BACKGROUND PAPER

Broadband Mapping Systems in Europe and the Status of Harmonization in the Region

Version 1.1

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The paper was prepared as the background contribution to the ITU Regional Regulatory Forum for Europe on Regulation Supporting Digital Transformation, held on 30 November and 1 December 2020. Version 1.1 of this document is a living draft document. Following the event, the document will build upon the discussions held and comments received from participants of the ITU Regional Regulatory Forum for Europe and will be submitted for further inputs and comments to the National Regulatory Authorities or administrations in charge of broadband mapping of Albania, Bosnia and Herzegovina, north Macedonia, Montenegro, Serbia, Georgia, Moldova and Ukraine, which are specifically considered in this document.

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1. Introduction

1.1 The current landscape

Amid substantial advances in the deployment of broadband in recent years, now more than 84.43% of the population in Europe enjoys access to the Internet[1], a substantial increase when compared to 63.18% of 2010.[2] With the European Union acting as a leader from a regulatory, investment and technical point of view, notable advancements have been also carried out in non-EU countries which are catching up in terms of Internet penetration according to ITU data.

The gap between what is achieved on the ground and the objectives of national and regional policies is being reduced, which is positive. At the same time, however, creating the conditions for efficient investment to cover all households or to upgrade existing infrastructure towards very high-capacity networks (VHCNs) is becoming more and more difficult.

This in turn increases the pressure on policymakers and regulators. Any policy aimed at enhancing broadband networks requires careful evaluation to identify the right incentives to foster new investments in coverage and network upgrades whilst maintaining the conditions for markets to operate competitively and seize appropriate returns on investments (ROIs). In essence, policymakers and regulators are caught between societal demand for broadband and the necessity to apply competition rules to avoid market distortion, while operators are pressured by high costs of deployment, especially in areas where investments are not cost-effective.

In order to cope with these challenges, several National Regulatory Authorities (NRAs) in field of telecommunications and Government Ministries in charge of ICTs in Europe have established **broadband mapping systems** with the primary aim of gathering data to support the application of state aid rules or to foster identification of synergies in the market to reduce the cost of deploying new infrastructure.

In the case of the EU, this process has been driven by a series of legislative acts which have set obligations for Member States to collect information to support decision making, for example when it comes to allocation of state aid for broadband or information about physical infrastructure. In non-EU countries, by contrast, advancements have been driven by the mirroring of the EU's regulatory advancements as well as authorities' expected benefits

Broadly considered, broadband mapping is now a reality in the region and a cornerstone for any regulatory framework seeking to spur investment aimed at increasing the reach and quality of broadband networks, especially in fixed, but also in mobile broadband markets.

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[1] ITU Europe Region comprises 46 countries. A full list is available at: https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Pages/MemberCountriesinEurope.aspx

[2] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicators "i99H")

1.2 Purpose of the paper

The purpose of this paper is to provide a picture of broadband mapping regulatory developments in the European region, comprising of 46 countries, identify recent innovations in the regulatory framework, and then focus more in detail eight non-EU countries in South-Eastern Europe, an area with high potential for broadband development where securing investment whilst ensuring competition is of high priority.

As it is possible to see in Box 1[3], within the context of Global Symposium for Regulators the ITU has recognized connectivity mapping as an essential regulatory tool at the disposal of regulators to ensure markets thrive. Through these systems, in fact, regulatory bodies and other authorities can efficiently turn market gaps into opportunities for investment and growth.

> Box 1: Connectivity mapping as a tool for evidence-based decision-making
>
> Substantial research and evidence suggest that best-practice regulation does matter and both the design and the effective enforcement of regulatory frameworks are essential for digital markets to thrive. The digital transformation brings about challenges to regulators and grounding regulatory decisions in robust, multifaceted and thoughtfully interpreted evidence can prove instrumental in generating positive market dynamics in the short and long term….
>
> We [the regulators participating in the 2019 Global Symposium for Regulators] recommend [the] main clusters of benchmarks for regulators:
>
> - Connectivity mapping: Tracking the deployment of the various kinds of digital infrastructure can inform the regulatory process and allow regulators to identify market gaps and market stakeholders – to turn them into opportunities for investment and growth.
>
> … In order to leverage on these evidence-based instruments, the volume and quality of data accessible to regulators need to be increased, and their sources diversified.
>
> These instruments can also enable market players to reflect on their performance and impact on the economy and development, and engage in self-regulation.

After taking substantial steps forward in this field in 2013 and 2014, more recently the European Union has been steaming ahead with an additional impulse on both regulatory and technical aspects of broadband development, including broadband mapping. The recent European Commission Recommendation "on a common Union toolbox for reducing the cost of deploying very high-capacity networks […]"[4] released in September 2020 and calling for improving the regulatory toolbox in order to accelerate the deployment of VHCNs, is only the latest of such strategic inputs.

[3] Source: GSR-19 Best Practice Guidelines to "Fast forward digital connectivity for all": https://www.itu.int/en/ITU-D/Conferences/GSR/2019/Documents/GSR19BestPracticeGuidelines_E.pdf

[4] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=69383

In light of this development, there is a concrete risk that already existing regulatory, technical and policymaking gaps between EU and non-EU countries are exacerbated. Following objectives of the ITU Regional Initiative for Europe on ICT infrastructure the primary goal is not only to ensure that existing gaps are not widening but act to avoid that new ones are not created.

Chapter 2 of this paper will unravel the development of the European Union's regulatory framework concerning broadband mapping, addressing the EU's strategic input, the inception of regulation and the most recent developments. Chapter 3 will then discuss relevant actions undertaken in the field by the European Commission with the aim of aggregating the data as well as present a list of broadband mapping systems that have flourished in Europe Region over the past years. The section will also provide some considerations on these developments vis-à-vis the ongoing reforms taking place at the EU level. Chapter 4 will finally focus on eight non-EU countries of South-Eastern Europe including, Albania, Bosnia & Herzegovina, Georgia, Moldova, Montenegro, North Macedonia Serbia and Ukraine and, in particular, will address for each

i) the status of broadband development;

ii) the regulatory framework for mapping systems; and

iii) the technical solution in place or under development.

Chapter 5 will finally briefly draw attention to ITU work in the field of broadband mapping, outlining the project on ITU Interactive Transmission Maps which focuses on enhancing collaboration with National Regulatory Authorities and Government Ministries on mapping backbone networks, identified as fundamental for the global connectivity resiliency.

Overall, this work will set the basis for exchange of information and compel all countries to identify areas of improvement in this impactful field of regulation and policymaking. The conclusions to this document will identify avenues for future work in non-EU countries in the field of broadband mapping in relation to the outlined developments taking place within the European Union.

1.3 Disclaimer

Although broadband comprises of both fixed and mobile markets, the paper will discuss broadband mapping with a focus on fixed networks only, for three main reasons.

The first is that fixed networks are more reliant by nature on physical infrastructure which have substantial civil engineering costs, and thereby have a relevant impact on coverage and quality of the delivered fixed services.

The second reason is that in the age of COVID-19, reliable household access to the Internet has become an essential part of life, enabling families to cope with restrictions to the extent possible. Although

efficient broadband mapping will not secure FTTH/FTTB coverage in all areas, it nevertheless supports the efficient identification of alternative solutions.

The third reason is that with the shift to 4G and more recently 5G networks, backhaul and backbone costs have been rising substantially for the mobile sector. Looking at the future, as fixed and mobile infrastructure are rapidly converging, and considering that realizing the full potential of 5G will require upgrading from the current non-standalone to standalone services, the role of backhaul will be determinant.

2. The European Union's regulatory framework

2.1 The strategic drivers for broadband mapping

As anticipated in the introduction of this paper, broadband mapping systems have mostly arisen in Europe in follow up to legal requirements and obligations placed upon competent authorities at the national level. From the opposite angle, mapping systems and the obligations for data submission they set for market players would not be possible without provisions enshrined in EU law and are, in turn, affected by these. As this holds true, the roots for the existence of broadband mapping systems must be researched in the underlying strategic policy drivers.

In 2010, the first Digital Agenda for Europe (DAE)[5] identified "lack of investments" and low take-up of broadband, as one of the key challenges to be addressed by the European Union in the timeframe 2010-2020. The Commission Communication called "to stimulate private investment, complemented by carefully targeted public investments". Moreover, it added that policies to be rolled out in the context of the Digital Agenda for Europe "should, in particular, lower the costs of broadband deployment in the entire EU territory, ensuring proper planning and coordination and reducing administrative burdens. For instance, the competent authorities should ensure: that public and private civil engineering works systematically provide for broadband networks and in-building wiring; clearing of rights of way; and mapping of available passive infrastructure suitable for cabling."

In 2016, the European Commission updated the 2010 DAE strategy with a Communication on "Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society,"[6] thereby kickstarting reform of the EU's regulatory framework for electronic communications. Beyond setting 2025 targets for broadband coverage and speed, the Gigabit Society strategy established "access to and take-up of very high-capacity connectivity as a regulatory objective" to be achieved through appropriate incentives for investment in connectivity. In this context, it is worth quoting at length that "Regulation will be more effective if it is based on in-depth local knowledge of an increasingly diverse network landscape, with a variety of different local, national and multinational actors. Interventions will be tailored to geographic areas where market dominance persists and to the real prospects of network deployment by incumbent and alternative operators. Mapping will allow more joined-up policy, identifying private investment opportunities or public investment needs, or areas where local initiative can remove obstacles or promote demand. It will allow regulators to increase transparency about network deployment plans and to provide investors with more predictability and protection. This will be especially important in ensuring that less densely populated communities' benefit from better Internet connectivity".

[5] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:FIN:EN:PDF

[6] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=17182

Clearly, this provision builds upon the 2010 DAE strategy, expanding on the notion of mapping on the utility and scope of mapping exercises. Moreover, the strategy sets concrete priorities to:

i. Require regulators to map network investment intentions;
ii. Require public authorities to seek investors in under-served areas;
iii. Require network access remedies to directly support competitive infrastructure deployment wherever feasible;
iv. Provide retail choices already available to end-users;
v. Promote co-investment and wholesale-only business models facilitating deployment in suburban and rural areas.

Compared to the 2010 DAE strategy, the Gigabit Society strategy of 2016 more clearly identified mapping as a key tool insofar it endows public authorities at all levels of government greater with a more precise knowledge of market failures and connectivity gaps, thereby supporting decision making of targeted public initiatives.

In 2020, the European Commission published its latest digital strategy "Shaping Europe's Digital Future",[7] which focuses on a consumer centric approach, securing competitive digital markets and fostering an open, democratic, and sustainable society. It is interesting to notice that in this context, beyond reiterating the need of adequate investment to achieve the 2025 connectivity targets through an efficient combination of public resources unlocking private investment, no particular reference to mapping as such is made. Although at a first glance, it may interpreted as a sign of discontinuity compared to previous strategies, this fact only proves the maturity of the EU's regulatory framework, since broadband mapping has been fully embedded into the regulatory framework as a mandatory practice detailed by regulation to which this paper will now turn.

Takeaway: regulatory developments in field of broadband mapping in the European Union stem from a strategic policy driver. While in the case of the EU, it materialized through the impulse given by the European Commission, at the national level in non-EU countries, the strategic rationale for broadband mapping could emerge through a more concrete wording introduced in national strategies for digitalization or in national broadband plans.

2.2 Key legislation underpinning broadband mapping

Although the first DAE was established in 2010, traces of the founding building blocks for mapping of electronic communications, and more particularly of infrastructure, can be found in the INSPIRE Directive[8]

[7] https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[8] https://inspire.ec.europa.eu/inspire-directive/2

approved in 2007. Originally established to create a European Union spatial data infrastructure for the purposes of EU environmental policies, the Directive also mandates that the spatial data on the infrastructure of the Member States should follow a series of common Implementing Rules (IR) aimed at ensuring interoperability and cross border usage of the data, which includes telecommunication infrastructure.[9]

Together with the Public Sector Information (PSI) Directive[10] approved in 2003 (then updated in 2013[11] and 2019[12]) which provides a framework for open data in government, an important merit of the INSPIRE Directive was to set the framework for the establishment of a data-driven approach to public administration across EU Member States. It is important to recognize that the subsequently emerged regulatory framework pertaining to broadband mapping builds upon a wider trend and on the principles and provisions contained in these other regulations.

The principles of open data in government have been further strengthened by the more recent "European Commission digital strategy: A digitally transformed, user-focused and data-driven Commission" published in 2018.[13] A data-driven strategic approach to public administration is needed to enshrine a culture of information-based decision making at the country level. Moreover, the introduction by the Commission of a framework legislation on open data in government and on technical specifications for the development and usage of data in the public sector supports the overall claim for a data driven approach for public administration and for envisaging closer collaboration from the private sector.

The paper will now turn to outline how under the impulses of the EU digital strategies and, on the basis of a the rationale for a harmonized data-driven approach to public administration, the regulatory setting for broadband mapping systems has come in place over the past eight years.

2.2.1 The EU Guidelines on State Aid for Broadband (2013)

Following an unsatisfactory assessment of the investments in broadband networks for the period 2007-2013, the European Commission announced the "EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks" in January 2013. The Guidelines were released with the aim of providing clarity to unlock the investments needed to achieve the policy goals set by the

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02007L0002-20190626&from=EN

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0098&from=en

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0037&from=FR

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L1024&from=EN

[13] https://ec.europa.eu/info/sites/info/files/file_import/digitally-transformed_user-focused_data-driven_commission_en.pdf

DAE back in 2010, whilst maintaining a consistent application of EU competition law enshrined in the EU treaties.

The European Commission noted that one of the main obstacles to investment was uncertainty on the application of EU state aid rules in the field of telecommunications. To provide more clarity and transparency, the Guidelines therefore broadly define the following essential points for the correct definition of state aid packages:

1) Identification of the viable options for public funding of broadband projects;
2) The distinction between "basic broadband" and NGA;
3) The distinction between white, grey and black areas, both for basic broadband and NGA; and
4) The key criteria applied for the assessment of State aid such as compatibility principles "step change" the proportionality of a broadband measure, and the balancing test.

As it is not in the scope of this paper to linger on all the provisions contained in the guidelines, it is worth elaborating on compatibility principles (Art. 2.5) to identify the framework for broadband mapping. Compatibility principles are, in fact, the most important condition to be met in order to ensure compliance of an aid measure. These include (i) Contribution to the achievement of objectives of common interest, (ii) Absence of market delivery due to market failures or important inequalities, (iii), Appropriateness of State aid as a policy instrument, (iv) Existence of incentive effect, (v) Aid limited to the minimum necessary, (vi) Limited negative effects, and (vii) Transparency.

In this context, the EU State aid guidelines (Art. 3.4) state that in order to fulfil such compatibility principles, among other actions, Members States should first conduct a) "**detailed mapping and analysis of coverage**", which broadly encompasses all the four points outlined above. The same article further specifies that "Member States should clearly identify which geographic areas will be covered by the support measure in question, whenever possible in cooperation with the competent national bodies. […] Best practice examples suggest creation of a central database of the available infrastructure at a national level thereby increasing transparency and reducing the costs for the implementation of smaller, local projects."

Moreover, the same article defines other conditions to fulfil compatibility principles, including having a public consultation (b), a competitive selection process (c), identifying the most advantageous offer (d), ensuring technological neutrality (e), facilitating the use of existing infrastructure (f), of wholesale access (g), enabling wholesale access pricing (h), of monitoring mechanisms (i), transparency (j) and reporting (k). Point (f) is particularly relevant here as it creates the link to another piece of legislation, the Broadband Cost Reduction Directive (2014), that focuses co-deployment and infrastructure sharing and which will be outlined in the next session. What is important to underscore is that the mapping and analysis of coverage is at the top of the list and is an essential element for all other provisions (b-k).

Beyond the detailed mapping and analysis of coverage, another important concept which is established by the Guidelines (Art. 3.2) is the possibility for administrations to **gather information on operators' investment plans**, mainly for the purpose of identifying white, grey and black areas and to further ensure that public aid does not hinder private sector investment. According to this provision, authorities should verify whether private investors have concrete plans to roll out their own infrastructure over the 3 years after the entry into force of the aid package.

Operators should express their interest in investing in a specific area once the aid measures are submitted before them for consultation. In order to avoid walkouts which would hit that specific area not in the scope of the aid measures, authorities may require the operators for commitments or even a corresponding contract with conditions. While this provision may partially solve the problem of identifying future plans of operators and consequently address the challenge of future allocation of public funding it also may create a disincentive for operators to express their interest in investing in a specific area.

