UNOFFICIAL MACHINE TRANSLATION

Methods for mapping network coverage fixed and mobile networks

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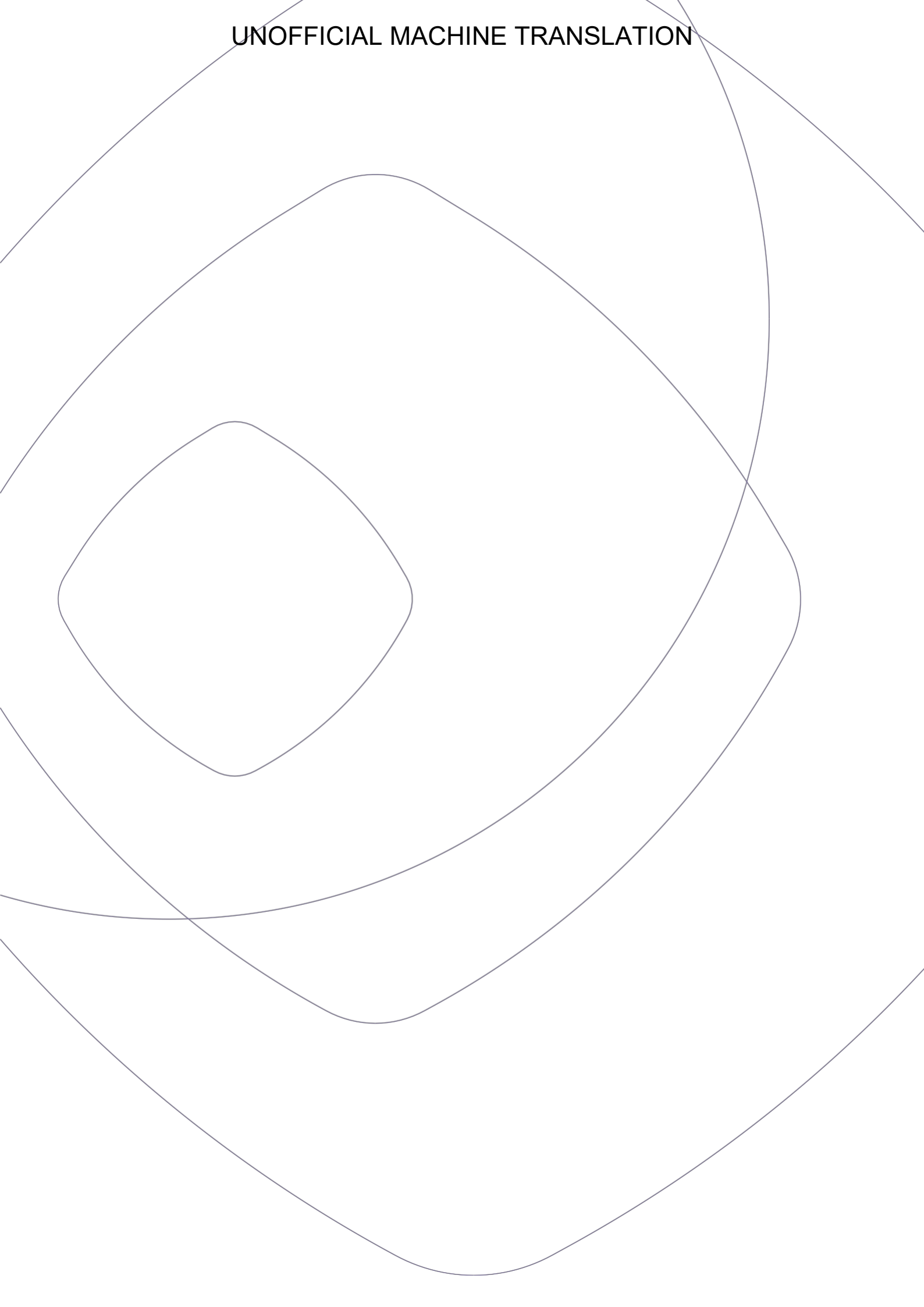

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Abbreviations used

Abbreviation	Description
4G / 5G	4th / 5th generation of IMT mobile communications
AM	Address space
API	Application Programming Interface
BCO	Broadband Competence Office
BEREC	The Body of European Regulators for Electronic Communications The Body of European Regulators for Electronic Communications
BoR	Board of Regulators
CATV	Cable television
CO	Central office
CSV	Standardised text format for representing tabular data, known as Comma Separated Values
CU	Control Unit, but I'm not sure if this relates to what's in the text
CVDSL	VDSL2 from the distribution cabinet
Czech Republic	Czech Republic
ČTÚ	Czech Telecommunications Office
DESI	Digital Economy and Society Index
DOCSIS	Standard for the transmission of data services over coaxial cables Service Interface Specification
DSL	Digital Subscriber Line
DP	Distribution Point
EECC	European Electronic Communications Code Communications Code
EC	European Commission
ESD	Electronic data collection
EU	European Union
EUR	Euro
EVDSL	Ethernet over VDSL
FTTH / FTTB / FTTP / FTTC / FTTN / FTTx	Fibre to the home (apartment) / to the building (to a block of flats with multiple residential units) / to the building's base / with the fibre terminating in an outdoor distribution cabinet (pole) / hybrid access network / other applications of optical fibre
FWA	Fixed Wireless System
GBER	General Block Exemption Regulation
GHz	Gigahertz
GIA	Gigabit Infrastructure Act
GSD	Geographic data collection / network mapping
GSMA	Association representing the interests of mobile network operators, Global System for Mobile Communication Association
HFC	A transmission network created by combining coaxial cable and optical fibres, known as Hybrid fibre-coaxial
HTTP	An Internet protocol designed for communication with WWW servers, from the English HyperText Transfer Protocol

INSPIRE	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing Infrastructure for Spatial Information in the European Community
ISP	Internet Service Provider
ITU	International Telecommunication Union
KPI	Key Performance Indicators
LAU	Local Administrative Units
LTE	Technology preceding the 4th generation of mobile communications, Long Term Evolution of the 3GPP radio technology
m	metre
M / Gbit/s	Mega / Gigabits per second
MIMO	An abstract mathematical model for a multi-antenna form of a wireless network, in English Multiple-Input Multiple-Output
MPO	Ministry of Industry and Trade
MRR	Less developed regions
NGA	Next Generation Access Networks Networks
NRA/OCA's	National Regulatory Authority / Other Competent Authority Other Competent Authorities
NTP	Average number of data streams
NUTS	Nomenclature of Territorial Units for Territorial Statistics
OECD	Organisation for Economic Co-operation and Development Co-operation and Development
OP TAK	Operational Programme Technology and Applications for Competitiveness
PLC	Powerline Communications
PR	Transition regions
QAM	Quadrature Amplitude Modulation
QoS	A parameter expressing the quality of service
RÚIAN	Register of Territorial Identification, Addresses and Real Estate
SCOBAM	Collective designation for OBAM, OVMAM and SOCAM address locations
SMP	Providers with significant market power
UF	Utilisation Factor
VDSL	A DSL technology enabling faster data transmission over existing telephone lines, Very High Speed DSL
VHCN	Very High Capacity Networks
Wi-Fi	A type of wireless technology for wireless LANs based on the IEEE 802.11 standards
WiMAX	A system for microwave access networks, known as Worldwide Interoperability for Microwave Access
WLAN	Wireless local area network
xDSL	A collective term for DSL connections implemented in various ways
ZSJ	Basic settlement unit

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1 Executive summary

Mapping of electronic communications network coverage in the Czech Republic is carried out in accordance with BEREC BoR (20) 42 guidelines and fulfils the obligations set out in the European Electronic Communications Code. Although the CTU fulfils its regulatory tasks responsibly and provides the necessary basis for monitoring coverage, there are areas relevant to the MIT where there is room for improvement, which could support the effective development of connectivity and the fulfilment of national and European targets in the field of digital infrastructure. The need for improvement is all the more urgent given that the Czech Republic still lags behind the EU average in terms of high-capacity network coverage and the achievement of national connectivity targets is unlikely. It is important to emphasise that, regardless of any changes to the data collection process, efforts should be made to keep the process as simple as possible, both from a user perspective and from a technical standpoint. It is advisable to continue reviewing the content and use of forms and to limit the scope of data collected to that which provides genuine added value for regulatory and analytical purposes. The aim is not only to make it easier for operators to fulfil their obligations, but also to ensure that data is collected and analysed to the standard required for the development of digital infrastructure.

One current shortcoming is the reporting of parameters for FWA networks, which may not fully reflect actual connection capabilities. This problem is particularly evident where actual parameters do not match the advertised speeds. It is recommended that a mechanism be introduced whereby operators transparently report the technical parameters of the infrastructure, including actual capacity, even at the backhaul network level. This would improve the quality and accuracy of the data and enable more precise identification of areas requiring intervention.

Current mapping provides sufficient quality from the perspective of legislative obligations; however, the collected data cannot yet be effectively utilised to support the development of telecommunications networks and improve connection quality, with the biggest problem remaining the definition and reporting of FWA connections and the lack of information on the overall network topology. Mapping could thus better serve to target support and direct investment towards areas where it is most needed in terms of meeting national connectivity targets and the development of VHCN networks. At the level of international cooperation, it is also important to monitor BEREC’s actions and the adoption of updated guidelines on mapping coverage by electronic communications networks

Management summary

The mapping of electronic communications network coverage in the Czech Republic is carried out in accordance with BEREC BoR (20) 42 guidelines and fulfils the obligations of the European Electronic Communications Code. Although the CTU performs its regulatory tasks responsibly and provides the necessary basis for monitoring coverage, there are relevant areas for the MIT where there is room for improvement, which could support the effective development of connectivity and the achievement of national and European digital infrastructure objectives. The need for improvement is all the more urgent given that the Czech Republic is still lagging behind the EU average in high-capacity network coverage and meeting national connectivity targets is unlikely. It must be emphasised that, across all possible modifications to the data collection process, efforts should be made to keep the process as simple as possible, both from a user and technical perspective. It is appropriate to continue reviewing the content and use of the forms and to limit the scope of data collected to that which provides real added value for regulatory and analytical purposes. The aim is not only to make it easier for operators to fulfil their obligations, but also to ensure that the data collected and analysed meets the quality standards required for the development of digital infrastructure.

A key shortcoming is currently the reporting of parameters for FWA networks, which may not fully reflect the actual connectivity. This problem is particularly evident where the actual parameters do not match the desired speeds. The recommendation is to put in place a mechanism whereby operators transparently report the technical parameters of the infrastructure, including the actual capacity.

The most applicable mechanism appears to be the one presented in Scenario 2, which involves enhanced data collection on available connections and the introduction of an advanced data analysis and verification process. This would improve the quality and accuracy of the data and allow for more precise identification of areas requiring intervention.

The current mapping meets legislative requirements, but the collected data cannot yet be effectively used to support the development of telecommunications networks and improve connection quality, where the main challenges remain the definition and reporting of FWA connections and the lack of information on the overall network topology. Consequently, mapping could better serve to target support and direct investment towards areas where it is most needed to meet national connectivity goals and drive VHCN network development. At the level of international cooperation, it is also important to follow the steps taken by BEREC and the adoption of updated guidelines on electronic communications network coverage mapping

2Introduction

This document is based primarily on Article 22 of the European Electronic Communications Code (hereinafter the 'EECC') [2018/19721], which sets out the obligations of Member States (hereinafter 'MS') regarding the geographical mapping of electronic communications networks enabling the provision of broadband access, and the issue of collecting geographical data on telecommunications infrastructure and the methodology for its collection in accordance with BEREC, specifically BoR (20) 42 (hereinafter "BoR (20)42"), which sets out the definitions of the indicators that national regulatory authorities / other competent authorities (hereinafter "NRAs/OCAs") must provide, including the minimum granularity of information.

2.1 Purpose of the document

The subject of this document is to prepare proposals for the efficient collection of data, limited to the minimum necessary scope, which:

- complies with the obligations arising from Article 22 of the EECC,
- supports the objectives of the Gigabit Infrastructure Act (GIA),
- complies with the obligations and recommendations arising from the BEREC Framework Directive, and
- meets the conditions of the EC Block Exemption Regulation [GBER 2] 651/2014 and the resulting requirements for adjustments to state aid.

At the same time, a key objective is to define the needs of the Ministry of Industry and Trade (MPO), particularly in relation to the identification of intervention areas (see the specific task to be addressed below), which is reflected in the need for additional information.

Geographical data collection serves not only the purposes of Article 22 of the EECC, but also to gather input for further activities both within the CTU (e.g. analyses of relevant markets, reviews for universal service purposes, etc.) and within the reporting of statistical data to the national statistical office, DESI, high-speed internet coverage, the OECD and others. The aim is therefore to describe existing data collection methodologies so that further information gathering needs can be identified in line with the requirements of the Ministry of Industry and Trade (below), which cannot be assessed on the basis of current data collection.

The main objective is to define the MIT's information requirements so that the relevant needs on the part of the MIT are captured; these form an essential basis for establishing strategies for the development of electronic communications networks (see below) and support decision-making processes in the field of public administration and the planning of state aid in accordance with strategic objectives. **The MIT's needs in relation to geographical mapping (whether regular or ad hoc) can thus be summarised as the need to have high-quality data available for informed decision-making.**

The objectives of geographic data collection/network mapping (hereinafter GSD) are as follows:

- **Obtaining data on broadband network coverage**: To enable national regulatory authorities and other competent authorities (NRAs/OCAs) to collect accurate data on network coverage.
- **Supporting regulation**: To provide the necessary evidence for effective regulatory intervention.
- **Designing national broadband development plans:** To assist in the creation and updating of strategies to improve the availability and quality of broadband networks.
- **Identification of market failures**: To identify areas where coverage is insufficient or where the market itself is failing, thereby enabling the design of appropriate subsidy policies.

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[1] Directive (EU) 2018/1972 of the European Parliament and of the Council

[2] Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in accordance with Articles 107 and 108 of the Treaty Text with EEA relevance

- **Compliance with obligations under the EECC and other documents**: To ensure compliance with the requirements and objectives arising from European and national legislation.
- **Support for extended needs beyond data collection**: To provide data for further analysis and decision-making that goes beyond routine geographical data collection.

The document will analyse the minimum requirements for the scope and granularity of data collection arising from national and international regulations, examples of best practice from abroad, and specific proposals for optimising the GS for the Czech Republic in line with the needs of the Ministry of Industry and Trade.

The output should lead to a clear definition of the MIT's data needs regarding the electronic communications market and the resulting evaluation of the network status, cost reduction, effective subsidy policies and acceleration of the roll-out of VHCN infrastructure.

2.2 Regulatory framework

The mapping must be designed and carried out in such a way that it can be used for the relevant regulatory obligations and policy/strategic objectives implemented at Member State level. These obligations arise in particular from the following documents, which directly or indirectly influence the obligations regarding the form and structure of the GSD:

- DIRECTIVE (EU) 2018/1972 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL – European Electronic Communications Code
  Electronic Communications (EECC)
- REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on measures to reduce the costs of deploying gigabit electronic communications networks and repealing Directive 2014/61/EU (GIA)
- DIRECTIVE 2014/61/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014
- Commission Regulation (EU) 2023/1315 'General Block Exemption Regulation' (GBER)[3]
- Commission Communication – Guidelines on State aid for broadband networks (2023/C 36/01)
- BEREC Guidelines on the geographical mapping of BoR network roll-out (20) 42
- BEREC Guidelines on the geographical mapping of BoR network roll-out (21) 32
- BEREC Guidelines on the geographical mapping of BoR network roll-out (21) 82
- BEREC Guidelines on Very High Capacity BoR Networks (23) 164

In the following sub-sections, we briefly discuss the relevant regulations for mapping. These do not relate solely to the actual mapping of networks, but also to supporting the implementation of a broader strategy to strengthen digital infrastructure in the EU, which is in line with the objectives set out in the Digital Decade initiative.

2.2.1 European Electronic Communications Code (EECC)

Of particular relevance to this study is Article 22 of the EECC, which summarises the key parameters of the GSD:

*"National regulatory and other competent authorities shall carry out geographical mapping of the coverage of electronic communications networks capable of delivering broadband access **at least once every three years**. Geographical mapping **may also include a forecast** for a period determined by the relevant NRA.*

*In a designated area, the competent authorities may invite undertakings and public authorities to make **a declaration of their intentions to roll out very high-capacity networks** during the period covered by the relevant forecast and to make a declaration of their intentions to roll out very high-capacity networks in the designated area or to significantly upgrade or extend their networks to a download speed of at least 100 Mbit/s.*[4]

[3] Replaces Commission Regulation (EU) No 651/2014 General Block Exemption Regulation (GBER)

[4] The EU Regulation, known as the GBER, further provides

Member States shall ensure that the authorities carrying out the geographical mapping provide the results, provided that the receiving authority ensures the same level of confidentiality and protection of trade secrets. BEREC, in close cooperation with the Commission and the relevant national authorities, shall issue guidelines to assist national regulatory or other competent authorities in the uniform fulfilment of their obligations."[5]

In conclusion, the following minimum obligation applies:

- To carry out geographical mapping of electronic communications network coverage at least once every three years.
- Mapping may also include forecasts for the roll-out of very high-capacity networks.
- The results are to be shared with the appropriate level of confidentiality.

2.2.2 General Block Exemption Regulation (GBER)

Another key document that quantifies the characteristics of the GSD for the implementation of broadband network development policies is the GBER, specifically Article 52, which deals with the regulation of aid for the deployment of fixed and mobile networks and, **in its Section 2d, aid for backbone interconnection networks**.

