BEREC
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Implementation report on the BEREC Guidelines on Geographical surveys of network deployments

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Contents

Executive Summary

BEREC is publishing this Implementation Report, which gathers evidence about the extent to which the Article 22 provisions and the BEREC Guidelines have been followed by authorities and how. This information should enable BEREC to judge the usefulness of its Guidelines to conduct the GS and to implement consistently the Article 22 provisions, identify any lessons learnt, detect areas for improvement and, finally, consider whether BEREC should programme a partial or more substantive update of its Guidelines in 2025.

This implementation report has shown that overall Article 22 EECC and the BEREC Guidelines have contributed to a substantially increasing number of GS across the EU and improving their granularity and the quantity and breadth of information retrieved. At the time of drafting the BEREC Guidelines, many countries collected no geographical information or information which was not sufficiently granular, and the use of GIS was not widespread. In contrast, today all MS collect very granular information and all NRAs/OCAs use GIS. The BEREC Guidelines have also improved the comparability across national outcomes, especially for fixed wired networks and coverage information, since the definition of “premises passed” has been almost unanimously adopted and information is collected at a very granular level, so that there are no problems of data aggregation in producing national or regional connectivity statistics.

Hence, overall, it can be concluded that the BEREC Guidelines and the NRAs/OCAs efforts in implementing these guidelines have resulted in a very solid foundation for a harmonized delivery of GS in European countries.

However, MS experience important problems in collecting QoS information at a sufficiently granular level and expected peak time speed plays out as a specially challenging indicator. More could be done to assist authorities regarding the QoS indicators in general and for FWA. Also, BEREC needs to think about the information to characterise mobile networks as the harmonization of the coverage of 5G networks calculated by the various NRA/OCA seems to be quite challenging. Indeed, the approaches adopted by the NRA/OCA could be very different, since the collections are mostly based on the distinction between 5G SA and 5G NSA, but also other distinctions (based on frequencies or BTS characteristics) are used.

BEREC Guidelines provided a first step towards a better mapping of broadband networks, but in the light of

- Technology developments
- More recent BEREC documents, in particular the VHCN GL[1]
- New EU legislation, in particular the Gigabit Infrastructure Act (GIA)[2]

[1] BoR (20) 165 and an updated version related to mobile VHCN BoR (23) 164; currently the VHCN GL are updated with regard to fixed VHCN.
[2] Regulation (EU) 2024/1309 of 29 April 2024 replacing the BCRD.

- A multitude of more recent EU and EC soft law documents such as the Annex I in the EU State Aid Guidelines mapping[3] and measurement of the Digital Decade Key Performance Indicators[4]

BEREC considers it appropriate to update the BEREC Guidelines on Art. 22 broadband mapping. In particular, the existence of several more recently introduced broadband mapping methodologies that partly overlap can cause confusion for operators and authorities, a situation that should be avoided. Also, as this implementation report has shown there is room for improvement regarding the approaches to implement the Guidelines to achieve further harmonization and with this increase the comparability across MS.

BEREC will work on the update once the outcome of the EC "Methodology on 5G Mobile and Fixed QoS Coverage Mapping"[5] is known, most likely in the second half of 2025.

1. Introduction

Article 22(1) of the European Electronic Communications Code ('**EECC**') established that National Regulatory Authorities ('**NRAs**') and/or Other Competent Authorities ('**OCAs**') should conduct a geographical survey of the reach of electronic communications networks capable of delivering broadband ('**GS**') by the 21rst December 2023. The GS should be sufficiently granular and include quality of service information ('**QoS**'). It may also include forecasts of the reach of very high capacity networks (´**VHCNs**´). The GS was meant to facilitate the effective design, implementation and monitoring of broadband policies and related regulation.

Article 22(7) EECC tasked BEREC with the delivery of guidelines to assist authorities to implement their obligations under Article 22 consistently. BEREC published three different Guidelines[6] which were published as a Handbook (BoR (21) 104) in June 2021. Paragraph 15 of the Core Guidelines (BoR (20) 42) established that BEREC would prepare an Implementation Report to examine how different European countries and member states ('**MS**') had transposed and enabled the Article 22 provisions. Afterwards, BEREC would consider whether to revise and update the Guidelines.

In October 2024 BEREC is publishing this Implementation Report, which gathers evidence about the extent to which the Article 22 provisions and the BEREC Guidelines have been

[3] See Annex I in Communication From The Commission Guidelines on State aid for broadband networks 2023/C 36/01 available at EUR-Lex - 52023XC0131(01) - EN - EUR-Lex (europa.eu).
[4] See Implementing decision setting out key performance indicators to measure the progress towards the digital targets | Shaping Europe's digital future (europa.eu) of 30 June 2023 (C(2023)4288_final).
[5] 1st Draft presented on 16th July 2024.
[6] The BEREC Guidelines to assist NRAs on the consistent application of Geographical surveys of network deployments – doc. BoR (20) 42, also known as Core Guidelines; The BEREC Guidelines on Geographical surveys of network deployments Article 22 (2), 22 (3) and 22 (4) – doc. BoR (21) 32; The BEREC Guidelines on geographical surveys of network deployments - Verification of information – doc. BoR (21) 82.

followed by authorities and how. This information should enable BEREC to judge the usefulness of its Guidelines to conduct the GS and to implement consistently the Article 22 provisions, identify any lessons learnt, detect areas for improvement and, finally, consider whether BEREC should programme a partial or more substantive update of its Guidelines in 2025.