Following the publication of the Guidelines, the Commission released a report on "The broadband State aid rules explained: An eGuide for Decision Makers,"[14] an important tool where further explanation is given enabling all policymakers involved to develop a concrete understanding of the Guidelines and the wider competition regulatory framework are provided.

Takeaway: the "EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks" establish two firm principles for application of state aid rules which underpin the need of broadband mapping for administrations: (i) the **mapping and analysis of coverage** entailing an assessment of service availability and how that service is brought about (infrastructure), (ii) the **identification of investment plans in a given geographical area**. Considering that state aid rules are an essential element of attention for accession countries, the broadband mapping component deriving from these deserves equal attention.

2.2.2 The Broadband Cost Reduction Directive (2014)

Just over a year after the guidelines were published, the European Commission finalized another important piece of legislation which also, and even more strongly, contains provisions setting the conditions for broadband mapping systems to emerge. The "Broadband Cost-Reduction Directive" (BCRD) adopted in May 2014[15] primarily "aims to facilitate and incentivise the roll-out of high-speed electronic communications networks by promoting the joint use of existing physical infrastructure [intended as 'any element of a network which is intended to host other elements of a network without becoming itself an

[14] https://ec.europa.eu/regional_policy/sources/conferences/state-aid/broadband_rulesexplained.pdf

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0061&from=EN

active element of the network][16] and by enabling a more efficient deployment of new physical infrastructure so that such networks can be rolled out at lower cost" (Art. 1)[17].

The Directive's impact assessment,[18] which is carried out for all draft directives one year prior to finalizing the final legal instrument, highlighted that the major cost factors for broadband deployment is due to inefficiencies and bottlenecks, and consequently identified clearer rules around co-deployment and infrastructure sharing as the main solution to the problem.[19]

In this context, it is also worth mentioning that the impact assessment for the first time takes stock of "advanced open-access and digital infrastructure atlas, including not just telecom ducts but also other utilities and all physical infrastructures suitable for broadband", at that time only present in Germany and Portugal, while in other 18 countries partial systems were identified. The fact that policymakers already identified best practices while drafting the legislation is relevant as it highlights the grounded and evidence-based approach to policy development enacted by EU policymakers.

Going back to the Directive, the BCRD identifies four main pillars for change to be transposed with appropriate legislation at the national level:

1) Access to existing physical infrastructure (e.g., ducts, manholes, etc), including those belonging to energy and other utilities, for telecom operators willing to deploy high-speed broadband networks;[20]
2) Efficient coordination of civil works;[21]
3) Faster, simpler and more transparent permit-granting procedures; [22]
4) Equipment of new buildings and major renovations with high-speed physical infrastructures (e.g. mini-ducts, access point) and access to in-building infrastructure.[23]

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[16] https://ec.europa.eu/digital-single-market/en/news/report-implementation-broadband-cost-reduction-directive

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0061&from=EN.

[18] https://ec.europa.eu/digital-single-market/en/news/impact-assessment-accompanying-document-proposal-regulation-european-parliament-and-council

[19] For more information on co-deployment and infrastructure sharing in Europe please consult the background paper on "Infrastructure sharing and co-deployment in Europe: good practices based on collaborative regulation" available at https://www.itu.int/go/EUR_RRF-20

[20] The impact assessment identified that civil engineering costs may amount up to 75% of total cost of deployment of telecommunication infrastructure.

[21] The impact assessment identified that the potential savings from co-ordinating civil engineering works when the project is shared between two parties at 50% of the civil engineering works cost, or up to 40% of the total cost.

[22] The impact assessment found that the high number of authorities, scarce collaboration among them and lengthy administrative procedures are among the factors augmenting the burden of permit-granting processes.

[23] The impact assessment found that standardizing procedures for in-building infrastructure procedures would avoid duplication of costs and approval of each owner of the building.

For the purposes of the analysis of the roots of broadband mapping in Europe, provisions under point number 1 and 2 of the list above are most relevant since creating a space for sharing information on existing or planned infrastructure as well as on access to it is key to the overall scope of the directive.

The Directive recognises (comma 8) that "the roll-out of high-speed fixed and wireless electronic communications networks across the Union requires substantial investments, a significant proportion of which is represented by the cost of civil engineering works," up to 80% of the total cost, and that (comma 13) "It can be significantly more efficient for electronic communications network operators, in particular new entrants, to re-use existing physical infrastructures, including those of other utilities".

To address this challenge, the BCRD mandates the establishment of a Single Information Point (SIP) at the National level (commas 20-22), that would request network operators to provide minimum information on infrastructure where not available and make the information available to network operators, and telecom operators in particular. This would, the Directive goes, enable telecom operators to assess the potential for using existing infrastructure in a specific area and reduce damage to any existing physical infrastructures for any planned civil works.

In particular, with Article 3 on "Access to existing physical infrastructure", the Directive establishes that "a network operator [including service providers of gas, electricity, public lighting, heating, water, disposal or treatment of wastewater and sewage, and drainage systems as well as transport services, including railways, roads, ports and airports] has the right to offer to undertakings providing or authorised to provide electronic communications networks access to its physical infrastructure with a view to deploying elements of high-speed electronic communications networks."

With more relevance to broadband mapping, Article 4 on "Transparency concerning physical infrastructure" provides that each telecommunication network operator "has the right to access, upon request, the following minimum information concerning the existing physical infrastructure of any network operator:

(a) location, and route;

(b) type and current use of the infrastructure; and

(c) a contact point."

Article 4 is crucial insofar not only it sets the obligation for telecommunication network operators to submit minimum geo-referenced data to the SIP but sets the obligation for all network operators, including those from other industries, and relative public sector bodies alike. Requiring location and route data, in fact, automatically implies that geo-referenced data is gathered by the one authority in charge of the SIP.

The provisions are then completed by Article 6 on "Transparency concerning existing or planned civil works" mandates that "Member States shall require any network operator to make available […] the

following minimum information concerning on-going or planned civil works related to its physical infrastructure for which a permit has been granted:

(a) the location and the type of works;

(b) the network elements involved;

(c) the estimated date for starting the works and their duration; and

(d) a contact point.

Although this does not provide information on planned investments to either operators or public administrators, it facilitates the transparency of the data gathered by the SIP thereby setting a strong incentive for the emergence of co-deployment and infrastructure-sharing practices[24]. The Directive, in fact, mandates that the SIP has to publish the information by 1 January 2017.

As anticipated, these important provisions mentioned underpin the overall scope of the Directive. While strong requirements were set for Member States, it must be noted that since the legal instrument chosen is a Directive, Member States had some margin of manoeuvre to implement provisions into national legislation with slight variations and to start applying the rules from 1 July 2016.[25]

Takeaway: the "Broadband Cost Reduction Directive" established a strong legal basis and a mandate for the creation of information systems gathering geo-referenced data on the infrastructure of all network industries at the national level. While it left to the Member State the decision on the most appropriate authority for the SIP, the Directive enshrines in EU law the important principle of a **data-driven approach to regulation of network industries**, including telecommunication. Moreover, the BCRD seeks to create an **enabling environment for the emergence of collaborative practices among different types of network operators** to primarily save cost and lower administrative burdens.

2.2.3 The European Electronic Communications Code (2018)

In the Gigabit Society Strategy released after the EU Guidelines on State aid for broadband and the BCRD, the European Commission proposed a major reform of the regulatory framework for electronic communications which would take the form of a European Electronic Communications Code (EECC). The Code would, among many other objectives, ensure consistency with the other EU policies and in particular set "out measures, such as mapping of network deployments, that also provide useful information for

[24] For more information on co-deployment and infrastructure sharing in Europe please consult the background paper on "Infrastructure sharing and co-deployment in Europe: good practices based on collaborative regulation" available at https://www.itu.int/go/EUR_RRF-20

[25] As it is not for this paper to discuss the nuances in implementation of the BCRD, for a full overview of the implementation in each Member State please consult: https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=53109

State aid purposes and thereby enhances the coherence of the two policies [EU Competition Law and the EECC]".[26] In addition, the ECC foresaw to endow BEREC with additional normative power among which is to set standards in the conduction of geographical surveys of the reach of electronic communications.[27]

Two years later, in December 2018, the European Electronic Communications Code was finally approved and is now due to come into application by 21 December 2020[28]. In these context, the provisions touching upon the regulatory framework of broadband mapping are:

- Article 20 on "Information request to undertakings": this article sets the obligations for Member States to require that electronic communications networks and services providers, provide all the information necessary, including financial plans or future network service deployment, for national regulatory authorities, other competent authorities and BEREC to ensure conformity with the provisions of the Code. Moreover, the article states that confidentiality should be ensured. This article reinforces the provisions of the BCRD, empowering NRAs in the field of telecommunications vis-à-vis the market they are tasked to regulate.
- Article 22 on "Geographical surveys of network deployments": this article mandates that "each National regulatory and/or other competent authorities shall conduct a geographical survey of the reach of electronic communications networks capable of delivering broadband ('broadband networks') by 21 December 2023 and shall update it at least every three years thereafter." The article further mandates that BEREC should issue guidelines to assist national regulatory and/or other competent authorities on the implementation of this obligation. This article clearly sets a mandate to map service availability in the EU, thereby reinforcing the EU Guidelines for State aid for broadband, which previously required in 2013 "detailed mapping and analysis of coverage" to properly apply state aid rules.
- Articles 64 to 67 on "Market analysis and significant market power" [SMP]: these articles address significant market power and mandate that geographical surveys are to be taken into consideration. The article is relevant insofar expands on one of the functions of geographical surveys which is to support the application EU Competition Law and "SMP regulations".
- Articles 84 to 92 on "Universal service obligations" [USO]: these articles address universal service obligations, mandating that Member States should take into account the results of geographical surveys to identify the availability at a fixed location of an adequate broadband Internet access. Similarly, to the significant market power, these provisions expand the functions of geographical surveys in supporting the application of universal service obligations.

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[26] https://eur-lex.europa.eu/resource.html?uri=cellar:c5ee8d55-7a56-11e6-b076-01aa75ed71a1.0001.02/DOC_3&format=PDF , p.3

[27] Ibidem, pp. 13, 147-148

[28] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN, art. 124

Though there would be other provisions indirectly touching on the regulatory framework for broadband mapping as in the case of SMP or USO, suffice to notice that the most comprehensive EU reform in the field of electronic communications reiterates that information about the geographical attributes of electronic communications services is a required enabling factor underpinning the work of National Regulatory Authorities.

Takeaway: the "European Electronic Communications Code" importantly established the requirement for NRAs or other competent authorities to conduct **geographical surveys of electronic communications**, which in essence consists of **mapping total service availability**" and confers BEREC more power in this field. Moreover, the Code attributes more power to NRAs and other competent authorities to **demand information from network operators** in the field of electronic communications. These two main elements support the application of the EU Guidelines on State Aid for broadband and also strengthen the provisions of the BCRD.

2.3 Recent regulatory developments

2.3.1 Revision of the EU Guidelines on State aid for broadband

In a press release from September 2020,[29] the European Commission noted that following the adoption of the EU Guidelines on State aid for broadband in 2013 and the General Block Exemption Regulation (GBER)[30], technologies have significantly improved and users' needs have increased, requiring larger bandwidth as well as an improvement of the networks in terms of other parameters such as latency, availability and reliability.

The Commission has therefore launched two consultations. The first is a public consultation,[31] to check whether regulation in this field has met objectives, whether regulation have had an impact on the market and competition and whether these need to be updated in light of recent technological and market developments, as well as the new EU digital policy goals set by the "Shaping Europe's Digital Future" agenda. The second is a technical consultation[32] to collect information on specific provisions of the Guidelines. Section 6 (questions 39-48), specifically address the notion of "mapping" as inserted in the

[29] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1576

[30] the General Block Exemption Regulation (GBER) is an additional piece of EU legislation which mandates that regional aid for broadband network development can be granted only in areas where there is no network of the same category and where no such network is likely to be developed on commercial terms within three years from the decision to grant the aid. This exempts Member States from the obligation to notify aid packages for deployment broadband networks, provided that the above conditions are met. As GBER is very specific to application of EU Competition Law, it falls out of the scope of this paper

[31] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12398-Evaluation-of-State-Aid-rules-for-broadband-infrastructure-deployment

[32] https://ec.europa.eu/eusurvey/runner/TargetedPublicConsultationBBGLs

original Guidelines. Both consultations are open until 5 January 2021 and results are expected in Q2/Q3 2021.

The eventual revision will draw substantially upon stakeholders' responses making it relevant to closely monitor any development in this field. However, the revision will also be based on other studies such as the CERRE Report on "State Aid for Broadband Infrastructure in Europe: Assessment and Policy Recommendations,"[33] which for example highlights that the "mapping exercise", which is required to define white, grey and black areas, has caused some difficulties to national authorities in obtaining accurate responses from operators.

Another important study, upon which the revision of the Guidelines will eventually be based on is "The role of State Aid for the broadband networks rapid deployment of in the EU" which was mandated by the Commission in 2016 and concluded in 2020.[34]

Table 1 - Mapping exercises in EU and granularity

Date of last mapping exercise and granularity

Country	Last mapping exercise	Granularity[69]
Austria	May 2019	Address
Bulgaria	1 January 2012	Municipality
Denmark	5 August 2019	Address
Estonia	22 December 2017	Address
France	30 September 2019	Address
Germany	18 November 2019	Address
Hungary	1 June 2015	Address
Ireland	8 October 2019	Address
Italy	9 February 2019	Address
Latvia	1 December 2014	Municipality
Poland (SA. 43484)	2019	Address
Portugal	30 September 2018	Municipality
Slovakia	3 May 2019	Municipality
Slovenia	11 February 2019	Address
Spain	1 April 2019	See footnote[70]
Sweden	October 2018 - March 2019	N/A
United Kingdom	December 2014[71]	Address

33 https://cerre.eu/wp-content/uploads/2018/11/CERRE_StateAidBroadband_FinalReport.pdf

34 https://ec.europa.eu/competition/publications/reports/kd0420461enn.pdf

Beyond taking stock of mapping activities in Member States according to Guidelines' provisions (see Table 1 above), the study also provided some recommendations to address the main identified challenges, which are ensuring the completeness and accuracy of coverage data alongside ensuring the accuracy of forecasts or proper of enforcement. Among others, some of the most relevant recommendations include:[35]

- Setting out clear expectations regarding the technologies that will be considered when identifying zones as white vs grey or black, based on the principle of technological neutrality;
- Providing a **consolidated mapping system so that there is a single system for a given country. Ideally, this system could bring together mapping of passive infrastructure** (in line with the **BCRD** and any SMP obligations applying to ducts and poles) **as well as mapping broadband infrastructure inter alia to identify State Aid zones and conduct geographic analyses of markets** which may be susceptible to ex-ante (SMP) regulation (see article 22 of the **EECC**);
- Establishing a regular mapping exercise (at least annual) with mandatory participation and penalties for failure to provide data on current deployment and forecasts within a given period
- Including a wide range of stakeholders within the data-gathering exercise including municipalities, where relevant;
- Cross-checking viability of given areas for commercial deployment through bottom-up modelling.
- Collecting data at the lowest level of aggregation which is realistically achievable. This should preferably be at the address level and follow the BEREC Guidelines mandated under Art. 22 EECC;
- Aggregation of data should be based on an administrative unit that is sufficiently granular to distinguish areas of market failure and which reflects operators' existing footprints and deployment targets. It would be helpful to pursue an approach that is consistent with the approach taken by NRAs in geographic segmentation of markets in the context of SMP market analysis;
- Reporting on actual deployment against forecasts and setting a deadline after which zones previously identified as NGA grey or black could be open to state intervention;
- Taking action to apply penalties in accordance with article 29 of the EECC (or under competition law as appropriate) in cases where operators knowingly mislead the authorities as regards their deployment plans e.g., whether they deploy, extend or upgrade their network, or fail to do so without objective justification and with negative consequences for competition, while ensuring that legitimate network extension e.g. to address specific business demand can still occur.