*The Directive further addresses eligible costs, requiring that … "Where an investment is carried out … without a competitive tender, the amount of aid must not exceed the difference between the eligible costs and the normal operating profit from the investment. Operating profit shall be deducted from eligible costs ex ante on the basis of reasonable assumptions and verified ex post through a clawback mechanism. For a measure to be considered a reasonable assumption, it is required **that all costs and all revenues** expected to arise over the economic lifetime of the investment **be taken into account**"*[6]

The GBER further stipulates that:

*"All elements of the methodology and the underlying technical criteria used for mapping target areas must be publicly available. **The mapping must always be verified through a public consultation**."*[7]

"The subsidised network must provide wholesale access… The price for wholesale access must be based on one of the following reference values and pricing principles:

a) average published wholesale prices prevailing in other comparable and more competitive areas of the Member State concerned;
b) regulated prices that have already been set or approved by the national regulatory authority for the relevant markets and services;
c) cost orientation or methodology established in accordance with the sector-specific regulatory framework'

Specifically for the 4G and 5G mobile networks sector, it is stipulated that:

"Supported infrastructure shall not be taken into account for the purposes of meeting mobile network operators' coverage obligations arising from the conditions attached to 4G and 5G spectrum rights."[8]

Specifically regarding support for backbone interconnection networks:

*"…the deployment of a backbone interconnection network must take place in areas where **no backbone interconnection network based on optical fibre or other technologies exists**."*[9]

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[5] Article 22 of DIRECTIVE (EU) 2018/1972 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL – European Electronic Communications Code (EECC)

[6] Article 52 of Commission Regulation (EU) 2023/1315 on the General Block Exemption Regulation (GBER)

[7] Ibid.

[8] Article 52a of Commission Regulation (EU) 2023/1315 on the General Block Exemption Regulation (GBER)

[9] Article 52d of Commission Regulation (EU) 2023/1315 (the General Block Exemption Regulation (GBER))

Network mapping to support the roll-out of fixed broadband networks and the deployment of mobile networks must, as a minimum, meet the following conditions:

- Network mapping may be considered appropriate if it is no more than eighteen months old.
- The mapping must include all networks that provide download speeds of at least 100 Mbit/s but less than 300 Mbit/s during peak hours (threshold speeds)
- The granularity of data for geographical target areas shall comply with the BEREC Framework Directive, see Chapter 3.
- The subsidised infrastructure must provide wholesale access at prices based on average wholesale prices or regulated prices approved by the national regulatory authority.

2.2.3 Gigabit Infrastructure Act (GIA)

Although the GIA Regulation does not directly concern the geographical mapping of electronic communications networks, it is a significant EU regulation closely linked to the development of broadband connectivity and the fulfilment of the Digital Decade's connectivity objectives.

The aim of this regulation is to facilitate and promote the roll-out of very high-capacity networks by supporting the sharing of existing physical infrastructure and facilitating the more efficient construction of new physical infrastructure, so that these networks can be rolled out more quickly and at lower cost. The recommendation on regulatory support for gigabit connectivity is also helpful for NRAs/OCAs.

The GIA focuses in particular on facilitating the coordination of broadband network deployment. The key articles are those relating to infrastructure and information sharing. These are, in particular, Articles 5, 6 and 10.

Article 5 stipulates:

'A request for the coordination of construction works submitted by an undertaking providing or authorised to provide public electronic communications networks to an undertaking providing or authorised to provide public electronic communications networks may be considered unjustified if both of the following conditions are met:

a) the request concerns an area covered by any of the following:
   i. a forecast of the coverage of broadband networks, including very high capacity networks, pursuant to Article 22(1) of Directive (EU) 2018/1972;
   ii. a call for the notification of an intention to build very high capacity networks pursuant to Article 22(3) of Directive (EU) 2018/1972;
   iii. a public consultation on the application of Union State aid rules;

b) the applicant undertaking has not expressed its intention to build very high-capacity networks in the area referred to in point (a) in any of the recent procedures referred to in that point and relating to the period during which the request for coordination is submitted.

Article 6 establishes the right of access to minimum information on all (public and private) planned construction works carried out by network operators via single information points in electronic form, including georeferenced information. Such access could be restricted, for example, on grounds of network security, national security or commercial confidentiality.

It provides for the earlier and proactive provision of minimum information on planned public construction works by all network operators through single information points, with the aim of facilitating the coordination of construction works where necessary.

Article 10 provides for a single national digital contact point and access to digital tools, in particular where there are multiple single information points or where information is located elsewhere, enabling the exercise of rights and compliance with the obligations laid down in this Regulation."[10]

[10] REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on measures to reduce the costs of deploying gigabit electronic communications networks and repealing Directive 2014/61/EU

2.2.4 BEREC Guidelines on the Geographical Mapping of Network Deployment BoR (20)42

The key document setting out the parameters for the GSD and elaborating on Article 22 of the EECC is the BEREC BoR (20)42 guidelines. The outputs of this manual can be divided into two main groups from a legislative perspective: guidelines necessary to fulfil **the obligations** arising from the Code, and **recommendations**.

2.2.4.1 Obligations

The boundary between an obligation and a recommendation is in many respects very blurred; under Article 21(1) of the EECC, NRAs/OCAs have the power to require information on electronic communications networks and associated facilities:

'… Obligations to provide information and submit reports under national legislation other than that relating to the general authorisation may require national regulatory and other competent authorities to require undertakings to provide information in relation to the general authorisation, rights of use or specific obligations referred to in Article 13(2), which are proportionate and objectively justified…'[11]

In accordance with Article 22, and pursuant to Article 20(1) of the EECC*,* NRAs/OCAs shall *ensure that* undertakings provide all necessary information:

…NRAs/OCAs, where necessary for the performance of their tasks, are in particular entitled to require such undertakings to provide information concerning the future development of networks or services that could have an impact on the wholesale services they make available to competitors, as well as information on electronic communications networks and associated facilities, which is broken down at local level and is sufficiently detailed to enable the national regulatory authority to carry out geographical mapping and designate areas in accordance with Article 22….

This means that the BoR guidelines (20)42 are designed to fulfil the obligations arising from Article 22 of the EECC. They do not directly impose obligations, but merely provide *guidelines* on the format of data collection, so that the data collected and reported complies with Article 22. BoR (20) 42 leaves considerable scope for NRAs/OCAs to supplement data collection with relevant parameters so that the objectives and strategies for broadband network development are met.

Further obligations arise from the so-called designated areas, which were identified within the GSD and the verification process as suitable areas for grant support for the deployment of broadband networks. According to Article 22(5), this requires authorities to take geographical mapping into account:

- when verifying the availability of services falling within the scope of universal service obligations,
- when allocating public funds for the deployment of electronic communications networks and drafting national broadband plans, including the appropriate identification of market failure areas,
- when defining coverage obligations associated with rights of use for radio spectrum

2.2.4.2 Recommendation

In view of BoR (20)42*, which* supplements Article 22 of the EECC *"requiring BEREC guidelines to aim for harmonisation and to establish a mandatory minimum number of QoS-1 indicators",* most of the subsequent GSD parameters are recommended by BEREC within the framework of BoR (20)42. However, as mentioned above, by referring to the relevant directive and regulation, NRAs/OCAs are permitted, within the framework of the GSD, to utilise derived mechanisms for the collection and sharing of the required data from network operators, particularly in the case **of the identification of intervention areas and state aid proceedings,** and**,** where applicable, pursuant to Article 29 of the EECC (2), to impose penalties for knowingly or through gross negligence providing misleading, incorrect or incomplete information.

[11] Article 21 of DIRECTIVE (EU) 2018/1972 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL – European Electronic Communications Code (EECC)

2.2.4.3 Conditions for the publication and aggregation of data

Data aggregation and its publication in the form of broadband market information for both private and public use are absolutely essential for realising the full potential of GSD. In the Czech Republic, for example, this is represented by the Broadband Competence Office (BCO)[12], which not only uses data from geographical mapping to provide an overview of available telecommunications services, but also creates its own data and map resources based on this information.

The results of the GSD should therefore be made available at a level of detail that enables end-users to ascertain the availability of connectivity in a given area, and which is sufficient to support their choice of operator or connection and to provide data for operators on intervention areas and their parameters.

However, in many cases, the data is subject to a certain level of confidentiality. When publishing such data, NRAs/OCAs must therefore take into account the legitimate interest of operators in protecting trade secrets and other confidential information, such as the protection of end-users' personal data, where a trade secret is defined *as*: *'confidential information relating to the business activities of an undertaking, the disclosure of which could cause that undertaking serious harm'*[13]

[12] https://www.bconetwork.cz/#gsc.tab=0

[13] Act No. 412/2005 Coll., on the protection of classified information and on security clearance, as amended

3 Mapping data structure

In this chapter, we examine the GSD data structure, the definition of intervention areas/state aid areas, and the mechanism for verifying and validating public consultation data. The information presented below is a summary and interpretation of BEREC guidelines for the geographical mapping of network roll-out, in particular BoR (20) 42, BoR (21) 32 and BoR (21) 82, which set out obligations and recommendations for NRAs/OCAs. In this chapter, we focus on fixed broadband network coverage, including FWA technology.

3.1 Data structure

In accordance with the guidelines of BoR (20)42, we adopt the definitions and terminology of BEREC (speed, range, resolution, etc.) in this study.[14] A specific feature is the QoS (Quality of Service) categories developed as part of *The European Broadband Mapping project,* which divides QoS into three categories:

- QoS-1: Calculated service availability – theoretical network performance of the existing infrastructure;
- QoS-2: Measured service provision – Measured service provision – Measurements using probes or drive tests, excluding measurements in the end-user environment;
- QoS-3: Measured service experience – Measurements using an internet access service, including measurements in the end-user environment, for example using online speed tests.

The aim of the Framework Directive is to define the smallest possible number of QoS-1 indicators (calculated on the basis of theoretical coverage and performance information) that are relevant to the majority of Member States; **however**, **it is within the exclusive competence of NRAs/OCAs to increase the number of indicators or categories for individual indicators**. NRAs/OCAs may decide:

- obtain information from operators;
- generate their own coverage and performance information using their knowledge of existing infrastructure;
- where necessary, use a third party to generate this information.

The main source of data and information is network operators who control any part of the access network (last mile, backhaul, etc.). National statistical offices and land registries may also provide relevant data for geographical surveys of broadband coverage. NRAs/OCAs must use a unified database that identifies each address or network using a unique code. The GSD survey on current broadband coverage should be **conducted at least once a year.**

3.2 Characteristics fixed network connection or service

The description of mandatory GSD parameters for telecommunications networks is **divided into Information and characteristics** required for fixed broadband connections and mobile broadband connections**. In this study, we focus solely on fixed broadband connections (including FWA)**, where the level of detail is to be at the level of specific addresses.

(14) For a complete description of the definitions, see the BEREC BoR (20)42 document https://www.berec.europa.eu/en/document-categories/berec/regulatory-best-practices/guidelines/handbook-of-berec-guidelines-on-geographical-surveys-of-network-deployments

NRAs/OCAs may choose the format for data collection from operators, provided that the data supplied is used to create a minimum dataset. The basic mandatory parameters for fixed broadband connections are:

1. the concept of households covered (so-called 'homes passed');
2. information on download and upload speeds;
3. access technology used;
4. high-resolution [data15].

Two different levels of granularity are permitted for fixed networks:

- **address level (address point) and**
- **in the case of FWA, a grid level of 100 x 100 m** or smaller (similar to a polygon level).

BEREC therefore distinguishes between data requirements according to the type of resolution chosen by NRAs/OCAs for coordination.

3.2.1.1 A subset of data characterising network coverage and performance – address-level accuracy

Network coverage is characterised by structured data that primarily describes the addresses provided by various operators. NRAs/OCAs must therefore provide the following information for each covered address:

- Operator code
  Technology code classified into a category in accordance with sub-section 3.2.1.3;
- Maximum download speed category in accordance with sub-section 3.2.1.4;
- Maximum upload speed category in accordance with sub-section 3.2.1.4;
- Expected download speed category during peak hours in accordance with sub-section 3.2.1.4;
- Expected upload speed category during peak hours in accordance with sub-section 3.2.1.4;
- Number of premises covered by the operator's network at the given address (optional)[16];
- Determine the VHCN network category for the address in accordance with Table 1.

If more than one technology is available at a given address for a single operator**, information must be provided for each technology**. To qualify its networks, the operator must specify a single VHCN category code, as set out in Table 1. Where networks meet the conditions for classification into a VHCN category based on multiple criteria, the operator need only specify a single code. A declaration that an address is covered by a Category 3 or 4 VHCN network means that all relevant quality of service thresholds for peak-time conditions are met at that address.

The BoR (20)42 guidelines require NRAs/OCAs to use a single address database, thereby creating a consistent summary of information from operators, as well as aggregated information.

3.2.1.2 A subset of data characterising network coverage and performance – grid-level accuracy

It is **also** possible **to collect** data **temporarily at network level** with the aim of collecting data at address level as soon as a geocoded address becomes available.

- Operator code
- Technology code categorised according to sub-section 3.2.1.3
- Maximum download speed category in accordance with sub-section 3.2.1.4.
- Maximum upload speed category in accordance with sub-section 3.2.1.4.
- Expected download speed category during peak hours in accordance with sub-section 3.2.1.4
- Expected upload speed category during peak hours in accordance with sub-section 3.2.1.4
- Number of areas covered by the given technology in the locality (optional)
- Determine the VHCN network category in the given grid cell according to Table 1.

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[15] Also known as granularity. Resolution expresses the size of the smallest object in a spatial data set that can be described, i.e. the smallest detail that can be distinguished.

[16] If detail is not collected at the level of the number of areas covered by a given AM, detail is collected at the level of coverage of a given address point (address passed).

Operators specify VHCN categories as set out in Table 1 below. For a grid cell to be classified as served by a VHCN network of a given category, the conditions relevant to that category must be met for at least 95% of the addresses in the grid cell. This means, for example, that 95% of the addresses in the grid cell are within the coverage area of the optical access infrastructure, or that 95% of the addresses in the grid cell are served by base stations connected via optical fibre.

3.2.1.3 Subset of data to be collected for the purpose of determining the coverage and performance of an FWA network

FWA architecture differs from that of fixed networks due to the intrinsic characteristics of wireless connectivity. FWA technologies are divided into licensed-spectrum FWA and unlicensed-spectrum FWA (see Table 2). NRAs/OCAs may further subdivide these categories if they deem it appropriate for their needs. In accordance with the principle of technological neutrality, both fixed and FWA architectures may be used to provide fixed services. Regulatory authorities may therefore include FWA infrastructure in their GSDs as fixed broadband rather than mobile broadband. By combining information from fixed and FWA architectures, it is stipulated that **the same speed categories and QoS parameters defined for fixed networks also apply to FWA.** This requires the calculation of 4 different speed indicators per address (or at grid level):

- maximum download speeds;
- maximum upload speeds;
- expected download speeds during peak hours;
- expected upload speeds during peak hours.

NRAs/OCAs may require that each speed indicator be based on a separate and independent calculation. However, with a view to the efficient provision of data**, they may also use reasonable and appropriate estimates, in which case operators must inform the NRAs/OCAs of their assumptions and demonstrate their reliability**.[17] QoS-1 speed indicators relevant to Article 22 **should take into account the achievable speed**, rather than the speed actually experienced by end-users.

3.2.1.4 Technology

BEREC considers it important to collect information on the type of physical transmission medium and the technology on which the provision of the service in the access network is based.

Table 1 VHCN categories

VHCN category	VHCN code
Not covered by VHCN.	0
Installation of an optical network at the address	1
Installation of an optical network to the base station (relevant for FWA)	2
No optical network is connected to the address, but all performance thresholds under criterion 3 of the VHCN Network Guidelines are met	3
No optical network is connected to the base station, but all performance thresholds under criterion 4 of the VHCN Network Guidelines are met (relevant for FWA).	4

The regulatory authority **should collect information on the type of physical medium and** technology supporting service provision at the network access point (Table 2). NRAs/OCAs may collect this information at the medium level and use medium codes if data is collected at the network level and/or if data is provided by multiple operators. NRAs/OCAs may include new categories of media codes as they become available.

[17] With a view to harmonisation at European level, BEREC is analysing the prerequisites for providing information on speed categories for the purpose of geographical mapping.

Table 2 Media code categories

Description	Code	Media code
DSL over copper	DSL	Copper
VDSL over copper	VDSL	
VDSL-Vectoring over copper lines	VECT	
DOCSIS 1.0/2.0 coaxial cable	DOC1	Coaxial
DOCSIS 3.0/3.1 coaxial cable	DOC3	
FTTH/FTTB	FTTH/B	Fibre
FWA in the licensed spectrum	FWA	Air
FWA in unlicensed spectrum	Wi-Fi	
Other	OTHER	Other

3.2.1.5 Classification of speed categories

Both the maximum and expected peak-time speeds must be stated. The submission of speed category information requires the calculation of various speeds at a specific address (or, where applicable, at the grid level, relevant for FWA) (maximum download/upload speed and expected peak-time download/upload speed). NRAs/OCAs may require that each speed indicator be based on a different and independent calculation.

QoS-1 speed indicators relevant to Article 22 should reflect the achievable speed rather than the speed experienced by the end-user. Likewise, the requirement for an intervention area (Article 22(2)) necessitates consistency between VHCN category information and speed category information, specifically with regard to the threshold of +100 Mbit/s. Therefore, the layer at which speeds must be calculated must be the layer specified in the VHCN guidelines, i.e. based on the IP packet load layer (transport layer).

Table 3 Speed categories

Speed	Code
Greater than or equal to 1 Gbit/s	1000
≥ 300 Mbit/s < 1 Gbit/s	300
≥ 100 Mbit/s < 300 Mbit/s	100
≥ 30 Mbit/s < 100 Mbit/s	30
≥ 10 Mbit/s < 30 Mbit/s	10
≥ 2 Mbit/s < 10 Mbit/s	2

3.3 Data collection systems

The main data collection system is GIS. This sub-section provides information on how to start the mapping process and which data are relevant to these guidelines.

3.3.1 Data collection layers

A map layer may contain groups of point, line or area (polygon – multipolygon) features representing a specific category or type of real-world objects, such as customers, streets, postcodes, etc. A layer contains both a visual representation of each feature and a link from the feature to its database attributes.