Therefore, to prepare this document BEREC has gathered information from 27 public authorities that are responsible for the conducting the GS[7]. The GSs are delivered by the NRAs of 18 MS, OCAs of 4 MS, whilst in 5 MS they are a joint responsibility of an NRA and an OCA[8] or performed in part by a NRA and in part by an OCA[9].

According to the information retrieved in 2024, 27 MS implement the GS for fixed broadband and 26 for mobile broadband. In all MS the GS is carried out at least once a year, and in many cases with more frequency[10]. The BEREC guidelines required information to be collected at a very granular level and this is the case very generally: for wired fixed broadband in 24 MS at address level, 2 MS use small grids (this is, smaller than or equal to 100 x 100 m^2) and the last one combines small grids and addresses; for FWA either at address level or small grids; and for mobile broadband in all MS but one in small grids. Accordingly, all the authorities tasked with the delivery of the GS use geographic information systems (GIS) to store and manage the GS databases.

According to BEREC information, in 2019, there were 21 MS with one or more fixed broadband maps and 17 MS with one or more mobile broadband ones. In many of those maps the granularity was rather low. Out of 25 fixed broadband maps, only 13 had information at address level, 5 had grid information but 9 had large administrative areas as a reference unit (parishes, postal sections, municipalities, NUTS 3 areas). In the case of mobile broadband, out of 18 known initiatives, 4 had address level information, 8 were based on grids/polygons of different sizes, and 5 relied on large areas). The use of GIS was not widespread.

Therefore, Article 22 and the BEREC Guidelines have resulted in an important increase in the number of MS carrying out the GS and in the granularity of the information included in these initiatives.

Moreover, in 2024, in all MS but 4, the information nurturing the GS is retrieved from all operators, as recommended by the BEREC Guidelines that established that all the operators in control of any part of an access network should be providing information, regardless of their size and of the technologies they used. In the countries where not all operators are consulted, those that are excluded from the data collection are either small (for example, one MS

[7] BEREC has gathered information from 26 MS and from Iceland. All NRAs have consulted with relevant OCAs to provide information.
[8] For example, an authority may be collecting the raw data and the other authority storing and treating it, or alike.
[9] For example, fixed broadband may be the responsibility of an authority and mobile broadband of the other responsibility or alike.
[10] 2 MS have GS that they update continuously and 25 MS have GS with periodic updates: 10 update their GS yearly and 15 more often than that.

excluded only one operator with a market share of 0.12%) or using specific technologies (in one country operators deploying limited P2P connections to serve specific end users' needs were excluded).

24 authorities conclude that Article 22[11] and the BEREC Guidelines sufficiently empower them to collect the data sets to evaluate the geographical coverage and performance of broadband networks properly. Among the 3 that disagree, one explains that despite the tools some small operators still face technical difficulties, another that given the established status of their broadband map at the time of publishing the Guidelines, new definitions were not accommodated and, the third one, that BEREC Guidelines provided a first step towards a better mapping of broadband networks, but that they became obsolete in parts that were developed in other regulations (Annex I in the EU State Aid Guidelines mapping[12] and measurement of the Digital Decade Key Performance Indicators[13]). The existence of several regulations that partly overlap and the problems this may cause will be looked at later.

Several authorities explain that the BEREC Guidelines have contributed to a harmonization of the criteria to map broadband coverage among MS, which results in a better comparability of national situations. The BEREC Guidelines promoted common definitions, processes and understandings. One authority concludes that this implies that the same standardised information can be used to implement different policy and regulatory tasks (i.e. such as verifying the availability of services for USO, state aid proceedings, assessment of the deployment of competitive networks and services (for market analysis procedure)). Another that the Guidelines aimed to support digital inclusion and to create a more uniform regulatory framework across the EU.

An authority explains that the Guidelines provided clear and detailed information to assist NRAs and OCAs in effectively implementing the GS in their country, another that it did not have to develop a full methodology to carry out the GS and a third one that the use of common templates and formats across Europe helped convincing operators to provide the information.

However, several authorities identify difficulties in implementing the BEREC Guidelines and confirm that providing information and checking it is quite resource demanding for operators and NRAs/OCAs. These difficulties are spurred when there is no unified address register in the MS.

Moreover, an authority expresses that because of the new and unique nature of the GS task, authorities may need more guidance. In this respect, several authorities state that the BEREC definitions regarding QoS information (expected peak time speed and some VHCN classes) are difficult to adhere to in practice/a burden to collect and to verify. One authority would

[11] One authority explains that Article 22 provided the legal basis to collect forecast information about fiber rollouts that were previously collected on a voluntary basis.
[12] See Annex I in Communication From The Commission Guidelines on State aid for broadband networks 2023/C 36/01 available at EUR-Lex - 52023XC0131(01) - EN - EUR-Lex (europa.eu).
[13] See Implementing decision setting out key performance indicators to measure the progress towards the digital targets | Shaping Europe's digital future (europa.eu)

welcome a common definition of expected peak time speed and guidelines regarding the measurement of VHCN thresholds and their verification.[14] Finally, an authority states that for mobile networks, the need to request VHCN information is unclear as they find this not necessary, moreover they have no way to store this data.

A technology that has given rise to many comments is FWA. An authority describes the task to include FWA in the GS as “non-trivial” and three other authorities would appreciate more detailed guidance with respect to the approach regarding these networks, one specifying that clear recommendations regarding the treatment of FWA capacity are needed. A fifth authority explains that some FWA operators do not have the capability or tools to report peak time speed and that the authority would require guidance on verification in those instances.

