INTERNATIONAL TELECOMMUNICATION UNION

TECHNICAL SPECIFICATIONS FOR THE IMPLEMENTATION OF BROADBAND MAPPING SYSTEMS IN ALBANIA

Table of Contents

Acronyms

- ITU: International Telecommunication Union
- GIS: Geographic Information System
- NRAs: National Regulatory Authorities
- BEREC: Body of European Regulators for Electronic Communications
- EU: European Union
- BCRD: Broadband Cost Reduction Directive
- EECC: European Electronic Communications Code
- DSV: Delimiter-Separated Values
- CSV: Comma-Separated Values
- XML: Extensible Markup Language
- API: Application Programming Interface
- WMS: Web Map Service
- WFS: Web Feature Service
- RDF: Regional Development Forum
- SDGs: Sustainable Development Goals
- NSDI: National Spatial Data Infrastructure
- ASIG: State Authority for Geospatial Information
- AKEP: Electronic and Postal Communications Authority
- VHCNs: Very High-Capacity Networks
- GIA: Gigabit Infrastructure Act (assumed from context)
- NMS: National Mapping Systems (assumed from context)
- QoS: Quality of Service

Introduction to the Work

This report outlines the technical specifications to update Albania's ATLAS and provides a set of documentation to take part to tender procedures while considering all aspects of tendering and legal procedures that would be required for a successful bead by major funding organisations which will be investigated upon completion of these technical specifications.

This work is based on the ITU Guidelines "Establishing or Strengthening National Broadband Mapping Systems" and the ITU experts' recorded work experience in this field. It is important to note, nonetheless, that the following technical specifications produced in this report are the translation effort of the ITU Guidelines, as these are the ITU's operational Guidelines designed to be used as a baseline tool for non-EU NRAs and other institutions in charge of broadband mapping systems at the national level to assist them in the establishment or strengthening of broadband mapping tools. The guidelines address both strategic and regulatory issues and project setup and technical requirements, which are inextricably linked. The body of knowledge on broadband mapping produced by the European Union have positioned this region of the world at the forefront, and as a result, the ITU Guidelines drew on the experience of this region, including not only the European Union but also the European NRAs, BEREC, and the European Commission, addressing the critical questions that all stakeholders face in this field.

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Background Information

In the dynamic world of global telecommunications, the International Telecommunication Union (ITU) and more specifically the ITU Office for Europe play a crucial role in providing meaningful support to its Member States in the ITU Europe Region. This support extends to countries in the Balkan Region, such as it in this context the specific case of Albania, a new democracy, eager to accelerate its technological advancement and catch up with cutting-edge technologies present in other nations.

ITU's assistance to Albania goes beyond mere advisory roles. It actively aims to offer various forms of technical support to bridge global digital divides and advance the country's telecommunications sector. On the other hand, Albania's proactive stance and the series of initiatives it presented in the series of ITU forums held in 2023 reflected its ambition to align with global telecommunications trends and emerge as a regional leader in ICT. This momentum is the outcome of collaborative efforts involving Albania's Ministry of Infrastructure and Energy, the State Authority for Geospatial Information (ASIG), and the Electronic and Postal Communications Authority (AKEP). Their collective focus on robust ICT frameworks, comprehensive broadband infrastructure, digital literacy, and adherence to global digital standards underpins Albania's strategic approach to telecommunications development.

In response to Albania's request for support, ITU aims now to provide comprehensive assistance, encompassing technical assistance, policy guidance, and capacity-building opportunities. This support included aiding Albania in advancing the broadband infrastructure development in the country, by among others, by defining technical specifications for upgrading the national broadband ATLAS for network planning; additionally, support is planned also by conducting a feasibility study on the upgrade of the national frequency monitoring systems to facilitate efficient spectrum management.

Over the past months, Albania has leveraged ITU's platforms to express its commitment to advancing its digital transformation journey. For instance, Albania's RDF Contribution and pledge to host the Regional ITU Conference in Tirana in 2024 was noteworthy. This conference, focusing on the development of future digital infrastructure, aligns with key ITU priorities and showcases Albania's active role in regional telecommunications discourse. Moreover, ASIG's initiatives in developing a National Spatial Data Infrastructure (NSDI) demonstrates Albania's dedication to enhancing its communications sector infrastructure, aligning with various Sustainable Development Goals (SDGs).

In addition to Albania's initiatives, Slovenia's presentation at RDF-EUR 2023 on its advanced broadband mapping system, developed by AKOS, illustrated a comprehensive approach to telecommunication infrastructure management. The potential for collaboration between Albania and Slovenia, especially in broadband mapping, appears evident especially as it aligns with the WSIS Action Lines, C2 – Information and Communication Infrastructure[1] promoting international and regional cooperation in advancing the ICT agenda.

One other example worth noting is Albania's commitment to advance digital development also via the active engagement of its regulator: during the ITU-EKIP Regional Regulatory Forum 2023 in Budva, Montenegro, discussions emphasized the need for Gigabit connectivity and resilient networks in Europe. Albania, represented by AKEP, played a significant role, engaging in discussions on broadband infrastructure, 5G technology, and digital transformation challenges. AKEP's active participation in the discussions with other regulators culminated in a bilateral meeting between the ITU Telecommunications Development Director and the Chair of AKEP. This marked a significant step in

[1] More information on the Wsis Action Lines can be found at the following link: World Summit on the Information Society (itu.int)

engagement between AKEP and ITU, aimed at strengthening cooperation between the two parties, reaching agreement on ITU's support to AKEP would take place in the following months.

In conclusion, ITU's support for Albania, combined with the country's national ambition and strategic engagement of its key stakeholders in the digital infrastructure sector, as well as its longstanding collaboration with Slovenia, represents a holistic approach to effective multilateral efforts in ICT and digital development. These endeavors not only enhance Albania's position in the European telecommunications landscape but also align with the ITU's broader goals of bridging the digital divide. The events of RDF-EUR 2023 and the ITU-EKIP RRF 2023 underscore the vital role of collaboration in shaping the future of telecommunications. Albania's active involvement with ITU, and the potential partnership with Slovenia illustrate a comprehensive strategy for advancing telecommunications and ICT in the region. These initiatives play a pivotal role in advancing the regional and global ICT agendas, emphasizing the importance of international cooperation in achieving sustainable development objectives.

The ITU Experience: ITU Guidelines and Technical Assistance on Broadband Mapping Systems

The International Telecommunication Union (ITU) has played an active role in the development and strengthening of global broadband mapping. Moreover, the ITU expertise on broadband maps (bbmaps) can be consulted to the list of products for geospatial analysis to support decision-making at https://bbmaps.itu.int.

This initiative is encapsulated in the ITU Guidelines for establishing or strengthening national broadband mapping systems[2]. These guidelines constitute a comprehensive set of recommendations created by ITU to address a specific knowledge gap. They are intended to be a valuable resource for the worldwide community of stakeholders involved in broadband mapping, providing clear and concise guidance on regulatory, technical, and project management aspects related to this field. These guidelines function as a practical tool for national regulatory authorities and other relevant institutions responsible for broadband mapping at the national level. These ITU guidelines are also the result of a concertized effort of ITU with its various partners which share extensive experience in this field.

Broadband mapping holds significant importance, not only for the European region but also for the global community. The COVID-19 pandemic has underscored the critical role of network security and resilience in sustainable development, emphasizing the need for efficiently developed broadband mapping tools. These tools are essential not just for addressing connectivity gaps but also for responding to network incidents and monitoring resilience. The ITU's experience highlights the vital collaboration between regulators and operators to provide affordable broadband connectivity, which often requires substantial initial investments. Effective legislation and tools are necessary to collect relevant data, promote competition among market players, and attract new investments.

Clearly, within this context, the ITU Office for Europe has played an important role in advancing knowledge of broadband mapping systems across the ITU membership of the Europe Region over the past years. This includes providing regional workshops and ad hoc intervention. For instance, ITU Office for Europe, upon request, has carried out a policy analysis in favor of Bosnia and Herzegovina, a necessary prerequisite instrument to assess the regulatory environment and maturity level of the country to own and operate a broadband mapping system, followed by tailor-made technical specifications to establish and operate the system. On the other hand, in the Republic of Moldova, as the legislative framework and regulatory environment was already established, the ITU Office for Europe developed technical specifications that serve as a basis for creating a robust broadband mapping system to be interoperable with the Register of the Physical Infrastructure of the country (ROITE).

On a broader scale, the ITU Office for Europe in coordination with the Future Network and Spectrum Management Division (FNS) conducted a global gap analysis of national broadband mapping systems initiatives in 2021. This analysis assessed the progress and challenges faced by countries worldwide in implementing broadband mapping systems, providing insights and recommendations for enhancing connectivity. Moreover, the ITU Office for Europe has published a background paper that sheds light on broadband mapping systems in Europe and regional harmonization initiatives. This document offers an overview of the state of broadband mapping in Europe and the collaborative efforts to standardize mapping practices across the region.

Collectively, these publications and initiatives underscore the ITU's continuous commitment to promoting broadband access and infrastructure mapping in Europe and beyond. They provide governments and stakeholders with essential resources and guidance to establish effective broadband

[2] Link to the Guidelines: MAY 2022 ITU Guidelines for establishing or strengthening national broadband mapping systems_v1.2 - RTR1_AG[1].pdf

mapping systems and policies, ultimately contributing to bridging the digital divide and fostering digital development across nations.

The European Experience

It was a natural decision for the ITU Guidelines for establishing or strengthening national broadband mapping systems to draw upon the European experience, as Europe has demonstrated substantial efforts towards harmonizing broadband mapping systems in recent years compared to other regions of the world, where national broadband mapping systems may be developed, but lack the harmonization component which is distinctive of the European Member States.

While this section offers an overview of the European experience to introduce technical specifications and tender documentation, it also outlines the primary factors motivating European legislators and regulators to promote harmonization in this area. Subsequently, we will delve into the key instruments introduced by the European Union, specifically the EU Guidelines on State Aid for Broadband (2013), the Broadband Cost Reduction Directive (2014), and the European Electronic Communications Code (2018).

In 2013, the "EU Guidelines for the application of State aid rules concerning the rapid deployment of broadband networks" were published with the aim of assisting member states in developing clear strategies to unlock investment opportunities in line with the Digital Agenda for Europe (DAE). It's important to emphasize that these guidelines stressed the importance of maintaining market competition, a hallmark of EU legislation, to prevent any distortion of the market due to State aid.

Among the various provisions outlined in the guidelines, Art 2.5, which addresses compatibility principles, plays a central role by providing a framework for establishing broadband mapping systems. Efficiency, both in terms of work and financial aspects, is crucial for the sustainability of any endeavor, including broadband mapping systems. Addressing this challenge directly, the creation of the Single Information Point (SIP) centralized all the necessary information on physical infrastructure, complete with specific parameters, reducing costs and enhancing transparency as the data became readily accessible at the national level.

While not delving into the exhaustive conditions required for fulfilling compatibility principles, the decision to "facilitate the use of existing infrastructure" paved the way for the Broadband Cost Reduction Directive, published in 2014. This directive primarily focused on co-deployment and infrastructure sharing. It also offered various options that determined the complexity and granularity of broadband mapping systems based on the amount of data collected. For instance, collecting data on network locations and quality was crucial but initially raised concerns about potentially disclosing operators' confidential business information. Although we won't explore the granular details here, it's important to underscore how high-quality data is indispensable for regulation. Once again, the European experience played a pivotal role in defining the necessary data for an effective and relevant broadband mapping system.

The Broadband Cost Reduction Directive's objective of "facilitating and incentivizing the rollout of high-speed electronic communications networks" included promoting the joint use of existing physical infrastructure and enabling a more efficient deployment of new infrastructure at reduced costs. This directive also recommended establishing a dispute settlement body (DSB), which is equally important as the SIP. The DSB not only enhanced rule clarity by enforcing obligations set forth by the BCRD but also established a general reference for National Regulatory Authorities (NRAs) lacking a pre-existing legislative framework.