Table 4 Data collection layers

Layer type	Layers that may be held by NRAs/OCAs	Layers relevant to the basic guidelines of BoR 20 (42)
Reference layer	• Rural and urban areas (polygons or raster)	• Addresses (points),

	• Places of public interest, such as universities, schools, hospitals and public spaces • Land cover (polygons or raster) • Transport routes (lines or polygons) • Environmental data (polygons or raster) • Census areas with socio-demographic data (polygons) • Base maps	• Grid cells, 100 x 100 m or smaller (polygons that can be rasterised)
Raw inventory data layer		• Covered areas by operator, transmission medium, technology, speed, VHCN network category and other parameters for fixed broadband connections at reference address points • Covered area by operator, transmission medium, technology, speed, VHCN network category and other parameters for fixed and mobile broadband connections – in reference grid cells.
Layers of analysis results		• Aggregated grid cell coverage, 1x1 km • Aggregated grid cell speed, 1x1 km • Other as determined by the NRA or BEREC

3.4 Specification of development forecasts

Article 22 of the EECC requires Member States to conduct a survey of the current geographical coverage of broadband connections. **However**, NRAs/OCAs **may also request forecasts** of future broadband coverage, including VHCN; nevertheless, the collection of such data is not mandatory under Article 22.

Detailed information on the broadband network development plan is necessary in particular for the following:

- **Identification of intervention areas:** This follows from the definition in Article 22(2) of the EECC. NRAs/OCAs may assess that, during the relevant forecast period, no undertaking or public institution has deployed or plans to deploy VHCN, or to significantly upgrade its network to a performance of at least 100 Mbit/s for data downloads. The NRA/OCA may therefore, after 'designating' an area, request further information on the parties' intentions to introduce VHCN or upgrade their networks to a download speed of at least 100 Mbit/s, in the form of a so-called public consultation.
- **State aid proceedings**: The State Aid Guidelines impose an obligation on the competent authorities to conduct a public consultation, which may enable them to obtain information on the investment plans of economic operators in defined areas (grey, white) that do not meet various broadband availability standards. White areas are those where there is no broadband infrastructure and where it is unlikely that any will be built in the near future. Grey areas are those where a single network operator is present and further network infrastructure is unlikely to be built in the near future.

3.4.1 Broadband coverage forecasts

For the purposes of forecasting broadband development, it is appropriate to use a different level of information than that required purely for the GSD of broadband networks. The use of methods for verifying, recording or not recording repeated failures in the provision of information, etc., should be within the remit of NRAs/OCAs.

Identification of information providers

NRAs/OCAs must request information from all potential investors (network operators, public authorities and, where applicable, other investors). Small players are also important, and it is in their own interest to provide this information so that their investment plans are not disrupted by subsequent public intervention

Definition of the data collection area

Locations where no VHCN or network with a download speed of at least 100 Mbit/s is available in the area and no plans for its deployment are known. In the context of state aid, information on forecasts should be collected for areas where public authorities intend to intervene (grey, white and areas where market failure is expected to occur).

Frequency of data collection
BEREC recommends that data be collected regularly, once a year, within the selected areas.

Data resolution

For the purposes for which the data is collected (state aid and the identification of intervention areas), high resolution is essential. In the case of fixed broadband, this means data collected at address level with precise geocoding. In the case of FWA, at least at address level or at a grid level of 100 x 100 m or smaller (or polygons with equivalent resolution).

Types of data collection
Forecast information should be provided in accordance with the following table:

Table 5 Information to be collected on forecasts

Variable download	Grid or address	Area code (optional)	Operator	Code technology	Category Maximum network download	Category VHCN network	(Estimated) Date launch construction	Estimated end end construction
	Data to be requested from network providers							
Description	Information identifying grid or address provided at the NRA.	Area code taken into account to the lowest administrative unit in Member state.	Code operator according to list provide NRA	Codes in the table 2 (column 2) (fixed connection) and category in Table 13,	Category speed after structure network. The code in table in Appendix 2.	Codes according to Table 1 (fixed and wireless)	Date (may be and in the past)	Date (before end three-year-old period)

3.4.1.1 Verification

NRAs/OCAs should endeavour to verify information on broadband coverage forecasts in accordance with the principle of proportionality and in compliance with legislative rules. Two types of verification may be considered: ex ante verification (i.e. at the time the information is requested) and ex post verification (i.e. after the period for which the forecast was compiled has elapsed).

Ex ante verification involves:

- An assessment of the operator's investment track record (e.g. scale, population density and location of past investments) in comparison with the proposed investment.
- Comparing the size of the investment with the size of the operator.
- Comparing the investment forecasts of different operators to identify 'outliers' (e.g. in terms of the size of the investment relative to the size of the company).
- Assessing the achievement of key milestones in the investment plan within the planned project timeline (taking into account the scope of the project, the granting of permits, and the execution of engineering works).

Ex-post verification involves comparing forecasts with the network roll-out projects actually implemented, to verify the extent to which the operator adheres to the planned timetable and achieves the project's key milestones. In the event of significant deviations, the operator may be asked to justify them.

3.5 Data publication

The EECC **requires NRAs/OCAs to make GSD data** that is not subject to commercial confidentiality **directly accessible**, thereby enabling its re-use. This topic is further covered by Directive [2019/1024][18] on open data and the re-use of public sector information, as well as the obligation of NRAs/OCAs to make data available to the Commission and BEREC upon a justified request. Requirements for the GSD information system should reflect the guidelines of the INSPIRE Directive.[19]

NRAs/OCAs shall make information tools available that enable end-users to determine the availability of connectivity in different areas, at a level of detail that is useful for supporting the choice of operator or service provider.

NRAs/OCAs have several options for publishing GSD data:

- Interactive maps published in a dynamic web application;
- Interactive address search published in a dynamic web application;
- Application programming interfaces ("API") providing access to the data;
- Data files in open and common formats, such as CSV,
- Statistical reports, including tables and analyses.

3.5.1 Data confidentiality

When publishing GSD data or providing access to it, NRAs/OCAs should take into account the legitimate interest of economic operators in protecting their trade secrets and other information relating to their business, as well as confidential information such as the protection of end-users' personal data.

Some examples of information that may be considered trade secrets and which may be regarded as confidential in the context of the GSD are:

- Operators' forecasts regarding network roll-out;
- Detailed information from operators regarding the location and type of various network elements, with the exception of network elements subject to a wholesale access obligation requiring the disclosure of such information; and
- Operators' manufacturing secrets and processes, as well as information relating to the undertaking's know-how, such as the tools and methods it uses to calculate coverage information.

GSD data can be accessed at various levels of spatial resolution, such as points, grids, postcodes or NUTS. The European Commission uses aggregated information at national level (based on NUTS 3 data) to monitor and compare the digital performance of Member States.

3.5.2 Aggregation and access to data

When granting access to GSD data, NRAs/OCAs must bear in mind that granting access to data entails varying levels of risk relating to data confidentiality:

[18] Directive 2019/1024 of the European Parliament and of the Council https://eur-lex.europa.eu/legal-content/CS/TXT/?uri=CELEX%3A32019L1024

[19] Directive 2007/2/EC of the European Parliament and of the Council, https://inspire.ec.europa.eu/documents/directive-20072ec-european-parliament-and-council-14-march-2007- establishing

- Geocoded information (e.g. points or addresses) requires a strong incentive for publication, as data privacy concerns are more likely to arise with such highly precise geographical data.
- Network-level data, compared to geocoded information, typically involves a different scope and user requirements than network-level data. However, it can potentially have a significant impact in terms of data confidentiality.
- Data at the level of local administrative units ('LAU' or postcodes) carries a medium risk of disclosure. In most cases, these are likely to be sufficiently small territorial units to avoid data privacy issues.
- Data at the NUTS level most likely poses a low risk to data confidentiality. In most cases, these are likely to be sufficiently large territorial units to prevent any breach of data confidentiality.

Examples of appropriate spatial aggregations of the collected data are as follows:

NUTS 3 level:

- for monitoring the objectives of the European Gigabit Society;
- for the European Broadband Mapping Portal (public view).

Local Administrative Unit (LAU) level

- to verify the availability of services falling under universal service obligations (Article 22(5)) or to impose relevant universal service obligations (Article 86(1));
- To determine coverage obligations associated with rights of use for radio spectrum (Article 22(5)). This is not an exhaustive list of examples, but rather some common ones.
-

The level of a 1 km grid square:

- to define an area with clear territorial boundaries where no undertaking or public authority has built or plans to build a VHCN network;
- nor does it plan to significantly upgrade or extend its network to a download speed of at least 100 Mbit/s (Article 22(2) and (3));
- for the European Broadband Mapping Portal (expert view)

Geocoded information at point or address level:

- for the application of State aid rules (Article 22(1));
- for the allocation of public funds for the deployment of electronic communications networks and the drafting of national broadband plans, including the appropriate identification of market failures (Article 22(5)).

3.6 Summary of obligations and recommendations

The EECC refers directly to the guidelines issued by BEREC. The summary of obligations and recommendations arising from BEREC's BoR (20) 42 guidelines is divided into obligations and recommendations by type of broadband connection, namely fixed and wireless (including FWA). See Table 7.

Table 6 Summary of obligations and recommendations for mapping coverage by electronic communications networks

	Fixed connections	
GSD parameters	**Obligation**	**Recommendation**
Geographical mapping	**X**	
Annual mapping frequency		**X**
Households covered (so-called 'homes passed')	**X**	
Access technology used	**X**	
High-resolution data	**X**	
Grid resolution 100 x 100 m		**X**
Availability of broadband services in a specific area (100x100 m)	**NA**	**NA**
User location	**NA**	**NA**
Maximum download speed category	**X**	
Maximum upload speed category	**X**	
Invitation to submit investment proposals (public consultation)		**X**

In connection with the GSDs required to obtain grant support for network deployment**,** the General Block Exemption Regulation (GBER) emphasises **additional obligations relating in particular to the organisation of data collection and evaluation.** These obligations are specifically tailored to the mapping of areas falling within intervention zones and state aid areas, and are key to the effective processing and implementation of state aid in these sectors. This includes, in particular, the following obligations:

- Mapping must always be verified through a public consultation.
- The subsidised network must provide wholesale access, with the price for wholesale access based on one of the following reference values and pricing principles:
  a) average published wholesale prices prevailing in other comparable and more competitive areas of the Member State concerned;
  b) regulated prices that have already been set or approved by the national regulatory authority for the relevant markets and services;
  c) cost orientation or a methodology established in accordance with the sectoral regulatory framework

For the purposes of the Ministry of Industry and Trade and the direction of grant support focused on the construction and development of electronic communications networks, the creation and development of a unified digital platform for existing physical infrastructure, which stems from the **GIA** Regulation **and relates in particular to data sharing arrangements,** is also decisive**.**

3.7 Data collection mechanism

Within the framework of the GSD objectives, this chapter addresses **the** BEREC **recommendation** and the consistent implementation of Article 22(2), (3) and (4) of the EECC Directive. These paragraphs describe certain optional policies that NRAs/OCAs may adopt with the aim of informing private and public entities about the unavailability of existing or planned VHCN networks and providing information to potential investors, thereby creating a more transparent environment for investment in VHCNs.

3.7.1 Definition of intervention areas pursuant to Article 22(2–4) of the EECC

An intervention area is an area with clearly defined boundaries where no undertaking or public body has deployed or plans to deploy a VHCN network, or to significantly upgrade or extend its network to a capacity of at least 100 Mbit/s for download speeds. The definition and publication of these areas is an important (optional) tool that enables public and private entities to be informed about the state of broadband connectivity in these areas.

3.7.1.1 Information on intervention areas

With regard to the data collected under the GSD for the purpose of identifying intervention areas, the following information is used:

- availability of a fixed broadband service providing a download speed of at least 100 Mbit/s;
- availability of mobile broadband providing download speeds of at least 100 Mbit/s;
- availability of VHCN fixed broadband services;
- availability of VHCN mobile broadband services.

BEREC requires that, for fixed broadband services, NRAs/OCAs provide information on speeds within the country for two different speed definitions: maximum achievable speed and expected

peak speed, either at address level or for small grids (100 x 100 m). For mobile broadband connections, BEREC **has** recommended the **optional** use of maximum achievable speed for the classification of small network services across the entire national territory. When publishing intervention areas, the type of speed definition must also be published so that operators can understand the characteristics of these intervention areas.

In addition to up-to-date information on broadband coverage and service quality, NRAs/OCAs may use information from network development forecasts obtained under the GSD to define intervention areas.

"This forecast shall contain all relevant information, including information on the roll-out of very high-capacity networks and on significant network upgrades or extensions to download speeds of at least 100 Mbit/s planned by undertakings or public authorities. To this end, national regulatory or other competent authorities shall require undertakings and public authorities to provide them with such information to the extent that it is available and can be provided with reasonable effort"[20]

The reliability of forecast information is important in many respects. The competent authority should therefore make reasonable efforts to verify broadband coverage forecasts obtained from GSD data provided by relevant operators.

3.7.1.2 Delimitation and definition of intervention areas

Based on previous GSDs, NRAs/OCAs should already have a certain understanding of the parameters and quality of broadband service. The following paragraphs set out **BEREC's recommendations** regarding the delineation of intervention area boundaries and other criteria that may be considered for defining these areas in accordance with the objectives of this process.

In the case of a call for expressions of interest regarding future deployment, it may be sufficient for the competent authorities (NRAs/OCAs) to identify addresses without relevant services; however, in the case of more comprehensive spatial planning and development, the definition of relevant areas should take into account a wider range of parameters.

Intervention areas must meet the conditions of Article 22(2) of the EECC, namely:

- Addresses/grids (100 x 100 m) that are not covered by VHCN or a network offering download speeds higher than 100 Mbit/s;
- clear territorial demarcation;
- a published list of intervention areas (see BoR 20(42)).

NRAs/OCAs may wish to group addresses/grid cells according to the network's expected profitability. Areas with higher expected profitability may offset those with lower profitability, so that the intervention area as a whole remains attractive to investors. Given the nature of intervention areas, it is in the interest of NRAs/OCAs to take into account additional defining criteria, such as socio-economic and demographic characteristics.

BEREC recommends that the requirements for the publication of information on intervention areas be carried out on an annual basis, which can align with the regularly conducted (annual) GSD, thereby enabling the definition of intervention areas based on up-to-date information.

The publication of information regarding intervention areas is mandatory if the areas have already been defined by the competent authority. The information must be accessible on the competent authority's website or on related web portals. The published information must enable the precise boundaries of the intervention areas to be identified. BEREC recommends one of the following approaches:

- Interactive maps published in a dynamic web application;
- Interactive address search published in a dynamic web application;
- An application programming interface ('API') providing access to the data;

[20] Article 22 of the EECC – Directive (EU) 2018/1972 of the European Parliament and of the Council

- In the case of administrative boundaries that are easily understandable to all parties, by publishing a report.

3.7.2 Calls for declarations of investment intentions

Article 22(3) describes **optional procedures** by which the competent authority may invite undertakings and public authorities to notify their intention to deploy VHCN within intervention areas; this is divided into a first and a second call for notification of investment intentions. Under the first call, NRAs/OCAs may invite relevant entities to declare their intention to deploy VHCN within the given forecast period. Secondly, if this call results in a declaration by any of the entities of their intention to invest within a given intervention area, the competent authority may invite other undertakings and public authorities to notify any intention to deploy VHCN or to significantly upgrade or extend their network (>=100 Mbit/s) in that area. In the second call, NRAs/OCAs should clearly inform the public of the definition of speed.

Calls must be published for public authorities and private entities. The publication of calls must ensure that procedures are effective, objective, transparent and non-discriminatory, and in accordance with applicable legislation.

3.7.2.1 Procedures for the first call

Calls must take the form of a public consultation to ensure that no relevant operator or public authority is overlooked. The NRA/OCA is responsible for ensuring that the data requested in the call is at least at a similar level of detail to that required and taken into account in the forecasts pursuant to Article 22(1) of the EECC. Penalties in the event that an entity knowingly or through gross negligence provides misleading, incorrect or incomplete information during these selection procedures shall be governed by Article 29(2) of the EECC. The timeframes for the forecast period shall be determined by the competent authorities and should be consistent with the objective pursued.

In order to achieve the objectives of the call for investment proposals, it is recommended that at least the following elements be required:

- The identity and contact details of the respondent,
- An exhaustive list of the targeted areas where the investor plans to build networks,
- A project plan that is as detailed as possible in terms of both geographical and technical aspects (i.e. the planned coverage of addresses/small grids by the responding undertaking and the network topology),
- A network roll-out timeline, including specific construction milestones, covering at least the fixed forecast period,
- Technological suitability in terms of the service level of the very high capacity network,
- Information on whether funds for the investment have already been allocated.

The competent authority may consider requiring the publication of further information, provided that such information is relevant to enabling operators to better assess their investment plans and respond to the second call. All information must comply with the obligation to protect trade secrets. Sensitive information must therefore be published in summary or anonymised form.

When publishing data and information from the first call, it is recommended to publish the following information:

- the number of entities that declared an intention to invest in the first call;
- the status of investments (announced, planned, funded, ongoing);
- the percentage of the territory (or addresses) to be covered within the designated area, or alternatively qualitative information on territorial coverage (for example: low coverage – less than the pre-determined coverage threshold; medium – coverage between pre-determined thresholds; higher than the coverage threshold);
- Reported intention of a wholesale operator;
- Reported intention of a state-owned enterprise;
- Network type (technology or medium used).

To ensure the credibility of the published information, NRAs/OCAs may require further information regarding the declared intention of the submitted deployment plan:

- Financial feasibility of the project (planned budget, financial commitments, bank guarantees),
- Commitment to complete the investment and adhere to the roll-out schedule,
- Marketing information on offers to retail customers,
- Terms and conditions available for a competitive offer of electronic communications services (specifications of wholesale services, including technical information such as supported access interfaces, or legal and financial terms of the offers, e.g. non-discrimination agreements),
- Description of backbone network technology and specifications of backbone network equipment, backbone network design and operational assumptions.