The GS on mobile broadband networks also receives a couple of comments. One authority explains that speed information is too complex to determine in this case and another that the comparison of national results may be hindered because the BEREC Guidelines defined too few thresholds for mobile broadband networks.

The specifications for the GS of fixed broadband networks are questioned by one authority that suggests that the low-speed intervals should not be mapped. An authority requires more guidance to support the delivery of documentation to operators so as to better ensure that forecasted deployments are implemented in the project timeline and not just to avoid state aids.

Finally, according to a few comments, authorities would welcome more guidance with respect to how much their practice could differ from the BEREC Guidelines or what is the minimal information to be collected according to the BEREC Guidelines.

In conclusion, Article 22 EECC and the BEREC Guidelines have contributed to increasing the number of GS across the EU and improving their granularity and the quantity of information retrieved. The BEREC Guidelines have also improved the comparability across national outcomes, especially for fixed wired networks and coverage information. However, more could be done to assist authorities regarding the QoS indicators, in particular expected peak time speed and FWA. Also, it is important for authorities to think about the information needed to characterize mobile networks for regulatory and policy decision-making and to inform end-users (see below).

2. BEREC Guidelines definitions

The Core Guidelines adopted all the definitions included in Article 2 of the EECC and provided definitions for 15 additional concepts related to the reach of networks capable of providing

[14] See ch. 5 below.

broadband. Those included: the reach of fixed broadband networks and of mobile broadband networks, the definition of maximum achievable speed and of expected peak time speed and the definition of address passed and premises passed.

Here BEREC briefly reviews to the extent to which the NRAs and relevant OCAs adhered to these definitions and collected the information as recommended by the BEREC Guidelines. Section 5 will describe the situation regarding the mapping of VHCNs, which is not included here, and section 3.1 will provide a more detailed summary of the use of the concept of premises passed.

In 16 MS, the NRAs/OCAs adhered to all the definitions and collected all the information which was described as non-optional by the BEREC guidelines. For fixed broadband 25 authorities relied on the recommended definition of premises passed, 25 collected technology information and out of those 21 used the BEREC categories and 25 collected information on maximum achievable speed. Expected peak time speed for fixed broadband was collected in 16 MS, and not collected in 11 countries. In some of these countries, operators find it difficult to provide data about expected peak time speed or cannot provide this information at address level, as required.

Mobile broadband technology was collected in 25 MS, but there are differences in the technologies being collected. For example, 2 authorities do not collect 5G coverage.

	Fixed broadband				Mobile broadband
	Premises passed definition	Technology	Maximum achievable speed	Expected peak time speed	Technology
Authority collects information (*)	25	25	25	16	25
Authority does not collect information	2	2	2	11	1
No information is available	0	0	0	0	1

*For premises passed, this should be read as in 25 MS the authority used the BEREC GL definition.

Table 1 Information collected by NRAs/OCAs on aspects of fixed/mobile broadband definitions

3. Fixed Broadband

3.1. Definition of Premises Passed

The BEREC Guidelines provided the definition of premises passed[15], which is the cornerstone of the fixed broadband GS, since ultimately the information collected is the number of premises passed with a certain technology/network in one address or small grid and the number of premises served with a specific speed in one address or small grid.

Of the 27 MS who provided information to BEREC about their fixed broadband GS, 25 use the premises passed definition and 2 MS do not. Yet, in one of these cases the definition used by the authorities is quite similar in principle to the one included in the BEREC Guidelines. This authority considered a premise as passed if there is an empty pipe at the property boundary or with a fiber for FTTH/FTTB technology, respectively if there is an HFC network available.

The BEREC Guidelines required that information was retrieved at address or small grid level but explained that authorities could use proxies to provide the information of "premises passed" in an address or a small grid. A common hypothesis is to consider all the premises in an address as passed when the address is. In fact, in 22 MS this assumption is used by authorities. In one country the actual number of premises passed is considered, another collects the number of internet connections in each address (already existing or easy to build) and reports this as premises passed, and in another, since an address may identify more than one building, each building is checked separately and no general assumption is made.

The authorities in 8 MS reported to BEREC that operator had experienced problems in providing premises passed information. In some cases, the operators cannot say exactly if an address can be connected in 4 weeks because each case is different and it would be expensive for them to make this assessment, in addition there is also the problem of obtaining approvals, which in many cases takes longer than 4 weeks[16]. Also, operators that offer wireless connections and that cannot determine premises passed information are helped by the NRA by providing them with different determination methodologies. Most of the MS do not

[15] The definition is: "A premise is considered passed if, on request from an end-user, the relevant operator can provide broadband services (regardless of whether these premises are already connected or not connected to the network) at the end-user premises. The provision of broadband services at the end users premises should not exceed normal connection fees, i.e. without any additional or exceptional cost if it is the standard commercial practice and, in any case, not exceeding the usual cost in the country. The reference for "normal connection fees" should be determined by the relevant NRA/OCA. Furthermore, the operator must be able to technically connect the end user, usually within 4 weeks from the date of the request.".