[35] https://ec.europa.eu/competition/publications/reports/kd0420461enn.pdf, p.83

Takeaway: The European Commission is looking for ways to ensure that the EU Guidelines on State aid for broadband are fit for purpose. The combination of **consultations** and recent **studies** on the matter will lead to a way forward, most likely in Q3 2021. It is relevant to notice that the Commission is placing an emphasis on better detailing the notion of "detailed mapping and analysis of coverage". Particularly interesting is the recommendation of the study carried out for the Commission for Member States to **consolidate a mapping system that brings together mapping of passive infrastructure** (in line with the **BCRD** and SMP obligations) **and mapping infrastructure and available services** in line with the **EECC** article 22 and the EU Guidelines on State aid for broadband, to serve the purposes of application of State aid rules and avoid duplication of efforts.

Non-EU and accession countries could **anticipate** this trend and already take necessary steps to integrate all functions into one effort.

2.3.2 Revision of the Broadband Cost Reduction Directive

in fulfilment of Art. 12 of the Directive, in June 2018 the European Commission published a first Report[36] on the implementation of the BCRD. This included a summary of the impact of the measures and an assessment of the progress made towards achieving the Directive's objectives, including whether and how the Directive could further contribute to reaching the DAE and Gigabit Society targets.

The report notes that as the Directive touches upon cross-sectoral competencies affecting not only the telecommunications sector but also utilities, building laws, administrative law, among other, transposition resulted in complex and required numerous adaptations. Notably, the deadline for implementation at the national level of 1 January 2016 was not met by all Member States except one.

The assessment also noticed that the assignment of the Single Information Point has been given to the National Regulatory Authority in the field of telecommunications only in 50% of cases while for the other cases Government Ministries were made in charge of the SIP.

Focusing more on NRAs, the Body of European Regulators for Electronic Communications (BEREC) "Report on the implementation of the Broadband Cost-Reduction Directive" published in December 2017[37] and which the European Commission report draws upon, identified that the information available on the SIP managed by NRAs grants the user the possibility to (i) browse a graphic presentation of the data, (ii) choose between several scales, (iii) export data and also to print out the data; (iv) select the infrastructure in the area in which they request access to information.

In this regard, the "Study on Implementation and monitoring of measures under Directive 61/2014," which also constitutes an input to the Commission's report, with particular reference to the mapping of existing infrastructure, recommends that "Responsible authorities should consider going beyond the

[36] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=53109

[37] https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7534-berec-report-on-the-implementation-of-the-broadband-cost-reduction-directive

minimum requirements of the Directive, especially in markets where there are a large number of potential access seekers and/or access providers. In the case of existing infrastructure, SIP managers should consider the use of mapping, the inclusion of data on availability and capacity and make provision to ensure data is up-to-date."[38]

Accordingly, in the wider implementation report the European Commission recommended that "for existing infrastructure, the **single information point could further be enhanced to a mapping exercise and include data on availability and capacity**", a very important claim suggesting a stronger emphasis on service mapping and alignment with the provisions of the EU Guidelines on state aid for broadband. Moreover, the Commission recommended that "in the case of co-deployment, Member States should consider a pro-active approach, whereby relevant public (and also private) actors are required to pre-notify deployment plans and invite interested parties to respond." This testifies the importance of anticipating investment plans to ensure better coordination between public and private entities and support the creation of joint ventures in civil works. Gathering information on investment plans (Investment mapping) is often a controversial undertaking but has the potential to unlock concrete investment that would otherwise not materialize.

Finally, it must be noted that the nature of the legal instrument (a Directive which leaves space for interpretation and adaptation at the country level) has opened for very different transposition at the national level, partially undermining the sought harmonization at the European Union's level in this field. One of the main issues identified by a recent report from the Centre on Regulation in Europe was the institutional design which did not clearly identify an authority for the implementation of the Directive and for the assignment of the SIP.

For this and other reasons, the Commission has initiated a review of the Directive with the objective of:[39]

- Fostering a more efficient and faster deployment of very high capacity networks;
- Strengthening and maximise the potential of current measures with a focus on potential synergies across sectors;
- Ensuring consistency with the European Electronic Communications Code; and
- Introduce sustainability measures contributing to the greening of the ICT sector.

The consultation received 22 contributions from stakeholders between June and July 2020. These will contribute to the Review currently underway and expected by Q4 2022.

[38] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=53090

[39] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12463-High-speed-broadband-in-the-EU-review-of-rules

Takeaway: The European Commission's stance towards **strengthening infrastructure mapping** and **investment mapping** to ensure better future co-deployment and consequent abatement of costs emerged clearly in the implementation assessment. In addition, **integration of service mapping into the work undertaken by the SIP on infrastructure mapping** was also mentioned. As the revision of the BCRD is undertaken in 2021, EU countries as well as accession countries should monitor developments closely and be ready to adapt their efforts to avoid delays or duplication of efforts in the future.

2.3.3. The BEREC Guidelines

As mentioned earlier, Article 22 of the European Electronic Communication Code (EECC) requires Member States to conduct geographical surveys of the reach of electronic communications by 21 December 2023, which includes (comma 1) the current reach of electronic communications capable of delivering broadband, (comma 2) a forecast on investment plans in the deployment of electronic communications, including very high capacity networks (VHCNs), and (comma 6) the requirement to published the information electronic format considering the level of the confidentiality of the data.

The article (comma 7) further sets the mandate upon the Body of European Regulators for Electronic Communications (BEREC) to produce a set of Guidelines on these matters by 21 June 2020 to support Member States, and NRAs in particular, in the fulfilment of their obligations under article 22 with the indirect consequence of supporting Member States' application of State aid rules.

Thanks to NRAs common effort in coordination with the BEREC Statistics and Indicators Expert Working Group, ad following a public consultation on draft Guidelines carried out in Q4 2019, BEREC released the "BEREC Guidelines on Geographical surveys of network deployments"[40] in March 2020.

The Guidelines first provide a set of epistemological definitions, such as a description of the concept of "address passed" or "geographical information system" and importantly define "broadband service mapping" as "systems that gather, analyse and present information on the supply side of broadband service provision, including the available bandwidths (speed), technologies, operators/service providers and quality of service in a specific area". The Guidelines then define that consistently with Art. 21, NRAs or other competent authorities (OCAs) have the power to require information to operators. NRAs/OCAs should consider whether the information from wholesalers is sufficient and in case exempt access operators from providing the data.

Concerning the spatial data, the Guidelines go on to provide technical definitions of the parameters to be used for both fixed and mobile spatial data recommending geocoded address-level data for fixed broadband, at 100m x 100m grid level of granularity for mobile broadband and either address-level or a

40 https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/9027-berec-guidelines-to-assist-nras-on-the-consistent-application-of-geographical-surveys-of-network-deployments

100m x 100m grid for fixed wireless broadband (FWA). Moreover, Section 2.5 defines and characterizes GIS systems and their functions and list a set of layers relevant to broadband mapping:

- Addresses (points);
- Grids, 100m x 100m or smaller;
- Premises passed per operator, medium technology, speed, VHCN class and other parameters for fixed broadband in reference address points;
- Areas covered per operator, medium technology, VHCN class, speed and other areas for fixed and mobile broadband in reference grids;
- Aggregated grid coverage 1km x 1km;
- Aggregated grid speed 1km x 1km;
- Other (to be decided by the National Regulatory Authority.

Accordingly, and with regard to the minimum data to be collected for each of the three types of services, indicators are reported in section 2.4 as well as Annex 2 and Annex 3 of the Guidelines. For the purposes of this paper, it is interesting to note that for fixed networks, the minimum indicators are as follows:

- Operator code (*according to the list possessed by the NRA*)
- Technology code (*DSL, VDSL, VDSL vectoring, DOCSIS 1.0 or 2.0, DOCSIS 3.0 or 3.1, FTTH/FTTB, FWA, WIFI, Other*)
- Maximum download speed class per subscription (*≥ 2 Mbit/s and < 10 Mbit/s, ≥ 10 Mbit/s and < 30 Mbit/s, ≥ 30 Mbit/s and < 100 Mbit/s, ≥100 Mbit/s and < 300 Mbit/s, ≥300 Mbit/s and < 1 Gbps, More or equal to 1 Gbit/s*)
- Maximum upload speed class per subscription (*same as above*)
- Expected peak-time download speed class per subscription (*same as above*)
- Expected peak-time upload speed class per subscription (*same as above*)
- Number of premises passed by the operator at the address (*optional*)
- VHCN class at the address (*not covered by VHCN, fibre rollout to the address, fibre rollout to the base station, no fibre rollout but VHCN equivalent service to criterion 3 of VHCN Guidelines, no fibre rollout but the VHCN equivalent service to criterion 4 of VHCN Guidelines*)

Another important component of the Guidelines is the section on forecasting the reach of broadband networks including VHCN, which is not mandatory under Art 22. EECC, though would reinforce the investment mapping layer identified by Art. 3.2 of the EU Guidelines on State aid for broadband. In this regard, the Guidelines provide a series of recommendations for forecasts reiterating their importance for (i) identification of designated areas where no undertaking is planning to deploy a VHCN or significantly upgrade the network, or for (ii) state aid proceedings to avoid, in particular, distortion of incentives to private investors. These recommendations are:

- Information should be requested to all entities who are potential investors, beyond operators or public authorities;
- Information on a designated area should be requested where no VHCN network is available and where there are no known development plans (in fulfilment of the EECC) or should be collected wherever public authorities intend to intervene (in fulfilment of state aid rules);
- Information should be collected annually, or even more frequently according to specific national requirements;
- Information should be collected in a high resolution (address level or 100m x 100m squares);
- Information should be collected from operators on type of technology, maximum download speed, VHCN class, expected start date of the rollout and expected end date of the rollout;
- Information from the forecast should undergo ex-ante and ex-post verification to ensure an appropriate assessment has been made.

Finally, the Guidelines conclude with indications as to the publication, data resolution, confidentiality issues, aggregation of the data and access to information by other public authorities (section 2.7).

Takeaway: The **BEREC Guidelines** provide **detailed epistemological and technical information** with regards to the implementation of Art. 22 EECC and to support Member States in fulfilment of their obligations pertaining to **service mapping** in accordance with the EU Guidelines on State aid for broadband. These indications are a **first attempt to ensure better harmonization** in the field of service mapping at the level of the European Union. In addition, relevant provisions on **forecasting** imply the recognition that **investment mapping** is an important component for efficient use of public sector resources in line with state aid rules.

Accession countries as well as non-EU countries **should keep these Guidelines as an important reference** while embarking in initiatives relating to service mapping.

3. Broadband mapping systems in the EU

As this paper has outlined the legal framework of the European Union pertaining to broadband mapping, starting from the development of its main pillars to then address the current status and recent developments for each, it is now time to provide a broad overview of concrete actions undertaken by the European Commission, with regards to data aggregation, and Member States when it comes to implementation of specific systems at the national level.

3.1 The EU's approach

In 2014, the European Commission released a "Study on Broadband and Infrastructure Mapping"[41] providing a methodology for the design and establishment of broadband mapping systems within Member States'.

The study reviewed a number of mapping initiatives regionally and globally and developed an encompassing methodology for implementing four types of broadband mapping, namely infrastructure, service, demand and investment mapping. Over the years, this effort has come to being recognized as a reference by the "mapping community" within Europe as well as in non-EU countries and beyond, though a revision taking into account the concrete experiences of EU Member States may be envisaged.

While it is not the concern of this paper to delve into the findings and recommendations of the study,[42] which nevertheless would provide an essential reading for interested stakeholders, from a regulatory perspective it is interesting to notice that the study recognizes the BCRD and the EU Guidelines on State aid for broadband as key regulations that have an impact and shape the definition and scope of broadband mapping. However, the study recognizes that despite there being sound legal rationales for broadband mapping, broadband mapping remains "methodologically unregulated".

Although this has formally changed with the implementation of the EECC's Art. 22 and the BEREC Guidelines, the regulatory process to provide better technical requirements already started two years earlier, in 2016, with the European Commission's project on "Mapping of Fixed and Mobile Broadband Services in Europe"[43] which sought to develop the "first European-wide" integrated monitoring platform on Internet connectivity" evidently focusing on the service layer.

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41 (SMART 2012/0022) https://ec.europa.eu/digital-single-market/en/news/mapping-broadband-and-infrastructure-study-smart-20120022

42 A good summary can be found on the website of the European Commission https://ec.europa.eu/digital-single-market/en/broadband-and-infrastructure-mapping-project

43 (SMART 2014/0016) https://www.broadband-mapping.eu/information

The map, which is available online,[44] gathers data from over 30 public authorities in charge of service mapping at the country level and aggregates the information into a European map to provide decision-makers with a tool to monitor progress made in the reach and quality of broadband services in Europe. The platform features a collection portal for public authorities to submit the information, an expert portal which can be only accessed by authorities (including to data suppliers, national regulatory authorities and national ministries as well as institutions of the European Union and of the EEA, and a public portal, which however carries some restrictions.

Most of the data gathered and displayed refers to Quality of Service 1 (QoS-1), or calculated availability of service coverage by network operators and is currently in the process of expanding towards QoS-2 (measured provision of Service - Measurements via panel probes or drive tests, not taking into account the end user's environment) and QoS-3 (measured experience of service: measurements via online speed tests, including end user's environment / actual user experiences). Moreover, the second phase of the project "Mapping of Fixed and Mobile Broadband Services in Europe" will define a new methodology focused on harmonizing gathering of data on QoS-1 in the context of VHCN, in relation to the new VHCN guidelines released by BEREC[45] and in accordance with the Gigabit Society targets. The final delivery is expected by Q2 2021.

In parallel, the experience gained over the past four years with QoS-1 has been feeding into the process of development of the BEREC Guidelines on service mapping throughout 2019 which, as we have seen, are a first attempt to technically regulate service mapping. Future developments include the development from BEREC of a second set of Guidelines focusing on the QoS-2 and Qos-3 parameters where the experience of the European Broadband Map will further ensure that any technical guideline defined will also take into consideration the EU policymakers aim to aggregate the data at the block's level.

Such projects on defining a methodology for service mapping are instrumental for harmonizing the approach at the European level and therefore better inform policymakers into the status of attainment of EU strategic goals and relative use of public funding. Similar harmonization could be recommended on infrastructure mapping, although the infrastructure is a more sensitive topic as it also includes business secrets and critical infrastructure considerations, just to mention a few potential obstacles.

[44] https://www.broadband-mapping.eu/public-portal/

[45] Other relevant BEREC work in this field are the BEREC Guidelines to foster the consistent application of the criteria for assessing co-investments in very high capacity network elements (2020) and the BEREC Report on Access Regulation (including prices) based on EU State Aid (forthcoming in 2021)

3.2 An Overview of national approaches

As previously mentioned, the EU's regulatory framework provides a degree of freedom into how EU legislation is implemented at the national level. Coupled with methodologies which are yet to fully enter into force, this leaves space for mapping systems to be implemented in different ways.

It has been argued that the "Study on Broadband and Infrastructure Mapping"[46] provides a comprehensive methodology for the design and establishment of broadband mapping systems within Member States. However, assessing Member States' implementation of various layers of broadband mapping with reference to the methodology would entail a vast piece of work far beyond the purposes of this paper and not a competence of the ITU. For now, it will be sufficient to pool some of the existing mapping systems identified in the countries in order to provide useful information and help the reader discover initiatives otherwise unknown.

Even though there is no pretence to provide an exhaustive overview, the list below synthetises ITU findings into mapping systems in place in each EU Member State. For this purpose, the widest possible definition of "mapping systems" is used, namely any web application displaying georeferenced data collected by a National Regulatory Authority or a Government Ministry directly or through a third/party provider.[47]

Member State	Organization in Charge	Mapping System in Place	Type
Austria	Federal Ministry for Transport, Innovation and Technology	Breitband Atlas.at	Infrastructure/Service Mapping
Austria	Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR)	RTR NetTest	Speed testing
Belgium	Institut Belge des Services Postaux & des Télécommunications (IBPT)	Mobile (https://www.bipt-data.be/fr/projects/atlas/mobile) Landline (https://www.bipt-data.be/en/projects/atlas/landline) Atlas	Infrastructure/Service Mapping

[46] (SMART 2012/0022) https://ec.europa.eu/digital-single-market/en/news/mapping-broadband-and-infrastructure-study-smart-20120022

[47] In some cases this may include mobile broadband mapping.