NRAs/OCAs must take into account the actual ability of entities to report the required information and adhere to the principle of reasonable effort when aggregating and publishing the required data. The condition of accessibility of information, i.e. that the information is easily accessible to all entities, requires, as a minimum, that the information be made available on the relevant authority's website or on related portals.

3.7.2.2 Procedures for the second call

Depending on the results of the first call, the NRA/OCA may decide to issue a second call. The second call serves to supplement any missing information and, in particular, to target a broader audience. To ensure that all entities are treated equally, the same information must be requested in both the first and second calls.

3.7.3 Conditions for ex post publication of call information

Information will be published either following the second call or following the first call, if no second call has taken place. The competent authority will always analyse the risk of publishing the information and consider the appropriateness of aggregation to avoid compromising trade secrets. Information should be provided:

- To entities that participated in the process (and which expressed an interest in investing);
- Other public authorities with specific responsibilities, so that they may take this information into account in the performance of their duties. These are local, regional and national authorities responsible for allocating public funds for the deployment of electronic communications networks.
- BEREC and the EC, but only upon a duly justified request.

3.8 Verification process

BoR Guidelines (20) 42 set out the definitions of all mandatory indicators that NRAs/OCAs must record, and the minimum granularity of information. As part of the verification process, all authorities should regularly check the internal consistency of the QoS-1 data provided by operators. The verification process thus lies at the intersection of GSD data collection and evaluation.

The basic steps for ensuring data quality are as follows:

1. Step 1: validation of the internal consistency of the database;
2. step: use of external intermediaries to report data inaccuracies;
3. step: verification phase, during which data is compared with external data sources;
4. step: decision following external validation that the data is incorrect; and
5. step: where necessary, amendment of the data and further consequences.

NRAs/OCAs may use the information collected under Article 22 to support the state aid process, but it may also be necessary to collect supplementary information in accordance with state aid rules. However, it is essential during the data verification process to use the same methodology that was used for data collection.

As part of the verification of fixed broadband data, data characterising network coverage and performance (Section 3.2.1.1.) are checked, namely:

- Operator code
  Technology code classified into a category in accordance with sub-section 3.2.1.3;
- Maximum download speed category as per sub-section 3.2.1.4;
- Maximum upload speed category as per sub-section 3.2.1.4;
- Expected download speed category during peak hours in accordance with sub-section 3.2.1.4;
- Expected upload speed category during peak hours in accordance with sub-section 3.2.1.4;
- Number of premises covered by the operator's network at the given address (optional)[21];
- Determine the VHCN network category at the address in accordance with Table 1.

3.8.1 Verification steps

Responsibility for providing coverage and performance indicators lies directly with the operators, with NRAs/OCAs collecting and processing this data; however, authorities may also find it useful to carry out certain verifications of their own calculations to check the assumptions used in the modelling. A detailed description of the five basic data quality assurance steps outlined above follows.

3.8.1.1 Internal validation

The first step is designed to ensure that the data used by NRAs is accurate and reliable:

1. Consistency checks: Routinely verify the internal consistency of service quality (QoS-1) data from operators.
2. Quality assurance: Check the main databases to ensure that no data is missing, that there are no errors in the reported units, and that there are no internal inconsistencies.
3. Consistency: Use algorithms or automated checks to assess data consistency.
4. Anomaly analysis: Conduct a detailed analysis to identify any inconsistencies or anomalies in the data.
5. Time series comparison: Compare data across different periods to detect unreasonable discontinuities.
6. Ensuring data integrity: Verify the integrity of the database before publishing any data.

3.8.1.2 Using third parties to identify inaccuracies in data

In the second step of the third-party data verification process, the NRA should:

1. Encourage public feedback: Actively encourage public feedback on published broadband data to identify any inaccuracies.
2. Assess reports: Carefully evaluate reports from third parties, such as end-users and other stakeholders, to identify any discrepancies in the data.
3. Cooperation with operators: Consult with telecommunications operators to address and rectify reported discrepancies.
4. Simplifying reporting: Integrating features into public mapping tools that enable end users to submit reports easily, including details such as observed speeds and service characteristics.
5. Using technology to extend reach: Utilising APIs and other technologies to maximise the dissemination of map data and gather more extensive feedback.
6. Publication of detailed geographical data: Where possible, detailed geographical data must be published to ensure that feedback from the public and stakeholders is as accurate as possible. Where this is restricted, it is important to provide the most detailed data possible, as far as is legally and technically feasible.
7. Data confidentiality: The sharing of necessary data with other public authorities takes place under strictly confidential conditions.

[21] If details are not collected at the level of the number of areas covered by a given AM, details are collected at the level of the specific address (address passed).

3.8.1.3 Verification and decisions regarding data accuracy

For verification steps 3 and 4 (section 3.8 above) in the verification phase and when deciding on validity, the NRA should proceed as follows:

1. External validation: External validation of the main database using other available data sources, such as georeferenced information on active connections, the location of access nodes, general telecommunications databases and data from state aid proceedings.
2. Use of existing databases: Verification using existing databases available within the authority or from other public authorities.
3. Assessment of data requests: Where further data is requested from operators, the relevant authority should assess the necessity and proportionality of such requests to ensure that they are proportionate and do not place an undue burden on the provider.
4. Resolving discrepancies: Where discrepancies are identified, contact the relevant operators and discuss with them any discrepancies found between the data they have submitted and the verification information.
5. Authority's decision: The final decision on updating the main database lies with the authority, based on its assessment following a review of all verification information and feedback from operators.
6. Integration of data into GIS: For effective verification, integrate the main and secondary databases into various layers of the geographic information system (GIS). Consider creating new databases for newly acquired data.

4 Geographical data collection in the Czech Republic

In the Czech Republic, the Czech Telecommunications Office (ČTÚ) is responsible for geographical data collection. Every year, the ČTÚ regularly collects data on the existence of electronic communications networks enabling the provision of internet access services in various GSD speed categories, via the electronic data collection system (ESD). This data is geographically broken down into individual address points according to the Register of Territorial Identification, Addresses and Real Estate (RÚIAN), as of 31 December of the given year. The authorisation to collect data stems from the provisions of Section 115a(1) of the Electronic Communications Act No. 127/2005, as amended. Paragraphs 2 and 3 of the said Act and the implementing regulation on access to the Mapping (ESD) software application, laid down by Decree No. 52/2022 Coll.[22] are also key to the mapping process.

The collected data is used, among other things, by the Ministry of Industry and Trade (MPO), which utilises it to define intervention areas to which subsidy support for the construction of electronic communications networks should be directed. The CTU uses the collected data for its other activities, particularly in the context of market monitoring, analysis, inspection, international reporting and the state statistical service.

Currently, the statutory obligation arising from Article 22 of the EECC and the BoR guidelines derived therefrom (20)42 is being fulfilled. Furthermore, the CTU endeavours to meet market requirements, reduce the administrative burden of GSD for operators and simplify the entire registration process.

4.1 Entities subject to data collection

Within the Czech Republic, the GSD contains data only for business entities that are registered with the CTU and that submit data via the ESD. Non-business entities (i.e. entities not registered with the CTU) are not currently required to submit completed GSD forms.

4.2 Data collection procedure

Businesses provide data on the number of available connections for various technologies such as FTTH, FTTB, xDSL, CATV and wireless technologies. This data is categorised by speed, ranging from 2 Mbit/s to over 1 Gbit/s. The resulting data is then processed and aggregated by the CTO into territorial units, known as basic settlement units (BSUs), for which colour codes (white, grey, black) were previously assigned based on infrastructure coverage.

The ESD system is a secure information system that uses electronic forms for data collection. Access to the system is restricted to registered users, and all required information is submitted exclusively in electronic form. The CTO provides form templates and detailed instructions for completing them, which also include geographical data.

Different forms serve specific purposes and focus on various aspects of telecommunications activities. Key forms include:

[22] Decree No. 52/2022 Coll. on the technical and organisational conditions for the use of the software application and electronic form for data collection in the field of electronic communications

Form ART242 – Services provided in electronic communications

- It contains data on the types of services provided, their scope and geographical distribution.
- It is used for market monitoring and international reporting.
- It includes annexes for geographical data collection, which are used for detailed mapping of service coverage and availability in various areas.

Form BH23 – Geographical data on access and distribution optical networks

- Records information on optical networks and their transfer points.
- It is used for infrastructure planning and for geographical mapping of coverage.

Form ART241 – Services provided in electronic communications

- Provides interim information required for monitoring and analysing the electronic communications market at the mid-year point.
- It contains information on the same services monitored under Form ART242, but in a version of the form with a smaller scope of data (for the period from 1 January to 30 June of the relevant year).
- It is used to assess the state of the market and determine regulatory measures, in a similar way to Form ART242.
- It does not include geographical data collection, which is only part of the annual data collection.

4.2.1 Publication of data

Given the strong emphasis on a single information point within both the GIA and the BoR (20)42 BEREC guidelines, the publication of information is divided across several related websites:

- Internet Map (https://www.mapainternetu.cz/)
  provides an interactive map showing the coverage of the Czech Republic by electronic communications networks enabling fixed-location internet access across various speed and technology categories, by specific infrastructure operators, down to the address level.

- Telecommunications Services Visualisation Portal (https://vportal.ctu.gov.cz/intro)
  VPortal offers a comprehensive visualisation tool that helps users compare the quality of telecommunications services (fixed, mobile and others) in the Czech Republic.

- Public Consultation (https://www.verejnakonzultace.cz/)
  The Ministry of Industry and Trade's web portal for public consultations on programmes to support the roll-out of high-speed internet networks across the Czech Republic

4.3 Assessment of network capacity based on data collection

The assessment of the impact of network capacity on the performance of internet access services is specified in the methodological procedure *"Methodology for assessing the impact of electronic communications network capacity on the performance of internet access services, version 1.0"*[23]. The methodology is in accordance with BEREC Guidelines BoR (22) 81: *Implementation of the Open Internet Regulation*.

A key aspect is the analysis of how network capacity affects the actually achieved speed (SDR), which is an important indicator for internet service providers and the regulator. The methodology is based on queuing theory and the Poisson process for modelling incoming data traffic (NTP), which allows the probabilistic distribution of data traffic within a given time interval to be quantified. This approach makes it possible to determine the probability that a certain number of events will occur within a given time interval

[23]https://ctu.gov.cz/sites/default/files/obsah/ctu-new/kontrola-a-mereni/metodika-pro-vyhodnocovani-kapacity-siti-ek.pdf

data flows, and to derive from this probabilistic models for calculating the expected performance of internet access services depending on network capacity.

The methodology includes an assessment of network capacity, which involves an analysis of network traffic and technical parameters that may affect network performance. Based on this data, the CTO uses models to assess how well network capacity meets end-users' needs and what the potential impacts are on quality of service (QoS), including latency, jitter (delay variation) and packet loss. The results of these analyses are then used for network regulation and optimisation, with the aim of ensuring that service providers comply with regulatory standards and commitments. The methodology can also provide important information for network infrastructure planning and for operators' investment decisions.

4.3.1 Verification procedures

Data verification procedures within the backbone interconnection and access network system are designed to ensure that the data provided by the operator is accurate and corresponds to actual coverage. The verification process is divided into several steps depending on the type of concern. Here is a summary of the individual procedures:

Procedure I – Verification in cases of doubt regarding the sufficient capacity of backbone interconnection networks

Essence of the procedure: It is verified whether the backbone interconnection networks, as reported by the operator, actually have sufficient capacity to provide services.

The operator is required to:

- To provide evidence of the network topology;
- Details of the type and capacity of individual nodes;
- A list of ZSJs that the operator is able to cover.
- Documentation regarding the commissioning or final inspection of the equipment.

If the operator fails to provide the required information, the Ministry of Industry and Trade will consider the data unreliable and the municipality will be deemed unconnected.

Procedure II – Verification in the event of a dispute regarding the coverage of a specific AM by the access network at a certain speed level

Essence of the procedure: It is verified whether a specific address point (AM) is covered at the speed level as reported.

The person submitting the objection is required to:

- To provide evidence of an interest in establishing a connection and a negative response from the provider;

The business operator is required to:

- A statement regarding the complaint and proof of the possibility of establishing a connection or of services already provided.

If the operator fails to provide the information, the Ministry of Industry and Trade will consider the data to be unreliable.

Procedure III – Verification in the event of a challenge to the coverage of multiple AMs or specific ZSJs

Essence of the procedure: In-depth verification of the credibility of coverage of multiple AMs or

the entire ZSJ. The entrepreneur is required to provide:

- A statement regarding the complaint;
- To provide supporting information such as network topology, map data, contracts with suppliers, construction documentation, etc.

If the information is consistent, the complaint is resolved. If the information is inconsistent, the MIT and the OTA carry out an in-depth verification and may request further evidence.

4.4 Data collection outputs for 2023

The European Commission's report *Broadband Coverage in Europe* [202324], which utilises data from geographical studies, is used to analyse the results. It shows that, in particular, the percentage of Czech households covered by VHCN is well below the EU average, as operators have historically prioritised the modernisation of VDSL over the roll-out of FTTP. The results of the latest data collection are as follows:

Overall coverage: Almost all Czech households (99.6%) had access to at least one fixed broadband technology as of June 2023, with coverage in remote (rural) areas reaching 98.7%.

NGA broadband services: These were available to 88.4% of households and 63.6% of rural households.

Networks with 1 Gbit/s capacity (FTTP & DOCSIS 3.1): These covered 50.5% of Czech households, but only 7.2% of rural households. This is well below the EU average, which stands at 78.8% of total household coverage and 55.7% in rural areas.

VHCN as defined by BEREC: The proportion of households connected via VHCN is 55.6% on average across the Czech Republic and 14.8% in rural areas.

DSL technology: The most widespread technology, covering 91% of households. VDSL and VDSL2 networks covered 81.8% and 81.7% of households respectively.

Fixed wireless access (FWA): Covered 80.5% of households, which is above the EU average (67.9 %).

DOCSIS 3.0 cable connections: Reached 38.5% of households, primarily in urban areas.

DOCSIS 3.1 cable connections: In June 2022, these were available to 32.2% of households.

FTTP coverage: Increased to 36% of households, with major market players now making significant investments in the roll-out of fibre networks.

LTE services: Were universally available throughout the Czech Republic.

5G networks: Covered 94.6% of households, with coverage reaching 39.3% of households within the 3.4–3.8 GHz frequency band.

Technology availability in rural areas: DSL covered 77.5% of rural households, VDSL and VDSL2 Vectoring 61.5%. DOCSIS 3.1 was not available in rural areas; FTTP covered 8.1% and DOCSIS 3.0 covered 3.8% of rural households. FWA covered 85.4% of rural households and 5G covered 72.7% of these households.

Regional coverage: Combined FTTP & DOCSIS 3.1 coverage varied considerably, ranging from over 90% in Prague to 26.3% in the Vysočina Region. FTTP coverage also differed significantly between regions, ranging from almost half of households in the Karlovy Vary Region and Prague to 18.5% of households in the Plzeň Region.

Table 7 Overall statistics for the Czech Republic (as of June 2023):

Technology	Total coverage (%)	Coverage in rural areas (%)
DSL	91	77.5
VDSL	81.8	61.5
VDSL2 Vectoring	81.7	61.5
FTTP	36	7.8
DOCSIS 3.0	38.5	2
DOCSIS 3.1	32.2	0

[24] https://digital-strategy.ec.europa.eu/en/library/digital-decade-2024-broadband-coverage-europe-2023 Data processed by Omdia and Point Topic.

FWA	80.5	85.4
LTE	100	100
5G	94.6	72.7
5G at 3.4–3.8 GHz	39.3	32.3

Source: Broadband coverage in Europe 2023

From the perspective of historical trends in coverage statistics, the problem lies in the slow uptake of VHCN connections, which (partly due to changes in demographic parameters) shows insufficient year-on-year growth in the number of connected households and, in some categories, even a negative year-on-year change in connectivity. For example, FTTP fell year-on-year from 37.4% of households in 2022 to 36% in 2023. In the context of this study, it is interesting to note that the Czech Republic fares significantly better when VHCN connections are counted in accordance with BEREC guidelines, with FWA VHCN (BEREC category 4) connections accounting for 10% of all VHCN connections, i.e. 5.3% of the total 55.8% of households.

4.5 Planned steps and development

Discussions are currently (2024) underway regarding a proposal to limit data collection in electronic communications via the ESD system for 2024. This proposal stems from the need to reduce the administrative burden and changes to the CTU's information requirements, which are linked to the planned deregulation of relevant markets. Below is an overview of the proposed changes to data collection for 2024, broken down into annual and half-yearly data collection, as well as by individual sections of the ART form:

- **ART242 form – Annual data collection for 2024:**
  It is now proposed, within the framework of aggregated indicators (without a geographical annex), to discontinue data collection by **9% (148 indicators)** and, in geographical data collection, by up to **40% (32 indicators)**.
- **ART241 form – Data collection for the first half of 2024:**

A total of **56% (653 indicators)** are **proposed for discontinuation**.

5 Mapping of data collection in the EU

This chapter maps the ways in which national regulatory authorities in individual EU Member States obtain telecommunications data from operators. Member State regulatory authorities have developed a range of different methodologies for mapping coverage and service quality, leading to numerous mapping initiatives using different datasets and attributes (which NRAs/OCAs, ministries and regional agencies sometimes carry out in parallel). Mapping data is not comparable across the EU, and public authorities often lack detailed and reliable data to set policies, ensure that public funding complies with relevant regulations, programme funds and successfully monitor the implementation of these measures at regional, national and European level.