[16] Footnote 10 in the Core Guidelines stated that: "This four-week period does not take into account delays due to external, non-technical factors, such as delays from the end user side, delays arising from operator administrative reasons, or delays due to extreme weather conditions)". Therefore, administrative delays should not be considered to declare a premise as passed or not. Moreover, in general, one would expect that the kind of technical works needed to make a "premise" passed would not require an administrative permit as the "premises passed" definition is allowing only for small investments needed to connect the end-user demanding connectivity in a short period of time and at no additional cost.

know the calculation methodology for determining the premises passed by the operator, however, one of the MS specified that it would be a 15 meters buffer from the central office.

Finally, an NRA that is collecting information at point level for wired networks ((X,Y) coordinates) has provided BEREC with the view that operators should provide such information rather than premises passed (premises passed can be calculated from point information by the authority) since points allows the inclusion of all kinds of sites in the broadband map (solar plants, street signs, surveillance poles, agricultural plots, street cabinets).

The **conclusion** that BEREC draws from this chapter is that most countries have respected the definition of premises passed included in its Guidelines and that quite generally if an address was considered as passed then all the premises at that address were considered as passed. BEREC can also draw the conclusion that in some MS the operators found it difficult to transmit the data at the premises passed level.

3.2. Resolution of Data Collection for Wired Fixed Broadband Networks

BEREC recommended that data for wired fixed broadband networks be collected at least at an address level or at a level of a 100m x 100m or smaller grid. 23 MS provided BEREC with the information that they collected fixed broadband information at the address level, 3 MS that they collected the data at the 100mx100m grid level and one MS that it uses both since geo-coded points do not exist in all countries. In one of the MS using a grid the next data collection will be done at the level of address, another of those explained that the data collection is done at the postal code level and that it will take some time until it is realized at the address level. The operators were able to transmit the data requested at the address level for wired networks in 23 MS[17]. In one country small operators experienced problems in doing this.

The availability of an address database in an important resource in the delivery of the GS and the BEREC Guidelines recommended that MS used one unique address data base to collect the information. In 22 MS there is such address database but in 5 MS there is none. In one of these MS there is a state project in progress in which, together with the local town halls, a single address database will be created.

In 5 MS the address database is updated permanently, in 2 MS weekly, in 2 MS once a month, in 1 MS quarterly, in 1 MS once every 6 months and in 7 MS annually. One MS declared that the address data base is updated as often they received new data from the operators and other MS declared that they are expecting a new version in the next couple of months.

[17] Is should be noted that there are variations in the data requested by authorities across Europe, since several do not request data on peak time speed or some VHCN classes.

In 22 MS, the NRA/OCA uses the available address database. A problem raised by MS about the address database is the lack of information related to the new addresses, but which either the operators have, or the users of the information made available by the authority complain about their lack. In this case, some MS notify the owners of the address database so that they can update their information or oblige the operators to update their databases with the missing information so that at the next report the address database can be completed or corrected. There are also cases in which information about new addresses is ignored by the MS.

15 MS out of the 24 using a unique address database, can share it with the operators for the purpose of collecting information for the GS, but there are also 9 MS that allow the operators to transmit information on their own address/geocoded databases, which they then need to reconcile and put together in one

From the point of view of the possibility/obligation of the operators to update the unique address database, in 10 MS the operators have the possibility/obligation to update this database. In some MS, the operators do not have this possibility/obligation but they have the obligation to inform the owners of the address database about any lack of information.

In many MS operators must use the unique address database and adapt the information to their own database, if the operator does not adapt the information to its own address database, then the data transmitted by it will not be displayed on the broadband map. However, there are also MSs that, using the geocoding method, check whether the geographic coordinates sent by the operator touch the outline of the buildings in the unique address database and in this case the data informed are considered valid. Also, a MS imposed the rule to the operators that the geographical coordinates of the address point should be in the middle of the building (GIS centroid) so that the data are considered correct and displayed on the broadband map.

For the integration and verification of information provided by operators, most MS use GIS methods including methods such as geocoding and, also, certain data matching algorithms were also mentioned.

The GS aims at measuring the number of premises passed and coverages (premises passed/premises) and to do this in a precise way it is important to know how many premises exist at each address. In some MS this information exists but in others it does not. 14 authorities in different MS have access to such information and 9 do not. Those with access indicated the following sources of information: Real Estate Register, National Institute of Statistics, State Land Service, Building cadastre, Tax Agency and Office for Land Surveying, Mapping and Cadastre. These are institutions where they can obtain the number of premises at address level.

Finally, 14 MS have a GS that identifies connectivity in public service buildings like hospitals, schools, major transport hubs, public administration. From those 14 MS, one MS specified that some of these premises are provided broadband on private networks provided by municipalities, and that since these municipalities do not operate a public network they are not obliged to provide the GS data. Another MS declared that in some cases the identification of

hospitals is excluded and other MS declared that they collect data on address level regardless of what type of building the connection concerns but they are constrained by certain legal issues that do not clarify whether they can collect information about non-commercial and closed networks (restricted to a limited group of users). 13 MS do not collect this connectivity information specifically, but one of the MS explained that in some cases these buildings appear on the map, being identified only by their use (family building, one house, etc.) and other MS specified that there are specific mappings that fall outside the scope of Article 22 where, for example, schools, hospitals or public square can be identifies.

3.3. Technologies

In order to characterize the theoretical coverage of fixed broadband networks, the BEREC Guidelines considered it important to collect information on the kind of physical medium and technology that supports the provision of the broadband service in the access network.