The third policy instrument is the European Electronic Communications Code, a European directive issued in 2018, which overhauled the regulatory framework for electronic communications. A crucial aspect of this code empowered the Body of European Regulators for Electronic Communications (BEREC) with additional responsibilities, allowing the regulatory body to set standards for EECC

implementation across the entire Union. One of the requirements mandated European NRAs to conduct geographical surveys of electronic communications systems at the country level.

In conclusion, Europe's sustained and dedicated efforts over the past 15 years have positioned it as a pioneer in the field of connectivity harmonization. The region has demonstrated a profound commitment to pushing the boundaries of what harmonization entails in the realm of broadband mapping, making it a leader in knowledge, capacity, and implementation measures related to this critical domain.

In recent years, Europe is facing continuously increasing connectivity demand from both households and businesses for fast and ubiquitous high-quality connectivity has been increasing rapidly across the continent, strengthened by the COVID-19 pandemic.

To contribute to achieving the 2030 Digital Decade Gigabit connectivity targets set in the digital decade policy programme and in the light of supporting faster deployments of very high-capacity networks (VHCNs) with cost-efficient measures on infrastructural access, civil works, permit granting, in-building infrastructure, and single information points, the European Commission is currently proposing the adoption and implementation of Gigabit Infrastructure Act (GIA). GIA is expected to bring the upgraded and directly applicable benefits which were previously addressed by the BCRD.

ITU Guidelines for Establishing or Strengthening National Broadband Mapping Systems

Broadband maps are key to informed decisions on new ICT network deployment. Under the ITU geospatial activities[3], the Union has conducted national experiences on ICT infrastructure maps and produced the ITU Guidelines, Establishing or Strengthening National Mapping Systems (NMS), based on international best practices.

Two pillars are at the foundation of The ITU Guidelines Establishing or Strengthening National Broadband Mapping Systems: the first one pertains to policy-related aspects, whereas the second pillar addresses the project setup and technical requirements, together with the strategies for correct project management. The second pillar is elaborated in chapter three and four of the Guidelines. These two chapters on the technical components of the ITU Guidelines are the result of a concerted effort achieved at the European level.

This work, developed by ITU experts on broadband mapping, benefitted from relevant inputs from various stakeholders, including European NRAs, EaPeReg, BEREC, EIB, European Commission, and from an external actor from the Europe Region, i.e. World Bank. All these actors have contributed extensively by providing their experience of broadband mapping through a series of bilateral calls as well as by commenting and suggesting inputs during the draft of the Guidelines. The first technical chapter, chapter three, addresses the aspects on the project setup and technical requirements, under which guidance is provided to the reader for what concerns the project framework and objectives (i), as well as the project design (ii); whereas the chapter four deals with all management-related aspects, with relevant input from the different stakeholders who have contributed to the drafting of the guidelines focusing on common challenges and solutions(i) on data quality (a), data confidentiality (b), data sources (c), reporting types (e) and regulations (f). Also, the project management outlined the general success factors (ii) considering the stakeholder involvement (a), the definition (b) and type of mapping (c) and ultimately the long-term sustainability (d) with examples such as the actions to be done in the field of reporting.

The complexity of the development of broadband mapping systems was discussed in chapter three, touching on a variety of topics. These recommendations were presented as to limit the scope of the digital map and precisely make it in accordance with the real needs of the NRA. As an example, questions are submitted to the reader whether the desired broadband map should consider fixed broadband to be considered or whether it may allow for an integration with mobile networks. It is also important to reiterate the significance of selecting the data transfer form, the type of interface, the level of detail, and the way in which the system gathers, arranges, and validates the data. Additional desirable features include the use of a mobile application for citizen's convenience and a helpdesk for support in case the users experience technical issues.

Finally, a cost estimator for creating the broadband mapping system was also created as part of the work on these guidelines. The cost calculator was developed following a comparison of data on the adoption of the broadband mapping system in European nations. The ITU Guidelines highlight that developing a broadband mapping system does not mean just selecting what one would want and pay for that price tag; or the country area, which correlates with the number of system elements or the number of system users, the more expensive the broadband mapping system would be. Developing a broadband mapping system is a multivariate challenge that considers many parameters. However, this does not mean that it may not be possible to have a close estimation of the actual cost, regardless of the small error probability assigned to the externality that always exists in every equation. Indeed,

[3] More information about the ITU Geospatial activities can be found at the following link: https://bbmaps.itu.int/

there are certain aspects, mostly related to the organization, management and implementation of the broadband map – e.g the number of days required and assessing the NRA's capacity for hiring IT personnel - that all NRAs face in the same way when designing the project proposal. Those are just two examples that show how such common challenges have an impact on complex work like developing a broadband map. By trying to standardize these series of commonly experienced via the creation of a simple cost calculator, the guidelines offer a simple solution to swiftly advance on such decisions.

To put it in other words, the project setup and technical requirements together with the project management have been designed to be perceived by the reader as a set of precise instructions and helpful measures to be simply followed and implemented to successfully develop a broadband mapping system fit for purpose.

Development of a Broadband Atlas for Albania

Preliminary assessment of past efforts of AKEP and existing system implementation

In the process of preparing this study and consequently during recent meeting with AKEP in Albania, ITU also evaluated the structure and properties of the existing broadband mapping system in the country, in order to evaluate the possibilities of a direct upgrade of the system. The existing ATLAS platform is an electronic geo-register managed by AKEP, but it is filled directly with data reported by Internet Service Providers (ISPs), who are obliged to update their network every 90 days.

The data in the ATLAS system covers three entities of public communication networks, i.e. cable routes, electronic communications facilities and broadcast radio. Cable route data contains information on geographical coordinates for road alignment, coordinate geosystem and technical details (type, dimensions, material, free capacity, usage % evaluation). Electronic communications facilities data covers geographical coordinates of the object, graphic display, technical details (dimensions, type, purpose, material, capacity, usage % evaluation). Broadcast radio objects data offers information on geographic coordinates of the location, technical details of the objects and installed equipment (i.e. antenna height, data on radiation directions, type, weight, usage % evaluation concerning energy and static capacity).

According to the compiled scheme of the existing data, for a comprehensive consideration of the network, there is a noticeable lack of a recorded access network, especially with a network connection point. The connection with the end user's data would offer the regulator a series of new options, primarily for two-sided verification of the obtained data, and in addition to verification, a new range of options for analyzing the obtained data. The NRA is already noting the lack of prompt updating and the need to check directly in the database for every ISP, which is a very time consuming process (by the second half of 2024, there are 256 operators with General Authorization in Albania; out of them, 126 operators have access and network in the ATLAS, however this is not updated and only 19 operators have updated their network. In addition, there are 16 new operators registered in 2024 which are currently working to populate the ATLAS). It should be noted that the main issue related to network information input in the ATLAS system originated from local government authorities, which have input insufficient information until now. Having said that, it must also be noted that the current system lacks the capacity for analysis and data exports.

Although in all three forms of collected data, it is stated that the information is consistent with the coordinate geosystem, the researcher was unable to find unambiguous direct connections between existing spatial databases (layer interconnection). For future development, it is essential that the data are marked with unique identifiers, meaning that they are unique and irreplaceable. Thus, it is necessary to pre-specify the unique identifier for each Node address for the desired accuracy (province / commune / town / street / building / geometric centre coordinates) so that the format of the transmitted data will not be left to the data owners. A logical approach would be to require the use of cadastral nomenclature, which will allow the use and placement of other layers of collected geodetic data (WGS-84 coordinate system with appropriate accuracy), in compliance with the Albanian NSDI legislation that mandates the use of the 'Korniza Referuese Gjeodezike Shqiptare' (KRGJSH) as the geodetic reference system. According to DCM no. 669, dated 7.8.2013, and its amendments DCM no. 322, dated 27.04.2016, and DCM no. 359, dated 29.05.2019, KRGJSH is based on the European Geodetic Reference Framework and must be used for all applications related to coordinates within Albania. This requires transitioning from the WGS-84 coordinate system to KRGJSH to ensure consistency and compliance with national standards. In other words, the method of collecting infrastructure data relevant to the telecommunications industry must enable at least direct connections between existing spatial databases for an established geo-data system at the regulator.

The present paper notes that Albania has already made a significant effort in the past establishing the current broadband mapping system, but its inherent flaws pose significant limitations, which suggests that an attempt to perform a direct upgrade would be in this case impractical. Additionally, the system lacks the capacity for analysis, imports, and exports, further underscoring the need for a comprehensive overhaul or a fresh start. Considering these constraints, it appears more beneficial to contemplate initiating the construction of an entirely new system, starting from the foundational stages, to ensure a more effective and comprehensive solution.

Rationale of the pre-feasibility study (WB23-ALB-DII-01)

The overall objective of the project: *WB23-ALB-DII-01: Development of a Broadband Atlas for Albania, Pre-Feasibility Study Benchmark results and Reporting functionality* was to improve the current ATLAS tool from AKEP (the broadband mapping system) to contribute to the economic development and to further bridge the digital gap between the different areas within Albania by providing a better view on broadband infrastructure and connectivity in the country at a granular geographical level. The project shall improve policy-making and planning in the digital sector and increase the efficiency of broadband investment. The project remained a pre-feasibility and therefore provided methodologies and requirements for future development of the platform, but not the development of the new ATLAS itself.

The future Atlas, outlined in the March 2022 inception phase and report, aims to enhance existing capabilities by expanding coverage to the last mile in mobile networks, collaborating with municipalities and utilities to optimize infrastructure sharing under the Broadband Cost Reduction Directive, improving the precision of data collection, offering more detailed information on infrastructure utilization and ownership, fostering partnerships with key stakeholders like ASIG and INSTAT for shared data, and creating a tool for improved identification of white areas. These ambitions collectively aim to advance the Atlas' effectiveness in mapping and managing telecommunications infrastructure.

Outcomes of the pre-feasibility study

The current Atlas in Albania faces several limitations, as outlined in the pre-feasibility study for the development of a broadband Atlas. While the existing system collects data from telecom operators, it lacks granularity, with only infrastructure and limited service mapping available. Crucial elements such as last mile information, demand and investment mapping, as suggested by European guidelines, are missing. Furthermore, data is primarily provided by telecom operators, neglecting information from municipalities, and the quality of data received by AKEP is not always reliable. Manual processing of data from over 250 operators proves time-consuming and costly. The absence of non-telecom data from various government agencies further hinders the Atlas' comprehensiveness. The study suggests a shift towards a more comprehensive and automated broadband mapping system to address these limitations and improve the efficiency of data collection and utilization in Albania.

The pre-feasibility study suggests that while planning the future Atlas for broadband mapping in Albania, it is crucial to consider the specific European framework for such systems. The investigation into European developments, in line with the local context of broadband in Albania, reveals valuable insights. Article 22 of the Electronic Communications Code and guidelines from BEREC offer indications and methodologies for implementation, ensuring a harmonized approach. Furthermore, directives and guidelines like the Broadband Cost Reduction Directive and State Aid, some of which are under revision, outline general requirements for infrastructure, service, and investment mapping. As Albania

is a candidate for EU integration and aligns with the European regulatory framework, adopting these European guidelines serves as a foundational basis for developing the new Atlas. This approach not only aligns with current standards but also provides valuable directions for late adopters, supplementing specific obligations within the European framework.

Advanced Member States have pioneered broadband mapping systems, often surpassing the EU framework to cater to their local needs with specific regulations. Notable examples include ARCEP in France, AKOS in Slovenia, and UKE in Poland, all of which offer best practices for Albania's future Atlas. While these systems vary in features and user interfaces, they provide valuable guidance. AKOS's geoportal is advanced in infrastructure and investment mapping, including last-mile details, demonstrating strong interoperability with non-telecom networks. The AKOS system also integrates an official speed test for commercial disputes and is based on popular open-source technologies. UKE in Poland is a reference for investment mapping, particularly in white areas, and stands out as one of the few systems in Europe to provide demand mapping, albeit with limited outcomes so far. Studying these advanced systems provides valuable insights for enhancing and refining Albania's broadband Atlas. The recommended solution for the future Atlas is informed by recent EU developments (guidelines) and draws inspiration from top initiatives of advanced NRAs. To simplify representation, especially when combining fixed and mobile data, we propose organizing datasets in the Atlas based on mapping type and technology. This approach aims to create a more intuitive GUI, potentially increasing user interest. Currently, the mapping system in Albania predominantly focuses on infrastructure mapping, utilizing data from operators and some utilities (primarily Tirana municipality) on a quarterly basis through specified datasets.