At the pan-European level, the BEREC organisation operates a system that establishes the method and form of data collection in EU Member States. NRAs/OCAs and the EC must take the utmost account of all opinions, recommendations, guidelines, advice or best regulatory practices adopted by BEREC. Under these provisions, the NRAs/OCA's of individual Member States were required to carry out a geographical survey of the coverage of electronic communications services capable of providing broadband connectivity in their country by 21 December 2023. The survey on the current reach of broadband connectivity should be carried out at least once a year (but must be updated at least once every three years).

All Member States are striving to achieve BEREC's objectives as effectively as possible; however, in some Member States, for example, coverage of specific locations is not always recorded at a sufficiently detailed scale (regional boundaries – 100 x 100 m grid – address points). In some Member States, this survey is carried out beyond the scope of BEREC's requirements (data collection several times a year – half-yearly, quarterly; 50 x 50 m grids, detailed mapping).

In autumn 2024, BEREC published [an] implementation [report25] addressing the implementation of the BoR 20(42) guidelines on mapping coverage by electronic communications networks. In it, it summarises that there has been a significant shift towards harmonising GSDs across Member States. From the perspective of this study, the findings concerning the mapping/reporting of FWA networks are particularly relevant. As BEREC itself notes, the greatest challenge within the GSD lies in the collection of information on QoS at a sufficient level of granularity, as well as on expected connection speeds, which are particularly difficult to analyse in the case of FWA. We examine BEREC's findings in more detail in Chapter 8, on mapping FWA network coverage.

5.1 Case studies of best practice in EU countries

To fulfil the objectives of this study, a description of examples of good practice and the specifics of data collection in specific countries has also been included. Within the case studies, we will focus on three countries from different perspectives relevant to the coverage of electronic communications networks, in particular NGA and VHCN networks (FTTP & DOCSIS 3.1). With this in mind, the case studies selected countries where either VHCN network coverage is at a very high level, or where VHCN network coverage is expanding very rapidly, or countries whose VHCN infrastructure is similar to that of the Czech Republic. As all EU Member States were required to incorporate BEREC guidelines by the end of 2023, the case studies will not address general mapping parameters but will focus on the specific characteristics of data collection and analysis in the selected countries.

5.1.1 Lithuania – comprehensive mapping

Since 2017, Lithuania has been ranked as one of the best EU countries in terms of broadband coverage. According to the latest data, approximately 78% of Lithuanian households were covered by FTTP in 2021, which is 18% higher than the EU average. One of the main reasons for this success is the comprehensive mapping and analysis of networks by the local regulator, Ryšių reguliavimo tarnyba (RRT). This involves four different components of network mapping:

[25] https://www.berec.europa.eu/en/all-documents/berec/reports/implementation-report-on-the-berec-guidelines-on-geographical-surveys-of-network-deployments

1. **Infrastructure mapping:** Covers the main areas of mapping, namely telecommunications infrastructure, construction works and other relevant infrastructure.

2. **Investment mapping:** Divided into private/public investments and planned and completed investments.

3. **Service mapping:** Information on bandwidth, access technology, service provider, QoS, service availability and price.

4. **Demand mapping:** This primarily covers user data, specifically demand for bandwidth, QoS, willingness to pay for services and take-up rates

Another key aspect is the collection and sharing of information via the unified information system 'Gateway for Territorial Planning and Construction' (TPS Gateway: https://www.planuojustatau.lt), which is managed by the Ministry of the Environment, where information on network status is shared and updates on network planning and construction are provided. The TPS platform provides a comprehensive map of broadband services, which includes data on broadband availability by address, a list of providers, access types, speeds, prices and the geographical distribution of broadband services.

Address-based mapping in Lithuania operates on six levels, ranging from national coverage, through European NUTS 3 regions, to individual municipal mapping, which reaches a grid of 60x60 metres. Individual addresses are recorded using precise coordinates. If multiple types of services are provided at an address, the overview shows the highest network speed. The connection speed mapping also includes the identification of weak spots – a coverage plan for all areas exceeding 100 Mbps.

The entire mapping process is clear thanks to a detailed nomenclature of signalling point codes, enabling unique identification of the destination/network among different telecommunications operators or service providers. Examples of signalling point codes:

- National Signalling Point Code (NSPC): Identifies exchanges within the national public telephone network.
- Payment card identification number: Identifies SIM cards or other service management cards issued by telecommunications operators.
- Signalling Network Code (SANC): Assigned by the International Telecommunication Union (ITU) to identify the country in which a telecommunications operator's network is located.
- International Signalling Point Code (ISPC): Identifies international exchanges of public telephone networks.
- Public Data Communications Network Identification Code (DNIC): Identifies public data communications networks.
- Public Data Communications Network Country Code (DCC): Public Data Communications Network Code: A code assigned by the ITU that identifies the country of the public data communications network operator.
- Public mobile telephone network code (MNC): Identifies public mobile telephone networks.
- Public mobile telephone network country code (MCC): A code assigned by the ITU that identifies the country of the mobile network operator.

5.1.2 Austria – similar definition of technology and backbone network

Austria is an example of a country that is at a high level in terms of network mapping. It focuses on comprehensive mapping of the overall network topology, including the technologies used, even at the backbone network level. This practice has proven particularly effective in the context of planning private sector investments and mitigating risks associated with the high costs of constructing and expanding communication networks, such as construction costs. One such measure is the operation of three Single Information Points (SIPs) by the NRA RTR.

Single Information Point for Infrastructure (ZIS)

ZIS is a directory of all existing infrastructure that can be used for telecommunications purposes, and of planned construction projects (usually civil engineering works). This data is provided by network providers from both the public

and private sectors, such as electricity, gas, lighting or transport. The ZIS thus supports both cross-sector shared use and the joint laying of telecommunications infrastructure. As a result, new or expanded broadband networks can be implemented more cost-effectively.

Single Information Point for Broadband (ZIB)

The ZIB directory contains information on current and planned coverage by broadband communication networks (fixed and mobile networks). It maps the coverage of buildings and areas based on available bandwidths, the number of connection points that can potentially be provided, or the number of existing broadband subscriptions and their demand for various bandwidth categories. This information provides an overview of the current supply and demand for broadband connections in Austria. Statistical data based on ZIB data are published quarterly in the RTR Internet Monitor, and coverage information is published in the Broadband Atlas of the Federal Ministry of Agriculture, Regions and Tourism (BMLRT). Data from the ZIB also forms the basis for identifying areas eligible for broadband funding under the Broadband Austria 2020 and 2030 programmes.

Single Point of Contact for Permits and Licences

This overview contains information on the conditions and procedures for authorising construction works that may be necessary for the deployment of high-speed electronic communications networks and their components; it provides an overview of the conditions and procedures for obtaining authorisation for construction works and aims to accelerate the process of telecommunications infrastructure construction.

An interesting feature of the approach to network mapping in Austria is the code designation of individual parts of the network, which together form a clear and easily interpretable data basis for a detailed overview of the network status and the potential identification of areas for support in fulfilling the GIA objectives. Infrastructure types are stored in a data field

RTRTYP – Code		Infrastrukturtyp	Geometrietyp	Erläuterung
Nicht gefördert	gefördert			
0		Nicht zutreffend	**Punkt oder Linie**	Diese Kategorie umfasst Bauvorhaben, die nicht der Errichtung von Telekommunikations-infrastrukturen dienen, jedoch eine Mitverlegung ermöglichen (z.B. Straßensanierungsprojekte, Kanalbauten, Erdkabelverlege-arbeiten). Die Kategorie steht ausschließlich für Nicht-Telekommunikations-Infrastrukturen zur Verfügung.
1	11	Übergabepunkte	**Punkt**	Diese Kategorie umfasst Standorte von Übergabepunkten, z.B. Hausanschlüsse oder Zugangspunkte zur gebäudeinternen Netzinfrastruktur.
2	12	Leerrohre/Rohre	**Linie**	Diese Kategorie umfasst unabhängig von der Befüllung den Verlauf von Leerrohren, Rohren, Kabelkanälen, Kabelschächten, Kabeltrassen, Ducts, Microducts etc.
3	13	Kontrollschächte	**Punkt**	Diese Kategorie umfasst den Standort von Einstiegschächten, Revisionsschächten und Manholes und stellt Schachtbauwerke dar, die beispielsweise zur Richtungsänderung, Höhenüberbrückung, Zusammenführung, Überprüfung und Wartung von Rohrleitungen dienen.

Figure 1 Examples of infrastructure type coding in Austria

"rtrtyp" in the attribute table of ESRI shapefiles or OGC GeoPackage files. The "rtrtyp" field contains the RTRTYP code (1, 2, 3, etc.). These codes refer to the infrastructure type, geometry, etc.

5.1.3 Germany – advanced investment control and SMP

In the past, companies were reluctant to roll out new generations of fibre-optic lines. As a result, in 2022 only 19% of households had access to FTTP connectivity, compared to the EU average of 56%. Due to historical developments and the reluctance of businesses to invest in network modernisation, the main strategy for FTTP development was to increase competition and support the expansion of fibre networks.

In 2023, a national policy objective was introduced to ensure that 15 million households would be connected via FTTP by 2025 and that there would be full gigabit network coverage by 2030. The Federal Government provided €12 billion in subsidies for fibre connections, and with the launch of the Gigabit Programme in April 2021, funding was extended to NGA grey areas as well. However, the German NRA/OCA is aware of the risk of the growth of undertakings with significant market power (SMP) resulting from the massive increase in support.

The Federal Network Agency (BNetzA) and the Federal Ministry for Digital and Transport (BMDV) therefore established a monitoring centre in July 2023 to record fibre-optic expansion projects. As part of the verification processes, they introduced the principle of ‘Doppelausbau’ (double expansion). The aim of this measure is to conduct a comprehensive inventory of investment projects. The emphasis is on the systematic and ongoing recording of projects so that a well-founded assessment of competitive activity can be carried out. These activities are carried out by the monitoring centre. The monitoring centre is responsible for detailed data collection, investigating cases and their ongoing analysis with the aim of ensuring fair competition and mitigating any practices that distort competition in the expansion of the fibre-optic network in Germany. The monitoring centre’s working procedure includes:

- Systematic data collection: Use of an online questionnaire to collect responses. As of 1 March 2024, 525 responses had been received, which were consolidated into 427 cases after taking into account overlapping reports from various perspectives.
- Case investigations: Investigation of all reported cases, including in-depth interviews with key stakeholders in 14 selected cases.

- Main areas of analysis:
  - Analysis of competitor behaviour: Focused solely on lucrative core areas: Examining whether companies focus their expansion efforts solely on profitable key areas.
  - Short-term reactions: Assessing whether new companies react quickly to the expansion efforts of existing competitors.
  - Empty announcements: Investigating whether companies make announcements about expansion without following them through.
  - Impact on original expansion plans: Determining whether these practices cause incumbent firms to partially or completely abandon their plans to expand their coverage.
  - Grouping of cases: Deutsche Telekom cases: Cases in which Deutsche Telekom or its subsidiaries are new entrants to the market.
  - Competitor cases: Cases where the new market entrant is a competitor of Deutsche Telekom.

- Preliminary findings:
  - Identification of patterns: Initial analysis reveals patterns in Deutsche Telekom’s behaviour that do not appear in competitors’ cases. Expansion of core business: More frequent in Deutsche Telekom cases. Short-term reactions: More frequent in Deutsche Telekom cases.
  - Empty announcements: Rare in both groups. Partial/complete withdrawal: Occurs in about 20% of Deutsche Telekom’s cases.
- Solution: complexity. The document proposes simplifying these programmes and consolidating efforts under a single public body to speed up the implementation process.

Outcome of Chapter 5:

For effective mapping of network coverage, there are a number of approaches within EU Member States that can lead to a more detailed and realistic overview of the state of networks. More frequent and detailed mapping allows for better identification of network topology and supports the development of connectivity, which is key to achieving transparency in the services provided and for investment planning. The main advantage of these approaches is therefore that the mapping results more closely reflect reality and provide greater transparency. On the other hand, this level of detail brings an increased administrative burden for both operators and regulatory authorities, which can be mitigated by introducing user-friendly data collection tools and partial automation, which would facilitate the entire process and minimise the costs associated with detailed mapping.

5.1.4 Overview of data collection in EU countries

Frequency of data collection at national level

Frequency of data collection	Country code
Once a year	CZ, BE, BG, DK, FI, IT, LT, HU, DE, PL, PT, EL, SE
Twice a year	LV, LU, MT, RO, SK,
4 times a year	EE, FR, HR, IE, NL, AT, SI, ES

Country	Specific technologies
Belgium	Technology: division into non-NGA and NGA: Broken down by individual technologies: Fibre (FTTH/B/P), copper (xDSL, VDSL 2), cable (DOCSIS 3.x, HFC), others (FWA, LTE, 5G, satellite)
Bulgaria	Technologies: Fibre (FTTP), Copper (xDSL), cable (DOCSIS 3.0), others (FWA, LTE, 5G, satellite)
Czech Republic	Technology: Fibre (FTTH, FTTB, FTTC), copper (ADSL, VDSL, VDSL 2, SDSL/SHDSL), cable (DOCSIS 3.x), others (Powerline – PLC, FWA, LTE, 5G, satellite); - VHCN deployment levels (0 – not covered, 1 – fibre network deployed to the address, 2 – fibre network deployed to a base station or other access point, 3 – the fibre network is not deployed to the address, but performance thresholds 1 are met, 4 – the fibre network is not deployed to the station or access point, but performance thresholds 2 are met
Denmark	Technology: Fibre (FTTH, FTTB), copper (xDSL), cable (DOCSIS 3.x), other (FWA, LTE, 5G, satellite)

Estonia	Technology: Fibre (FTTH, FTTN), copper (xDSL, VDSL 2), cable (DOCSIS 3.0, 3.1), other (FWA, LTE, 5G, satellite)
Finland	Technology: Fibre (FTTH, FTTB, FTTP), copper (xDSL, VDSL 2), cable (DOCSIS 3.0, 3.1), others (FWA, LTE, 5G, satellite); Record of technology connections along the network (CU; FTTB/C -> downstream technology; FTTH)
France	Technology: Standard speed (up to 100 Mbit/s): Copper (xDSL, VDSL 2), cable (DOCSIS 2.x), other (FWA, WiMAX, LTE, satellite) High-speed services (over 100 Mbit/s): Fibre (FTTH, FTTLA – Last Active), Cable (DOCSIS 3.x, HFC – Hybrid fibre-coaxial), others (5G)
Croatia	Technology: Fibre (FTTx), copper (xDSL, VDSL 2), cable (DOCSIS 3.x), Other (FWA, LTE, 5G, Satellite)
Ireland	Technology: Fibre (FTTH, FTTP, FTTC), copper (ADSL, EVDSL, CVDSL), cable (DOCSIS 3.x), others (FWA, LTE, 5G, satellite)
Poland	Technology – division into non-NGA and NGA: - non-NGA: Copper (xDSL), cable (DOCSIS 1.x, 2.x), others up to 30 Mbit/s (FWA, LAN, satellite) - NGA: Fibre (FTTx), cable (DOCSIS 3.x), others above 30 Mbit/s (FWA, LAN, 5G, satellite)

6 MPO Agenda

The MPO's agenda is based on core tasks arising from the international and national targets to which the Czech Republic has committed in relation to broadband connectivity. One of the MPO's key tasks is to identify locations suitable for investment support for the construction of electronic networks and the associated operational processes, in accordance with GIA measures. Typically, this involves the implementation of a grant programme for the roll-out of electronic communications networks and the connection of premises within the framework of, for example, the Operational Programme Technology and Applications for Competitiveness (hereinafter "OP TAK", formerly "OP PIK").

The objectives can thus be summarised as *widespread and affordable access to high-speed internet infrastructure and services*[26]. A necessary condition is to interfere as little as possible with the natural market environment so that resources are allocated as efficiently as possible and private investment by entities operating in the electronic communications networks market is not jeopardised.

Commitments and activities of the Ministry of Industry and Trade:

- **National Plan for the Development of VHCN Networks** – The aim of the National Plan for the Development of Very High Capacity Networks ('National Plan') is to identify the necessary conditions to facilitate investment in VHCN networks, define the Czech Republic's strategic approach to the construction of these networks, and determine the necessary role of the state in achieving VHCN network coverage, particularly in securing support from public funds and minimising interference with competition.
- **Digital Decade/DESI** – Infrastructure support is crucial for achieving sustainable development goals. This includes supporting effective measures to facilitate investment in innovative digital technologies. The economy should harness the potential of digital technologies and the internet and support innovation in products, services, processes, organisations and business models. Within the Digital Economy and Society Index ([DESI27]), connectivity is currently the weakest point in the Czech Republic's assessment.
- **Fulfilment of the GIA** – The primary objective is to establish minimum speed requirements for broadband services so that they can be classified as gigabit services; this amounts to 1 Gb/s for fixed connections at the address level and, for mobile connections, comprehensive 5G coverage across the EU by 2030.
- **Subsidy policy –** In this context and at this stage, the main focus is on the OP TAK, which is aimed at rolling out public broadband electronic communications networks and enabling reliable internet access via high-capacity networks (VHCN). This agenda is based on the announcement, evaluation and allocation of grants. The GSD and subsequent analysis primarily influence the evaluation phase, during which intervention areas are defined. The precise identification of these areas helps to develop high-speed internet and protect investments precisely in the highest-priority locations. The effective implementation of the grant scheme is one of the metrics for fulfilling the MIT's commitments.

Secondary objectives

- Development of a competitive environment;
- Reducing costs for businesses;

In the following chapters, we present the MIT's requirements and recommendations in connection with or following on from the mapping of electronic communications network coverage, which lead to the fulfilment of the MIT's objectives in the area of broadband connectivity.

Within the scope of this study, we do not deal in detail with the current form of the GSD, but focus on the MIT's needs that are relevant in relation to legislative obligations and the set objectives. These include, in particular, a proposed definition of the information to be collected for its optimal use and a justification of the need to obtain this information.

[26] EU Guidelines on the application of State aid rules in relation to the rapid deployment of broadband networks (2013/C 25/01)

[27] From 2023, DESI is incorporated into the Digital Decade Progress Report.