25 MS (out of 27) collect data categorized by fixed technology and of these, 21 MS followed the classification of the Core BEREC Guidelines. 11 MS collected additional technologies or split technology types into more detailed categories. Thus, one of the MS split FWA into 3 categories like this: "4G Fixed" = FWA based on mobile networks" THD Radio = FWA licensed spectrum, fixed LTE >30Mbps, "HD Radio": licensed spectrum, fixed LTE >8Mbps. Some MS collected separately data on FTTH and FTTB (not in one category) and data on wireless access technology fixed LTE/5G (not as a part of other FWA in licensed spectrum). A MS included DSL, VDSL and Vectoring in the FTTC category, included all DOCSIS in the HFC category and FWA was not collected separately.

There were 11 MSs that introduced new categories such as UTP/FTP, DOCSIS 4.0 and FTTP or split the BEREC DOCSIS 3 code into DOCSIS 3.0 and DOCSIS 3.1 and within FTTH/B collected data on GPON and XGSPON technologies. Broadband Speed Classes

According to the information retrieved by BEREC, 25 NRAs/OCAs (out of 27) collect data on the maximum upload and download achievable speed as defined in the Core BEREC guidelines. Only two NRAs/OCAs do not collect this data. Among those, one NRA/OCA has been collecting data for over ten years, so all its speed definitions had been established before the BEREC GL were published and this authority is only collecting maximum download speed but not upload speed, and the other NRA/OCA collects this speed data only for mobile and FWA technologies but for fiber (the most prominent technology in the country), assumes a maximum download speed of 1 Gbit/s.

16 NRAs/OCAs (out of 27) point out that they collect data on expected upload and download peak time as defined in the BEREC Guidelines. On the other hand, 11 NRAs/OCAs (out of 27) do not collect any data on expected peak time speed. Among those not collecting these data, one NRA/OCA collects information on maximum available download and upload speeds, including maximum and minimum speeds within a 100x100 meter area, and another NRA/OCA collects data only on technically available maximum speeds. In addition, 5

NRAs/OCAs state that they find it difficult to collect data on expected peak-time speeds at address-level information as required by the BEREC Guidelines.

According to the gathered information, 13 NRAs/OCAs (out of 27) pointed out that they request the speed information from operators in the tiers proposed by the BEREC guidelines. On the other hand, 14 NRAs/OCAs (out of 27) do not use this classification of speed. Among those 9 NRAs/OCAs (out of 14) request exact speed information from operators, which can be easily be placed into the BEREC tiers.

Only 3 countries (out of 14) request speed tiers which are incompatible with BEREC's. Finally, one NRA/OCA (out of 27) does not request speed information for all technologies.

3.4. Fixed Wireless Access (FWA)

18 NRAs/OCAs (out of 26) include FWA in their GS, while 9 NRAs/OCAs did not. Among the countries excluding FWA, one authority stated that its FWA networks are primarily based on 4G/5G mobile networks, eliminating the need to distinguish them separately. Another explained that only radio connections are included in the FWA, while mobile broadband at fixed locations is excluded. Furthermore, 5 NRAs/OCAs reported there is no FWA in their country, and 2 that the FWA network is not widely used.

12 NRAs/OCAs (out of 18 collecting FWA information) collect FWA data at address level, while 5 NRAs/OCAs collect this data on grid level. One NRA stated that it collects data at address and grid levels of different sizes (100m, 50m). Among the 5 NRAs/OCAs that collect data on grid level, three NRAs/OCAs collect data on a 100x100 m and two NRAs/OCAs on a 50x50 m.

A couple of NRAs/OCAs expressed that it was difficult for FWA operators to provide data at address level. In these countries the grid alternative is used.

Two NRAs/OCAs stated that they find it difficult to collect information about premises passed at the address level for FWA. Eight NRAs/OCAs stated that they find it difficult to collect information on coverage at the address or grid level. Furthermore, one NRA/OCA stated that coverage, as passed, is not representative or usable because it provides high values, around 99.5%. Also, there is a significant capacity problem, as the user's business model determines a major difference in performance, especially when dealing with 5G infrastructure. Another NRA indicated that operators face difficulties in providing information at the specific address level, particularly regarding data download and upload speeds.

3.5. Technical conclusions

As it has been mentioned, 27 MS implement the GS for fixed broadband and carry out this regularly and frequently (at least once a year). These GS procure very granular information on the available technologies- address level data in 23 MS[18] and small grids or a combination of address level data and small grids in the rest of countries for wired broadband networks. There is also a very high resolution for FWA[19]. In 22 MS, the NRA/OCA uses a unique address database to compile all the operators' information (as recommended by the BEREC Guidelines) and all the authorities tasked with the delivery of the GS use geographic information systems (GIS) to store and manage the databases.

Moreover, in all MS but 4 the data is being collected from all network operators, and when some are excluded, it is because they are either very small or use very specific technologies like P2P connections.

Adding to this, almost all (25) MS use the definition of "premises passed" included in the Core BEREC Guidelines[20], which is the cornerstone of the GS for fixed broadband and 25 MS collect technology availability information and maximum achievable speed information as recommended by the BEREC Guidelines. 18 MS include data on FWA coverage in their GS and where this is not included in most cases it is because the country has no or very little FWA.

All these positive developments have been costly, and some MS still experience problems of implementation. For example, in some MS operators find it difficult to provide coverage information at such granular levels - for example for copper networks - and in some MS the address database used to collect information has missing information and cannot be appropriately updated. In a few cases such database does not even exist.

Yet, overall, these developments provide very solid foundations for a harmonized delivery of GS in European countries, which should advance more comparable statistics across European countries, as it is currently the case for coverage information of wired networks.