While the Atlas already provides partial coverage of passive infrastructure (with potential expansion through the addition of pole datasets), there is a need for further datasets, particularly focusing on infrastructure owners, leveraging the Broadband Cost Reduction Directive (BCRD), and including all utilities since municipalities may lack the necessary skills and tools to provide relevant information.

The most significant improvement in broadband (active) infrastructure mapping is anticipated through last mile mapping, drawing from international experiences of analyzed NRAs. This involves representing network termination points (NTP) for network coverage by building, requiring the integration of information from different operators to obtain a comprehensive view at a given address. Additionally, distribution points are suggested for simulation purposes rather than mapping the cables themselves. The last mile information is crucial for specific reporting and mapping processes, especially for methodologies related to white areas, which require last mile information for address-level reporting.

The proposed solution for Albania's future Atlas draws inspiration from recent EU guidelines and successful initiatives by advanced NRAs. Current limitations, particularly in service mapping, will be addressed by following BEREC guidelines for mobile and fixed networks. Improved granularity, extended coverage, and QoS enhancements will be implemented. For demand mapping, a crowd-based approach similar to Poland's UKE will be adopted, with a user-friendly graphical interface. Investment mapping will replicate AKOS's system, featuring a standalone web portal for collecting investment intentions. White area and white spot mappings will aid State Aid management. Ten new layers will be developed, each conforming to the State Standards for Technical Specifications of Geospatial Information in Albania – Topic: Utility and governmental services, as approved by DCM no. 998, dated 9.12.2020. These layers must adhere to national standards, ensuring compatibility with existing databases, and follow specific data models and schemas to maintain consistency across different datasets. This approach guarantees interoperability and efficient data sharing between governmental entities. This includes interactions with the National Addressing system, in compliance with DCM no. 399, dated 19.06.2019, which mandates that geospatial data exchange between public authorities adhere to specific rules. These rules require that data be exchanged solely for public functions, use the National Geoportal for data published therein, and follow formal request

procedures for unpublished data. Additionally, geospatial data must not be used for non-public purposes or shared with third parties except ASIG. Any refusals to share data must be justified and may be reviewed by the Geospatial Information Board. The future Atlas will prioritize public accessibility, with automated quality control checks compensating for resource limitations. On-demand reporting, not standard in European systems, will be introduced for joint reporting on network coverage and population datasets sourced from INSTAT census data. Manual analysis will be the primary method to reduce project costs, satisfying stakeholder needs by publishing data in the Atlas.

Choices presented by the pre-feasibility study

The future Atlas requires a new IT architecture to ensure flexibility for future developments. AKEP aims to retain full control, including security concerns, and prefers using physical servers over cloud-based services to share hardware costs. While upgrading the current system is a short-term option, a new software architecture leveraging shared hardware is deemed more suitable for long-term flexibility.

For the new system, AKEP can choose between a proprietary approach (e.g. Mapbox), as used by ARCEP in France, or open-source technologies, similar to AKOS in Slovenia. Both options leverage PostgreSQL database with PostGIS spatial extension and GeoServer, offering flexibility for developing and integrating new features. Open-source technologies, as utilized by AKOS, are recommended for their step-by-step development approach and cost-effectiveness, considering the expected usage.

Improving AKEP's system requires enhanced interoperability with local stakeholders. While the current Atlas only interoperates manually with ASIG geoportal, automation through WMS services is feasible. Additional systems, particularly around investment mappings, such as the National Address System and data collected by INSTAT through the Census, offer valuable information. Establishing MoUs with these organizations can facilitate advanced mappings with automated solutions, enhancing precision in white area mappings. Data from INSTAT is also available in open formats. In compliance with DCM no. 399, dated 19.06.2019, geospatial data exchange between public authorities must follow specific rules. These include exchanging data solely for public functions, using the National Geoportal for published data, and formal request procedures for unpublished data. Geospatial data must not be used for non-public purposes or shared with third parties except ASIG. Any refusals to share data must be justified and can be reviewed by the Geospatial Information Board.

In addition to IT developments, AKEP's interaction with the telecommunications ecosystem in Albania will expand through training and an enlarged regulatory framework. Given the lack of GIS skills, especially among municipalities and smaller operators, it is recommended to conduct training on free open-source solutions initially. This approach aims to engage stakeholders, enhance data quality, and establish clearer procedures. Subsequently, once the future Atlas is available, a second training course will be essential to familiarize stakeholders with the new system and its functionalities. Other experienced stakeholders may not require such training.

Beyond training, the impact of the future Atlas's development will be accelerated by regulatory adaptations. Ongoing alignment of the Albanian regulatory framework with the European Code and the Broadband Cost Reduction Directive (BCRD) will facilitate additional requests to telecom operators and other passive infrastructure data owners. While some players like municipalities are already regulated, there is a need for additional regulation to enforce the collection of investment intentions, particularly for utilities. Enforcement poses a significant concern in Albania, and developing digital skills through training is seen as a first step to bridge the gap. Municipalities face challenges in terms of both the quantity and qualification of human resources. This issue extends beyond the Atlas, requiring broader digitalization efforts in urban planning for all infrastructures.

Further legislative work may be necessary to align interoperability with national address systems and INSTAT, operating under different rules. In the interim, relevant agencies should establish MoUs to make progress on a case-by-case approach.

The total cost estimate for the full project ranges from 410,000 to 505,000 EUR, excluding VAT. The major costs involve software development, technical support, and server hardware, including cybersecurity measures for the core project. Training costs are minimal, as they can be derived from open-source materials, and interoperability is more a regulatory concern than a challenging technical development. This estimate considers the local context, which involves additional intermediaries like logistics, resellers, and distributors, as well as the likely evolution of inflation.

Rationale of Intervention of ITU

There are several arguments why it might be more sensible to create and establish a new Atlas system rather than upgrade an existing one. Some key reasons include:

- **Technological obsolescence**: while AKEP's Atlas was established while ago in some ways could technologically obsolete and the technology used is no longer competitive or sometimes supportive of modern needs, it makes sense to start anew with the latest technological solutions.

- **Total costs**: Sometimes upgrading an existing system can be equally or even more expensive than establishing a new one. While building a new system may require initial investments, it can bring lower long-term maintenance and update costs.

- **Functional deficiencies**: If the existing system suffers from serious functional deficiencies or limitations that cannot be easily rectified through an upgrade, it makes sense to consider a new system that can meet modern requirements and expectations.

- **Flexibility and scalability**: A new system shall allow flexibility and scalability right from the start. If it's anticipated that the system will need increased capacity or additional functionalities in the future, it's easier and more cost-effective to establish a system designed for those needs.

- **Integration with new technologies**: Some new technologies have emerged that are not compatible with the existing system, it would be more sensible to start afresh with a system that allows easy integration with these new technologies.

- **Speed and time efficiency**: Building a new system allows for a faster start and adaptation to changes in requirements. Upgrading an existing system may require more time and effort, especially if significant changes in architecture are needed.

- **Direct request from AKEP for a new system**: During ITU's visit to AKEP's premises, AKEP colleagues expressly requested a new system, stating a clear preference for this over upgrading the existing one. This decision was driven by the engineering limitations inherent to the current ATLAS system's nature.

To make the above arguments concrete, it has to be added as mentioned in the Pre-feasibility study: "Building a new cost-efficient system based on open source can significantly reduce development costs in a number of proven ways. It is much less expensive to acquire than commercially licensed software or in-house developed software. These cost savings start with acquisition, but extend to deployment, support, and maintenance:

• Avoids functionality overkill and bundling — Many proprietary products have an overload of capabilities that clients rarely use, need, or even want (For example: ArcMap in the current system);

• Helps prevent vendor lock-in. Even where commercial OSS vendors provide a channel to deliver and support open-source, customers have the freedom to switch vendors or even drop commercial support entirely, without changing the application or code in use;

• Benefits from ongoing community support — Active communities often provide higher quality support than commercial support organizations, and what's more, community support is free;

• The significant number of expert organisations or employees in the market makes the competition and the quality of service potentially higher.

The web application architecture based on open-source technologies is similar in comparison to commercial solutions and includes such main milestones:

• The desktop and mobile GIS software. The leading open-source and cost-free GIS software in the world is QGIS for desktops and QField for mobile devices. The QGIS products are the second most popular GIS after the commercial Esri products. The QGIS is available for all available operational systems (Mac, PC, Linux). The field survey app GField is available for the macOS, Android and Windows devices.

• The leading in the GIS projects PostgreSQL database with spatial extension PostGIS. The currently existing PostgreSQL+PostGIS can be reused in order to reduce the final development price for the new Atlas.

• The open-source GeoServer (already installed in the current system) can be reused as geographical server to serve the geographical data from PostgreSQL database to OpenLayers or Leaflet HTML web page (to frontend part). GeoServer can serve the data in a standard way, OGC Web Map Server (WMS) or Web Feature Service (WFS) and both are acceptable by OpenLayers and Leaflet. many other APIs. The WMS and WFS could be used even in desktop GIS software such as ESRI ArcMap, ArcGIS Pro or QGIS). The WMS/WMTS services can be used to establish the automatization in the interoperability process between the institutions. The Web Processing Services (WPS) allows running queries to the database, which allows filtering data, exporting data or even setting up the Boundary Box in order to display the data only in the observed by user area (reduce the load on the web browser).

• The API in order to connect the Frontend with the Database. The API is necessary to link the frontend interpreted in the client's side web browser and remotely store data in the database. In terms of new Atlas functionality, it is recommended to use one of the open-source API solutions: OpenLayers or Leaflet. The using of the stock mapping APIs potentially will reduce the development time and the final cost for a new system.

• The Frontend visual part of the product. The Frontend part is the part which is available to the final user. The Recommendation is to develop the new frontend part with the integration of OpenLayers to avoid using the commercial options. The recommendation is to develop the traditional web platform by using the HTML 5 (body), CSS 3 (styling) and JavaScript (functionality).

The Pre-feasibility study makes conclusion that “The web mapping application based on the Leaflet libraries is lighter and faster to deploy, including the rapidly growing worldwide community. However, the OpenLayers is more complex and dedicated to solving challenging tasks. Both options seem appropriate for the new Atlas system, nevertheless, the OpenLayers is more reasonable from a long-term perspective of the evolution of the system.”

Stakeholder Analysis: Roles and Responsibilities

AKEP - The Electronic and Postal Communications Authority

The Albanian National Regulatory Authority's competencies stretch in the electronic communications and postal services field – it supervises the regulatory framework provided for in the Law on Electronic Communications in the Republic of Albania (Law No. 54/2024, based on EECC EU directive 2018/1872/EU), the Law on Postal Services in the Republic of Albania (Law No. 46/2015) and development policies defined by the Council of Ministers.

It has similar institutional role and competencies to those characteristic of most modern European national regulatory bodies (a legal, public, non-budgetary person, independent in making decisions and abides by its own adopted internal regulation).

AKEP annually manages the data concerning mobile telephony service (active users; market share; user structure), fixed telephony service (number of subscribers; market share ; number of subscribers with broadband access) and internet access service (number of subscribers with Internet access through fixed networks; number of subscribers with broadband access through 3G/4G mobile networks; market shares of fixed broadband by subscriber).

As a stakeholder, AKEP should continue playing the main and connecting role in the process of establishing broadband mapping. Namely, geo-mapping would allow to process data at a higher quality level, which improves (or even enables) the implementation of national legislation, policies and development policies. On the other hand, the collected and used data must be georeferenced in order to change them from general statistics into data that are useful for business users, investors and end-users, consumers.

Ministry of Infrastructure and Energy

The Ministry of Infrastructure and Energy has as its mission the drafting and implementation of the general state policy, in the planning and urban development sector, in the infrastructure and transport sector, in the telecommunications and postal service sector, in the energy sector, the use of energy resources and mining and in the industry sector.