7 Needs of the Ministry of Industry and Trade

7.1 Primary needs of the MIT

7.1.1 Accurate and consistent overview of the network

Given the exponential growth in data consumption and the desired development of VHCN, comprehensive and accessible identification of network topology and ensuring data consistency are essential for better planning of grant support and faster infrastructure development. For a specific network point (address, polygon), the network topology and characteristics should be clear not only at the address point level, but also for the backhaul and backbone networks (network structure, topology, aggregation point capacity, etc.). The output could, for example, be the ability to predict capacity at higher network levels, easily verify connectivity options, and define intervention areas to support the roll-out of broadband electronic communications networks.

In the current GSD format, the collected and analysed data depend on a number of assumptions. When used to meet the key needs of the Ministry of Industry and Trade, these assumptions result in an unclear picture of the network's status. These include, in particular:

A. Inconsistent data on available connections within wireless networks:

Data on available connections, particularly in wireless networks (FWA), is inconsistent. There are significant differences between regions and operators in the reporting of available connections. Such inconsistent data is problematic from an analytical perspective, which can lead to ambiguities when planning state support and defining intervention areas.

B. Unclear technology/medium at access network level:

It is unclear which technology is used at individual network nodes (DP-CO[28]), which makes it difficult to assess the suitability and sustainability of connectivity in a given area.

C. Reporting the connectivity of available connections within 4 weeks

Currently, it is up to operators to report, based on their network capacity, the coverage of addressable locations (available connections[29]) that they are able to connect[30]. However, there is no methodology specifying which available connections should be reported or how (at what speed) they should be reported. This leads to lower consistency, more demanding data analysis and more complex planning of intervention areas.

By mapping the backhaul infrastructure in detail and gaining detailed knowledge of the network topology, the Ministry of Transport and Communications (MPO) can significantly refine the definition of intervention areas and target support more effectively at key locations. One of the main benefits of such mapping is the identification of bottlenecks in the network infrastructure that may limit the availability of high-capacity connections. For example, if backhaul network capacity is insufficient in certain areas, collecting data on the type and capacity of the network will enable the MPO to better identify locations where support needs to be focused on strengthening the infrastructure. Collecting information on the media used, network capacities and structure provides not only a more detailed overview of the current state of the infrastructure, but also more accurate estimates of future needs. In this way, investments can be better targeted to meet actual needs whilst minimising the risk of inefficient use

[28] By the term DP-CO, we seek to describe a topology encompassing all network node elements, from the access layer to the central nodes. By the capacity or technology of network nodes, we mean the capacity/technology of the Distribution Point (DP), which aggregates connections from the access network and concentrates individual connectivity segments towards the backhaul network's end node, referred to as the CO (Central Office).

[29] There is at least one available connection at the address location

[30] Or to establish a connection corresponding to the relevant declared parameters and provide the corresponding internet access service within four

weeks of the subscriber expressing an interest, without any fees for establishing the connection and activating the service exceeding their standard amount.

public funds. This data will thus play a crucial role in the MPO's decision-making process, particularly when determining interventions in line with market conditions and technological trends.

The need for the Ministry of Industry and Trade can thus be characterised as an enhanced ability to analyse the availability and capacity of backhaul networks in specific locations. This information should help identify areas where the infrastructure is unable to support high-quality connectivity, thereby enabling the Ministry to focus on strengthening these critical elements. This is particularly important in less populated or rural areas, where infrastructure development is often more costly and slower. Furthermore, knowledge of these capacity constraints enables a technology-neutral approach to support – decisions on supporting specific technologies, such as FTTH or FWA, will be based on real capacity data and actual market needs.

Detailed mapping of network topology also provides added value in identifying intervention areas and specifying them during public consultations with operators. The Ministry of Industry and Trade would then be able to conduct a more constructive dialogue based on more accurate and objective data, which will lead to better verification of the data reported by operators. Such data validation is essential not only for refining intervention areas but also for ensuring a fair and transparent allocation of support.

Ultimately, this approach is directly linked to the MIT's strategic objectives, including the fulfilment of national and European connectivity targets. Thanks to better mapping and more effective targeting of support, it will be possible to accelerate the development of VHCN networks and ensure that funds are directed to areas where they have the greatest impact. This should thus increase the availability of high-speed connectivity, but also contribute to strengthening the Czech Republic's competitiveness in the digital economy.

The Ministry of Industry and Trade's requirements therefore consist of creating a codification of the network's topology and characteristics, and subsequently using this data to target state support more precisely, as well as defining further operational steps to achieve the goals of the gigabit society.

7.1.2 DESI – Improving the connectivity dimension score

DESI[31] is a key metric comparing the European Union's performance across four dimensions of the Digital Decade policy agenda: human capital, connectivity, digital integration and digital public services. Within this assessment, it is connectivity (specifically VHCN coverage) that is the dimension significantly lowering the Czech Republic's score.

In terms of VHCN coverage, the Czech Republic stands at 55% of households covered, compared to the European average of 88%; and when it comes to VHCN coverage in rural areas, the Czech Republic is one of the lowest-ranked countries, with coverage at just 15% compared to the EU average of 70%.[32]

One of the requirements is **therefore to improve the assessment of the connectivity dimension**; in the context of this study, this involves an overview of the development of VHCN networks and reducing the discrepancy between the quality parameters advertised in providers' commercial offers and the actual quality of internet access services.

In relation to mapping, the MIT therefore needs to collect data on the actual state (performance, quality, type) of connections and adjust support based on informed decisions reflecting the MIT's objectives and the state of the market.

This means, for example, creating a network capacity model that would perform an analysis to identify further areas for intervention based on connection speeds and the number of ISPs, whilst also taking into account other network parameters such as sufficient backhaul capacity, the ability to connect households within the declared four-week timeframe, and others. This issue is discussed in greater detail below as a specific operational requirement of the MIT within the scope of this study.

7.1.3 Revision of the definition of intervention areas

Given the update to connectivity targets, where from 2022 KPIs are derived not from NGA coverage but from very high-capacity networks (VHCN), a situation arises where a number of areas (ZSJ) that were historically reported as

[31] From 2023, DESI is incorporated into the Digital Decade progress report.

covered (black), may now, conversely, be eligible for grant support. This discrepancy is particularly evident in areas covered by FWA technology with higher population density, where it is difficult to guarantee connectivity of an adequate quality. A partial solution could lie in a broader yet more precise definition of intervention areas, followed by a public consultation process. To protect investments, it would be up to operators to demonstrate the technical suitability of their infrastructure and, where necessary, exclude the area in question from public support.

The amount of the grant depends on the level of development of the region, with less developed regions (LDRs) and transition regions (TRs). The maximum subsidy rate for eligible expenditure is 85% for LDRs and 70% for TRs. Target areas, or intervention areas, are divided into four categories of supported areas (A, B, C, D), which are also represented by the so-called ZSJ colours. The ZSJ colour scheme indicates the ratio based on the coverage of addressable locations (SCOBAM) under Activity II of the OP TAK and the supported areas of Activity I of the OP TAK, which concern the construction of a backhaul network. The support categories under Activity II thus define the coverage conditions for ZSJ within the given category.[33]

The key source for identifying ZSJ as an intervention area is the proportion of SCOBAM covered by a specific speed. To clarify grant support, it is possible to adjust the definition of supported areas (methodology for establishing intervention areas) and support categories so as to simplify the entire process and focus solely on areas (ZSJ) rather than defining support based on data derived from address locations. Operational programmes and the definition of ZSJ colour would be based on cumulative values for a given ZSJ, rather than the values currently used, which are based on reported available connections at the address point level for all SCOBAMs in a given area.

The Ministry of Industry and Trade (in cooperation with the Czech Telecommunications Office) should be able **to assess**, on the basis of data**, the technical characteristics of the basic infrastructure and the access costs associated with various technologies. This assessment should take into account factors such as network congestion, spectrum availability and the feasibility of deploying technologies**, particularly in areas with low competition, characterised, for example, by a small number of ISPs.

7.2 Secondary requirements of the MIT

7.2.1 Optimisation of the digital interface for questionnaire-based data collection

The interactive data entry interface (API) for questionnaire-based data collection provides an automated and standardised approach to gathering information from businesses within the GSD. The interface focuses on providing a simple and intuitive environment that includes predefined questionnaire and question templates, minimising the complexity of data entry and reducing the error rate. Thanks to automated validation and error checking, the data collection process is optimised and the quality of input information is improved. The API enables the import and export of data from existing systems, minimising manual data entry and reducing the risk of errors. Support for automation and integration with other information systems enables efficient data exchange and increases process efficiency. Data security is ensured, protecting sensitive information and complying with relevant legislation.

The modified interface could also serve as a platform for discussion with operators, which would strengthen cooperation and enable more frequent data collection with a lower administrative burden. This approach thus represents a step towards a simpler and more flexible ESD system that could respond to current market needs and improve coordination within geographical surveys.

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[33] **Category A** (so-called ‘white’ at 30 Mbit/s): UAFs where no existing network is capable of providing a download speed of at least 30 Mbit/s. A UAF is classified in this category if:

- ≤ 40 % of SCOBAM in the ZSJ is covered by one or more infrastructures providing this speed, or
- ≤ 50% of the SCOBAM is covered by only one infrastructure providing the specified speed

Category B (so-called ‘white’ at 30 to 100 Mbit/s): ZSJ where there is no network capable of providing at least 100 Mbit/s. Classification into this category is similar to that for Category A, but with a threshold speed of 100 Mbit/s.
Category C (so-called ‘grey’ at 100 to 300 Mbit/s): ZSJ where there is only one network capable of providing speeds between 100 Mbit/s and 300 Mbit/s. ZSJ are classified in this category when:

- 50% of SCOBAM in the given ZSJ is covered by only one provider
- or > 40% and <= 50% of the SCOBAM is covered by a single provider via more than one infrastructure

Category D: ZSJs that do not meet the conditions of the previous categories and are designated as unsupported areas for the purposes of II activities.

7.3 Prerequisites for the Ministry of Industry and Trade's requirements

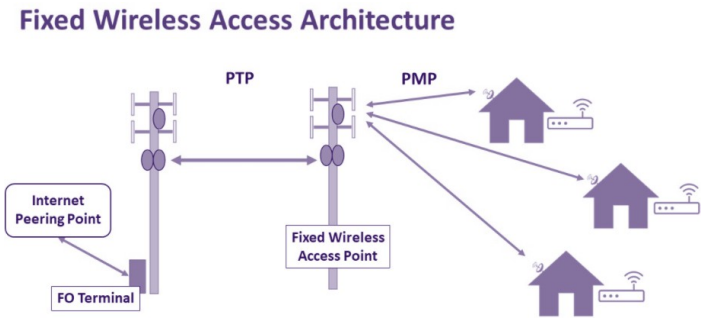
In the context of the Ministry of Industry and Trade's requirements, it must be emphasised that the proposed agenda entails a higher workload in terms of processing and evaluation. This workload affects not only the Czech Telecommunications Office (CTU)/Ministry of Industry and Trade, but also operators, who must respond to the changes. This is also associated with additional costs for implementing these changes, which may affect both the administrative processes and the financial aspects of all parties involved. To this end, these are primarily potential recommendations or scenarios, the further analysis and discussion of which with the sector is a key aspect for their implementation and the prioritisation of these recommendations.

8 Specifics of mapping FWA network coverage

Mapping and analysing FWA technology data is particularly key to addressing the needs of the Ministry of Industry and Trade. To simplify the issue, this concerns the impact of capacity and data limitations. In this regard, we will focus on the FWA mapping methodology in accordance with BEREC guidelines, the general mapping guidelines BoR (20) 42 and the guidelines for VHCN BoR (23) 164, examples of solutions from around the world, and a proposal for a possible approach to mapping FWA network coverage and defining intervention areas. FWA measurement is in line with technological neutrality and applies to all networks providing wireless connectivity (mobile networks, public WLAN/WiFi networks, satellite networks).

Mapping and measuring FWA network coverage presents a complex challenge for NRAs/OCAs, made all the more significant by the development of 5G technology and VHCN connectivity requirements. In the guidelines for mapping FWA coverage, the reporting parameters are general and may not accurately reflect reality. This ambiguity is particularly relevant to the situation in the Czech Republic, where FWA/5G has a long history and a higher level of FWA coverage compared to the EU average, whilst overall household coverage by VHCN networks lags significantly behind the EU average. The technological complexity of FWA lies in the wide variability of connection speeds and quality depending on the distance from base stations (so-called access points), the base station connection (fibre or microwave link), the quality of the infrastructure, the number of connected households, their tariff, etc.

This is particularly critical when a single operator classifies an FWA connection as VHCN, thereby potentially hindering the development of high-capacity infrastructure in the area. Such a decision may have a negative impact on end-users, as in practice the connection may not achieve the quality and speeds expected for gigabit infrastructure according to BEREC definitions.



The issue of FWA coverage reporting is clearly illustrated by a simple example:

In the specific Rožnov (ID: 22 519) in the north of České Budějovice, VHCN connectivity is reported for FWA with a connection speed of 1 000 Mbit/s; this service area covers 0.99 km^2 and comprises 1 622 households, of which 1 100 are not covered by VHCN technology. The main problem is therefore to determine for how many households in the given service area a connection speed meeting the VHCN parameter is available.

It is not possible to identify from the GSD how many base stations there are, what their capacities are, or how many sectors a given base station serves.

In our example, we will focus on two variants[34]:

a) **In the first example,** we will use a 4-sector base station with four transmitters utilising 40 MHz (in the 3.5 GHz band) of spectrum bandwidth and the newer 256-QAM modulation (LTE Release 12 and later) with an 8x8 MIMO configuration, where the peak downlink system capacity per cell is around 1,600 Mbit/s.
b) **In the second example,** we will use a 4-sector base station with four transmitters utilising 20 MHz (in the 3.5 GHz band) of spectrum bandwidth, 64-QAM modulation (LTE Release 11 and later) and a 4x4 MIMO configuration, where peak downlink system capacity per cell is around 400 Mbit/s.

For our theoretical calculation, we used the CTU calculator for assessing the impact of electronic communications network capacity on the performance of internet access services. We are basing our analysis on VHCN connection conditions, where the average uplink bit rate is 350 Mbit/s and the actual achieved speed (SDR) of the connection is 350 Mbit/s. The Poisson process is set for urban areas (95%) with an NTP aggregation ratio of 1:50 and a utilisation factor of 0.15. These parameters are the same for both variants.

First example: With these settings, the resulting value for the average number of network end-points with a VHCN connection is **8**, excluding the utilisation factor (UF), and **13** including the utilisation factor per sector, i.e. a total of 32 (4×8) and 52 (4×13) end-points respectively, which can actually be connected at the required speed.

Second example: NTP at level 0 without taking UF into account and also 0 with UF taken into account, see Figure 2 below. This illustrative calculation clearly demonstrates the first problem in reporting connections using FWA, where technology, capacity, UF, population density and a whole range of other factors fundamentally influence the NTP connectivity potential.

This means that if no analysis is carried out, the operator may report VHCN connectivity capability in a given service area; however, depending on the technical equipment, they may be able to connect 52 households in the first example, or no households at all in the second example.

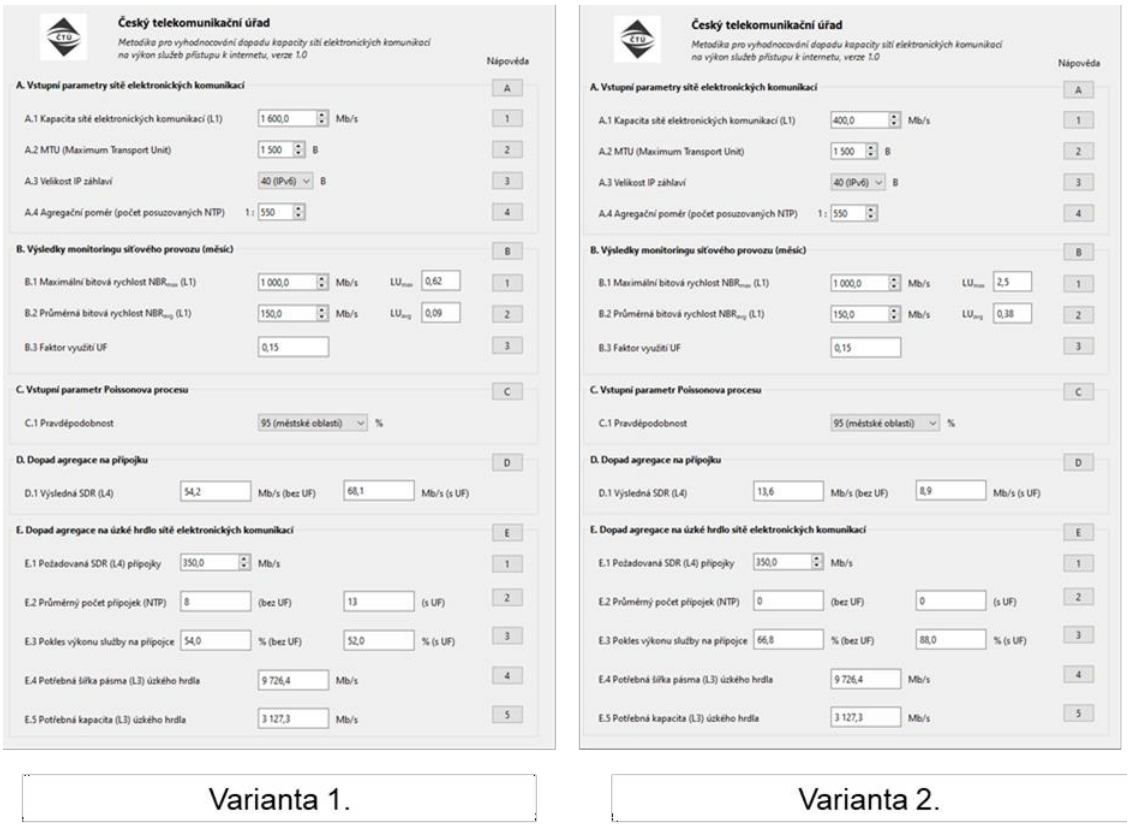


Figure 2 Base station capacity variants

[34] The data used in the theoretical case are for illustrative purposes only. The actual Mbit/s capacity of the system should be based on the technical parameters of the transmitter, etc.