Bulgaria	Ministry of Transport, Information Technology and Communications	BB Mapping Survey	N/A
Croatia	Croatian Regulatory Authority for Network Industries (HAKOM)	HAKOMetar Plus	Speed testing
Croatia	Croatian Regulatory Authority for Network Industries (HAKOM)	Interactive GIS Portal	Infrastructure/Service Mapping
Cyprus	Office of the Commissioner of Electronic Communications & Postal Regulation (OCECPR)	N/A, new system planned in line with EECC.	N/A
Cyprus	Office of the Commissioner of Electronic Communications & Postal Regulation (OCECPR)	cynettest	Speed testing
Czech Republic	Czech Telecommunications Office (CTU)	NetMetr	Speed testing
Czech Republic	Czech Telecommunications Office (CTU)	Coverage Map	Infrastructure/Service Mapping
Denmark	Danish Energy Agency (DEA)	Tjekditnet	Infrastructure/Service Mapping and Speed Testing
Estonia	Estonian Consumer Protection and Technical Regulatory Authority (TTJA)	Netikaart.ee	Infrastructure/Service Mapping
Finland	Finnish Transport and Communications Agency (TRAFICOM)	MONITORi	Infrastructure/Service Mapping
Finland	Finnish Transport and Communications Agency (TRAFICOM)	Verkkotietopiste	Investment/Infrastructure Sharing Mapping
France	Autorité de Régulation des Communications électroniques et des Postes (ARCEP)	CarteFibre	Infrastructure/Service Mapping
France	Autorité de Régulation des Communications électroniques et des Postes (ARCEP)	MonReseauMobile	Speed testing

Germany	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (BNetzA)	Infrastruktur Atlas (restricted access)	Investment/Infrastructure Sharing Mapping
Germany	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (BNetzA)	Breitband messung and https://www.breitband-monitor.de/infrastrukturatlas/uebersichtskarte-leitungslaengen for infrastructure	Speed testing
Germany	Federal Ministry for Economic Affairs and Energy	Breitbandatlas	Infrastructure/Service Mapping
Greece	Ministry of Digital Policy, Telecommunications & Media	Geographical System of Broadband	Infrastructure/Service Mapping
Greece	Ministry of Digital Policy, Telecommunications & Media	Hyperiontest	Speed testing
Hungary	National Media and Infocommunications Authority (NMHH)	http://english.nmhh.hu/research-study#Internet	N/A
Hungary	National Media and Infocommunications Authority (NMHH)	Szelessav	Speed testing
Ireland	Department of Communications, Climate Action and Environment (DCCAE)	High Speed Broadband Map	Infrastructure/Service Mapping
Italy	Autorità per le Garanzie nelle Comunicazioni (AGCOM)	Agcom Broadband Map	Infrastructure/Service Mapping
Italy	Autorità per le Garanzie nelle Comunicazioni (AGCOM)	Sinfi Portal	Investment/Infrastructure Sharing Mapping
Italy	Ministry of Economic Development	MisuraInternet	Speed testing
Latvia	Electronic Communications Office	N/A	N/A

Lithuania	Communications Regulatory Authority (RRT)	Matavimai	Speed testing (Roads and Railways
Lithuania	Communications Regulatory Authority (RRT)	Matuok	Speed testing
Lithuania	Communications Regulatory Authority (RRT)	geoportal.lt	Infrastructure/Service Mapping
Luxembourg	Institut Luxembourgeois de Régulation (ILR)	map.geoportail.lu	Infrastructure/Service Mapping
Luxembourg	Institut Luxembourgeois de Régulation (ILR)	Chekmynet	Speed testing
Malta	Malta Communications Authority (MCA)	SIP is held by the Ministry of transport. A new system planned by MCA in line with EECC	N/A
Netherlands	Authority for Consumers and Markets (ACM)	Breedband Atlas	Infrastructure/Service Mapping
Netherlands	Ministry of Economic Affairs and Climate Policy	Arcgis	Service Mapping
Poland	Office of Electronic Communications (UKE)	Geoportal	Infrastructure/Service Mapping
Portugal	Autoridade Nacional de Comunicações (ANACOM)	Sistema de Informação de Infraestruturas Aptas (SIIA)	Infrastructure/Service Mapping
Portugal	Autoridade Nacional de Comunicações (ANACOM)	Netmede	Speed testing
Romania	National Authority for Management and Regulation in Communications of Romania (ANCOM)	Mobile (https://www.aisemnal.ro/home) and Fixed (https://statistica.ancom.ro/sscpds/public/serviceCoverage#gmap)	Infrastructure/Service Mapping
Romania	National Authority for Management and Regulation in Communications of Romania (ANCOM)	Netograf	Speed testing

Slovakia	Regulatory Authority for Electronic Communications and Postal Services	RU Mobil Test	Speed testing
Slovakia	Regulatory Authority for Electronic Communications and Postal Services	Not publicly available	Infrastructure/Service Mapping
Slovenia	Agency for Communication Networks and Services of the Republic of Slovenia (AKOS)	Geoportal AKOS	Infrastructure/Service Mapping
Slovenia	Agency for Communication Networks and Services of the Republic of Slovenia (AKOS)	AKOS Test Net	Speed testing
Spain	Secretaría de Estado para la Sociedad de la Información y la Agenda Digital	Mapa de Cobertura de Banda Ancha	Infrastructure/Service Mapping
Sweden	Swedish Post and Telecom Authority (PTS)	Bredbandskartan	Infrastructure/Service Mapping

Other examples which are worth reporting despite coming from non-EU countries are Liechtenstein's LKW,[48] managed by the Office for Communications (LLV) which maps infrastructure and services, Switzerland's Broadband atlas,[49] managed by the Office Fédéral de la Communication (BAKOM) which maps infrastructure and services, and the United Kingdom's service and coverage map for fixed broadband and FWA,[50] which is overseen by the Office of Communications (Ofcom). It is nevertheless important to underscore that the EU regulatory framework has been impacting to some extent these systems due to geographical proximity and regulatory affinity between the EU and these countries.

Not considering for the moment the countries in scope of Section 4, taking into account Israel, Iceland, Monaco, Norway, San Marino, Turkey, San Marino, Vatican no publicly available information has been found on infrastructure or service mapping.[51]

48 https://www.lkw.li/angebot-und-leistungen/kommunikation/verfuegbarkeit.html

49 https://www.bakom.admin.ch/bakom/en/homepage/telecommunication/atlas.html

50 https://labs.thinkbroadband.com/local/broadband-map?utm_source=mainsite&utm_medium=navigation&utm_campaign=maps&utm_content=footer#6/51.414/-0.641/

51 For a full list visit: https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Projects/Broadbad%20Mapping%20Tools%20in%20Europe.pdf

3.3 General Considerations

As it has been argued in chapter two, the precise assessment of the implementation of regulations and consequent technological solutions (mapping systems) is not the scope of this research. Instead, the paper seeks to take stock of regulatory developments and draw some considerations into the impact that regulations had on the actual development of broadband mapping systems, thereby endowing the wider European audience with a grasp of implications of EU regulations on broadband mapping and their recent developments.

Concerning infrastructure, it must be reported that the BCRD had a relevant impact in compelling Member States to introduce the single information point, now in place in all countries apart from one in 2018,[52] though this process has faced substantial delays. However, if compared to the fact that few countries had implemented a central physical infrastructure atlas or infrastructure registry in electronic form in 2013, as found in the BCRD's impact assessment, it is fair to state that the Directive has had a relevant impact towards fostering a data-driven approach to regulation that sustains co-deployment and infrastructure cost-sharing across different industries.

With regards to service mapping, although the EU Guidelines on State aid for broadband did not have specific provisions beyond requiring Member States to perform a "detailed mapping and analysis of coverage" to support the allocation of public resources, many Member States have undertaken network termination point mapping to the level of the address and requested operators to provide information about the availability of service. Independently of whether countries have published this data at the address level or aggregated it at the level of grids or other administrative boundaries, the Guidelines have had an impact not only on Member States' ability to comply but also by increasing transparency on service availability for the market and consumers. This has substantially facilitated the creation of state aid schemes and plans to support coverage expansion, and more recently, network upgrades, resulting in the increased realization of private sector investments through more efficient public-private collaboration.

While it is too early to assess the impact of the EECC on broadband mapping, it is reasonable to state that the overall regulatory framework put in place by the European Commission has primarily acted as an impulse for Member States to create an enabling environment for investment. It has also indirectly promoted broadband mapping systems as tools to fulfil regulatory obligations, thereby advocating for a culture of data-driven decision making within regulatory authorities and other public bodies. In this context, it would also be important to provide clarifications on all provisions regarding disclosure of investment plans and further support public-private synergies to better achieve the goals set by policymakers.

[52] https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7534-berec-report-on-the-implementation-of-the-broadband-cost-reduction-directive

Beyond infrastructure and service mapping, it is overall important to notice that investment mapping remains a grey area characterized by regulatory uncertainty and large freedoms enjoyed by Member States. As investment mapping is increasingly seen as a useful layer for both infrastructure mapping (enabling creation of private-private undertakings) and service mapping (perfecting allocation of state aid), strengthening the regulatory framework in this area is an avenue which might be undertaken by EU policymakers.

Finally, the downside of the process of implementation of broadband mapping has been that the level of heterogeneity across the three layers taken into consideration (infrastructure, service, investment) remains generally high. This is primarily due to the legal instruments chosen by the European Commission for the rules on broadband cost reduction (a Directive) and for the rules on state aid (a Communication from the Commission), although it must also be recognized this flexibility is necessary for realistic implementation at the country level. In this context, the European Electronic Communications Code and article 22 on the obligation for Member States to conduct geographical surveys by December 2023, the BEREC Guidelines developed in fulfilment of BEREC's obligations towards the EECC, provide a first attempt to define minimum common definitions for service mapping, which is directly applicable by Member States. This way of harmonization should, in turn, support the efforts of aggregating data at the European Union's level.

Takeaway: two possible recommendations for non-EU countries that are seeking to develop their regulatory frameworks and mapping systems taking the European Union's approach as a reference are (i) to **identify best practices for the implementation** across the 27 EU countries for the areas of infrastructure, service and investment mapping, and (ii) **to create an enabling environment for a single integrated system** incorporating these three layers in order to reduce cost and provide certainty to the market.

4. Broadband mapping systems in South Eastern Europe

This chapter will outline the status of fixed-broadband development and broadband mapping efforts in Albania, Bosnia and Herzegovina, Georgia, Moldova, Montenegro, North Macedonia, Serbia and Ukraine. These selected South Eastern European non-EU countries are characterized by a strong potential for strengthening broadband mapping vis-à-vis the situation in the EU and therefore further accelerate broadband development. Before zooming on each country, however, it is relevant to contextualize the efforts already undertaken from a wider perspective.

In terms of broadband development, countries in the Western Balkans have made significant progress in the field of connectivity, as highlighted by ITU research[53] during the recent ITU Regional Forum for Europe on 5G strategies, policies and implementation.[54] According to the ITU findings, the Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia have passed from an average rate of Internet users on the total population of 43.06% in 2010 to 74.80% in 2019,[55] substantially reducing the gap with the Europe region taken as a whole (63.18% in 2010 and 84.43% in 2019). Moreover, in terms of fixed broadband subscriptions per 100 inhabitants, the figures for the region have more than doubled over the past 10 years, from 9.16 in 2010 to 19.41 in 2019, which is also reducing the gap with the region's average at 31.06 in 2019.[56]

The recent Digital Summit for the Western Balkans held virtually from 26 to 28 October 2020[57] (originally planned in Albania) reinforced the vision that the region has done progress in terms of connectivity but much more needs to be done on the investment in new infrastructure to ensure wider coverage and better services to citizens. In particular, it was reiterated that there is no digital transformation without the infrastructure to underpin it, especially when the current pandemic has provoked a substantial increase in demand for fixed broadband services.

From a regulatory standpoint, it must be reminded that several countries have started the procedure for accession to the European Union, and so close coordination between European Union institutions and the countries is detectable in various regulatory fields, including electronic communications. Accordingly, within the context of the Digital Summit, it emerged that countries are recommended to establish grants schemes in line with EU state aid laws to ensure that publicly financed infrastructure would grant access to access Internet service providers.

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53 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2020/5G_EUR_CIS/Session%200%20-%20Jaroslaw%20Ponder_Presentation%20on%20non-EU%205G%20country%20profiles%20%28Session%203%29-1st_Draft_IB_JM.pdf

54 https://www.itu.int/go/EUR_5G_20

55 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H")

56 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

57 https://digitalsummitwb6.com/

In this scenario, it is evident how information about the status of broadband infrastructure and service availability is even more crucial to carefully plan private and public investments and fully exploit untapped potential. Western Balkan countries have followed in various ways the EU's regulatory framework in the field of broadband mapping, at times cooperating with NRAs from the European Union in the field, though similar to the EU, results are rather heterogeneous and country-specific.

Looking beyond the Western Balkans, Eastern Partnership countries are too working in close coordination with European Union institutions and have made significant progress in terms of broadband development thanks to the work of the Eastern Partnership Electronic Communications Regulators Network (EaPeReg) composed of regulatory authorities of Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova and Ukraine. As the ITU Office for Europe covers Georgia, Moldova and Ukraine, these three countries only will be the focus of this paper.

Taking into account ITU findings, the three countries have increased their rate of Internet users on the total population from 24.25% in 2010 to 63.65% in 2018,[58] thereby catching up quickly with the Europe region considered as a whole. In addition, the figure on fixed broadband subscriptions per 100 inhabitants has almost tripled over the past 10 years passing from 6.32 in 2010 to 16.78 in 2019.[59]

Accordingly, the EaPeReg has recently taken substantial steps forward with regards to broadband mapping. As part of the third phase of the EU4Digital initiative financed by the European Union, and implemented by the World Bank,[60] the EaPeReg has been advancing a project aimed at accelerating broadband deployment in EaP countries[61]. A relevant pillar of this project is the third action on "Support for broadband mapping" that over the period 2019-2020 provided support to government administrations and national regulatory authorities on broadband infrastructure and service mapping in the EaP countries in line with the BCRD and the EU Guidelines on State aid for broadband.

In November 2020, under the auspices of the EaPeReg, the Technical Assistance and Information Exchange Instrument (TAIEX) of the European Commission together with support from Communications Commission of Georgia organised a workshop "TAIEX Online Regional Workshop on Tools and applications for Broadband Mapping" to discuss the draft report and its main findings together with project lead from the World Bank and experts from Croatian Regulatory Authority for Network Industries (HAKOM), from the Office of Electronic Communications (UKE) of Poland, and from Agency for Communication Networks and Services of the Republic of Slovenia (AKOS), who were involved in the work.

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58 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H")

59 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

60 http://documents1.worldbank.org/curated/en/261621532718613649/pdf/ITK425962-201806271508.pdf

61 https://eufordigital.eu/discover-eu/eu4digital-broadband-strategies-in-the-eap-region/

While the report is due to be released in December 2020, it is possible to anticipate that the primary outcomes of the report will be constituted by the stocktaking of the current situation in the countries compared to the EU's regulatory framework and by the provision of individual recommendations for countries to be undertaken in order to progress. As it will be argued in the following pages, there is great potential for improvement in the field of broadband mapping in these countries.[62]

Just as in the case of Western Balkan countries, considering that the regulatory framework for broadband mapping is country-specific, it is important to outline the situation for each country. The following country profiles will proceed towards giving a brief background of broadband development in the country and then proceed to identify the legal foundations and shortly describe technical solutions for broadband mapping. In consideration of the EU regulatory framework, this approach will provide the reader with an understanding of the potential which broadband mapping systems have to strengthen countries' pathway to unlocking investment accelerating broadband development whilst ensuring competition.

4.1 Albania

Background

In regards to broadband development, ITU data indicate that 69.64% of individuals in Albania had access to the Internet in 2019.[63] The number of fixed-broadband subscriptions per 100 inhabitants was 15.14 in 2019.[64] Between 2013 and 2020, fixed-broadband penetration for both population and family has increased more than twofold, although it remains well below the EU average and other penetration levels of neighbouring countries, albeit growing by 10%-15% annually.[65] Despite the significant increase, ITU data show that the proportion of households with Internet access at home was 32.9%.[66]

According to the Digital Agenda for 2015-2020, Albania's physical extension of fibre optic infrastructure reached 5,000km in 2015, and the network has been growing ever since.[67] Broadband is currently supplied through myriad fixed and mobile technologies including DSL, FTTH/FTTB, FTTx in combination with NGA. Most DSL lines are combined with fibre-optic and copper networks (FTTN /FTTB). Broadband is also supplied via coax cable (HFC) and electricity lines (BPL). Increased investments on fibre optics (FTTH and

[62] This information from the EU4Digital will be included to the extent possible in this report and be referenced as "forthcoming" publication of the EaPeReg and World Bank.