However, MS experience important problems in collecting QoS information at a sufficiently granular level and expected peak time speed plays out as a specially challenging indicator. 16 MS collect expected peak time speed directly from operators but in 11 MS this data is not being collected. In some of these countries, operators find the "peak time speed" information difficult to understand and to operationalize and in other ones, authorities are of the view that this information would not be sufficiently reliable to be considered in the GS.

[18] One MS is relying on small grids
[19] 12 NRAs/OCAs (out of 18 collecting FWA information) collect FWA data at address level, while 5 NRAs/OCAs collect this data on small grid level.
[20] 16 MS adhered to all the definitions and collected all the information which was described as non-optional by the BEREC Guidelines

Finally, another area which could be improved is the data collection in the case of FWA technologies as several authorities find this information quite difficult to collect. In some cases, operators are not sufficiently technically proficient to estimate coverage and QoS for FWA networks and the authorities have to step in by providing guidance and simplifications, for example to determine the number of premises passed. Moreover, the calculation of the capacity of an FWA network is not trivial and could do with further guidance. The available capacity on an FWA network, which is shared by all end-users, will inter alia be of relevance to the number of premises passed by that network.

In conclusion, Article 22 EECC and the BEREC Guidelines have substantially increased the availability of national GS across Europe and, in the case of fixed broadband, have also improved the range of information being collected and improved the comparability of the GS results across European countries. The BEREC Guidelines and the NRA/OCA efforts in implementing these guidelines have resulted in a very solid foundation for a harmonized delivery of GS in European countries, which should advance more comparable European statistics, as they are currently for coverage information on wired broadband networks. However, some important information has proved difficult to collect in a reliable manner. This concerns particularly the information on expected peak time speed, which many authorities cannot implement.

4. Mobile Broadband

All MS but one collect data for mobile broadband mapping/coverage.

4.1. Definition of grid passed

Paragraph 72 of the Core BEREC Guidelines stated that: "…, BEREC considers that a grid is covered by a mobile broadband technology if a broadband service (at least 2 Mbps) is available in at least 95% of the grid area with a high likelihood of a successful reception, where successful reception means a probability of successful service reception of 95%."

Sixteen NRAs/OCAs (out of 26 collecting mobile broadband information) pointed out that they use the BEREC guidelines criteria to declare a grid as passed, while ten MS) did not follow this guidance.

Seven out of the ten countries that do not comply with the BEREC guidelines provided different definitions of "grid passed". Namely, one NRA considers a grid passed if it covers 95% of the population and 90% of the territory. Another NRA defines a grid passed if the middle of the grid is covered. Two other NRAs consider a grid as covered if a mobile broadband service can achieve minimum data rates with a 90% probability at the cell edge and a cell load of 50%. The fifth NRA uses a cell edge coverage probability of 75% to define a covered grid. The sixth

authority deems a map reliable if its reliability level is at least 98% for areas larger than 1000 km² and 95% for areas larger than 100 km². Additionally, another NRA uses the concept of functional coverage which corresponds to mobile coverage, where it must ensure an 80% cell edge coverage probability of maintaining a connection at the cell edge for a given service. Finally, the last NRA defines "grid passed" based on the availability of a specific technology or speed.

Furthermore, one NRA stated that the operators perform mobile broadband coverage calculations. However, the criteria for this calculation do not prescribe values for cell edge or grid probability, so measurements verify the grid coverage.

4.2. Resolution

Eighteen MS (out of 26 collecting mobile broadband information) collect data on a 100x100 m grid, seven NRAs/OCAs collect data on a grid smaller than 100x100 m, and one country is on a 250x250 m grid. Among the countries collecting data on a grid smaller than 100x100 m, three (out of seven) collect data on a 50x50 m grid, two NRAs/OCAs (out of seven) collect data on a 25x25 m grid, one NRA/OCA (out of seven) collects data on a 60x60 m grid, and one NRA/OCA collects data on a 10x10 m grid. Technology data collection

All the MS but one collect data on the coverage of mobile broadband networks by technology. Clearly, the data collections are focused on the available technologies, therefore, while 4G coverage is included in the data collection by all the NRAs/OCAs, 3G coverage is no longer monitored if this technology has been already phased out or will be in the near future and 5G SA (5G Standalone) coverage is included only when already available. In some cases, the distinction between 5G SA and 5G NSA (5G Non-Standalone) coverage is not yet considered relevant and, in these cases, NRAs/OCAs collect data generically referring to 5G coverage.

In particular, 16 MS explicitly state that the collection data still includes information on 3G coverage and 21 collect data on 5G.

Referring to 4G coverage, only few NRAs/OCAs adopt some types of distinctions. For one of them 4G coverage would mainly consist of LTE 800 MHz coverage, since coverage is very frequency dependent. Another one collects data on 4G standalone and 4G non-standalone.

Finally, in 7 cases the coverage of 2G networks is included in the data collection exercise, although mobile broadband should exclude GSM/GPRS/EDGE technologies.

In addition to data collected by technologies, one NRA collects data even by frequency bands used by the operators. Another four refer to the characteristics of the BTS, among which 2 refer only to the backhaul technology distinguishing if the base-station is connected by fiber or other technologies (e.g. coax or radio link).

4.2.1. Data collection on 5G

The NRAs/OCAs adopt different approaches when collecting data referring to 5G coverage; therefore, the resulting data are less homogeneous with respect to those referred to the other technologies.