The role of the Ministry of Infrastructure and Energy in the field of telecommunication (in relation to the current division of competencies in the country) is outlined in the electronic communication law, broadband law and in some national strategies; its role is mainly in the preparation of normative, legislative bases - both for the implementation of mapping and for the regulation of the competencies of operational bodies. At the same time, it could be the right address for dealing with communication problems between individual institutions and government level entities (as pointed out previously by this analysis, one of the important aspects would be to address the insufficient information input from local government authorities). At this point, the role and division of competencies in implementing possible state aid of providing modern networks is still under research, but in general, the Ministry plays a major role because it can implement allocation of state funds; in this context accurate broadband mapping is crucial for efficient resource allocation policies for underserved areas.

It is also one of the main stakeholders in the "e-Albania" project (https://e-albania.al/), the unique government portal of Albania that serves as a single contact point for government services. On the other hand, ASIG/Geoportal has been established as the main portal for all infrastructures in GIS map (transport, energy and other thematic fields based on the INSPIRE directive) and ATLAS is the main portal for the electronic communications networks.

ASIG - The State Authority for Geospatial Information

The State Authority is under the supervision of the Prime Minister's Office of Albania and performs administrative and other technical tasks, relating to: geodetic survey; topographic mapping; cadastre; land registration; thematic mapping; hydrographic mapping; aerial photography and satellite imagery.

According to Law no. 72/2012 'For the Organization and Operation of the National Infrastructure of Geospatial Information in the Republic of Albania', ASIG is responsible for establishing and maintaining the national geospatial data infrastructure. This includes supervising the collection, processing, updating, and dissemination of geospatial data; ensuring interoperability and data sharing among public authorities; and developing standards for geospatial data and systems. Additionally, according to DCM No. 147, dated 20.2.2013, and amended by DCM No. 863, dated 27.12.2022, ASIG has specific administrative responsibilities and organizational structure. However, ASIG is not responsible for the collection and updating of geospatial data related to cadastre, land registration, or hydrographic mapping. The responsible authorities for these themes are specified in the NSDI. Regarding the utilities infrastructure, ASIG is designated as the responsible authority for the point of access as per DCM No. 166, dated 1.03.2017.

ASIG's main objective is the creation of a geodetic framework to enable the support of a unique map covering the territory of Albania, presenting the geospatial data and services provided by the responsible public authorities, as defined by The Law on the Organization and Functioning of the National Infrastructure of Geospatial Information in the Republic of Albania (Law No. 72/2012). Thus, it provides products and services such as home addresses, cadastre, land registration and information, topographic, historical and satellite maps incl. orthophotos, although cadastral portal is currently not available. Through its geoportal, it aims to establish a national infrastructure geospatial database that is accessible to anyone.

The role of the geodetic authority and connection with collected AKEP data is vital for the implementation of quality mapping. Being the competent authority for providing digital bases and maps, ASIG is the go-to entity for obtaining all spatial data for the territory of the country. The two-way cooperation could also lead to displaying all geolocated statistical data in the field of telecommunications on its geoportal.

INSTAT – Albanian National Institute of Statistics

The independent public legal entity, INSTAT's mission is to provide transparent, neutral and timely statistics that help the user to judge on the developments of the transformation processes within the country. In accordance with the provisions of The Law on official statistics (Law No. 17, dated 05.04.2018), it is the major source of statistical information providing decisions makers, research and education in Albania – including stakeholders in the mission of establishing broadband mapping.

Pairing statistical data with location infrastructure data would enable both geolocated presentation and analytical processing of all collected data on telecommunications at any level of (applicable) gathered statistical data from the Institute of Statistics.

Operators of electronic communications networks and services

To conclude the chapter of the assistance report, we must briefly draw special attention to the role and importance of telco operators. After all, it is the telco operators who own most of the data, the processing and mapping of which are the aim of this paper. Operators must be recognised as crucial partners when defining the exchange format and to establish a connection to serve as a platform for providing data to public authority. Mapping of the broadband infrastructure benefits a variety of stakeholders including telco operators as the owners of electronic networks infrastructure and operators of electronic communications services that need large-scale independent measurements to assess network performance.

Technical framework for automated data transfer and integration between stakeholders

This section outlines the technical requirements and framework for automating the data transfer and integration process between the Electronic and Postal Communications Authority (AKEP) and the State Authority for Geospatial Information (ASIG). The goal is to ensure efficient, accurate, and standards-compliant sharing of broadband mapping data to improve the overall effectiveness of Albania's national geoportal.

1. Data formats and interoperability standards

To enable seamless data transfer and integration between AKEP and ASIG, the following data formats and services are recommended:

- Data formats:
    - Shapefile: A widely used format for geospatial vector data, compatible with most GIS software.
    - GeoJSON: A format for encoding geographic data structures using JavaScript Object Notation (JSON), ideal for web-based applications.
    - GeoPackage: An open format for geospatial information, designed for use on a variety of platforms and suitable for both vector and raster data.
    - GML (Geography Markup Language): An XML-based format for expressing geographical features, highly suitable for complex data structures and ensuring interoperability across different systems.
- Services:
    - Web Map Services (WMS): Standard protocol for serving georeferenced map images over the internet, generated by a map server using data from a GIS database.
    - Web Map Tile Services (WMTS): Provides map tiles at predefined scale levels, ensuring efficient delivery of geospatial data for display on web platforms.
    - Web Feature Services (WFS): Allows for the direct access and query of geospatial features, facilitating dynamic data exchange and manipulation.

The use of GeoServer with WFS/WMS services remains highly recommended for web-based automated access and transfer of spatial data between systems. GeoServer, as an open-source server, allows geospatial data to be shared and published using standard services like WFS and WMS, facilitating automated data transfer by exposing these data as services that other systems can consume.

Key features of using GeoServer with WFS/WMS services include:

- Support for automated data transfer by exposing geospatial data as services, enabling other systems to access and use the data.
- Capability for data manipulation and transformation in real-time, making it an ideal choice for systems that require web services for real-time data access and transfer.
- Flexibility to allow the receiving system to request updates directly from the source system, ensuring that data is always current.

Real-time data exchange is often conducted using WFS services due to its efficiency in dynamic data transfer. Alternatively, APIs can be employed for customized data workflows that meet specific organizational needs, allowing for more tailored integration between systems.

In addition to these options, direct database access can be used for the exchange of spatial data. This approach may utilize tools like PostGIS, a spatial database extender for PostgreSQL that enables geographic objects to be stored in the database. While direct database access can offer improved efficiency in some cases, it is typically considered for specific use cases where tighter integration between systems is required.

2. Testing environment for geospatial services and datasets

To guarantee that the data and services meet the necessary standards, ASIG is planning to establish a testing environment specifically for geospatial services and datasets. This environment will automate the monitoring and validation processes mandated by the government, ensuring conformity with approved standards across various thematic areas.

The testing environment will evaluate datasets and services for the following quality dimensions:

- Completeness: Ensuring all required data elements are present.
- Logical consistency: Verifying the correctness of data structure and format.
- Positional accuracy: Confirming the accuracy of the spatial location of features.
- Thematic accuracy: Checking the correctness of attribute data.
- Temporal quality: Ensuring the data is up-to-date and reflects the correct temporal attributes.

3. Development of a conformity module for data validation

ASIG will develop a conformity module to automate data validation and quality checks. This module will include an integrated web interface that state authorities can use to perform automatic tests for conformity with the thematic standards they oversee.

Key functionalities of the conformity module:

- Data upload: Users can upload geospatial datasets in any of the preferred formats (Shapefile, GeoJSON, GeoPackage, GML) as a compressed zip file.
- Service integration: The module will allow users to input URLs for WMS, WMTS, and WFS services, facilitating automatic validation and compliance checks.

Upon data upload or service integration, the conformity module will:

- Automated compliance checks: Perform checks to verify schema compliance, coordinate systems, and data quality according to established standards.

- Quality assurance reports: Generate detailed reports outlining the data's adherence to these standards, identifying any discrepancies and suggesting areas for improvement.

This module will support a robust framework for automating data transfer and integration, ensuring that all datasets and services meet the quality criteria required for the national broadband mapping system.

4. Data transfer process between AKEP and ASIG

To enhance the data flow between AKEP and ASIG, the following steps will be implemented:

1. Data collection by AKEP: AKEP will gather data from telecom operators and other relevant entities, including the Register of Cadastre, in the approved formats.
2. Data integration at AKEP: AKEP will compile and integrate the data using internal systems that ensure conformity to standards set by ASIG. This process will include validating the completeness, accuracy, and consistency of the data.
3. Automated data transfer to ASIG: Using the recommended formats (Shapefile, GeoJSON, GeoPackage, GML) and services (WMS, WMTS, WFS), AKEP will automate the transfer of validated data to ASIG. The data transfer will be set up to occur at predefined intervals or triggered by specific events.
4. Data display on ASIG geoportal: Upon receiving the data, ASIG will utilize its conformity module to perform further checks. The validated data will then be displayed on the national geoportal, ensuring public accessibility and usability.

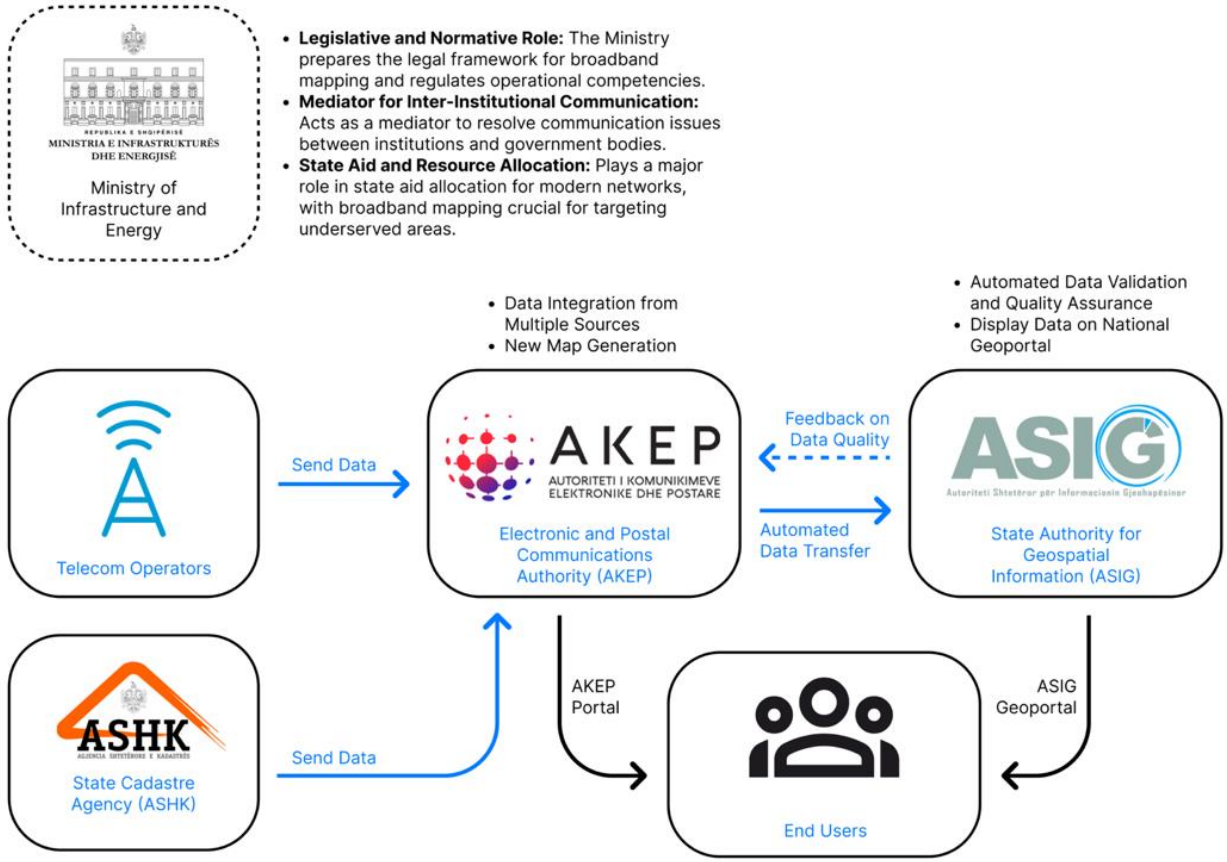
5. Benefits of the automated framework

Implementing this automated framework will:

- Improve data accuracy: Automated validation and testing will reduce errors and enhance data reliability.
- Enhance interoperability: Standardized formats and services will facilitate seamless data exchange between AKEP, ASIG, and other stakeholders.
- Increase efficiency: Automation will streamline the data transfer process, reducing manual intervention and processing time.
- Support compliance: The framework will ensure that all data meets government standards, improving regulatory compliance.