[63] ITU World Telecommunication/ICT Indicators Database online: http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H") https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Individuals_Internet_2000-2018_Dec2019.xls

[64] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

[65] http://www.infrastruktura.gov.al/wp-content/uploads/2020/07/National-Plan-BBand-EN.pdf

[66] https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

[67] Albania Digital Agenda 2015-2020, https://issuu.com/miap4/docs/booklet_m-inovacionit_preview

FTTB) are undergoing by fixed-network operators. Yet, broadband speeds, according to AKEP's reports and Feasibility Study's results, are low: the existing bandwidth in fixed and mobile networks is less than 30 Mbps.[68]

In terms of mobile technologies, broadband is supplied via 3G/HSPA/HSPA+ and 4G/LTE networks, as well as satellite technologies. In 2019, 99.2% of the population had 3G network coverage, while 4G covers about 95% of the population in Albania.[69] In 2018, the number of active mobile-broadband subscriptions per 100 inhabitants was 62.10,[70]and in total there are 63% of Albanians that use mobile broadband.

Broadband Mapping

Broadband mapping in Albania is regulated by Regulation No. 22 dated 24.06.2011 "On Technical Requirements for Construction of Urban Infrastructure and cable networks, fibre optics, suburban networks of Electronic Communications"[71] which establishes a framework to support network operators in the construction of infrastructure of electronic communications networks by defining technical requirements for the development, planning, design, construction and maintenance of new and existing infrastructure. This regulation was later amended in 2015 to ensure a more transparent regulation for permit granting and additional guidelines for civil engineering works, thereby providing more clarity to network operators.[72]

More importantly, Regulation No. 26 dated 16.08.2012 for "Content, form and functioning of Electronic Registry of public electronic communications networks in the Republic of Albania"[73] determines the content, form and functioning of the electronic register of public electronic communications networks in the Republic of Albania, which is to be administered by AKEP. According to this regulation, operators are obliged to submit their network maps in twice a year reports or within 30 days of new installations.

The first broadband map was established in 2012 in follow up to above-mentioned regulations and covered all types of mobile and fixed infrastructure available in the country as well as the quality of service for mobile services, gathering information in a geo-referenced format.

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68 http://www.infrastruktura.gov.al/wp-content/uploads/2020/07/National-Plan-BBand-EN.pdf

69 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicators "i271G and i271GA"

70 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicators "i911mw")

71 https://akep.al/wp-content/uploads/images/stories/AKEP/publikime-pas26prill/Vendim-Nr-1617-date-24-6-2011.pdf

72 https://akep.al/wp-content/uploads/images/stories/AKEP/publikime/2015/Vendim-Nr2557date100415.pdf

73 https://akep.al/wp-content/uploads/images/stories/AKEP/konsultime/Rregullore-funksionimi-ATLAS-160812.pdf

In 2016, in cooperation with ITU and the Agency for Communication Networks and Services of the Republic of Slovenia (AKOS), AKEP prepared a tender documentation for upgrading the Broadband Mapping System into the ATLAS.[74] In this context, the Office for Electronic Communications of the Republic of Poland (UKE), was also involved with regards to enhancing the mobile QoS monitoring feature of the system.

Figure 1 - AKEP ATLAS[75]

This led in 2018 to the implementation of the ATLAS, with all operators given access to the new system. The system provides the possibility of inputting data either by importing georeferenced data through a data model defined by AKEP or by drawing the online map on the ATLAs system. The new system has different layers and interfaces depending on whether the user is the public administrator or the operators and offers the possibility to update and create communication maps reports for internal usage. Some of the main features are passive infrastructure, optic fibre radio transmitters antenna basements and mobile QoS monitoring. More than 200 service providers and 3 mobile operators are currently included in the system[76].

[74] https://atlas.akep.al/visios/AKEP?__cf_chl_jschl_tk__=c1279208c3d3c6f6a819e0229c1b81efed065690-1592916167-0-AU6lgilwdDWX-9_foS1knl87Nz2e_Py_eMlBzKZHynBZm8yaZoSbk-X6YUpwa1fJ76VUNKsEmqYUCdXIUbJJ5Rl_0RzKKetj6jaXgyHiBQjxKxFDK29a4Vv_GKbipxOLDKdPeKkibh012acQq5sxmAvy1mxxV2xFxJNhFAXoxw1vS2smXDUSDThnGm2EySXkhNfw2t7gfM86Y_FN5-1IbIEdJo8HA59xOjYfI_tNOM_IJHK56ZWkFsTrUlQqKCvKUpH1G4APWibCbyVmqYkeu3xkKHg9j1NQToq27mY-IY2T

[75] https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/Bitri%20Albania.pdf

[76] https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/Bitri%20Albania.pdf

Although the system is undoubtedly supporting AKEP in infrastructure, a more detailed assessment of how the system functions and outcomes it can provide vis-à-vis EU best practices and regulatory requirements are foreseen. Moreover, additional information should be gathered with regards to how the ATLAS system can be developed on the service side to support the country in achieving broadband targets set by the country. It is important to notice that in this regards, AKEP is in the discussion with the Ministry to upgrade the system in this direction.

4.2 Bosnia and Herzegovina

Background

Bosnia and Herzegovina's Agency for Statistics shows that in 2018 alone, 70.12% of individuals in the country had access to the Internet.[77] In 2010, the ITU data estimate for Bosnia and Herzegovina was 42.75% and, in 2000, only 1.08%. Despite the existing ICT divides still present, the data estimates show a significant increase in terms of Internet penetration over the years, particularly from 2013 onwards.

In 2019, the number of fixed-broadband subscriptions per 100 inhabitants was 22.60.[78] According to the Communication Regulatory Agency (RAK), Bosnia and Herzegovina currently has 67 Internet service providers[79]. In 2019, ITU data show that the proportion of households with Internet access at home was 72%,[80] which is similar to what is found in other countries in the Western Balkan region. RAK data also show that the dominant type of Internet access remains xDSL, which accounted for 56.83% per cent of total broadband subscribers, followed by cable access with 33.41%.[81] The regulator also stated that further liberalization of the market of telecommunications and the introduction of new technologies are expected in the upcoming years.

Concerning the mobile sector, Bosnia and Herzegovina had a penetration of 111.91 mobile-cellular subscriptions per 100 inhabitants in 2019,[82] while the number of active mobile-broadband subscriptions corresponded to 59.13.[83] In terms of coverage, 3G covered 96% of the population in 2019, while 4G/LTE's

77 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Individuals_Internet_2000-2018_Dec2019.xls

78 https://www.itu.int/net4/ITU-D/icteye/#/countries

79 https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/see8/20190415%20-%20CRA%20BH%20-%20Regulatory%20Challenges%20in%20the%20Internet%20space%20in%20BiH_c84b20b9-cdcc-4c16-bd10-faecff78b36f.pdf

80 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

81 https://www.sarajevotimes.com/bh-communications-regulatory-agency-issues-report-on-number-of-Internet-users/

82 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911")

83 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911mw")

coverage covered 82% of Bosnia and Herzegovina's population.[84] In the context of schools, a 2020 study by UNICEF and RAK surveying the habits and parent's attitudes on media usage reveals that 93% of children in the country have access to so smartphone, with about 90% of these of children aged 7-18 use mobile phones/smartphones daily and this use increases with age.[85]

Broadband mapping

From the perspective of infrastructure mapping, noting the inception of the INSPIRE Directive in 2007 and in consideration of the Stabilization and Association Agreement (SSA) conferring "potential candidate" status for accession to the European Union, Bosnia & Herzegovina has mirrored the EU regulatory framework in this field and implemented two important pieces of regulation, the "Ordinance on Infrastructure and Special Data Planning of the Federation of Bosnia & Herzegovina (Official Gazette of FBiH, 1845/2014)"[86] and the "Rule on Method for Establishment and Maintenance of Network Cadastre (Official Gazette of RS, 58/2012)."[87]

On this basis, the country has proceeded, respectively, with the creation of two geo-portals[88]:

- The Geoportal of the Federation of Bosnia and Herzegovina,[89] which is operated by federal administration for geodetic and property affairs; and
- The Geoportal of the Republic of Srpska, which is operated by republic administration for geodetic and property affairs of the Republic of Srpska.[90]

84 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271G and i271GA")

85 https://www.unicef.org/bih/en/press-releases/93-children-bosnia-and-herzegovina-have-access-smartphones

86 http://www.fbihvlada.gov.ba/bosanski/zakoni/2014/uredbe/36h.html

87 https://www.paragraf.ba/propisi/republika-srpska/zakon-o-premjeru-i-katastru-republike-srpske.html

88 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/KOVACEVIC%20-%20BB%20Mapping_%20B%26H_%20July%202019.pdf

89 http://www.fgu.com.ba/en/572.html

90 http://www.geoportal.rgurs.org/geoportal/

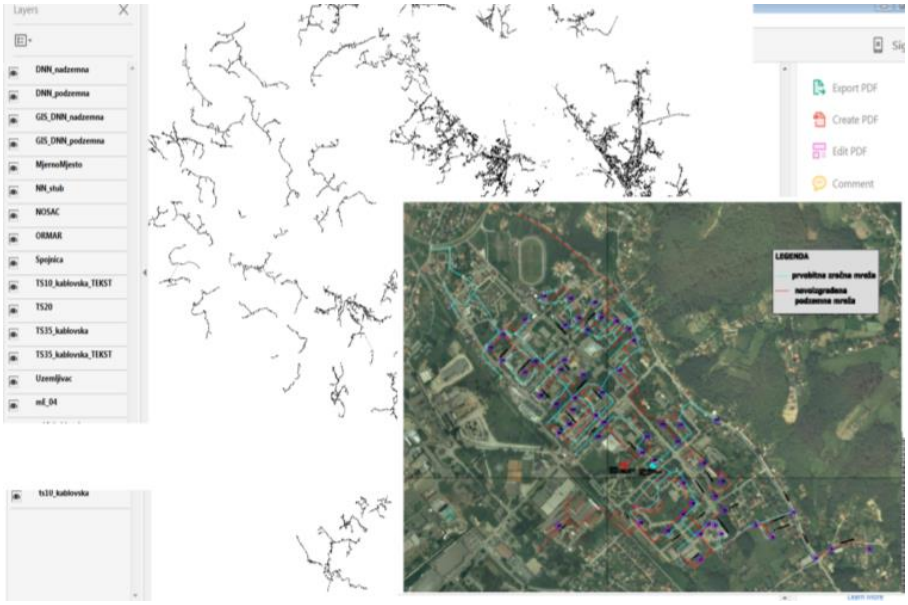

Figure 2 - Example of a digital map locally available for the energy grid and the TV cable network[91]

Although these systems provide a good basis for the use and integration of spatial data, currently, Bosnia and Herzegovina is not endowed with a nation-wide broadband mapping system for telecommunication infrastructure or services. It must be noted, however, that substantial work is being done by the Communications Regulatory Authority (RAK) on service mapping in at the level of statistical gatherings, though not yet in a geo-referenced manner as it is foreseen for service mapping.

Overall, RAK has identified two main issues preventing progress in the field. The first one pertains to the jurisdictional system that is fragmented and prevents collaboration across sectors, for example in the matter of permit granting and use of spatial data. The second issue pertains to the lack of regulations setting the obligation for operators to provide the agency with data on infrastructure and services up to the address point. This scenario makes it difficult in turn to make efficient use of public funding and have a data- or knowledge-based approach to public aid.

RAK is currently taking steps together with the Ministry of Communications and Transport to adopt a broadband strategy and create an enabling environment to coordinate the development of broadband infrastructure and service mapping and introduce investment and demand mapping layers by relying on existing geoportal databases and in line with the EU regulatory framework.

91 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/KOVACEVIC%20-%20BB%20Mapping_%20B%26H_%20July%202019.pdf

4.3 Georgia

Background

ITU data shows that 68.85% of individuals in the Democratic Republic of Georgia had access to the Internet in 2019 and that 75.8% of households in Georgia had Internet access at home.[92] The country's data published by the Georgian National Communications Commission (GNCC) from May 2020 show that that the Tbilisi and Adjara are the regions with the highest Internet penetration in the country, while the north-western region of Abkhazia has the lowest penetration rate.[93]

Wireline broadband networks (using fibre-optic or cable networks) are limited in their reach outside of urban areas.[94] Since 2014, fibre infrastructure has been steadily expanding in the country while xDSL has been reducing. In 2018, 75% of total subscribers used FTTx technology, compared to only 31% in 2010 (when xDSL accounted for 59% of total subscribers). Nowadays, fibre is by far the most used technology in Georgia and Wi-Fi the second most common, mostly in rural parts of Georgia, where FTTx connections are not available.[95]

In 2019, the number of active mobile-broadband subscriptions per 100 inhabitants was 79.85 in 2019.[96] At this moment, there are three 5 MNOs operating in Georgia—Geocell, Magticom, Beeline (Veon Georgia), and Silknet—that currently have licenses for the use of radiofrequency for commercial use. With extremely low prices compared to many other regional and European countries, 2G and 3G networks cover approximately 99.98% of Georgia's population,[97] while 4G/LTE covers 99.72%.[98] Although the majority of total mobile subscribers are individuals, data show that the number of corporate subscribers is growing, testifying that the country is on a steady path to digital transformation.[99] A nationally representative survey found that of the out 97.5% of firms in Georgia that had access to the Internet in 2016, about 40% had broadband, 31% used DSL connections and the remainder access Internet through their mobile phones (typically using a GSM connection)—although 9.5% engaged in e-commerce.[100]

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92 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H") & https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

93 https://analytics.comcom.ge/en/statistics/?c=Internet&f=subscribers&exp=penetrationbyregion&sid=801631

94 http://documents1.worldbank.org/curated/en/316241571855041161/pdf/Concept-Project-Information-Document-PID-Log-In-Georgia-P169698.pdf

95 https://analytics.comcom.ge/en/statistics/?c=Internet&f=subscribers&exp=technologies&sid=801640

96 World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911mw")

97 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271G")

98 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271GA")

99 https://galtandtaggart.com/upload/reports/11688.pdf

100 http://pubdocs.worldbank.org/en/352521517860642922/pdf/Broadband-for-Development-in-Georgia-clean.pdf

Georgia's National Broadband Network Development Strategy for 2020-2025[101] mandates that schools, highways and public facilities must be provided with Internet access at a download speed of 1 GBps by 2025, in line with EU plans, and also aligned with plans for 5G development in the country.[102] Within the framework of the OpenNet[103] project and the Georgia's National Broadband Network Development Strategy for 2020-2025, the World Bank is supporting the development of broadband through the Log-in Georgia Project, a 32.7 EUR million support package[104] which has the goal to expand access to affordable broadband in rural settlements and to support the development of Georgia's digital economy.[105] The three major project outcomes include: i) increasing access to affordable broadband Internet; (ii) promoting the use of broadband-enabled digital services; and (iii) project implementation support.[106] The project expects to connect up to 1,000 villages, including settlements in mountainous regions, to high-quality and affordable broadband service. Nearly 500,000 people, residing in locations currently unserved by high-quality broadband services stand to benefit from deployment of the broadband infrastructure envisaged by the Log-in Georgia Project.[107]

In the context of rural areas and under the project Harmonized Digital Market (HDM) EU4Digital "Eastern Partnership Countries (EaP) Broadband Infrastructure Development Strategy," other development goals in Georgia focus on enhancing the relevant legal and regulatory framework for broadband development in line with the EU norms and overcoming the digital divide across the country's regions.[108] In light of the arguments made in this paper, it is evident that in order to efficiently achieve all these objectives, mapping systems become of paramount importance.