21 NRAs/OCAs collect information about the 5G coverage in different ways. 7 refer generically to 5G, 6 collect data on both 5G NSA and 5G SA and 3 collect data only on 5G NSA. Although the most adopted distinction is 5G SA vs 5G NSA, some other distinctions could be adopted. One NRA collects data referring to 5G and 5G NR (New Radio), while another NRA distinguishes between 5G TDD (Time Division Duplex) and 5G FDD (Frequency Division Duplex), another one distinguishes between 5G and 5G in GHz band and one more refers only to the band at 700 MHz, since coverage is very frequency dependent. Finally, one NRA/OCA monitors the coverage of 5G SA, 5G NSA and 5G using 80 MHz and 3.4 GHz-3.8 GHz band.

With regard to the parameters collected for 5G coverage, in 6 cases the NRAs/OCAs adopt the same approach as with other technologies, i.e. they collect the same data for all technologies. These data include speed, coverage, technical data about BTS location and transmit parameters (frequency, power, antenna radiation diagram).

When a different approach for 5G is adopted with respect to the previous technologies, the most used parameters are coverage (distinguishing, when feasible, between 5G SA and 5G NSA or by frequency), maximum upload and download speeds, base station characteristics, signal strength and quality of service. 15 NRAs/OCAs resort on these, although clearly each one of them refers to a sub-set of indicators. Two of the NRAs/OCAs which measure speed take into account various download speed classes, differently defined, in the range between 30 Mbps and 1 Gbps; only one of these includes in the exercise the upload speeds.

For the remaining NRAs/OCAs, one monitors and publishes the location and frequency bands activated for each 5G base station and another one takes into account the service availability. A couple of NRAs/OCAs refer to the detailed guidelines for financing broadband infrastructure as part of the EU Guidelines on the application of State aid rules in relation to the rapid deployment of broadband networks or the data requested for by the EC in their Broadband in EU study.

Broadband mapping of 5G could introduce challenges that were not existing for the previous technologies (2G/3G/4G). Indeed, 10 NRAs/OCAs encountered specific challenges.

Even if the challenges encountered differ from one authority to another, some common issues can be identified. First of all, various issues regard 5G coverage and, going into details, they concern commercial information provided to the end-users and the harmonization of data received from the operators, an issue that is also present for other network generations. One NRA/OCA mentions that the operators should distinguish 5G coverage on the basis of the frequencies used – such as the 3.5 GHz band on the one hand, and different bands on the other – to avoid misleading commercial communications and reflect the theoretical quality of

a service available in 5G. Another has identified that 5G coverage reported by the mobile network providers do not correspond to 5G coverage as presented by the operators in their websites, while the experience of another authority shows that the differences in how pessimistic or optimistic the operators are in their theoretical coverage simulations makes it difficult to harmonize 5G coverage data between operators. Finally, the operators can use different criteria, when there was no agreement on the parameters and levels of radio coverage for 5G.

Other challenges refer to the 5G configuration as non-standalone, which means that 5G still relies heavily on 4G. First challenges concern understanding which anchor layers to use for different 5G frequency bands and the importance of the cell range when mapping 5G. Moreover, the 5G NSA configuration implies that, as mentioned by one authority, distinguishing between data going through 4G and 5G network could be difficult, since measurement devices are not able to work separately only in 5G and the information gathered for the GS can rely just on one category, i.e. the maximum downlink speed regardless of the technology. In any case, data gathering and visualisation of coverage information based on the different technical realisations of 5G, i.e. 5G standalone, 5G non-standalone and 5G non-standalone with DSS, could be challenging due to the different performance of these realisations.

Further challenges include propagation models, traffic models, smart antennas, carrier aggregation, different modulation schemes, the issue of line of sight and the fact that the parameters to record are changing each year.

Finally, one authority highlights that the sole availability of 5G technology is not sufficient information for end users, who expect to have an information on the quality of service they could expect from their operator in a given location. At this time, 5G is still being deployed, and its immediate benefit lies chiefly in the additional capacity it provides in locations where mobile networks are heavily solicited, if not saturated.

4.2.2. Calculation of mobile broadband coverage

When calculating the mobile broadband coverage, 22 NRAs/OCAs just resort on data provided by the operators, without adopting any specific own model nor tool. In the most of these cases, the operators are free to use their own propagation model or tool. Only some NRAs/OCAs verify the data provided by operators.

When authorities resort on data provided by the operators, some prescriptions or criteria could be required. However, the approaches taken by NRAs/OCAs differ among MS, therefore only some requirements are reported here. Some request to use as a reference the guidelines provided by standardization organizations (ITU and ETSI) or by BEREC. In some other cases, the measurements made by the operators must be based on specific technical parameters, concerning the signal strength, the recourse to calculation based on the real configuration of the radio sites and the inclusion in the propagation model of the terrain characteristics.

The remaining 4 NRAs/OCAs resort on own model or tools, which could be based or not on the prescriptions reported by standardization institutes, like ITU.

4.3. QoS data collection

When considering the quality of service, 17 MS resort to the speed and out of those, 11 define speed as the maximum data service speed per grid as recommended by the Core BEREC Guidelines. Among these 11 NRAs, one collects from the operators' information on usually available download and upload speeds as maximum, average and minimum speeds within a 100x100 raster cell (on top of the estimated maximum speed). For another authority theoretical or calculated mobile network coverage means that the indicated speed is available in ideal conditions; therefore, speed class data does not take into account factors including slower data transfer due to other users in the same area, the effect of buildings and natural obstacles, or speed reductions caused by the device being used. Finally, another one collects data on typical (50% load) uplink and downlink data speed in addition to the theoretical values (0% load); in both cases the requested values are calculated by the mobile operators at each grid point with their own planning tool, propagation model and terrain database.