The technical framework described above provides a comprehensive approach to automating data transfer and integration between AKEP and ASIG. By adopting standard data formats, services, and an automated conformity module, this approach will enhance the effectiveness of Albania's broadband mapping system and ensure the highest levels of data quality and accessibility.

This diagram shows the data exchange framework between key stakeholders:



ITU Proposed Project and Technical Considerations to Set Up a Bidding Procedure for AKEP to Implement, Own and Operate the National Broadband Mapping Systems

Project framework and objectives (infrastructure, services, investments, demand mapping, last mile)

To facilitate investment in broadband networks, reliable and up-to-date data on existing infrastructure and existing broadband services is essential. When starting broadband mapping initiative, there are some crucial decisions that must be made at the preliminary stage. Albania, as the target country of this report, can gain significant time over the implementation of the necessary mapping steps by applying good practices and anticipating the challenges already identified.

In case of Albania, infrastructure mapping would be the best choice to start with. As AKEP already has some infrastructure data the issue lies in the lack of data regarding the "last mile". ITU defines the infrastructure mapping systems as a broadband map capable of gathering, structuring and representing georeferenced data on passive physical infrastructure (e.g., pipes, ducts, poles, manholes, base stations, mobile towers, etc.), information about the type of infrastructure deployed (fiber, copper, water pipes, electricity) as well as information about the owners of that infrastructure (fixed/mobile telecommunications, other network operators, national and local government, etc.).

On a later stage, service mapping could also be considered. Service mapping is defined as the activity entailing the gathering, structuring and representing data about service availability (including bandwidth and or type of technology used to offer the service), the number of broadband service offers from operators and/or the estimated quality of service available for a specific address and/or a specifically defined geographical area (e.g. 100m x 100m grid).

On a third point, investment mapping is defined as the activity entailing the gathering, structuring and representing data about planned investments aimed at developing broadband infrastructure and services in a defined geographical area (e.g. region, municipality) should be also entitled. Investment mapping should include relevant information about publicly and/or privately funded projects. If, in the first phase, the collection of information on planned investments represents a major or additional problem, it is possible to start with the collection of data in a limited form, which is easier to achieve for implementation, i.e. mapping of state-funded investments in infrastructure. Investment maps may include reports about areas characterized by market failure or sub optimal outcomes.

Next, demand mapping relates to the activity entailing the gathering, structuring and representing data about the quantity and quality of broadband demand for bandwidth desired by the end user and the level of financial allocation foreseen in association with that given broadband fixed service.

Finally, last mile connectivity is a crucial element in ensuring that broadband services reach end users, representing the final segment of the network that connects the central infrastructure directly to consumers' premises. This segment is often the most challenging and costly to implement, particularly in rural or underserved areas, but it is essential for bridging the digital divide and achieving comprehensive broadband coverage.

To accurately map and improve last mile connectivity, various sources of data are utilized. These include geographical information, such as the location of network termination points (NTPs), existing infrastructure routes, and the topographical layout of areas that influence the feasibility of network extension. Demographic data, including population density, household distribution, and socioeconomic factors, are also integral to understanding where demand is greatest and where investment in last mile connectivity will have the most impact.

Data relevant to last mile connectivity is collected from multiple sources: telecommunication operators provide detailed information on existing networks and potential expansion plans; local government databases offer insights into community needs and infrastructure gaps; and field surveys or crowdsourced platforms can fill in data where official records are lacking or outdated. Additionally, satellite imagery and GIS data are employed to create detailed maps that highlight areas lacking sufficient connectivity. By overlaying demographic information with existing infrastructure data, planners can identify underserved areas and prioritize them for investment. This approach ensures that resources are allocated efficiently and that broadband expansion efforts are targeted where they are needed most.

The importance of last mile connectivity cannot be overstated in the context of national broadband mapping efforts. By focusing on this critical network segment, Albania can ensure that its broadband infrastructure not only reaches the majority of its population but does so in a way that is equitable and sustainable.

(Note: Annex table at the end of the document, summarizing relevant details related to last mile connectivity)

Data sources

Relevant data sources for broadband mapping should include infrastructure owners (i), telecommunication operators (ii), public utility entrepreneurs (iii) and local government authorities (iv). With the data provided by the main group of data sources, the challenging aspects are mainly low willingness to provide data and a tendency to present the situation better than it is or hide some important data which hamper the state aid interventions. To deal with these, two solutions may be considered: the first one pertaining to the use of legal reporting obligations to be imposed and the second one would aim for a voluntary basis approach. Data quality checks should be implemented in the broadband system. Additionally, administrative rules on penalties including financial penalties should be laid down in the national telecommunication law in case when decision is taken to go for mandatory reporting obligations.

Information to be collected

The information that can be collected from operators within broadband mapping can be divided into three levels. The first level is the type of information, i.e., nodes, lines, services.
The second level of information might relate to the master description which is added to the basic information about the very existence of the infrastructure or the availability of broadband service. This type of information is called attributes. The third layer should contain defined values or terms for the second level attributes.

In order to achieve broadband objectives, it is fundamentally important that there are reliable and valid data on existing broadband infrastructures and services offered. Data on broadband infrastructure and services are crucial to identify gaps of broadband coverage and quality of service level and identify suitable areas of investment. Gathering infrastructure data will be particularly useful to avoid duplication of financing, as subsidies should be allocated to areas truly affected by market failure. To avoid negative consequences of broadband data shortage the mapping platform has to collect data sets concerning broadband infrastructure and services. Data collection on the investment and demand can be performed on voluntary basis.

Data formats

The two most commonly used data formats for providing data within the broadband mapping process are DSV (mainly CSV) and XML.

DSV (mainly CSV)

Delimiter-separated values (DSV) is a text file that stores two-dimensional data, where values are separated by specific delimiter characters. In the .DSV file, each row is one database record. Any value can be used as delimiter character that separates the values. Most popular delimiter characters are comma (CSV, – Comma-separated values) and tab (TSV, - Tab-separated values). Colon, semicolon, pipe and space are also sometimes being used as delimiters.It is very important to choose a delimiter that is not being used in the data in order to avoid later issues with data read. It is possible to use double quotes for string values. All records should have the same number of fields and the same value order. This format is easy to read by databases and spreadsheet applications. It is also very easy to create.

XML

Extensible Markup Language (XML) is a universal mark-up language designed to represent various data in a structured way. It contains textual data. It is platform- independent, which enables easy document exchange between different systems. Using XML also means that the user may easily design a data hierarchy. This format is appropriate for large amounts of data and when one wants to emphasize the hierarchy of data. XML also supports data validation, especially structure validation. XSD (XML Schema Definition) is a file, where the user specifies the structure and description of an XML file. It is used for verification of the main XML file. The XML file is more complex than the CSV file, but it also gives more possibilities.

GIS data

There are a few different types of GIS data:
• vector spatial data,
• spatial raster data (e.g., orthophoto map) and
• attribute tables that are represented in tabular format.

The location of point features is determined by the coordinates of the point locating the feature. In the case of linear and area objects that are defined by a larger number of points, apart from their coordinates, it is important to arrange them properly, which is determined by the shape of the object.

Vector data

The most common vector data formats used are:

- DGN is the name used for CAD file formats supported by Bentley Systems' MicroStation and Intergraph's Interactive Graphics Design System CAD programs.

- AutoCAD DWG is the proprietary native file format for AutoCAD, one of the most popular computer-assisted design (CAD) packages.

- DWG is a compact binary format that stores and describes the content of 2D and 3D design data and metadata.

- Shapefile - Esri vector data storage format for storing the location, shape, and attributes of geographic features. It is stored as a set of related files and contains one feature class. Shapefiles often contain large features with many associated data and historically have been used in GIS desktop applications.

- GeoJSON - a format for encoding a variety of geographic data structures. GeoJSON supports the following geometry types: Point, LineString, Polygon, MultiPoint, MultiLineString, and MultiPolygon. Geometric objects with additional properties are Feature objects. Sets of features are contained by FeatureCollection objects.

- Keyhole Markup Language (KML) - an XML-based markup language designed to annotate and overlay visualizations on various two-dimensional, Web-based online maps or three-dimensional Earth browsers (such as Google Earth).

- Extensible Markup Language (XML) - a file format used to create common information formats and share both the format and the data on the World Wide Web, intranets, and elsewhere using standard ASCII text.

- A comma separated values (CSV) - contains different values separated by a delimiter, which acts as a database table or an intermediate form of a database table. In other words, a CSV file is a set of database rows and columns stored in a text file such that the rows are separated by a new line while the columns are separated by a semicolon or a comma.

Raster data

Raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature. Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps.

The most popular raster data formats are:

- Tagged Image File Format (TIFF) - the extensible feature of this format allows storage of multiple bitmap images having different pixel depths, which makes it advantageous for image storage needs. Since it introduces no compression artifacts, the file format is preferred over others for archiving intermediate files.

- Joint Photographic Experts Group (JPEG) - it is commonly used for storing digital photos and used by most digital cameras to save images.

Tabular format data

Tabular format data is represented by data organized into columns and rows. It can be said that it is the simplest data format, but it can be considered the easiest for operators to handle. An example of software that allows you to process tabular data is Excel.

Data supply process

To ensure the most efficient data provision within the broadband mapping process, the collecting body, probably AKEP, should elaborate a designated platform for data transfer. This is a core component of a mapping project and a key determinant of its success within a given country. The platform has to fulfil rigid safety and security criteria for data transfer, but also balance the user

experience to facilitate compliance by operators, particularly in contexts where the voluntary approach is adopted.

On the entity validation aspect, one basic method is using a logging-in system, which may be significantly strengthened by a separate procedure of obtaining usernames and passwords by the reporting entities. Importantly, only logged-in users should be able to report data. Simultaneously, the reporting system should give the possibility to log-in only to entities that report data. The platform should allow access to view data, as well as to edit them and update for reporting entities.

The platform should enable to transfer data in two basic ways – manual and automated. The first way should allow reporting data manually by a browser. It would be dedicated to entities that have a small amount of data to report and to those, whose data changes only a little between reporting periods.

The second, automated method should allow transferring data by entities via pre-prepared files. These files should have an appropriate structure, which has to be determined in advance. These data files could be for example CSV or XML files, or both. The precise reporting set up regarding the way of reporting in an automated way via files would be determined by the specific design of the reporting platform. This method should be dedicated to entities that have large amounts of data to report.

Data conversion

The platform should support and assist with the data reporting. It should make it possible to report data manually by hand and to automatically import prepared data files. The first way ensures functionalities that allow entering data manually through the browser. The second way can be a dedicated tool that helps to prepare data files for reporting. This tool should not be complicated to use and should allow generating files with large data volumes. This tool could represent a mix of manual and automatic data preparation. The third way can be a dedicated tool for large operators. This tool should be able to transfer large amounts of data to the platform. Entrepreneurs have to prepare data files (e.g., CSV or XML) on their own, based on their inventory systems. The tool would assist in checking the correctness and structure of the data.

Quality checks in broadband mapping

Data obtained from public and private sources are at the core of high-quality broadband mapping systems. Therefore, it is imperative to check all data used in the process. Thus, it is not a question of whether or not to check data in the broadband mapping process, but rather, which quality check process or which combination of processes to install. The three basic quality checks methodologies applied to broadband mapping are:

1. plausibility checks;
2. manual checks;
3. additional user feedback Plausibility checks.