101 http://www.economy.ge/uploads/files/2017/legislation/sainformacio_teqnologiebi/fartozolovani_qselebis_ganvitarebis_strategia_da_misi_ganxorcielebis_gegma.pdf

102 https://comcom.ge/uploads/other/3/3939.pdf

103 https://matsne.gov.ge/ka/document/view/3355632?publication=0

104 https://www.worldbank.org/en/news/press-release/2020/08/28/1000-villages-to-get-better-Internet-connectivity-as-part-of-world-bank-support-to-georgia-digital-transformation

105 http://www.opennet.ge/eng/list/show/50-World-Bank-will-co-finance-the-State-Program-of-the-broadband-infrastructure-development

106 http://documents1.worldbank.org/curated/en/316241571855041161/pdf/Concept-Project-Information-Document-PID-Log-In-Georgia-P169698.pdf

107 https://www.worldbank.org/en/news/press-release/2020/08/28/1000-villages-to-get-better-Internet-connectivity-as-part-of-world-bank-support-to-georgia-digital-transformation

108 http://www.economy.ge/?page=projects&s=18&lang=en

Broadband mapping

The Law on Electronic Communications, which is the main pillar for the telecommunication sector in the country, does not provide any specific recommendation for broadband mapping.[109] However, it provides the possibility for the regulator, the Georgian Nation Communication Commission (COMCOM) to obtain data from operators in the field of electronic communications to fulfil the duties conferred by the law (Art. 11). Moreover, it is relevant to notice that the country is in process of implementing a new specific infrastructure-sharing law aimed at reducing the cost of deployment and promote competition in the telecommunication sector.[110]

In April 2020, the Georgian National Communications Commission (COMCOM) published a Resolution[111] on "Approval of the information forms to be submitted by the authorized and / or license holders in the field of electronic communications for the purpose of mapping the telecommunication infrastructure on a single digital map" which is a milestone of the broadband mapping effort by COMCOM started in 2018. The Resolution mandates to create a unified digital map of telecommunications infrastructure by defining the data points to be submitted by operators to COMCOM in GIS format. These include:

- Linear objects (sewers, optical cables);
- Passive elements (cabinets, optical distribution devices, sewer wells terminal devices);
- Logical connections for fixed broadband network topology including type (backbone, backhaul, access), bandwidth, etc.;
- Masts and coverage (towers).

Considering that three months are given to operators to supply the data, COMCOM has been gathering the data and has proceeded to the establishment of its infrastructure map in Q3 2020. While there is no publicly available information on the map and no web application yet where the map can be publicly or privately accessed, it is important to point out to the forthcoming Report on "Broadband Mapping Recommendations" which outlines the outcomes of the work undertaken and experiences within the project "Eastern Partnership Countries (EaP) Broadband Infrastructure Development Strategy" financed by the EU4Digital project will provide a comprehensive overview of the regulatory and technical developments in the field of broadband mapping as well as country recommendations. The report is due to be released in December 2020.

While substantial work is being done in the field of infrastructure mapping, service and investment plans are not yet mapped in the country and could provide new avenues for development in the future.

[109] https://matsne.gov.ge/en/document/download/29620/26/en/pdf

[110] https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/Keburia%20Georgia.pdf

[111] https://matsne.gov.ge/ka/document/view/4861607?publication=0

4.4 Moldova

Background

ITU data shows that 72.12% of individuals in the Republic of Moldova had access to the Internet in 2017,[112] while the number of fixed-broadband subscriptions per 100 inhabitants was 16.58[113] with 94 active Internet service providers in the country.[114] Recent data from the National Regulatory Agency for Electronic Communications and Information Technology in Moldova (ANRCETI) shows that fixed broadband household subscriptions in Moldova amount to 25 every 100 inhabitants and, if an average of 3 persons per household is considered, then ANRCETI estimates around 75,0% of the population enjoys fixed access at home in 2019.[115]

In 2019, half the subscribers to fixed Internet access services benefited from data access and transfer speeds between 30 and 100 Mbps, while 13.8% enjoy speeds over 100 Mbps and around 35% under 30 Mbps.[116] According to ANRCETI, between January and September 2019, FTTx connections increased by 14.7%, reaching 452,300, while coaxial cable connections increased by 20.6% to reach 53,500. FTTx technology now represents 66.6% of the total number of subscribers,[117] with a significantly high rate in Chișinău and other major cities, while xDSL technology is most common in smaller towns and rural areas.[118] In addition, it must be noted that in 2019 the market for fixed broadband Internet access services in Moldova registered a significant increase, with the volume of sales rising by 6.1% year-on-year to reach 1.16 billion lei (59.1 million EUR).[119]

Concerning the mobile broadband market, according to ANRCETI data, the number of active mobile-broadband subscriptions per 100 inhabitants in 2019 was of 88.8, an increase from the same figure in 2018 standing at 79.4.[120] In terms of network coverage, 3G covers 99% of Moldova's territory[121] and 4G

112 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Individuals_Internet_2000-2018_Dec2019.xls

113 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

114 https://www.brodynt.com/business-internet-connectivity-in-moldova/

115 https://anrceti.md/files/filefield/Anuar%20statistic%202019_22aprilie_2020.pdf

116 https://eufordigital.eu/broadband-access-up-in-moldova-as-users-opt-for-higher-speeds/

117 https://eufordigital.eu/market-value-of-fixed-broadband-internet-access-services-in-moldova-exceeded-1-billion-lei-in-first-nine-months-of-2019/ and https://anrceti.md/news10122019

118 https://digital.report/moldova-state-of-affairs-report/#_ftn10

119 https://anrceti.md/news10122019

120 https://anrceti.md/files/filefield/Anuar%20statistic%202019_22aprilie_2020.pdf

121 https://anrceti.md/files/filefield/Anuar%20statistic%202019_22aprilie_2020.pdf

networks provide the coverage of 95% of the territory,[122] serving 98% of the population according to ITU data.[123]

Broadband mapping

At the moment, Moldova does not have particular provisions enshrined in law which empower the regulator, the National Regulatory Agency for Electronic Communications and Information Technology (ANRCETI), to request operators for georeferenced data on infrastructure and services. The prevalent rationale adopted in the past was based on the request for information but for statistical purposes only. As such, the country's regulatory framework is not fully aligned with the BCRD, the EU Guidelines on state aid for broadband and the EECC.

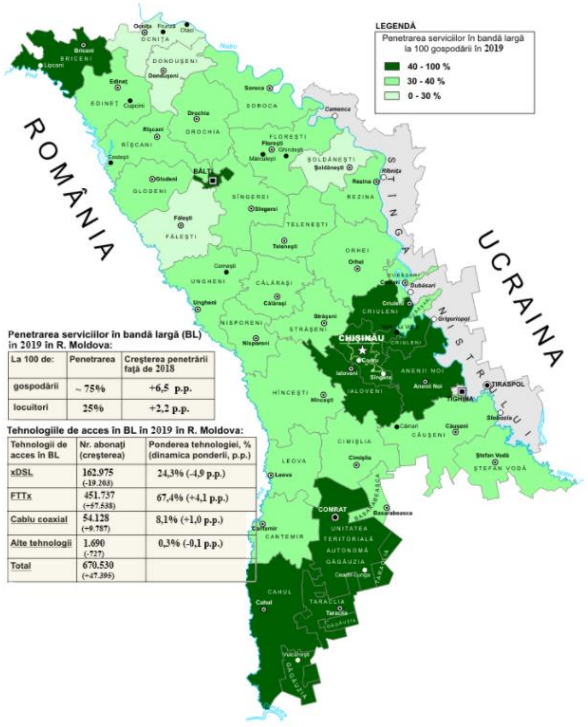

Figure 3 - ANRCETI "Development of broadband services at fixed points in the administrative-territorial unit"

Although the country publishes statistical information via an interactive map,[124] the country has not yet

122 https://anrceti.md/files/filefield/Anuar%20statistic%202019_22aprilie_2020.pdf

123 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271GA")

124 https://www.anrceti.md/bandalarga2019

introduced mapping systems as defined in the context of this paper. A more detailed analysis of broadband mapping in Moldova has been carried out in the project "Eastern Partnership Countries (EaP) Broadband Infrastructure Development Strategy" financed by the EU4Digital project, which will provide a comprehensive overview of the regulatory and technical developments in the field of broadband mapping as well as country recommendations. This activity's report on "Broadband Mapping Recommendations" is due to be released in December 2020.

4.5 Montenegro

Background

ITU data shows that 73.50% of individuals in Montenegro had access to the Internet in 2019[125] while the figure for fixed-broadband subscriptions per 100 inhabitants corresponded to 28.80 in 2018, according to the latest available data.[126] The north region of Montenegro remains the least connected, having about 64.8% of the households with some kind of Internet use.[127] The same data report also shows that while 80% of households in urban areas were connected in 2019 (representing a 3.7% increase compared to 2018), the percentage for rural areas was 62.8%. In terms of household connectivity, data from country's State Statistical Office show that 74.3% of the surveyed households had access to the Internet in 2019, which represents an increase of 2.1% in relation to the previous year.[128]

In 2019, the number of mobile-broadband subscriptions were equivalent to 80.50.[129] In 2019 alone, the percentage of households connected via mobile increased by 5.1% when compared to 2018. According to ITU data supplied by Montenegro's the Agency for Electronic Communications and Postal Services (EKIP), as of 2019, 4G/LTE networks cover 97.65% of the country's population,[130] with an average download speed of 10 Mbps.[131] 3G coverage is available to 98% of Montenegro's population.[132]

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125 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Individuals_Internet_2000-2018_Dec2019.xls for 2018 data. Data for 2019 data will be made available by ITU soon.

126 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Fixed_broadband_2000-2018_Dec2019.xls

127 https://www.monstat.org/userfiles/file/ICT/2019/ICT%20USAGE%20IN%20HOUSEHOLDS%20IN%202019.pdf

128 https://www.monstat.org/userfiles/file/ICT/2019/ICT%20USAGE%20IN%20HOUSEHOLDS%20IN%202019.pdf

129 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911mw")

130 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271GA")

131 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Regulatory%20Forum/3.%20EKIP.pdf For more information please consult http://www.ekip.me/zastita/kvalitet.php (only Montenegrin language)

132 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271G")

Finally, it is relevant to report that in 2019, the European Union awarded 600,000 EUR funding to Montenegro for the project on "Broadband Infrastructure Development in Montenegro" (PRJ-MNE-DII-001), which is currently being implemented.[133] Based on the complete mapping process of the infrastructure, the goal of this project is to analyse the current situation and examine the potential of the market to eliminate the existing infrastructural gap. There are three expected results and benefits:[134]

- Increase broadband coverage and availability of new generation broadband networks to the currently uncovered (mostly rural) areas in Montenegro;
- Offer an adequate infrastructure for fast and secure internet to all households, businesses, educational and health institutions in order to support the digital transformation of society and economy;
- Increased the percentage of households passed with NGA (Next Generation Access) network from 70% to 95%.

Broadband mapping

In Montenegro, the rules regulating the mapping of electronic communications include three main pieces of legislation. The first and most important is the "Law on Electronic Communications"[135] which identifies the Agency for Electronic Communications and Postal Services (EKIP) as the institution in charge of promoting the deployment of electronic communications infrastructure (Art. 11) and as the institution in charge of keeping the register of operators' electronic communications infrastructure (Art. 29) and of collecting operators' quarterly reports on the type, availability and geographic location of electronic communications infrastructure and associated facilities (Art. 55). Moreover, article 39 on "Construction and the use of electronic communications networks" provides the terms of use and other conditions for planning, construction, maintenance and the use of particular types of electronic communications networks; article 42 on "Electronic communication networks in buildings" sets out technical details for design, construction and use of infrastructure in buildings; and articles 53-54 on "Shared use of electronic communications infrastructure" laying out the conditions for infrastructure sharing.

The second piece of legislation, the "Rules on the type, manner of delivery and disclosure of data on electronic communications infrastructure and associated facilities which may be of interest for the shared use,"[136] prescribe the content and the form of data regarding cable ducts, masts and buildings which

[133] https://balkaneu.com/eur-600-000-for-the-montenegro-digital-infrastructure-sector/

[134] https://wbif.eu/project/PRJ-MNE-DII-001

[135] http://www.ekip.me/download/Zakon%20o%20elektronskim%20komunikacijama.pdf

[136] http://www.sluzbenilist.me/pregled-dokumenta-2/?id={0F791555-D1D5-4002-92F5-84DC0CBCC5AE}

should be provided by the operators which are the owners of electronic communication infrastructure. Moreover, the Rules on infrastructure sharing prescribe the creation of a georeferenced database, and associated web portal which is dedicated to collection and display of the data. It is important to notice that the database has been developed in collaboration with the Real Estate Administration of Montenegro.

The third piece of legislation is the "Law on the measures to reduce the costs of deploying high-speed electronic communications networks,"[137] which the Government proposed before the Parliament and is now awaiting consideration and adoption by the Parliament.

Based on this regulatory framework, EKIP has implemented a system for mapping of electronic communications infrastructure which aims to provide appropriate access to data on electronic communications infrastructure to stakeholders.[138] The mapping system seeks to:

- increase in the common use of electronic communications infrastructure (ducts, antenna poles, buildings / facilities, cable drainage, low voltage poles and public lighting posts);
- Improve planning documentation;
- Accelerate NGN development;
- Increase investment;
- Increase of broadband access availability.

The system is made of a georeferenced database where EKIP collects data from operators through a web application based on the Esri ArcGIS server platform. Data is provided in shapefile format and kept in the Posgtgre SQL database run by EKIP. EKIP reviews the data and makers various reports. Access to the platform is granted in two layers, one for public access[139] which is more conservative, and one restricted access for operators, designers and local/national institutions and the available data depends on the user according to the law.

The data available for restricted access covers:

- Ducts: geographical location, ownership of the ducts (placed cables), their owners and types, manholes (their owners and types), placed equipment, space availability;
- Antenna Poles: geographical location, height and dimensions of the pole (and ownership), placed equipment, space availability;
- Buildings/facilities: geographical location, ownership, placed equipment, space availability.

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[137] The Law is in process of approval and is expected to enter into force shortly.

[138] https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/ALEKSIC%20-%20EKIP%20-%20Montenegro%2028.06.2019.pdf

[139] http://ekinfrastruktura.ekip.me/ekip/login.jsp

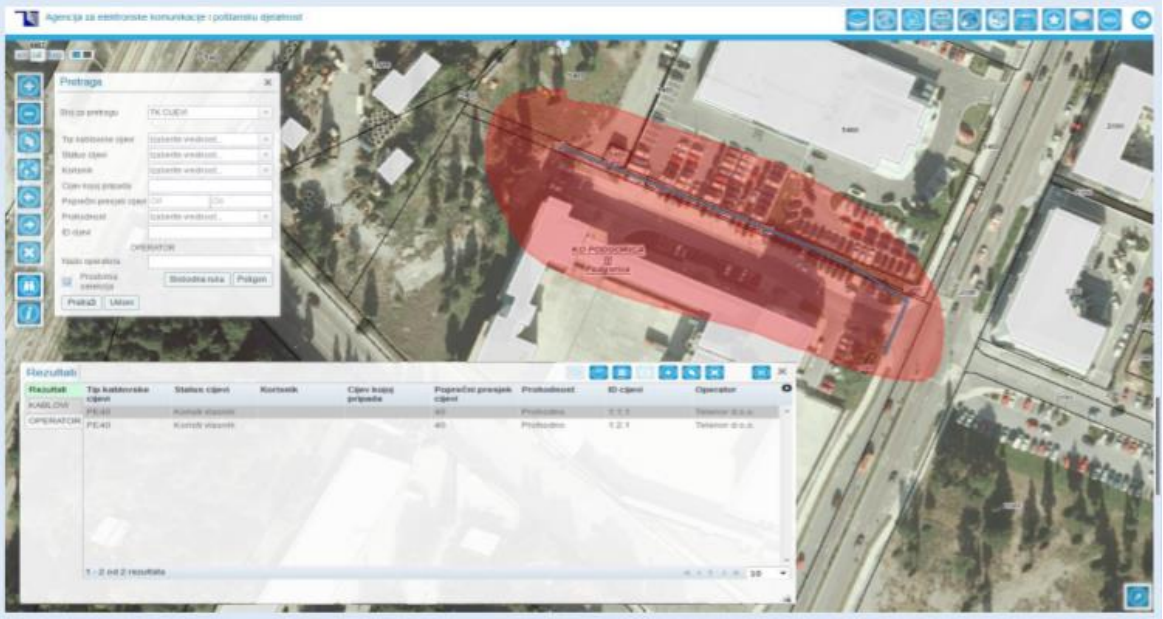

Figure 4 - EKIP mapping system (Ducts)

The mapping system supports EKIP in drawing ad hoc statistics and coverage analyses, otherwise intended as service mapping based on the analysis of network termination points. In 2018 it was possible to identify that the share of fixed broadband connections (30 Mbps) was 51.9% of all broadband access connections.