The example above illustrates that there are a number of possibilities/inconsistencies within the reporting process that the operator must address when reporting, and which the regulator must subsequently deal with. The main ones include:

Determining network capacity: How many base stations are there and what are their parameters? Which addresses/households can operators report as available connections to ensure compliance with connection QoS parameters? There is currently no methodological solution to answer this question that would impose conditions on operators for recording available connections. ISPs typically do not carry out radio planning. Relevant information on network capacity should therefore be ascertainable from the actual technical equipment and location of a specific base station. Here too, it is important to take into account the connection technology and the capacity of the aggregation point (GP-CO). Currently, this information is not collected within the GSD.

ZSJ colour and identification of the intervention area: The ZSJ colour indicates the ratio of inhabited address points that have at least one available connection to the total number of inhabited address points in the ZSJ. Based on
this 'colour coding', intervention areas and support options for a given ZSJ are defined. A black ZSJ is not part of the intervention area for support. However, given the changing needs of network capacity, it is advisable to adjust the parameters of intervention areas to encourage greater development of high-capacity connections.

Reporting and capacity when selling the service: What is the total and available capacity of a given base station, and how does this change when there is a shift in customer demand for connections? As mentioned above, the actual network capacity at the point of connection is not currently recorded, nor is the fact that new households may be connected to the network, thereby affecting (reducing) the actual available connection capacity.

Compliance with the statutory obligation to connect within four weeks: Should there be a significant increase in customer demand for FWA services – although this is a less likely scenario – the question arises as to whether the operator would be able to meet the statutory requirement to provide a connection of the declared quality within four weeks without significant investment. The above-mentioned characteristics of FWA connections and the method of reporting quality of service (QoS) in the given area may increase the risk of non-compliance with this obligation and expose the operator to the risk of penalties**.**

The contradictions that need to be addressed during FWA network coverage mapping are described in the example above. Our aim is to propose procedures to more accurately reflect the actual network capacity whilst striving not to increase the administrative burden on operators and to protect their investments. As these objectives are in conflict, it is necessary to define a compromise between these approaches that will not, for example, impose a blanket burden on all ISPs, but will provide relevant information for assessing network capacity and thus the number of available (home-passed) connections.

8.1 BEREC Opinion

For clarity, we provide BEREC's guidelines on the characterisation and reporting of FWA networks as VHCNs. BEREC considers the reporting of FWA as VHCNs to be a relatively new topic, as data collection procedures were not fully established at the time the first guidelines for VHCNs were published. To update VHCN criterion 4 (performance thresholds 2), BEREC asked mobile network operators to complete a questionnaire in May 2022. Based on the evaluation of the questionnaires, Thresholds 2 were established on 2 October 2023, which correspond to Criterion 4 and apply to wireless networks with fibre-to-the-base-station connectivity.

Criterion 4

Network providing wireless connectivity with equivalent performance: Any network providing wireless connectivity that is capable, under normal conditions at peak times, of delivering a quality of service defined by the following parameters (performance thresholds 2):

- Data transfer rate (downlink) ≥ 350 Mbit/s
- Data transfer rate (uplink) ≥ 50 Mbit/s
- IP packet loss rate (Y.1540) ≤ 0.01%
- IP packet loss rate (Y.1540) ≤ 0.01%
- Bidirectional IP packet delay (RFC 2681) ≤ 18 ms
- IP packet delay variation (RFC 3393) ≤ 5 ms

- IP service availability (Y.1540) ≥ 99.9% per year

Performance thresholds 2:

Performance thresholds 2 apply to a wireless network with optical fibres deployed up to the base station. End-user services provided by such a network are typically based on a mobile network (5G). Therefore, the setting of performance thresholds 2 is based on mobile networks with optical fibre deployed up to the base station:

- **Achievable QoS for end-users**: The thresholds are set based on the best achievable quality of service for end-users, taking into account current and emerging technologies such as 5G MIMO.
- **Peak-time conditions**: Performance must be measured under realistic peak-time conditions to reflect typical network usage.
- **QoS parameters**: These focus on data transfer rates (downlink/uplink), latency, error rates and network resilience to ensure a comprehensive quality measurement.

VHCN Category 4 reporting:

In accordance with BEREC guidelines on VHCN networks, FWA meets the VHCN Category 4 criteria provided the performance threshold is met
2. The following conditions apply to reporting in accordance with the BEREC guidelines:

- Performance thresholds 2 must take into account **the achievable end-user quality of service**, not the end-user quality of service currently being achieved.
- The area covered by FWA must be divided into appropriate sub-areas (e.g. the coverage area of a base station or group of base stations). For each sub-area, it must be determined whether performance thresholds 2 are met.
- An area meets performance thresholds 2 if, under normal conditions during peak times, end-users in outdoor locations within that (or a sub-)area have, on average, achieved at least the QoS level of performance thresholds 2.
- The typically achievable data transmission speed at the household level in a given area, as stated by operators, can only be provided to those end-users who currently subscribe to the highest data transmission speed currently offered by the operator.

BEREC is certainly aware of the issue mentioned at the beginning of this chapter, and has therefore stated in its guidelines that each NRA/OCA may deem it appropriate to carry out its own analysis or request the operator to analyse the parameters of FWA connections.

8.1.1 Findings of the BEREC Implementation Report

The findings of the BoR (24) 146 implementation report highlight the issue of FWA reporting and the challenges of integrating FWA into GSDs and collecting relevant information on VHCN connections. Of the 26 government bodies participating in the survey, 18 included FWA data in their GSDs, whilst 9 did not. One reason for non-inclusion is, for example, the fact that in some countries FWA networks are predominantly based on 4G/5G mobile networks, which eliminates the need for separate monitoring.

Key findings and challenges with FWA data collection:

Data collection methods:

- 12 authorities collect FWA data at address level.
- 5 authorities use grid-level data collection (e.g. 100 x 100 m or 50 x 50 m).
- One NRA/OCA combines both approaches (address-based and grid-based).

Problematic areas of data collection:

- Some operators have difficulty providing address-level data, leading to the use of grid-based collection as an alternative.

- Determining the number of 'home passed' address points for FWA and providing speed data is technically challenging.

Capacity and performance:

- FWA performance depends on the user's business model, particularly when using 5G infrastructure.
- FWA network capacity, which is shared among all users, is important for determining the number of covered locations, which presents further challenges.

Technical and capacity challenges:

- Calculating FWA network capacity is complex and requires more detailed methodology and guidance.
- For some operators, the lack of technical capabilities to accurately determine coverage and quality of service is a problem, which requires support and simplification from regulatory authorities.

Despite describing and identifying a number of problematic characteristics of FWA connection reporting, BEREC did not provide a proposed solution in its implementation report. It merely stated that it would continue working on guidelines that would provide NRAs/OCAs with more support regarding QoS indicators and the evaluation of FWA networks. BEREC did, however, indicate the direction of this support, which includes simplifying data verification and clarifying the minimum requirements for data collection.

8.2 An example of an FWA network evaluation method from around the world

An analysis of 5G/FWA technology development in the US, conducted by the GSMA in 202335, shows that in urban areas, performance is stable and speeds are higher thanks to the available spectrum (which meets VHCN parameters). Performance in rural areas is considerably more problematic, where measured values did not meet VHCN standards, primarily due to the distance from base stations and the quality of customers' receiving infrastructure. Specific data from operators T-Mobile and Verizon show that in the third quarter of 2023, Verizon achieved an average download speed of 155.77 Mbit/s in urban areas, but only 51.41 Mbit/s in rural areas. T-Mobile increased FWA performance in rural areas from 82.20 Mbit/s in the fourth quarter of 2022 to 91.96 Mbit/s in the third quarter of 2023. This difference only underscores the need to analyse capacity and connection characteristics in the case of FWA networks.

One of the few countries where information on this issue is publicly available is Canada. Given the country's geographical characteristics, there is relatively high demand for FWA, which in rural and remote areas often represents the only economically viable alternative for high-speed connectivity. The Communications Research Centre Canada (CRC) has prepared a study[36] in which it proposed a structured methodology for assessing the ability of FWA systems to meet broadband internet speed targets, particularly in rural and remote areas. The methodology comprises two key steps:

1. Pass/Fail Test: This test determines whether an FWA system can meet minimum Quality of Service (QoS) criteria. It assesses whether the system can consistently provide download speeds of at least 50 Mbit/s and upload speeds of 10 Mbit/s to a significant percentage of connected households, even during peak usage times.
2. Capability assessment: For systems that pass the initial test, a more detailed assessment evaluates the system's ability to deliver the required speeds under various conditions, including heavy usage and geographical challenges. The study uses parameters such as cell capacity, number of households and maximum transmission distance to calculate a 'capability score'.

Assessment procedure: Key information for assessing system capability includes:

- the system capacity per cell provided by the wireless technology;
- the maximum number of households per cell included in the analysis; and

[35]https://www.gsma.com/get-involved/gsma-membership/gsma_resources/u-s-the-rise-of-5g-fwa-the-battle-for-fixed-broadband-customers/

[36]https://ised-isde.canada.ca/site/high-speed-internet-canada/sites/default/files/attachments/CapabilityEvaluationBroadbandInternetService.pdf

- the longest distance between the base station and the household.

A pass/fail assessment is then carried out based on three basic criteria, which determines whether the system under evaluation delivers the required connectivity outcomes. However, there are no clear methodological guidelines on how to report such networks within the GSD.

8.3 Possible procedures for mapping FWA networks

To obtain more accurate values for mapping, so that geographical studies can identify the actual parameters of FWA connections down to the address level, it is necessary to obtain greater detail (more data) from certain operators. There are several options used to refine data within the GSD. Firstly, this involves a higher level of technology reporting during geographical data collection; secondly, it involves ex-post network analysis and connection simulations. The key in this case is to determine the scope of responsibility of the relevant entity (operator vs regulator) and to find a suitable combination of solutions which, on the one hand, will sufficiently protect the operator's investment in network development in the given area whilst minimising the administrative burden of coverage mapping, and on the other hand, will effectively develop the electronic communications network, its capacity and the availability of connections for customers.

1. **Supplementing data collection for specific locations/ISPs**: It is not only the number of end-points and the connection speed of a given technology that is important, but also the location of BTSs and the technology of the relevant transmitters (backhaul, technology). The collection of this data is a fundamental requirement for the ability to perform a connection performance analysis.

2. **Ex post analysis**: Determining the actual network capacity down to the level of a specific address is not straightforward due to the nature of the technology. There are a number of variables that cannot be resolved a priori given the limitations of data collection. Conversely, the data that would be required from operators would lead to a disproportionate administrative burden. It therefore seems appropriate to carry out an ex post analysis. Within the framework of the ex post analysis, it is possible to choose from three basic approaches, each of which has its advantages and disadvantages:

    i. **Network analysis and simulation by operators**: The regulator may require operators to provide data on their infrastructure within a specific area. Operators would supply information on the technology used at connected premises and on available connections in specific locations. This would be an approach that minimises the direct burden on NRAs/OCAs, which can thus avoid the need to carry out their own measurements, but it also has a number of drawbacks. If the data provided depends on the operators, it may contain inaccuracies or be oversimplified. The approach requires the definition of standardised values for connection simulations, which includes defining the parameters of the Poisson process, which must be the subject of public discussion between the regulator and the operator (see the existing ČTÚ methodology37).
    ii. **Ad-hoc regulator investigation (theoretical/factual):** In this scenario, NRAs/OCAs carry out their own theoretical simulation based on data obtained from operators, combined with other factors such as geographical location, demographic data and the technology used (modulation, MIMO, etc.). The aim is to simulate achievable connectivity and assess which standards the network meets. This approach allows for independent verification of data obtained from external sources, but requires greater capacity and resources from the regulator, as detailed analyses and simulations must be carried out. The advantage is that the regulator does not have to rely solely on operators and can verify the reality of the connection based on its own dataset. As with the previous approach, there is a need here to discuss the definition of standardised values for connection simulations and to strive for effective protection of the operator's investment.
        - **A supplementary aspect of the regulator's investigation is a field survey,** which involves random physical inspections in the field, during which the regulator carries out measurements on a real sample of customers in various locations. For this aspect, it is appropriate for the analysis to be carried out by a third party, currently, for example, BCO. Customers are selected on the basis of their tariffs and the network technology they use, and the investigation involves determining the speeds actually achieved, channel bandwidths and other technological parameters (e.g. transmission capacity or distance from the base station). We regard this approach as supplementary. In terms of accuracy, however, it is the most reliable, as it provides real-world data. On the other hand, it is logistically more demanding and costly, as extensive measurements need to be carried out at various locations. This approach would be particularly significant in the case of the first approach and the resulting need to rely on data reported by operators.

[37]https://ctu.gov.cz/vyhodnocovani-kapacity-siti

iii. **A broader definition of intervention areas and their adjustment during the consultation:** The third scenario involves expanding the list of intervention areas based on an evaluation of GSD data and a broader definition of areas where the network is likely to lack sufficient capacity for the required connections. This applies in particular to areas connected via wireless technologies or those with insufficient backhaul network capacity. Extending the criteria for qualifying intervention areas will make grant support available even to areas connected, for example, via VHCN at level 4 with only one provider, or where more than half of the addressable locations have connection speeds below 100 Mbps. Following the publication of the list of potential intervention areas, operators in the affected areas are notified that their network has been included in the list and may, in subsequent consultation, provide data on the technical capacity of their network to have the area removed. The definition of intervention areas may also be based on different levels of support. Categories A, B and C, which determine the level of support, already exist. It is therefore possible to utilise this mechanism within the broader definition of intervention areas.
This approach requires a standardised procedure for notifying operators and a methodology for documenting and evaluating network capacity. The advantage is that the regulator does not need to carry out detailed network analyses, whilst at the same time increasing operators' involvement in the process. To minimise the administrative burden on operators, it is crucial to establish a robust methodology for reviewing intervention areas during the public consultation and, where possible, to automate data processing and evaluation. This will ensure the consultation is effective and has the lowest possible impact on operators' administrative burden.

As also noted in the report on the implementation of the BEREC network mapping guidelines38, the issue of reporting and measuring FWA network coverage, particularly in the context of VHCN, does not have a simple solution that could be applied directly within the framework of the Geographical Sampling Data (GSD).

FWA technology, whether in conjunction with WLAN or 5G, exhibits significant variability in connection quality depending on deployment conditions and available spectrum. In the Czech Republic, where FWA coverage is above the EU average and where it plays an important role in meeting the Digital Decade targets, it is appropriate to analyse existing datasets and conduct a preliminary assessment of whether patterns are emerging within potential reporting anomalies that may impact the definition of intervention areas. This will make it possible to better identify areas where support for infrastructure development is needed, whilst also strengthening the competitive environment. Notwithstanding the above, such an amendment must be the subject of public discussion with operators and reflect market views, so as not to violate the fundamental principles of doing business in the field of electronic communications.

[38] https://www.berec.europa.eu/en/all-documents/berec/reports/implementation-report-on-the-berec-guidelines-on-geographical-surveys-of-network-deployments

9 Suggestions for optimisation

A description of possible optimisation measures can be summarised as the ability to identify backhaul network capacity and respond appropriately to information obtained during the network mapping process and the related agenda of the Ministry of Industry and Trade. In implementing this step, a conflicting tendency is apparent, where on the one hand there is the relevant objective of reducing the administrative burden on businesses in the electronic communications sector, and on the other hand the need for more detailed data collection. It is therefore appropriate to uphold the principle of proportionality and ensure that requirements for additional or more detailed data collection do not impose a disproportionate administrative burden, particularly on small businesses. Both the CTO and the MIT, as the organisations responsible for data collection and evaluation, are aware of this issue and are currently preparing measures to reduce the administrative burden and the number of required indicators (see Chapter 4.5).

When proposing optimisation measures for potential areas of mapping adjustment, we have endeavoured to summarise everything into two steps, which are based on the MIT's main needs whilst also taking into account the market and regulatory environment. These steps are framed by two areas, the resolution of which may lead to more informed decisions by the MIT regarding the development of telecommunications networks. Potential areas for improvement are as follows:

A. Overview of technology/medium at the backhaul network level:

It is unclear which technology is used at individual network nodes ([DP-CO39]), which makes it difficult to assess the suitability and sustainability of connectivity in a given area. In this step, the administrative burden could be reduced, and operators would now only report all available connections within range (typically within direct line of sight of the relevant AM), regardless of the network node's capacity; consequently, it would be possible to reduce the administrative burden and remove the data field relating to the reporting of available connections based on capacity.

B. Optimisation of ZSJ categories and colours

The current definition of intervention areas and their categorisation within grant programmes (OP TAK) is based on SCOBAM speed profiles and available connections. However, this approach may not always reflect dynamic technological developments or the actual capacity and quality of the network in the given areas. As a result, some areas that might be suitable for support may appear to be of lower priority. The process also entails a certain administrative burden, which may complicate its effective implementation.

One option could be to reassess the mechanism for defining intervention areas so that it focuses on aggregate information about network topology, the proportion of black AMs, or qualitative infrastructure parameters. This could refine the evaluation process and ensure that support is directed to areas where it is genuinely needed, whilst also taking into account the administrative simplicity of the process.