Plausibility check

Plausibility check is a method of data quality verification, where a value is checked to determine, whether it is plausible or not, that is if it is acceptable for the type of information being collected. It is not always possible to check the correctness of every data in such a way, but this type of check will allow detecting any obvious inaccuracy. Data collection tools used for broadband mapping ought to be designed to automatically check a range of plausibility rules. The validity of particular data can be either rejected by the software or flagged as being unlikely to be valid. In the broadband mapping process, it is the second approach that is more applicable, as flagged data may be additionally verified

both by the supplier at the point of entry, and then by the data collecting body, when verifying full data sets obtained through the process. Plausibility checks may be done manually, but most commonly are automated and are incorporated into the software of the collection tool used in the process.

Manual checks

Manual checks are not compulsory to be used within the broadband mapping process, but under certain circumstances, it may be useful to improve data quality for the process. They may be carried out using different approaches and intensities. A relatively simple approach is to cross-check data with data otherwise published by the same operator or infrastructure owner or check the same set of data provided by two different sources. When it comes to services provided, operators frequently publish the availability of their services on their own websites.

Additional user feedback

User feedback offers another additional route to check and potentially improve data quality. There is a number of routes that the user feedback may be obtained from, such as:

- functionality of the broadband mapping visualisation tool – the interested public may provide feedback directly through the map functionality, if they deem that information is not accurately presented for their situation;
- communication channels directly to the data collecting body – via collecting body's website;
- contact point or any other route offered;
- e-government contact routes for public – general routes of contacting governmental units provided by e-government tools.

This type of checks requires long term maintenance efforts on the collecting body's side.

Access to data

Publication of broadband data is an important tool by which end-users can obtain information about the availability and selection of services and the location of the telecommunications infrastructure. At the same time, in accordance with national laws on commercial confidentiality and personal data protection, some information collected as part of the broadband mapping may be considered confidential and should be protected by the national regulatory/national competition authorities. Additionally, the ATLAS system must ensure interoperability and secure data exchange with the National Geoportal as per NSDI legislation in Albania. This is achieved through standards that align with the EU INSPIRE Directive, covering what and how ATLAS will provide geospatial data to government agencies and the public:

Geodetic Reference Frame:
According to DCM no. 669, dated 7.8.2013, the Albanian Geodetic Reference Framework (KRGJSH) ensures that all geospatial data collected and published by the ATLAS system is accurate and interoperable. This standard provides a consistent geodetic reference that aligns with European standards, essential for interoperability between different geospatial datasets and maintaining the accuracy of geospatial information.

Thematic Data Specifications for Utilities Infrastructure:
DCM no. 998, dated 9.12.2020, defines the technical specifications for geospatial information, particularly for utility and governmental services. These specifications ensure consistency and reliability in the data collected and published by the ATLAS system. Adherence to these standards is

crucial for maintaining uniformity across various datasets, ensuring the data's reliability and consistency.

General Regulation for Integration in the National GIS System:
DCM No. 547, dated 28.09.2023, mandates compliance with state standards for integrating data into the National GIS system. This regulation ensures that all geospatial data shared and integrated within the National GIS framework is secure and interoperable. It covers the processes and standards for data exchange between public authorities, ensuring effective and secure data sharing.

The choice any mapping initiative has to make with regard to data publication is about who should have access to the data. There are three options for data access:

- internal use - data is collected only for analysis purposes;
- limited access to data - data made available in justified cases, upon request;
- public access - all data collected within broadband mapping is publicly available.

The goals of the broadband mapping initiative, as well as the level of detail that is theoretically available from the data collected, usually determine the choice of these options. If the goal is to inform the public or even generate interactions with the public, e.g., through a feedback function, then detailed data access that does not reveal any company secrets seems to be the most obvious choice.

A good incentive from the regulatory authorities would be to publish reference infrastructure sharing offers thus providing an incentive for public sector institutions (e.g. local governments) and other public or private institutions to publish the data. This would provide an incentive for traditional telecom operators to come forward finding that benefits outweigh the costs of sharing information about one's own network.

In addition to the issue of commercial confidentiality and protection of personal data, the particularity of critical infrastructure should also be taken into account in data publication.
A minor problem is found with the publication of data on mapping services and demand. The information can, in principle, be available to everyone, including users who are not logged in.

When considering publishing data on telecommunications infrastructure in the context of critical infrastructure, three options can be mentioned:

1. Define in the act what the critical infrastructure is and:
   - collect information about it and do not publish it,
   - do not collect this information.

2. Collect information about critical infrastructure with the attribute, whether the infrastructure is critical (yes/no) and provide such information only in justified cases.

3. Do not collect information about critical infrastructure and decide what critical infrastructure is left to network operators.

It is recommended to consider a scenario which mixes these three possible options of the confidentiality, i.e., defining the critical infrastructure in the legal act, introducing an attribute (yes/no) where the operator can indicate on the basis of the elements of the critical infrastructure described in the act and determining which collected information on the critical infrastructure cannot be publicly available.

Publication format

The choice of the form of data publication depends mainly on the preferences of potential users. One way to facilitate access to data may be to present the data in various publication formats. For some stakeholders, it may be important to visualize the data on a map and download it in vector form, for another group of entities, a report presenting a subset of results and analyses may be more useful. It is also worth verifying which group of potential recipients depends on the already processed and which on the raw data. Raw data can be provided in the form of tables, geographic files or web services. Web services have the advantage of being always up-to-date as the data is stored on the initiative's web server and is made available on request over the network for display in the user's GIS. Therefore, if errors in the dataset are corrected, it is guaranteed that external users will also receive updated information. The website allows the use of many different forms of visualization, from text, tables and picture map to dynamic maps, e.g. with the zoom function, to fully interactive maps that also allow us to access additional data or perform data analyses. *BEREC Guidelines on Geographical surveys of network deployments* suggests several options for publishing GIS data:

- Interactive maps published in a dynamic web application;
- Interactive address search published in a dynamic web application;
- Application Programming Interfaces ("APIs") for accessing data;
- Datasets in open and generalized formats such as CSV;
- Statistical reports, including tables and analyses.

Update frequency of data supply

While telco operators must report data quarterly, the frequency of reporting data by other entrepreneurs and public entities should correspond to the needs of the entity maintaining the map. Data reporting should be done at least once a year. It is viable to set up a large reporting window, i.e., a quarter, however with presumed reporting the status of data as of a set date. This enables smooth monitoring of the telecommunications market, as well as meeting most reporting needs.
Depending on the collecting body’s needs, semi-annual or quarterly reporting might be considered. However, it should be noted that more reporting obligations mean greater workload and costs for reporting entities. The possibility of reporting and updating data should be continuous, and the reported data should be up to date for the time reported. The choice of the form of data publication depends mainly on the preferences of potential users. One way to facilitate access to data may be to present the data in various publication formats. For some stakeholders, it may be important to visualize the data on a map and download it in vector form, for another group of entities, a report presenting a subset of results and analyses may be more useful. It is also worth verifying which group of potential recipients depends on the already processed and which on the raw data. Raw data can be provided in the form of tables, geographic files or web services. Web services have the advantage of being always up-to-date as the data is stored on the initiative's web server and is made available on request over the network for display in the user's GIS. Therefore, if errors in the dataset are corrected, it is guaranteed that external users will also receive updated information. The website allows the use of many different forms of visualization, from text, tables and picture map to dynamic maps, e.g. with the zoom function, to fully interactive maps that also allow us to access additional data or perform data analyses.
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- Statistical reports, including tables and analyses.

Project design

When initiating a broadband mapping system project, in addition to defining the reasons for undertaking a project, one should start with the stakeholder analysis. It is an important stage because it is worth starting with a consultation with interested parties, especially when there are no regulations regarding the implementation of such a system in a given country. Stakeholders are parties who will be affected by the project at any point during its life cycle, and their input can directly impact the outcome. It is essential to practice good stakeholder management and continuously communicate to collaborate on the project.

Listening to stakeholder concerns and feedback is a valuable source of information that can be used to improve projects and outcomes and help to identify and control external risks. For stakeholders, the consultation process creates an opportunity to be informed, as well as to inform the company about local contexts that may not be obvious, to raise issues and concerns, and to help shape the objectives and outcomes of the project.

The more a stakeholder group will be materially affected by the proposed project, the more important it is for them to be identified, properly informed, and encouraged to participate in the consultation process. It is therefore critical to determine who the various stakeholders are, as well as their level of interest in the project, the potential impact it will have on them, and the power they have to shape the process and outcome. In the case of broadband mapping system projects, identifying the stakeholders is not difficult, as it can be based on the experiences of other countries. As already mentioned, it is particularly important to involve stakeholders at various stages of the project. Below the following phases that are recommended:

- **Informing phase**: Providing stakeholders with balanced and objective information to help them understand the project, the problem, and the solution alternatives.

- **Consulting phase**: Gathering feedback on the information provided. Contribution levels can range from minimal interaction (online surveys etc) to extensive. It is also possible to consult the scope of collected information or data formats.

- **Involving phase**: Working with stakeholders during the process of defining system requirements to ensure that their ideas and concerns are fully understood and taken into account.

Collaboration phase: While stakeholders will not be useful when developing the system, they can be very useful at the stage of system testing. It is therefore worth involving them in this phase. One of the most important decisions to be made in the project is the choice of the system implementation formula. This decision must depend on the internal factors of various countries and their institutions, the strategic and regulatory objectives that the country seeks to achieve, and the financial means and available human resources. In fact, before setting up a project, broad objectives should be defined.

ITU Recommended Technical Requirements for the Public Tender and Proposed Contractual Obligations

This chapter covers a series of suggestions and recommendations designed specifically for the development of a broadband mapping system owned and operated by AKEP. These recommendations also include a series of recommended technical and human capacity requirements for potential applicants and detailed technical specifications. It also emphasized what kind contractual obligation should be put in place.

Proposed requirement for technical and human capacity

Required experience in the last (3) three years	Supporting document
Knowledge and experience in the field of planning and implementation of spatial systems of economic public infrastructure in the field of telecommunications	At least three references certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience in the field of planning, establishing and maintaining information support in the creation of spatial databases	At least five reference certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience in the field of collection and analysis of spatial data in the field of public utility infrastructure	At least two reference certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience with the entry of network connection points in the collective cadastre of public infrastructure	At least three reference certificates signed by the contracting entity, which show: - project title; - project value;

	- duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience with management, maintenance with PostgreSQL database management systems and with PostGIS extension and GeoServer server	At least two reference certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience in managing and using GIS software QGIS	At least two reference certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience in performing mass network analyses.	At least three references certificates signed by the contracting entity, which show: - project title; - project value; - duration of the project (exact start and end date of the project); - contact person of the project Contractor and his e-mail address or telephone number. The bidder may also provide several references. (In case of doubt, the Contracting authority may verify compliance with the condition).
Knowledge and experience in creating web GIS application based on open source solutions	At least two working web GIS applications based on open-source solutions (one in the field of telecommunications: - links to applications, - specified open-source-solutions used in applications

Expert knowledge	Certificates of appropriate education of employees collected by the provider: - at least a university degree in geodesy or geography (at least two employees); - at least a university degree in informatics (at least one employee) (In case of doubt, the Contracting authority may verify compliance with the condition).
Experiences	Curriculum vitae collected by the provider - key personnel who will participate in the project with at least five years of experience in the sector - at least two other employees who can provide support during the project
Quality of execution and data security	A description by the provider of the details of the measures to ensure the quality and security of the data - ISO9001 certificate or any equivalent proof - other relevant certificates

Recommended general technical specifications

The general technical specifications are covered below and in the next subchapter more detailed ones are presented, where AKEP may choose which ones will come in handy when designing a public tender.

- Capture of spatial data from various databases of public economic infrastructure
- Establishment of a local database that connects existing spatial databases and establishment of a system for capturing and integrating new data into the existing system
- Identification of geographical areas according to the number of households / population density
- Identification of rural and urban areas
- Determination of endpoints and in the intermediate space: inspection of the existing network (objects, availability …), if not, sewerage construction: route, distances, roads, etc.
- Collection of data on the availability of capacities of electronic communications operators
- Collection of data on the availability of capacities of other public infrastructure suitable for the sharing of electronic communications
- Geographical segmentation: overview of the territory of BIH and determination of the number of available access networks according to geographical units.