Looking forward, EKIP is taking steps to improve the georeferenced database and associated web portal, to:

- provide an upgrade and simplifications of the current software for electronic communications *infrastructure mapping;*
- develop the broadband mapping based on data related to the location of the network termination points, buildings and demographical data that will be provided by operators, national statistical and cadastral institutions (*service mapping*);
- develop a mapping of the plans related to new electronic communications infrastructure that will be provided by operators (*investment mapping*).

As it is possible to see from this set of priorities for the future, Montenegro is taking steps to align its regulatory framework and, consequently, the technical system to best practices observed in the European Union.

4.6 North Macedonia

Background

ITU data shows that 79.17% of individuals in the Republic North Macedonia had access to the Internet in 2018,[140] while in 2019 the number of fixed-broadband subscriptions per 100 inhabitants was 21.33.[141] Moreover, according to the latest Broadband Competence Office Report[142] on the country's broadband development, the Republic of North Macedonia reports the following indicators:

- Fixed broadband coverage (% of households) is 97,87%;
- Fixed broadband take-up (% of households) is 72,95%;
- 4G coverage (% of households) is 99,38%;
- Preparedness for 5G (% of harmonized spectrum) is 22,2% (14.07.2020);
- Fast broadband (NGA) coverage (% of households) is 78%;
- Fast broadband take-up (% of households) is 27,43%;
- Ultra-fast broadband (NGA) coverage (% of households) is 43,8%;
- Ultra-fast broadband take-up (% of households) is 1,74%.

The information detailed in the report shows that coverage with fast broadband networks is roughly the same as the average in the European Union. However, the existing coverage with ultra-fast broadband networks (43.8%) is lower than the EU average (58%).[143] For enterprises (with 10 or more employees) in 2019, 85.8% of them had fixed broadband connection, an increase of 4.3 percentage points compared to the previous year.[144] Additionally, the wholesale broadband market in North Macedonia is highly concentrated with few providers, and the high wholesale broadband prices prevent investments, especially among the smaller or regional operators.[145]

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140 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H")

141 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

142 http://bco.mioa.gov.mk/wp-content/uploads/2020/10/Извештај-на-НКБК-бр.2-усвоен-на-29.9.2020-eng.pdf

143 https://mioa.gov.mk/sites/default/files/pbl_files/documents/reports/north_macedonia_national_operational_broadband_plan_final_en.pdf

144 http://www.stat.gov.mk/publikacii/2020/Macedonia%20in%20figures-2020-web.pdf

145 http://documents1.worldbank.org/curated/en/348431571341516627/pdf/Concept-Project-Information-Document-PID-North-Macedonia-Digital-Economy-NODE-P170993.pdf

In regard to the mobile sector, the number of mobile-broadband subscriptions per 100 inhabitants was equivalent to 69.85 in 2019.[146] Moreover, according to ITU data 3G population coverage in North Macedonia is 99.88%, while 4G/LTE coverage is 99.53%.[147]

While broadband services continue to expand in the country, a 2018 domestic mapping of current commercial networks and operators' future plans indicate that 30% of households are located in "white zones." These white zones correspond to areas that lack capacities for access to super/ultra-fast Internet (with download speed higher than 100Mbps), and that there are no plans to invest in such networks in the foreseeable future.[148]

To tackle this issue, and in alignment with the NOBP, the Ministry of Information Society and Administration announced a collaboration with the World Bank to develop a National Transport Fibre Network. The government expects such network to access these "white zones" and be available for operators to provide last mile and access services to citizens. The only condition for this plan is that retail prices for super-fast internet access for households should not exceed 2% of the average monthly income in a respective planning region.[149]

Broadband mapping

In North Macedonia, the legal basis for broadband mapping is identified in two pieces of legislation. The first and most important is the "Rulebook on the manner of construction of public electronic communications networks and accompanying assets" published in 2016.[150] Article 29 mandates that the "Operator shall within 30 days from the day of commencement of the use of the public electronic communications network, submit to the Agency a written notification with a geodetic report for the built status of an infrastructure object in .shp or .dxf format, as well as a short technical description of the electronic communications network and accompanying assets with a minimum set of data according to the type of electronic communication network and associated assets, in a spreadsheet format (xls, csv, xlsx)."

This provision, which is the main focus of the regulation, mandates that operators are compelled to provide data on physical infrastructure and data on equipment, which ultimately allows estimating the

146 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911mw")

147 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271G and i271GA")

148 https://mioa.gov.mk/?q=en/node/2624

149 https://mioa.gov.mk/?q=en/node/2624

150 http://www.slvesnik.com.mk/Issues/7b22c4194f6e4cdb80987251d70a75cd.pdf

type and characteristics of service which can be provided with that equipment. More details are contained in the second piece of legislation, the "Guidelines for submitting data for newly built electronic communications network and accompanying assets."

The responsible authority for these endeavours is the telecommunications regulator, the Agency for Electronic Communications (AEC). In fulfilment of the law, since 2017 AEC has been implementing a project to build a Web GIS Collector[151] that (i) provides full electronic data delivery for newly built electronic communications and associated facilities, (ii) automatically verifies the correctness and completeness of the submitted data, and (iii) which provides three user roles, namely for geodetic companies, operators, and AEC employees.

The data is delivered electronically in .gml format using the same files provided to the Agency for Real Estate Cadastre (AREC) of North Macedonia which is complemented with the data attributes mandated by the Rulebook. The data is placed in a temporary database and then once validated by AEC is transferred to the production base.

As mentioned, the portal provides access to three different types of entities at three different stages of data collection. Geodetic companies can create new projects and associate spatial and attribute data and submit to the operator of electronic communications.

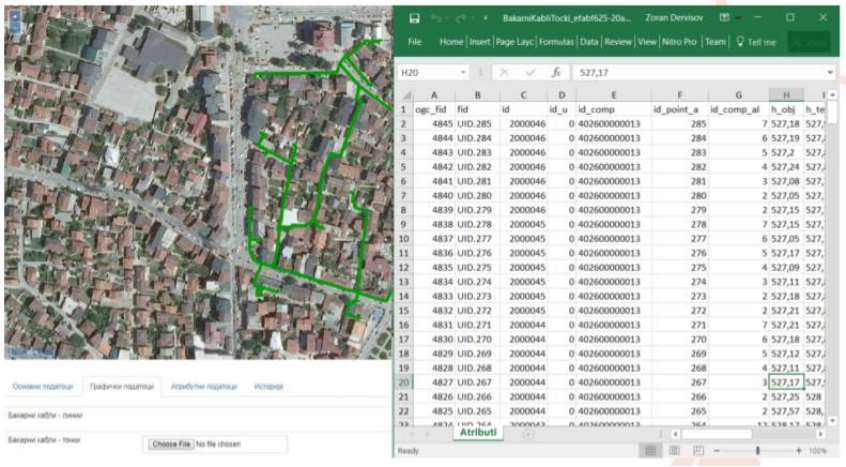

Figure 5 - Web GIS Collector, AEC[152]

The operator then controls the submitted project and returns with remarks to the geodetic company while

151 https://aek.mk/wp-content/uploads/2018/03/irc2018_irc2018_s1_03.pdf

152 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/ALEKSOV%20-%20Mapping%20Tools%20AEC%20Zoran%20Aleksov.pdf

in parallel it forwards the correct project to AEC. The system checks the validity of the submitted data and performs topological checks of the graphic data and then finally, the AEC employee controls the submitted projects, returns remarks to the operator and approves valid projects. Moreover, AEC can download graphic data as well as .xls data with attributes which results very helpful from a planning perspective.

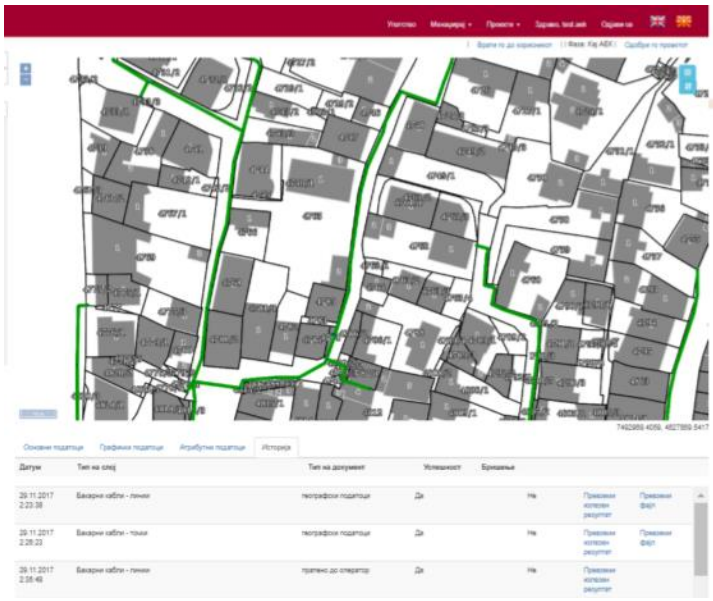

Figure 6 - Web GIS Collector, AEC (2)[153]

According to AEC, the benefits of the Web GIS Collector are:

- Full automation of the data delivery process for newly built infrastructure;
- Utilization of already prepared elaborates for enrolment of infrastructure which is aligned with the cadastre requirements and therefore is without additional obligations for operators;
- Encouraging the joint construction and use of public electronic communications networks and associated facilities;
- Protection of the infrastructure of the built public electronic communications networks;
- Improving the utilization of the capacities of public electronic communications networks.

Moreover, the system supports the Agency's efforts with regards to mapping of service coverage and availability and identification of operators' future plans for the identification of white and grey zones to ensure more efficient allocation of state aid. Notably, AEC collects investment plans from the 4 major operators in the country. AEC plans to strengthen the mapping work in these fields.

153 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2019/Mapping%20Warsaw/ALEKSOV%20-%20Mapping%20Tools%20AEC%20Zoran%20Aleksov.pdf

4.7 Serbia

Background

Regarding broadband development in the country, ITU data shows that 77.42% of individuals in the Republic of Serbia had access to the Internet in 2019,[154] while in 2018, the number of fixed-broadband subscriptions per 100 inhabitants was 17.63,[155] the being majority through xDSL (37.8%) or cable access (44.8%)[156]—although the number of users of xDSL users have been slowly decreasing over the years.[157]

Serbia's xDSL subscriber structure has changed significantly over the years, with an increase of the number of users of VDSL technology that accounts for 42% of the total number of xDSL users, due to greater demand for packages with bigger throughput.[158] While the north districts of Belgrade and South Bačka have the highest household penetration rates in terms of broadband subscriptions, the south districts Jablanica and Pčinja have the lowest.[159] ITU data show that 72.9% of households in Serbia had Internet access at home.[160]

Serbia is the country with the highest penetration rates for mobile services in the Balkans.[161] In 2019, the number of active mobile-broadband subscription per 100 inhabitants was 71.27.[162] Furthermore, data from the Republic Agency for Electronic Communications and Postal Services (RATEL) published in the market overview for 2018, all three MNOs have a high 3G and 4G/LTE mobile network coverage, covering between 96% and 97% of the population[163] and between 72% and 78% of the territory of the Republic of Serbia.[164]

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154 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H")

155 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/Fixed_broadband_2000-2018_Dec2019.xls

156 https://www.ratel.rs/uploads/documents/empire_plugin/Q1%202020%20ENG%20pdf.pdf

157 https://www.ratel.rs/uploads/documents/empire_plugin/An%20Overview%20Of%20The%20Telecom%20And%20Postal%20Services%20Market%20In%20The%20Republic%20Of%20Serbia%20In%202018.pdf

158 https://www.ratel.rs/uploads/documents/empire_plugin/An%20Overview%20Of%20The%20Telecom%20And%20Postal%20Services%20Market%20In%20The%20Republic%20Of%20Serbia%20In%202018.pdf

159 https://www.ratel.rs/uploads/documents/empire_plugin/An%20Overview%20Of%20The%20Telecom%20And%20Postal%20Services%20Market%20In%20The%20Republic%20Of%20Serbia%20In%202018.pdf

160 https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

161 https://www.itu.int/en/ITU-D/Innovation/Documents/Publications/eBAT_Brochure%E2%80%93DIP%20Serbia_432746_.pdf

162 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i911mw")

163 ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicators "i271G and i271GA")

164 https://www.ratel.rs/uploads/documents/empire_plugin/Pregled%20trzista%202018.pdf

Broadband mapping

The foundations of broadband mapping in Serbia can be found in the Electronic Communications Law from 2014[165] which mandates (Article 53) that the Regulatory Agency for Electronic Communications and Postal Services (RATEL) shall "keep an updated database on the type, availability and geographic location of capacities which may be subject of request for shared use or access." Moreover, the Agency "shall update and make publicly available the database […] on its website, providing a possibility of comprehensive browsing capacity." According to Art. 54, and in line with the EU's BCRD, the operator is also "entitled to interconnect with other operators and access network elements and associated facilities of another operator in order to provide electronic communications services to end-users."

Based on this law, in July 2015 RATEL published a Rulebook on the method of collecting and publishing data on type, availability and geographical location of the capacity of electronic communication networks.[166] The Rulebook required implementation of a database and a GIS Web application by July 2016.

Based on this framework, RATEL has established an infrastructure mapping system in late 2016[167] with the expectation of optimizing infrastructure deployment through better planning and cost-sharing to accelerate the development of NGNs in a competitive and efficient way.[168] The data which is subject to the request to operators includes 4 main criteria including (i) type (e.g. cables, other ground pieces of equipment, antenna towers, masts), (ii) availability, (iii) geographical location, (iv) for shared use/access only. An example of the data collected for cables is below:

- Name of operator (owner) / location / route; - WGS84 coordinates of important points (start/end, hub); - Cable type and route length / geodetic record; - other information (type of pipes / number of pipes on the route / manhole type / number of manholes on the route);
- Capacity for lease / unused capacity;
- Cable instalments and ending data (optional).

165 https://www.ratel.rs/upload/documents/Zakon/Electronic%20Communications%20Law.pdf

166 https://www.ratel.rs/uploads/documents/empire_plugin/Rulebook%20on%20the%20method%20of%20collecting%20and%20publishing%20data%20on%20type%2C%20availability%20and%20geographical%20location%20of%20the%20capacity%20of%20electronic%20communication%20networks.pdf

167 https://eki.ratel.rs/ratel/login.jsp (not available to the public)

168 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2016/Broadband%20Mapping/3.%20Ivkovic%20Measuring%20QoS%20and%20Mapping%20of%20Shared%20Infrastructure%209%2004%202016.pdf

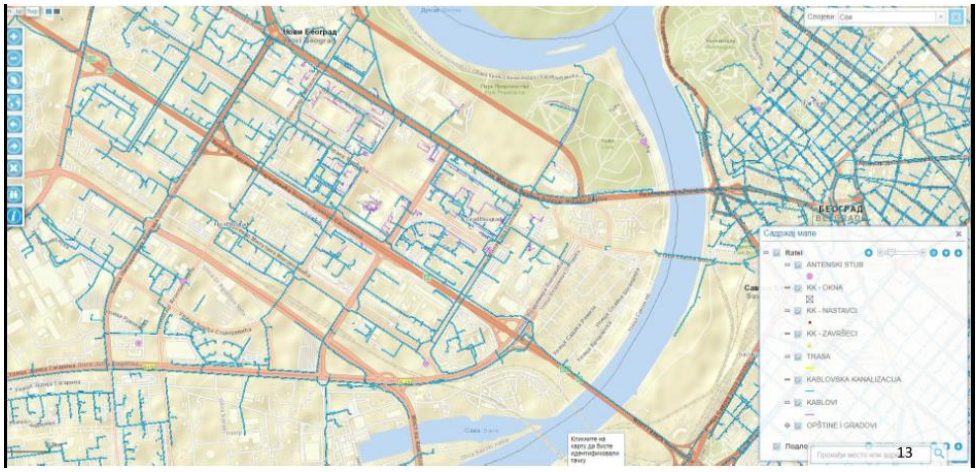

Figure 7 - RATEL's infrastructure mapping system

The data is displayed through a GIS web application to which only operators and RATEL have access. The GIS tool is endowed with features such as layer on/off functions, zooming, measurement of distance/surface, csv export and background selection.