9.1 Mapping of topology at the backhaul network level

This concerns the need to better account for backhaul network capacity and the introduction of a reporting obligation for base stations and their technical parameters. The new data will contribute to more accurate and continuous mapping of available network capacity and the resulting standardisation of data on available connections, which is key to supporting the planning, capacity estimation and analysis required to define and evaluate areas suitable for grant support. This option is risky, particularly in terms of increased administrative burden and incorrectly completed or incomplete GSD forms. This step can be implemented in two variants. The first variant, modelled on Austria, would involve recording network media/technology, whereby at the AM level it would be clear what the overall topology looks like from the AM to the backbone network and

[39] We use the term DP-CO to describe a topology encompassing all network node elements, from the access layer to the central nodes. By the capacity or technology of network nodes, we mean the capacity/technology of the Distribution Point (DP), which aggregates connections from the access network and concentrates individual parts of the connectivity towards the end node of the backhaul network, referred to as the CO (Central Office).

At the same time, data collection on DP-CO network nodes, where operators would only provide information relating to the distribution backhaul network. The second, less administratively demanding Option 2 would not involve the creation of a nomenclature and would 'only' require the capacity and technology/media of the backhaul network's distribution points to be taken into account (Option 2).

Option 1: Creation of a nomenclature for identifying media/technology across the access, backhaul and backbone networks. Taking into account the capacity of backhaul network distribution points; creation of a new data field relating to network topology/media issues, not only within the access network but also within the backhaul and backbone networks.

Objective 1: Creation of a nomenclature for identifying media/technology across the access, backhaul and backbone networks

The creation of a uniform nomenclature for identifying network media and technologies represents a key step towards refining the mapping and analysis of electronic communications network infrastructure. This approach would involve the introduction of standardised identifiers that would reflect the specific type of medium (e.g. optical fibre, cable technologies, wireless transmission) and its use in the individual layers of the network – access, backhaul and backbone.

A uniform nomenclature would serve to ensure data compatibility between operators, government bodies and other entities, which would enable more accurate mapping of network availability and capacity. This system could be inspired by the example of Austria, where an attribute system with infrastructure type coding has been introduced within geodatabases. In Austria, this approach enables the unambiguous identification of network elements and streamlines the planning of shared projects or network development in less-covered areas.

The introduction of a nomenclature would involve:

- Defining basic types of media and technologies: e.g. optical fibre, microwave links, copper lines, FWA technology.
- Coding the network structure: Identifiers for individual layers (access, connection, backbone) and their technical specifications.
- Integration into geographical surveys (GS): A standardised nomenclature would become part of the data fields in data collection forms, which would support the harmonisation of outputs at both the government and market levels.

Objective 2: Taking into account the capacity of backhaul network distribution points; creation of a new data field concerning network topology/media issues not only within the access network, but also within the backhaul and backbone networks

The aim of this objective is to ensure that the capacity capabilities of the access network are adequately taken into account within the GSD. This would involve the introduction of a new data field that would enable the collection and analysis of information regarding the topology of the network media used not only in the backhaul, but also in the access and backbone networks. The new data field should be used to capture specific parameters, the type of media (e.g. optical fibre, FWA, cable technology) and the media structure across the distribution network (e.g. backhaul). This data would provide a detailed overview of the network's capacity capabilities, which is essential for assessing its ability to cover a given area and meet service quality requirements. Based on the data in this field, it would be possible to better identify areas with potential capacity constraints (so-called bottlenecks) and thus prevent situations where locations are declared as covered, but the infrastructure capacity does not meet the actual needs of end-users.

NRAs/OCAs could then better identify those areas where, based on the data provided, it is not certain that the operator is capable of providing sufficient quality of service for the available connections. As part of the public consultation, it would be up to the operator to demonstrate that the current technology at the given network node is capable of covering the reported connections in accordance with legislative obligations (within four weeks, reasonable investment, etc.).

9.1.1 Risks associated with modifying the data analysis and defining intervention areas:

The introduction of GSD amendments entails a whole range of risks and significant challenges, such as:

- Higher administrative burden for operators and regulators: the introduction of new requirements for collecting more detailed data on network capacity, topology and connection media will result in a higher administrative burden. Operators will have to adapt their internal processes for data provision, whilst NRAs/OCAs will face increased demands for data analysis and validation.
- Risk of discrepancies in reporting: detailed data collection and reporting requirements for connection capacity may lead to greater discrepancies, particularly for connections reported as available but which do not have

sufficient capacity within the backhaul network. This may cause conflicts between reported data and market reality.

- Need for robust preparation and methodology: the design of the new system requires the creation of a clear methodology for data verification. This includes defining parameters such as the speed profile of connections, capacity limits of the backhaul infrastructure, and rules for verifying available connections. Without thorough preparation, there is a risk of inaccurate application of the rules.
- Potential conflicts with operators: requirements for more detailed data and stricter reporting rules may be perceived by operators as a disproportionate burden. This may lead to an increase in disputes over the interpretation of the required data and rules, which will slow down the validation and analysis process.
- Identification of areas with insufficient backhaul capacity: data obtained from collection may not always be sufficiently conclusive to determine whether a specific connection is suitable for reporting as available. It is essential to establish clear rules and procedures for assessing areas with limited backhaul capacity to prevent discrepancies.
- Risk of delayed implementation: given the scale of the required adjustments and the need for public consultation with operators on data collection rules, there is a risk of delays in implementation and, consequently, in meeting connectivity targets.
- Potential impacts on the availability of state aid: inconsistencies or ambiguities in the reporting of network capacity could lead to certain areas being incorrectly classified as unsupported, which could limit network development in these locations.

9.2 Optimisation of ZSJ categories and colours

An area that is not covered by any defined scenario or recommendation and is not part of the mapping issue, but is part of the MIT's agenda, is the setting of parameters for subsidy programmes. Intervention areas are currently defined on the basis of technology and SCOBAM coverage speeds in a given location. These areas are identified based on an analysis of GSD data (the number of available connections and their capacity). Given the dynamics of technological development and the need for the effective allocation of public support, a review of the mechanism for determining intervention areas for the development of high-capacity networks is possible. We recommend that the basic intervention areas within the geographical mapping be defined in a broader manner. That is, the definitions of support area categories (categories A–D within the OP TAK) should be based on aggregate information for the given area/ZSJ, rather than the proportion of available SCOBAM connections at a specific speed. Thus, an administrative district would be eligible for support based on a simple proportion of connections at a given speed. A possible adjustment could, for example, be that areas assessed as Category C would be those where optical infrastructure is lacking, or where it accounts for only a lower percentage of all available connections in the given area/administrative district (e.g. 10% as recommended)[40].

Process for evaluating intervention areas and categories of supported areas under the VHCN

The Broadband Guidelines define the parameters for white, grey, black and white-grey areas, based on the number of operators and speeds:

- White areas are areas in which no fixed ultra-fast network (+100 Mbit/s) exists or is credibly planned within the relevant timeframe.
- Grey areas are areas in which only one fixed ultra-fast network (+100 Mbit/s) exists or is credibly planned within the relevant timeframe.
- Black areas are areas in which at least two fixed ultra-fast networks (+100 Mbit/s) exist or are credibly planned within the relevant timeframe.

Current status: Support areas are now divided into categories A–D; an area is classified based on the proportion of SCOBAM connection speed profiles in that area:

Table 9 Current status of the definition of ZSJ area categories and colours.

Category	Speed (Mbit/s)	SOCOBAM	Number of providers	Definition according to broadband guidelines
A	0–30	<= 40%	1+	White
A	0–30	<= 50%	1	White
B	30–100	<= 40%	1+	White
B	30–100	<= 50%	1	White
C	100–300	> 40% and <= 50% SCOBAM	1+ (Infrastructure)	Grey/Black
C	100–300	> 50%	1	Grey
D	Not supported	NA	NA	Black

Proposed amendment to the assessment of support areas:

Determination of support for areas and their categories based on the proportion of black AMs in the given area. The definition of an area's 'colour' would be based on the definition in EFTA Surveillance Authority Decision No 004/23/KOL:

- White AM – Up to 100 Mbit/s, one connection provider (operator).
- Grey AM – Up to 100 Mbit/s, more than one connection provider (operator).
- Black AM – VHCN connections are provided by more than 2 operators.

We recommend that the basic intervention areas within the geographical mapping be defined in a broader manner. That is, the definitions of support area categories (categories A–D within the OP TAK) should be based on aggregate information for the given area/ZSJ, rather than the proportion of available SCOBAM connections at a specific speed. Thus, the ZSJ will be suitable for support based on a simple proportion of black connections. A possible adjustment could, for example, look as follows:

Table 9 Possible model for amending the definition of ZSJ area categories and colours.

Category	Current speed (Mbit/s)	SOCOBAM	Number of providers	Definition according to broadband guidelines	Proportion of black AMs in ZSJ	Support (YES/NO)	Qualitative parameters of VHCN
A	0–100	NA	<2	White	>10%	NO	NA
A	0–100	NA	<2	White	< 10 %	YES	VHCN Categories 1–4
B	100+	NA	<2	Grey	>10%	NO	NA
B	100+	NA	<2	Grey	< 10%	YES	VHCN Categories 1–3 (excluding VHNC FWA)

C	100+	NA	>2	Black	NA	NO	NA

The proposed recommendation to revise the definition of support categories aims to clarify the identification of intervention areas. The exact form and definition are not the subject of this study, but given the needs of the Ministry of Industry and Trade, a certain degree of clarification could and should offset any increased administrative burden resulting from a more detailed data analysis.

9.3 Further proposals for optimising mapping and data collection

9.3.1 Optimisation of data collection (API)

The suggestions for optimisation in this sub-chapter can be summarised as 'customer-centric (CX)' optimisation of data collection. The implementation of an API questionnaire for data collection does not stem from a legal obligation, but is part of the recommendations within the BoR (20) 42 guidelines. In the public consultations taking place between the CTO and business representatives, this technological solution is also proposed as a suitable format for data collection. However, the implementation of the API questionnaire represents a relatively high burden for the CTU. Any amendment to the GSD would therefore need to be compensated for in some way to avoid an unreasonable burden on the CTU. The key characteristics of the GSD data collection API implementation are as follows:

Standardised interface: The API should provide a standardised interface for communication with businesses, which includes predefined questionnaire and question templates. To facilitate integration with other information systems, detailed API documentation should be provided, containing information on available methods, parameters and data formats. The API should support automation and integration with other information systems, and support webhooks, which are HTTP callbacks that enable automatic notification to the client of events such as changes to data in the system.

9.3.2 Modification of data sharing and iteration

There is currently a centralised repository for the publication of data and analyses. Any modification should be designed with a view to efficiency, transparency and easy access to information for end users, businesses in the telecommunications sector and other stakeholders.

The amendment should serve the widest possible range of users:

- Ministry of Industry and Trade: a more efficient process for identifying and defining priority areas.
- Operators: protection of investments, updating of information provided within the GSD.
- Other stakeholders: feedback arising, for example, from complaints regarding internet access services, initiatives by municipalities and towns, or groups of central and regional coordinators (such as BCO).

Proposal for a central portal: Creation of a single central hub integrating various websites, such as the Internet Map, the Price Barometer, the Telecommunications Services Visualisation Portal and similar platforms. This portal should provide users with a unified interface for accessing various data and analyses.

Streamlining the data collection and interpretation process: Users should be able to easily search for and browse data on connectivity availability in different areas, including detailed analyses and visualisations.

Data interpretation: The portal should provide tools for interpreting data and offer users relevant information to assist them in choosing an operator or service provider.

Support for businesses in the electronic communications sector: The portal should provide businesses in the electronic communications sector with access to relevant data, enabling them to easily identify areas requiring intervention

areas and planned public funding for broadband roll-out in these areas. At the same time, it should serve as a verification point for these activities and enable the updating of information on the network status of the areas concerned (e.g. planned investments).

Publication of information on intervention areas: The central portal should publish information on intervention areas and planned infrastructure development projects in these areas, so that the progress and success of interventions can be monitored.

Data security: The portal should ensure the secure storage and transmission of data to protect sensitive user information and comply with relevant data protection legislation.

Transparency and protection of investments: Ensuring transparency when classifying areas into intervention programmes is key to protecting operators' investments. We recommend that the GSD system ensure that operators can easily monitor the classification of their reported areas and, where necessary, initiate changes to this classification. This step not only protects investments but also supports effective planning and ensures the availability of high-quality services for end-users.

10 Conclusion

The BEREC BoR Guidelines (20) 42 and the obligations arising from the European Electronic Communications Code (EECC), Article 22 of which, among other things, stipulates the obligation to conduct a geographical survey of broadband network coverage every three years, are fulfilled in the Czech Republic. However, there are areas where there is room for improvement, particularly in supporting the effective development of connectivity, which is especially significant in the Czech Republic, which lags behind the EU average in terms of coverage. There is some scope for improvement in the use of processes within the verification process. This also includes the possibility for regulators to set forecasts for future network development. NRAs/OCAs can thus request coverage data from operators and improve the transparency and efficiency of the GSD. To achieve objectives such as improving the Czech Republic's connectivity rating and meeting the requirements of the National Plan for the Development of VHCN Networks, more detailed geographical mapping at the backhaul network level and the introduction of standardised network codification are advisable.

To ensure efficiency and achieve VHCN connectivity targets in the Czech Republic, it is advisable to make better use of and improve the accuracy of the datasets that the CTU regularly collects via the electronic data collection system. Currently, the CTU collects data on networks at the level of address points in accordance with the RÚIAN within the framework of the GSD, which fulfils the legal requirements under Section 115(1) of Act No. 127/2005 and Article 22 of the EECC. This data is already being used by the Ministry of Industry and Trade (MPO) to define intervention areas for grant support; however, for the effective allocation of funds and the achievement of the objectives of both European and national strategies, the data level and analytical procedures should be expanded. This includes, for example, the need to take into account the complex topology of network technologies/media, from access to backbone networks. More detailed geographical data providing an overview of network technology from access to backbone networks will enable more precise identification of areas requiring support and better planning in line with end-users' needs. Some European standards, as indicated in the benchmark of EU countries such as Lithuania and Austria, demonstrate a detailed overview and codification of the network from backhaul to backbone, along with a more cost-oriented approach to data analysis. This makes it possible to better track the incentives that motivate customers to switch to very high-capacity networks. This approach leads to better decision-making when allocating grant support and planning network investments. Currently, the Ministry of Industry and Trade (MPO) is implementing this agenda through the Operational Programme Technologies and Applications for Competitiveness (OP TAK, formerly OP PIK), where the aim is to achieve widespread and affordable coverage with high-speed internet infrastructure, whilst minimising interference in the market environment to avoid distorting competition.

Mapping FWA network coverage faces the problem that the currently reported parameters may not accurately reflect the quality and speed of the connection, which can lead to a situation where an FWA network is classified as VHCN even in cases where it does not provide the expected gigabit parameters, nor does it meet the BEREC criteria for classification as VHCN. For example, in the case of a single base station with capacity in an urban area, VHCN coverage may be reported, regardless of the actual availability of capacity for potentially connected households. This problem is all the more evident in areas where an operator reports compliance with Category D parameters – unsupported areas ('black' areas) – based on the reported capacity of available connections, thereby blocking the possibility of subsidies for the construction of fixed high-capacity networks, which limits the choice of connections for end-users. The issue of mapping and measuring FWA networks is technically and administratively complex due to the variability in wireless connection quality, which is influenced by factors such as distance from base stations, the number of users, and the technical parameters of individual networks (MIMO configuration, channel modulation, etc.). With the advent of technologies such as 5G, and with VHCN requirements for gigabit speeds, it is necessary to regularly update the mapping methodology so that it truly reflects the actual capabilities of FWA connections, which is all the more crucial in the Czech Republic, where FWA traditionally has high coverage.

One solution could be to take into account the technical parameters of the DP-CO backhaul network (location, medium/technology used) and to establish a mechanism whereby operators would be required to transparently report both the actual capabilities of their infrastructure, including connection capacity, and other factors affecting the actual speeds achievable by users. The introduction of a uniform nomenclature for network media/technologies and the consideration of backhaul network capacity present a key opportunity to refine the mapping and planning of electronic communications network development. Accurate data on the topology and capacity of individual network layers would enable more effective identification of areas requiring intervention, the targeting of state aid, and the verification of reported data. However, such an approach places high administrative demands on both operators and regulators; its implementation therefore appears more feasible in Option 2, which involves mapping only the network media/technology and capacities at the backhaul level.

Further recommendations include the implementation of tools such as an API for questionnaire-based data collection. This will contribute to greater efficiency and accuracy in data collection, whilst reducing the administrative burden on businesses and the CTO. The data can then better reflect market conditions and facilitate the identification of areas with insufficient coverage. Consideration is also being given to a possible adjustment and extension of the criteria for determining intervention areas to take account of the actual state of coverage and technological capabilities. The introduction of these measures aims not only to improve the availability and quality of connectivity in the Czech Republic, but also to strengthen the competitive environment and protect operators' investments, particularly those already providing VHCN services.

It is important to emphasise that any proposal to amend the geographical data collection must be viewed as a potential contribution to reducing the administrative burden in meeting the needs of the Ministry of Industry and Trade (MPO). However, it is essential that the Czech Telecommunications Office (ČTÚ) also takes into account other purposes of geographical data collection, such as analyses of relevant markets, the performance of the state statistical service, and international reporting. An example of specific data collected for the needs of the Ministry of Industry and Trade (MPO) was information on active connections broken down by speed intervals, the collection of which was terminated by agreement with the MPO in 2024 as part of a reduction in data collection. However, there are opportunities to improve data collection, such as the implementation of API forms or adjustments to form data fields. These steps should be carefully consulted with both the relevant authorities and operators to verify their actual need and prevent an increase in the administrative burden.

At the level of international cooperation, it is also important to monitor BEREC's actions. In October 2024, an implementation study was published examining how individual Member States had implemented the provisions of Article 22 of the EECC and BEREC BoR (20) 42 guidelines for geographical mapping of networks. The adoption of updated guidelines and the incorporation of findings from this implementation report are expected in 2025. This revision should bring new opportunities for harmonising data collection and evaluation in line with European standards and ensuring a consistent methodology for data reporting.