used
Q28: Does your broadband mapping process include validation by an independent third party (e.g., audits, field tests)?	• Yes, with regular independent audits verifying ISP data; • Yes, but audits are occasional and not standardized; • No third-party validation
Section 5: Infrastructure, Coverage, Resilience, and Expansion	
Q29: How does your country define "rural areas"?	• 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
Q30: What percentage of rural areas in your country have access to basic broadband (≥2 Mbps)?	• Above 60%, with national resilience and crisis response plans; • Between 30% and 60%, with partial resilience planning; <30%; • Below 30%, with no resilience strategy
Q31: What percentage of rural areas have access to broadband speeds meeting the ITU's minimum recommended threshold (≥10 Mbps)?	• Above 60%, with national resilience and crisis response plans; • Between 30% and 60%, with partial resilience planning; <30%; • Below 30%, with no resilience strategy
Q32: Does your country use the Universal Service Fund (USF) to	• Yes, with clear eligibility criteria; • Yes, but funding is limited; • No, the USF is not used for broadband

develop broadband in underserved areas?	
Q33: 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
Q34: 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
Q35: 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
Q36: 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

Table 3: Questions asked in the questionnaire/survey, and associated answers

Category attributed to each question

The following table illustrates the Category attributed to each question (A, B or C).

Section / Question	Category	Focus
Section 1		
Q1	C	Policy (intangible, software)
Q2	B	Hardware/Software (mixed, tangible technologies)
Q3	C	Policy (intangible, software)
Q4	C	Policy (intangible, software)
Q5	A	Engineering (tangible, hardware)

Q6	C	Policy (intangible, software)
Q7	C	Policy (intangible, software)
Q8	A	Engineering (tangible, hardware)
Q9	B	Software (intangible, policy team)
Q10	A	Engineering (tangible, hardware)
Q11	C	Policy (intangible, software)
Q12	B	Software (intangible, integration)
Section 2		
Q13	A	Engineering (tangible, hardware)
Q14	A	Engineering (tangible, hardware)
Q15	B	Hardware/Software (mixed, tangible data)
Q16	B	Software (intangible, data collection)
Q17	B	Software (intangible, integration)
Section 3		
Q18	B	Software (intangible, data collection)
Q19	B	Software (intangible, data collection)
Q20	B	Software (intangible, regulation)
Q21	A	Engineering (tangible, public access)
Q22	C	Policy (intangible, software)
Q23	B	Software (intangible, regulation)
Section 4		
Q24	B	Software (intangible, data collection)
Q25	A	Engineering (tangible, hardware)
Q26	B	Software (intangible, updates)

Q27	A	Engineering (tangible, hardware)
Q28	A	Engineering (tangible, hardware)
Section 5		
Q29	C	Policy (intangible, definition)
Q30	B	Hardware (tangible, coverage)
Q31	B	Hardware (tangible, coverage)
Q32	C	Policy (intangible, software)
Q33	C	Policy (intangible, software)
Q34	B	Hardware (tangible, resilience)
Q35	C	Policy (intangible, software)
Q36	C	Policy (intangible, software)

Table 4: Category attributed to each question (A, B or C)

Category A is defined as of high importance, encompassing tangible, engineering and policy-focused questions that involve physical infrastructure and measurable outcomes, such as the presence of a broadband mapping system or a dedicated infrastructure division.

Category B is defined as of medium importance, including questions that blend tangible and intangible elements, such as the types of technologies deployed or methods of data collection.

Category C is defined as of low importance, focusing on intangible, policy- and strategy-oriented questions like the existence of penetration targets or rural broadband roadmaps plans.

This tiered structure ensures that the assessment prioritizes what delivers the most concrete results, connecting the categories to the practicality of broadband development.