Since its establishment, in 2019 the database reached hit the following figures:

- 30 registered operators (180 total);
- 1,500 antenna towers / masts;
- 1,500 fibre optic cables;
- 200,000 other cable elements;
- 7000 database access / year.

According to RATEL, current plans include the extension to reach all electronic communication infrastructure, the creation of synergies for co-deployment with other sectors (Power distribution, Geodetic), guidelines for infrastructure sharing and an overall, open data approach. At the moment, no plan for service mapping or investment mapping is foreseen in the country.

4.8 Ukraine

Background

ITU data shows that 62.55% of individuals had access to the Internet in 2018, with the majority being in urban areas, and that 61.9% of households had Internet access at home.[169] In 2019, 16.16 fixed

[169] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i99H") and https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

broadband subscriptions per 100 inhabitants have been registered in the country[170] and DSL remains the most used technology platform while fibre continues to grow due to the efforts by operators build networks based on Fibre-to-the-Premises (FTTP).[171] While most cities have access to fibre-optic networks operated by several private stakeholders, the urban-rural gap in terms of Internet coverage is significant in Ukraine, given that the country has more than 17,000 settlements not covered by this technology.[172] The government recently announced that about 65% of Ukrainian villages are not covered by high-quality broadband, which corresponds to about 5.75 million citizens.[173] For rural areas that not covered by optical fibres, the cost of connection exceeds the average market cost by about 150%. Continued growth in community wireless platforms based on Wi-Fi and WiMAX technologies is expected to attract investments and shape the average price for Internet connectivity.[174]

In 2018, the number of active mobile-broadband subscription per 100 inhabitants corresponded to 47.16.[175] Over the past years, significant investment has been made in extending 3G infrastructure, while operators have more recently concentrated on LTE. Kyivstar, Ukraine's largest operator, announced that the 3G coverage corresponded to nearly 80% in 2018, although a large portion of the territory still lacks 4G/LTE coverage.[176] With the recent expansion of LTE in Ukraine, it is expected that the majority of the country's territory will be covered in the next years.[177] Additionally, data from ITU show that in 78.1% of the population in Ukraine had 4G/LTE coverage in 2019, while 3G coverage corresponded to 89.1%.[178]

In January 2018, the Government and State Agency for e-Governance of Ukraine published the new "Digital Agenda for Ukraine 2020,"[179] which aims to guide the country's digital development. The agenda has seven main pillars, the first of which is "Telecommunications and ICT Infrastructure," illustrating how bridging the digital divide through the development of digital infrastructure is a topic of high priority in the country.

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[170] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

[171] https://www.reportlinker.com/p05355157/Ukraine-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses.html?utm_source=PRN

[172] https://data.gov.ua/dataset/788580dd-e3ae-45b4-a93b-f7f3e8a3f80d/resource/4d2fdbd7-41b5-4478-9bc0-d59eb2d86c19

[173] https://thedigital.gov.ua/news/17-tisyach-naselenikh-punktiv-ne-mayut-zhodnogo-optichnogo-provaydera-doslidzhennya-mintsifri

[174] https://www.reportlinker.com/p05355157/Ukraine-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses.html?utm_source=PRN

[175] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i992b")

[176] https://www.epravda.com.ua/publications/2018/03/15/634981/

[177] https://www.president.gov.ua/en/news/zhittya-dedali-bilshe-perehodit-v-onlajn-krayinu-treba-zyedn-61061

[178] ITU World Telecommunication/ICT Indicators Database online (2020): http://handle.itu.int/11.1002/pub/81550f97-en (indicator "i271G and i271GA")

[179] https://issuu.com/mineconomdev/docs/digital_agenda_ukraine-v2__1_

With specific reference to broadband development in Ukraine, and in context of the plan's focus toward a national hard digital infrastructure, the "Conception for Developing Digital Economy and Society in Ukraine for 2018 to 2020" calls for a national broadband plan that has appropriate indicators of I) Internet access coverage in the country; II) specifications on the technical requirements for the broadband Internet access services; and III) models for using the existing physical infrastructures (highways and railways, gas pipelines, power lines) for the development of telecommunications networks.

In this regard, the document argues that particular attention should be paid to broadband Internet access in rural areas.[180] In April 2020, Iskratel, PJSC Ukrtelecom and SID Bank signed an agreement to build a fibre-optic Internet network (GPON) to connect the rural areas of Ukraine under a two-year network construction project. This has had a total investment of almost 200 million Hryvnia (about 6.1 million EUR). The project will include the manufacture of more than 2,000km of fibre optic cables and the installation of modern certified telecommunication equipment.[181] Other initiatives concerning rural areas and Internet connectivity are currently undergoing under the auspices of the Ministry of Education and Science, Ministry of Digital Transformation, Ministry of Finance.[182]

Broadband mapping

Ukraine is currently undergoing revision of the laws of electronic communications which will broaden the competences of NRA, the National Commission for the State Regulation of Communications and Informatization (NKZRI), and also introduce provisions enabling authorities to collect more detailed information on infrastructure or services from operators. However, taking the EU regulatory framework as a reference, additional efforts will be needed in the future in case the country wishes to align, for example when it comes to provisions on the single information point or on state aid for broadband, as it has been identified in the case of Moldova.

Considering the above, no mapping system is yet available in the country. However, the Ministry of Digital Transformation is collaborating with the World Bank and the Ministry of Culture to adopt a state policy for broadband access and update the basic legislation to support broadband mapping development with regard to fixed broadband coverage (and therefore presumably focusing on service mapping)[183] As anticipated in the previous sections, this activity falls under the scope of the project "Eastern Partnership Countries (EaP) Broadband Infrastructure Development Strategy" financed by the EU4Digital project, which will produce a report on "Broadband Mapping Recommendations" by December 2020. This will

[180] https://zakon.rada.gov.ua/laws/show/67-2018-%D1%80#Text

[181] https://www.fibre-systems.com/news/rural-ukraine-benefit-new-fibre-network

[182] https://thedigital.gov.ua/news/podililisya-planami-rozvitku-optichnogo-Internetu

[183] https://thedigital.gov.ua/news/mintsifra-ta-svitoviy-bank-rozpochinayut-spivpratsyu-zi-svitovim-bankom

provide an in-depth assessment of the legal framework as well as recommendations into the actions to be undertaken both from the regulatory and technical side to advance broadband mapping and endow the country with an important tool for policymaking advancing broadband development.

5. ITU Interactive Transmission Maps

Back in 2011, the ITU recognized the potential for mapping the world's terrestrial fibre optic transmission networks as gathering the data in the field would support the creation of indicators to monitor backbone broadband supply. In addition, doing so in a geo-referenced format would enable to infer additional indicators to understand whether populations are adequately served, and supply meets demand.

As operators offer broadband services of increased bandwidth, the demand for bandwidth in the core network can escalate exponentially. In the quest to provide universal broadband, it is in fact important to know whether and how countries are connected to global information highways and whether the transmission networks have sufficient capacity for the population they serve. This argument has recently been reinforced due to the COVID-19 pandemic which in a matter of days during March 2020 rapidly increased demand for broadband, thereby putting pressure on networks resiliency.

As of November 2020, the ITU Interactive Transmission Map[184] encompasses more than 400 operators for a total of 2.703.066 Km, with 79 operators and 444.818 Km for Europe region alone. This result has been achieved primarily through extensive research and outreach for primary and secondary sources, and a validation processes with operators as well as through collaboration with UN ESCAP for the Asia Pacific Region, ECOWAS for the Africa Region.

Beyond fibre optic route length, the ITU Interactive Transmission Map also gathers information on six other indicators:

1. Fibre optic cable length (Route kilometers)
2. Node locations
3. Equipment type of terrestrial transmission network
4. Network capacity per channel (bit rate)
5. Number of optical fibres within the cable
6. Operational status of transmission network
7. Percentage of population within reach of transmission networks

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

The data is pooled into a GIS software and presented through a web application.[185] A complete framework methodology is available on the on the ITU website[186] and more details regarding indicators are also available.[187]

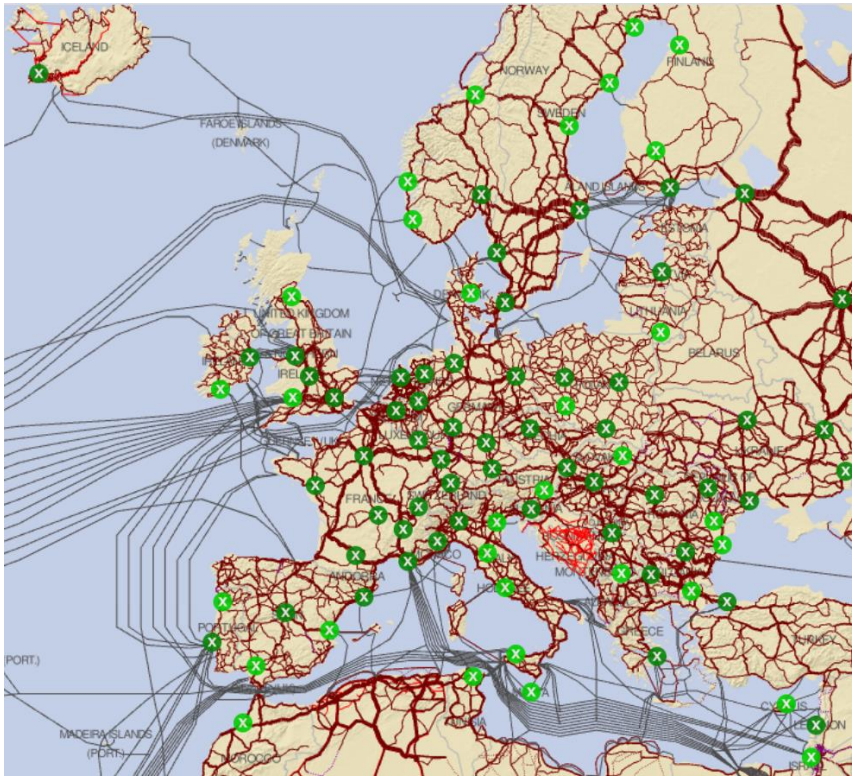

Figure 8 - ITU Interactive Transmission Maps (Europe region)

More recently, ITU recognized that beyond collaborating directly with operators, it is important to foster collaboration with NRAs and to promote the collection of data at the national level, a process which would in turn feed into the ITU project on Interactive Transmission Maps. In this regard, ITU has concluded collaboration agreements in Europe region with authorities from Andorra, Bosnia and Herzegovina, Poland, Montenegro and Serbia while advanced negotiation with Moldova and Ukraine as well as negotiation with other countries is underway.

185 https://www.itu.int/itu-d/tnd-map-public/

186 https://www.itu.int/en/ITU-D/Technology/Documents/InteractiveTransmissionMaps/Misc/MapFrameworkMethodology.pdf

187 https://www.itu.int/en/ITU-D/Technology/Documents/InteractiveTransmissionMaps/Misc/BroadbandTransmissionCapacityIndicators.pdf

6. Conclusions

This paper has recognised that broadband mapping systems have now become an essential tool for National Regulatory Authorities and other government bodies to efficiently sustain broadband development and deployment. This argument is fully aligned with and further strengthened by the new ITU Benchmark of Fifth Generation Collaborative Regulation, which we invite stakeholders to examine in detail.[188]

In particular, Chapter 2 reiterated the importance of the strategic and political support for mapping systems, or a data-driven approach to regulation. In this context, broadband strategies or digital strategies may be a fundamental strategic tool to create the demand for broadband mapping systems at the country level, wherever it is lacking. Following this line of reasoning, and taking the EU regulatory framework as a reference, it was possible to identify that the provisions relating to broadband mapping contained in the three pillars of EU legislation (the EU Guidelines on State aid for broadband, the Broadband Cost Reduction Directive and the European Electronic Communications Code) find a concrete backing in the strategic policies of the EU.

While the regulatory framework addressing infrastructure, service and investment mapping which has been established is rather complex, it has had a concrete impact on the creation and upgrade of broadband mapping systems at the country level. This has endowed regulators with better information on mapping of coverage, identification of investment plans, or facilitation of co-deployment or infrastructure sharing, thereby carrying positive consequences for fixed broadband development in European Union countries. Furthermore, as a comprehensive revision of the BCRD and EU Guidelines on State aid for broadband is underway, additional advancements are expected over the course of 2021 and even more impactful implementation is anticipated at the country level. In this context, it has been argued that non-EU countries, and accession countries in particular, should monitor the regulatory process closely, trying to identify best practices applicable in their own countries and ways to reduce the overall regulatory burden that the establishment of these systems requires.

Chapter 3 has then outlined a list of broadband mapping systems in the EU, supporting the claim that regulation has enabled mushrooming of broadband mapping systems within Member States. Moreover, it has outlined the main actions undertaken by the European Commission with particular attention to the European Broadband map as a unique example of service mapping that is increasingly supporting the direct allocation of EU funding. In addition, it has been argued that as the project gathers the direct experience of policymakers it has constituted a strong platform for the exchange of information, which has, in turn, fed the development of the first technical guidelines in the field of service mapping issued by BEREC as required by the EECC.

[188] https://www.itu.int/en/mediacentre/Pages/PR06-2020-Global-ICT-Regulatory-Outlook-G5-Benchmark.aspx

Despite being a necessary result of compromise and complex negotiations, one of the main shortcomings of the whole regulatory and implementation process at the European level is the fact it has produced a very heterogeneous (at times overlapping) landscape with regard to broadband mapping. A recent European Commission study on state aid for broadband has importantly recommended that an ideal solution would be to integrate the three layers of infrastructure, service and investment mapping, eventually by providing guidance about on interplay between the BCRD, the EU Guidelines on State aid for broadband and the EECC. In this context, non-EU countries not only are compelled to identify the best practices across the EU27 block but also have the chance of leapfrogging and create an enabling environment for a single integrated system which would reduce cost and provide additional clarity to the market and consumers.

Taking into consideration these EU-specific factors, in Section 4 the discussion has turned to eight non-EU countries selected as having a great potential for improvement and progress to accelerate the deployment of broadband networks. As in the case of the EU, countries have been working on broadband mapping rather heterogeneously, some more independently, while some others in a more collaborative way, as in the case of the EaPeReg in the context of the EU4Digital framework, but all taking into consideration the regulatory developments at the EU level.

This country-specific examination is not exhaustive and will further benefit from additional research and a close dialogue with the countries or institutions in the near future. However, the proposed country analysis has already highlighted two main trends:

1) Countries have given precedence to infrastructure mapping rather than service or investment mapping, meaning that there is scope for expanding and upgrading existing mapping systems in these areas. Moreover, within the context of infrastructure mapping, often the exercises limit to electronic communications operators. As seen with the implementation of the BCRD in the EU, the full benefits of infrastructure mapping are realized through cross-sector cooperation for co-deployment and infrastructure sharing.
2) Figures for broadband development in the 8 countries have been rapidly catching up with EU figures over the past 10 years, though a relevant gap remains. The benefits of broadband mapping are self-evident, whether the focus is on infrastructure, services, investment or a combination of these. Therefore, acknowledging that reducing the gap in broadband development depends on better information as well as targeted and efficient decisions by the relevant authorities further supports the rationale for establishing or upgrading broadband mapping systems to accelerate the attainment of broadband development goals whilst ensuring market competition.

Finally, Chapter 5 zoomed out to provide a short overview of the ITU Interactive Transmission Maps project and illustrate how even at the level of backbone, broadband mapping is an important regulatory tool, and one where ITU invites NRAs to further collaborate and engage at the national level.

To conclude, this piece of work has provided a general overview of regulation supporting broadband mapping in Europe region encompassing 46 countries. It has examined the European Union's approach, recent developments and has focused on 8 non-EU countries vis-à-vis the EU's regulatory and technical advancements, identifying areas for improvement. As mentioned in the introduction to this paper, following objectives of the ITU Regional Initiative for Europe on ICT infrastructure, the ITU Office for Europe aims at fostering harmonization in the region, reducing gaps and avoid the creation of new ones, eventually by providing technical support to countries leveraging its internal expertise and the expertise acquired on the ground by EU NRAs. Along the entire value chain, there is a significant potential for broadband mapping systems as an important regulatory tool and as a fundamental upgrade which NRAs or other competent authorities should undertake in the medium and long term to accelerate broadband development by unlocking investment, allocating public funding efficiently, and make sure competition is protected.