It is therefore necessary to establish connections between the existing spatial databases and to establish a geo-data system taking into account the existing hardware, software and communication equipment in the AKEP.

Considering that AKEP aims to perform various tasks with these analyses, therefore GIS experts appear to be necessary in such a way that their services could be used by the agency on a daily basis and not on a completed task. In this way, the tasks of the persons concerned could be changed on an ongoing basis, and further needs could be identified on the basis of the current results. It is essential that the AKEP may be able to determine on an ongoing basis what data and what analyses it expects. At the same time, the Contractor may, to some extent, provide additional training for the AKEP's employees who will be intensively involved in this in the future, for the basic operations of retrieving data, basic reports and analyses from the aforementioned databases.

Recommended detailed technical specifications

Working with databases (collection, processing, retrieval and validation of data)

The Contractor must merge and combine publicly accessible databases. In particular, the databases to which it has access as a user with the highest priority, the databases it has acquired from other public authorities, the databases it has collected or acquired from operators, and the databases it has acquired through data collection by means of field measurements.

Tasks in this area include:

- Consulting in the management of databases in the geo-information system, including the use of geospatial basemap data provided by the National Geoportal infrastructure, such as Orthoimagery, Satellite Imagery, and BaseMaps. This should encompass records of network connection points, cadaster of public infrastructure, register of spatial units, business register, cadaster of buildings, land cadaster, central population register, data on the retail and wholesale products or broadband access services, data from an operator with significant market power, data on the coverage of mobile networks with a signal, and data on high-quality products, etc. Data exchange should be secured by WebServices WMS, WMTS, WFS, or ATOM-A for some specific datasets, ensuring the interoperability and security of geospatial data sharing.
- Pairing and linking databases for further processing,
- Advising and carrying out logical checks to detect irregularities occurring both on the reporting side and on the import and vaporization side of this data,
- Periodic acquisition and import of data from the above records according to the instructions of the Contracting authority,
- Advice on the usability of data from various databases, options and on the procedures for ordering data for use and the implementation of the import of additional databases in accordance with the needs of the Contracting authority,
- Advising, importing and processing data on locations of expressed market interest

Database and server management and configurations

The Contractor's tasks in this area should include checking the status of servers, reviewing and installing operating system updates where available, resolving potential performance issues, updating software, monitoring the area, and advising in the event of updates, add-ons, or software updates and also the equipment that would bring improvements to GIS system. Tasks in this area additionally include care for the proper functioning of all connected systems, care for archiving and proper implementation. The Contractor will also be required to respond quickly and rectify in the event of a failure and malfunction of the connected systems.

Establishment, maintenance, upgrade and graphic design of an internal web GIS viewer and consulting in connection with a web GIS viewer

The Contractor should establish an internal online geographic information system that obtains data from databases on the Contracting authority's server and displays them graphically. The architecture of a web GIS browser must consist of a web page that combines graphical and attribute data into views, and of databases from which the web page draws this data, and a geographic server GeoServer. The databases on the Contracting authority's server from which the web GIS browser draws data are, for example: records of network connection points, cadastre of public infrastructure, register of spatial units, business register, cadastre of buildings, land cadastre, central population register, etc. GeoServer is a geographic server that makes images from geometric and geographic data. Functionally, the viewer must allow the user several types of access to the data itself and the ability to export tables. The website itself can be developed in the Microsoft Visual Studio 2015 environment.

It is a web project with the ASP.NET MVC architecture using the Microsoft.NET Framework. Additional booklets are from the NuGet repository, which are updated automatically. Tables and database insights are prepared with SQL script.

Tasks in this area include:

- Establishment and maintenance of an internal web GIS viewer of network connection points from the register of infrastructure networks and facilities and electronic communications from the cadastre of public utility infrastructure,
- Advising the Contracting authority on potential possibilities for improvements to the web GIS viewer,
- Consulting and implementation of solutions to improve the functionality of the web GIS viewer,
- Identification and troubleshooting of the web GIS browser,
- Care and tasks for the smooth operation of the web GIS viewer and its updates,
- Care for the correct operation and correct presentation of results,
- Elimination of web GIS browser errors according to the Contracting authority's instructions,
- Care, advice and execution of tasks for optimal operation of the web GIS viewer,
- Ensuring the information security of data accessed via an online GIS browser,
- Careful handling of data and notification of the identification of possible safety deficiencies,
- Implementation of measures to eliminate security deficiencies,
- Managing and arranging various level of access to the web GIS viewer according to the instructions of the Contracting authority and its IT department,
- Import and preparation of new data layers as required and according to the Contracting authority's instructions,
- Preparation of tools in the web GIS viewer that will enable individual analyses and processing of this data and export of results in the form of tables and displays,
- Updating graphical filtering and preparing the possibility of exporting graphs and tables taking into account the filter criteria,
- Graphic design of a web GIS browser,
- Taking care of compatibility and implementation of solutions for correct display using different web browsers,
- Participation in the implementation of an in-depth study for the preparation of a public version of the web GIS viewer for publication on the Contracting authority's website,
- In agreement with the Contracting authority and on the basis of the findings of the in-depth study, if necessary, the preparation of a public version of the web GIS viewer for publication on the Contracting authority's website,
- - pairing and linking databases for the completeness of the display of results in a web GIS browser,
- Pairing and linking databases in the preparation of new data layers,
- Preparation and interpretation of instructions regarding changes and application of improvements in the web GIS viewer,
- If necessary and according to the Contracting authority's instructions, preparation of a script with an open source web GIS browser, supplemented with an explanation (in accordance with the implemented updates),
- Execution of project tasks in connection with the web GIS viewer according to the current instructions of the Contracting authority,
- Related tasks related to the web GIS viewer according to the Contracting authority's instructions.

Geo-data system maintenance

Tasks in this area include:

- Care and tasks for the smooth operation of the system,
- Updates,
- Security updates,
- Ensuring proper operation,
- Editing database archiving,last
- Debugging.

Geo-data system optimization

In the geo-data system, the Contractor should combine large databases with large amounts of data, and certain operations are complex, so it will continue with certain optimizations.

Tasks in this area include:

- Care, consulting and implementation of process optimization as needed by the Contracting authority,
- Consulting, implementation, application development, in case of need and possibility for automation of certain related procedures,
- Archiving and clear marking and classification of performed analyses, tables and displays for reusability.

Concern for information security of the geo-data system and consulting

The Contractor would combine many databases in a geo-information system as some of which contain sensitive data. A high degree of caution is required for some databases that are part of a geo-information system.

Tasks in this area include:

- Advising and implementing measures to maintain a high level of protection of the databases that make up the Contracting authority's geo-information system,
- Careful handling of data,
- Notification of the identification of possible safety deficiencies.

Production of displays, tables, reports and basic instructions

Tasks in this area include:

- Production of all types of cartographic displays, tables, projects in the GIS tool, reports, short instructions,
- Interpretation of results and preparation of methodological explanations,
- Meaningful naming and classification of results for later use.

Geographical analysis and consulting

The Contracting authority aims to perform a number of analyses based on geo-located data. It carries them out on a regular basis as well as part-time, as needed. In addition to performing regular and "ad

hoc" analyses according to the Contracting authority's instructions, the Contractor's task will also be to advise on methodologies, appropriate approaches and potential improvements. Analyses will be performed as needed, which will be agreed upon by the Contracting authority with the selected Contractor. It is also important for the Contracting authority to determine the geographic market in accordance with legal provisions.

Tasks in this area include advising and performing geographical analyses in the analysis and use of data in connection with:

- The relevant markets defined in the European regulatory framework,
- Universal service,
- Coverage and availability of mobile and fixed broadband networks,
- The entire telecommunications infrastructure,
- Measures to reduce the cost of setting up high-speed electronic communications networks,
- Various "ad hoc" geographical analyses required by the Contracting authority in the process of regulating and supervising the electronic communications market in Albania,
- Services and prices of the retail and wholesale electronic communications market,
- The required periodic reporting to the European institutions and the replies to the ad hoc questionnaires,
- Support for other regulatory decisions,
- Related areas.

Acquisition of input data with data from mobile infrastructure networks at the level of Albania

The Contracting authority has at his disposal existing data on mobile networks (locations of base stations, network capacities). The Contractor will advise on obtaining this data and entering it into the existing geo-data system. Based on this data, the Contractor will be able to conduct a study of the capacity of mobile networks in the field of data transmission by individual geographical areas.

Consulting and implementation of the determination of the appropriate methodology for the implementation of the geographical segmentation of the relevant markets for access to the broadband network

European Commission Recommendation of 11 September 2013 on consistent non-discrimination obligations and methodologies for calculating costs to promote competition and improve the environment for broadband investment (2013/466 / EU) as a basis for assessing market power in each country or for segmenting regulatory measures indicates geographical segmentation. Geographic segmentation can take place in a variety of ways. According to the legal provisions, the definition of a geographic market is one of the two main components of the definition of the relevant market suitable for prior market regulation (product market definition and geographic market definition). After defining the relevant product or service market, it is necessary to define the geographical scope of the market, which enables the assessment of the conditions of effective competition in it. According to established practice, the relevant geographic market comprises an area in which the undertakings concerned are involved in the supply and demand of the products and services concerned, in which the conditions of competition are uniform, and which can be distinguished from neighbouring areas. In the field of electronic communications, the geographic scope of the relevant market is determined in accordance with established practice on the basis of two main criteria: the area covered by the network and the existence of legal and other normative instruments. Using the method of geographical segmentation, the Contractor will check whether the competitive conditions for entering the market are the same in all areas of Albania. In particular, it will be necessary to check whether the competitive conditions differ throughout those parts of the national territory where there is more

infrastructure (urban centres) than those where only one infrastructure is present and there is only one operator with significant market power.

Tasks in this area include:

- Advising and carrying out the determination of the appropriate methodology for carrying out geographical segmentation in future analyses of the relevant markets defined in the European regulatory framework.

Consulting and implementation of geographical analyses in the analysis of retail prices in the telecommunications market in Albania

For the purposes of the new regulation of the relevant markets 3a and 3b, the Contracting authority will identify flagship products based on the revised Recommendation on relevant markets and the recommendation on consistent non-discrimination obligations and methodologies for calculating costs to promote competition and improve the broadband investment environment. To this end, operators can expect to be provided with a questionnaire on the leading packages they offer to end users. To this end, for the purposes of reporting on the leading packages provided by operators to end users, the Contractor should prepare the optimal format for the preparation of input data and subsequent input into the geo-data system. Leading products will be a constant in further regulation, so analyses at the geographical level will also be permanent, which should be performed by the Contractor in agreement with the Contracting authority.

Consulting and implementation of various "ad hoc" geographical analyses that the Contracting authority needs in the process of regulating and monitoring the electronic communications market in Albania

The Contracting Authority often encounters the need to perform geographical analyses, which it needs in various processes of regulation and supervision of the electronic communications market and management and control of the radio frequency spectrum in Albania and performing tasks in the field of radio and television activities. The Contractor will advise and perform various ad hoc geographical analyses, especially in the field of electronic communications market infrastructure, and, if necessary, cooperate in conducting analyses with other sectors in the Agency.

Expansion in connection with additional collection of network layout forecasts and inquiry into market interest for the construction of high-performance networks and demonstration of new spatial layers due to legal changes

The Contracting authority is likely to take over the competence to investigate market interests for the construction of high-performance electronic communications networks. The Body of European Regulators for Electronic Communications (BEREC) has issued Guidelines to support national regulators and other public institutions in consistent implementation of the provision of Article 22 of the EECC, which he supplemented with guidelines on verification and procedures for this purpose. The Contractor should expand to enable easy generation of data on inhabited residential and inhabited addresses from the AKEP's database and to prepare public calls or publications. The GIS needs to be expanded in such a way that it is easy to collect, verify and enter stakeholder data on construction interests (including any additional parameters deriving from the guidelines). It is necessary to customize the scripts and enable navigational association with this table. Coordination with staffing agencies and geoportal operators will also be required to show the spatial layer. The Contractor should

cooperate with the technical and operational implementation of updates and provide all necessary technical support to the employees of the agencies.

Development of spatial applications and production of dedicated tools for spatial data processing tailored to the Contracting authority

The GIS will be used by the AKEP in practically all areas of its operation, as a support in the implementation of tasks and decision-making. Individual tasks that are repeated and performed by users with different levels of information and GIS knowledge, such as: inputs, validations, geocoding, generalization of statistical data, cross-sections, complex calculations with data from several tables, etc. The task of the Contractor will be with the development agency scripts and applications (Java, Pytho, etc.) that will help to optimally perform the regular work tasks of the AKEP, with special emphasis on simplicity and durability. This additionally includes automatically scheduled tasks (updates, startups, operation of WFS and WMS services, etc.).

Advice and support in performing advanced spatial analyses

If necessary and by agreement, the Contractors task should be to advise the AKEP on the most complex spatial analyses (network analyses, geo-routing, etc.). In addition, tasks in this area may include cooperation in the context of updating and supplementing the geoportal, specifically regarding the operation of the Geoserver and the display of data layers.

Providing all necessary information to the employees of the agency for the smooth use of tools

The task of the Contractor should be to provide the AKEP's employees with full access to the prepared tools, applications and scripts and to provide all the necessary substantive explanations. The task of the Contractor will also be to instruct the employees of the agency for the smooth management of tools and on the possibilities of their updates and additions. The Contractor will have to design and present all the tools in such a way that the AKEP's employees will be able to use them independently. If necessary and upon request, the Contractor should prepare additional written instructions for the products.

In addition to the permanently available geoportal, GIS employees use it daily for many tasks, so the Contractor is expected to provide all the necessary support in case of errors and all of the above to avoid disruptions at all.

Technical support in the operation of the Geoportal and development of an application for the use of the browser on portable devices

The Contractor should advise the AKEP on updates and, in agreement with the AKEP's employees, will ensure the smooth implementation of Geoportal upgrades (in the .NET environment). It will follow the relevant area and propose appropriate solutions for the smooth and safe operation of the system and for optimizing performance. For the AKEP, it should implement the possibility of reporting errors in the displayed TK data on Geoportal directly by users, and participate in other similar upgrades that will relate to the new data layers and their display. In the event that the Contracting authority's side needs additional functionality, the Contractor will implement it in the user interface after examining the options and in agreement with the Contracting authority.

In agreement with AKEP employees, the Contractor will develop an application for portable devices (smartphones, tablets and similar devices), which will offer a comparable user experience as a desktop version and take care of publishing security and functional upgrades. The app will need to be available in the Google Play and AppStore libraries and therefore run on the two largest platforms, Android and iOS.

Proposed contractual obligations

Consultants' hours for the provision of services under this contract should be carried out successively in accordance with the needs of the Contracting authority. The Contractor should start performing the service on the basis of an oral or written request from the Contracting authority. Under this contract, the Contractor should perform work at the Contracting authority's registered office, except in exceptional cases, unless otherwise agreed with the Contracting authority.

An important addition to the contract should be signing a non-disclosure agreement that should be concluded with the Contractor before the start of the provision of services.

The Contractor's response time to the Contracting authority's request should be as short as possible and/or not longer than 24 hours in the case of an intervention request or 3 days in the case of a normal request. The intervention of the task is defined by the Contracting authority.

Under the contract, the Contractor should undertake to:

1. Perform the services with the care of a good expert, flawlessly and with quality, taking into account regulations and standards in this field and to cooperate with Contracting authority's and take into account their requirements, insofar as they are in accordance with the subject and scope of this contract,
2. provide the Contracting authority with all necessary explanations and, if necessary, to resolve problems that may arise in the performance of services,
3. Provide services economically and for the benefit of the Contracting authority and to ensure the highest quality of services,
4. Fulfil its obligations within the time limit and in the prescribed manner.

The Contractor should also, separately by days and members of the project team who will perform activities in the previous week, report in writing on a weekly basis (e.g. every Tuesday) on the activities performed for the previous week and on the hours spent for these activities. This report must also show the number of hours spent for each activity or member of the project team. Several activities performed by person in one day and a description of the performed activity or performed activities.

The Contractor should undertake to report in writing to the Contracting authority, in the same way as on a weekly basis, by the 5th day of the month at the latest, on the activities performed and the hours spent for the previous month. The mentioned reports (weekly and monthly) must be submitted by the Contractor in writing (electronically) within the mentioned deadlines to the Contracting authority, who reviews them and within 5 days of their receipt answers whether he agrees with them or not. If the Contracting authority does not respond to the report within 5 working days of receiving of the monthly report, the report is considered confirmed. The individually approved monthly report should be the base for issuing an invoice for the consulting hours in the previous month.

After completing all activities defined by the contract, the Contractor must write a final report containing all possible technical details and instructions that the Contracting authority will need for further independent work.

Conclusion and Next Steps

Conclusion

The Technical Specifications for the Implementation of Broadband Mapping Systems in Albania, as delineated by the International Telecommunication Union (ITU), marks a significant step towards enhancing the country's telecommunications infrastructure. Drawing on the extensive experience of the ITU and European best practices, this endeavor not only aligns with the strategic vision of Albania to bridge its technological gaps but also sets a foundation for fostering regional cooperation and development. The detailed stakeholder analysis, encompassing roles and responsibilities, underscores the multifaceted approach required, engaging key players from AKEP to the Ministry of Infrastructure and Energy and beyond, ensuring a comprehensive and inclusive process.

The proposed project framework and technical considerations highlight the necessity of a robust, flexible IT architecture, advocating for open-source technologies to ensure cost-effectiveness and scalability. This approach is not merely about infrastructure development but also about creating a sustainable, adaptable system that can meet future challenges and integrate new technologies. The emphasis on training and enhancing the digital skills of local stakeholders, including municipalities and smaller operators, speaks to the broader goal of empowering local communities and fostering a knowledgeable workforce that can maintain and utilize the Atlas effectively.

Next steps

1. **Stakeholder engagement and capacity building**: Plan meetings with all stakeholders to present the technical specifications and receive feedback comments in order to finalize the document; Additionally, discuss roles, expectations, and project timelines for further engagement. Among others, this step would present also the ITU's free-of-charge, self-paced online training, "Introduction to Broadband Mapping"[4] to build local capacities in GIS and broadband mapping practices.

2. **Financial resource identification**: Identify funding sources for the Atlas upgrade, including government funding, international aid, private sector partnerships, and international grants.

3. Technical development and implementation: Upon financial resources have been identified, address all operational aspects necessary for Atlas's updated and/or development using the recommended IT architecture that favors open-source solutions. A detailed project plan with milestones may be foreseen in case all parties agree.

4. **Regulatory and policy framework adjustments:** In parallel to phase three, collaborate with all relevant stakeholders to adapt or establish frameworks conducive to efficient data collection and use. Ensure compliance with data protection standards and set up mechanisms for continuous data updating within the framework systems and across institutions.

5. **International cooperation and knowledge sharing with ITU**: Continue the engagement with ITU to exchange insights and experiences from the Atlas project. This collaboration will enhance regional ICT development efforts and contribute to the global knowledge pool on broadband mapping.

These integrated steps provide a comprehensive roadmap for the continuous cooperation between ITU and Albania in developing a sustainable, impactful, and efficient broadband mapping system in the country. This project not only aims to bridge Albania's digital divide but also positions the country

[4] More information can be found at : Introduction to broadband mapping | ITU Academy

as a leader in ICT innovation and regional digital collaboration, supporting long-term economic and social development.

Annex 1: Table summarizing the technical specifications for the implementation of broadband mapping systems in Albania

Category	Specification	Details
Data Collection	Types of Data	1. Network Termination Points (NTP), 2. infrastructure details (fiber, copper, wireless), 3. service availability, 4. performance metrics, 5. geospatial data, 6. ownership, 7. utilization
	Data Sources	1. ISPs, 2. government databases, 3. crowdsourced data, 4. field surveys, 5. satellite imagery
	Data Formats	1. CSV, 2. XML, 3. GIS formats (Shapefile, GeoJSON, KML), 4. raster data (TIFF)
	Data Collection Methods	1. Manual data entry, 2. automated data transfer, 3. crowdsourcing platforms, 4. geospatial mapping tools
	Quality Assurance	1. Plausibility checks, 2. manual verification, 3. user feedback integration
	Regulatory and Compliance Requirements	1. Reporting obligations, 2. data protection, 3. standardization
Data Processing	Database Management	1. PostgreSQL with PostGIS extension, 2. GeoServer
	Data Validation	1. Logical checks, 2. periodic data acquisition, 3. manual and automated quality checks
	Data Integration	1. Pairing and linking
Data Storage	Data Storage Solutions	1. High-capacity servers, 2. cloud storage options
	Data Security	1. Encryption, 2. access control, 3. regular audits
Data Analysis	Geospatial Analysis	1. GIS software (QGIS), 2. spatial data analysis
	Network Analysis	1. Capacity planning, 2. performance monitoring, 3. demand forecasting
Data Visualization	Visualization Tools	1. Web GIS viewers, 2. interactive maps, 3. dashboards
	User Interfaces	1. User-friendly web interfaces, mobile applications

Last Mile Connectivity	Mapping Last Mile Connectivity	1. Integration of NTPs for comprehensive coverage mapping by building, including both fiber and wireless technologies
	Data Collection for Last Mile	1. Collection of data from different operators to get a complete view at given addresses, including infrastructure type (fiber, copper, wireless)
	Representation of Last Mile Data	1. Use of distribution points for simulation, rather than mapping cables themselves, and accurate plotting of NTPs
	Detailed Information Requirements	1. Detailed information on infrastructure utilization, ownership, service availability, 2. performance metrics (e.g., bandwidth, latency)
	Address-Level Data Integration	1. Integration of data at the address level to enable precise last mile connectivity mapping and analysis
	Compliance with Standards	1. Adherence to national standards, including geospatial data exchange standards (e.g., DCM No. 399, National Geoportal integration), ensuring data accuracy and consistency
	Technology Integration	1. Incorporation of multiple technologies (fiber, DSL, wireless) to ensure comprehensive coverage and reliability
White Spots	Identification of White Spots	1. Identify areas with inadequate or no broadband coverage, focusing on service availability gaps, poor performance metrics, and infrastructure deficiencies.
	Criteria for Institutional Aid	1. Establish clear criteria for qualifying areas as white spots, such as lack of broadband service above a certain speed threshold or absence of infrastructure.
	White Spots Mapping Techniques	1. Use advanced geospatial tools (e.g., QGIS) to map identified white spots, including overlaying current infrastructure data to highlight areas in need.
	Incorporation into National Systems	1. Integrate white spots data with national broadband mapping systems and the National Address System to ensure comprehensive coverage and easy identification of aid-eligible areas.
	Institutional Aid Distribution	1. Develop a framework for distributing aid, prioritizing white spots based on severity of service gaps and potential impact of infrastructure development.
	Custom Reporting on White Spots	1. Provide detailed reports and visualizations specifically on white spots to inform policymakers, including progress on reducing these areas through aid programs.
Interoperability	Integration with National Systems	Integration with 1. National Geoportal, 2. INSTAT data, 3. National Address System

	Standardization	1. Use of standardized data formats, ensuring interoperability between different systems and stakeholders
Quality of Service (QoS)	Performance Metrics	1. Collection and analysis of QoS metrics, such as latency, bandwidth, and reliability
	User Feedback Mechanism	1. Mechanisms for users to provide feedback on service quality and infrastructure issues
Regulatory Compliance	Adherence to Regulatory Frameworks	1. Compliance with local and international regulations, including data protection laws
	Enforcement Mechanisms	1. Establishment of penalties for non-compliance, 2. clear procedures for reporting and addressing issues
Training and Support	Capacity Building	1. Training for local stakeholders, including municipalities and smaller operators, on the use of GIS and broadband mapping tools
	Technical Support	1. Ongoing technical support for system maintenance, 2. updates, 3. troubleshooting