In the remaining 6 cases, the definitions of speed vary across the MS and multiple choices are adopted, i.e. some NRAs/OCAs monitor various parameters.

First of all, 3 NRAs monitor the maximum speed and one of these measures the average speed as well.

Moreover, while 2 NRAs explicitly refer to achievable speeds, 5 NRAs refer to theoretical or expected values, among which one refers to the technically feasible speed per antenna. Among these 7 MS, 4 NRAs specifically take into account the load of the cell, since the achievable speed as well as the expected speed depend on the network load. Only one of them calculates the speed in two scenarios (10% of load and average load of each cell) in addition to the peak time scenario used by all the 4 NRAs. Finally, one NRA defines a minimum download and upload speed for a user at the cell edge that must be fulfilled according to a given cell edge coverage probability, which are reported in the following table.

Technology	Download Speed	Upload Speed	Cell-Edge Coverage Probability
4G	2 Mbit/s	512 Kbit/s	90 %
5G	2 Mbit/s	512 Kbit/s	90 %
5G in 3,6 GHz	5 Mbit/s	1 Mbit/s	90 %

Table 2 Minimum download and upload speed for a user at the cell edge

Only 6 NRAs take into account some other quality parameters in addition to speed for the mapping.

One of the most additional parameters which is used refers to the strength of the signal, which is correlated to the performance achievable. It could be the potential signal strength, the reference signals received power level and the signal strength per grid. The last of these could be used to count for indoor usage (-16 dB), outdoor usage with hand-held terminal (-8 dB) and outdoor usage without body contact or other obstacles (-0 dB).

Some other technical parameters are packet loss, jitter, latency and throughput as defined in RFC2544 refers to the qualities of a service with the highest achievable data transfer rate currently available on the network.

Finally, the following factors are taken into account in the mapping:

- other services that are provided to the same end user with the same quality;
- the limitations of the quality of service for the end user caused by the parameters of the mobile equipment that should not be taken into account;
- the environmental conditions in the populated area that affect the signal propagation characteristics, interference, reflections, etc.;
- only the part of the mobile network with optical cables to the base station, the highest aggregated spectrum (e.g. 60 MHz) and the highest number of parallel data streams in MIMO (e.g. 4x4 MIMO) are considered.

4.4. Technical conclusions

Almost all NRAs/OCAs collect data for mobile broadband mapping/coverage. 16 NRAs/OCAs use the grid-passed definition outlined in the BEREC guidelines, while seven NRAs/OCAs use their own definition. One NRA carries out measurements because it does not establish a threshold for cell edge or grid probability. Furthermore, 18 NRAs/OCAs collect data on a 100x100 m grid, 7 NRAs/OCAs collect data on a grid smaller than 100x100 m, and one NRA is on a 250x250 m grid.

The harmonization of the coverage of 5G networks calculated by the various NRAs/OCAs seems to be quite challenging. Indeed, the approaches adopted by the NRAs/OCAs could be very different, since the collections are mostly based on the distinction between 5G SA and 5G NSA, but other distinctions (based on frequencies or BTS characteristics) are used. For the same reasons, it results even more complex to compare data referring to quality of service (which is very relevant for 5G networks) or to the parameters used for the calculation of the coverage.

The first **conclusion** is that the data collections should be harmonised or at least some parameters should be based on common definitions. This is the case even of the speed, for which – even when the NRAs/OCAs resort to the Core BEREC Guidelines – some different approaches have been found.

5. VHCN classes

The BEREC Guidelines requested that NRAs/OCAs relied on the BEREC VHCN Guidelines to identify premises and grids as passed by a VHCN network[21] and that their GS provided information on one of four VHCN Class codes per address/grid, where each code corresponded to one of the four criteria defined in the BEREC VHCN Guidelines[22].

25 MS collect information regarding addresses/grids covered with VHCNs[23]. They do this by either requiring operators to declare the VHCN class in an address/grid (9 MS for fixed broadband and 8 MS for mobile broadband) or by having the public authority infer the VHCN class from the technology and QoS data provided by operators (16 MS for fixed broadband and 17 MS for mobile broadband).

All these MS hold information on VHCN Class 1, i.e. in their GS. It is relatively common that NRAs/OCAs establish directly that any FTTH and FTTB solution classifies automatically as VHCN Class 1. Several authorities explain that in their country FTTH and FTTB are a full fiber solution. A few other countries explicitly state that they only consider as class 1 the addresses/grids reached by a full-fiber solution and that in cases when part of transmission is provided by other technology (e.g. FWA PtP) and the network meets the specified performance thresholds they declare this solution as VHCN 3 class.

Only 9 NRAs/OCAs have collected data or received it from operators for VHCN Class 2 and even less (only 5 NRAs/OCAs) for VHCN classes 3 and 4. There is a variety of reasons for these low numbers. Some NRAs/OCAs say that they simply do not (yet) collect or request the data, others say that they base their assessment on assumptions rather their actual data. Recurring issues that prevented the collection of reliable data are the fact that the key

[21] Paragraph 49 of the Core Guidelines BoR (20) 42, requested NRAs/OCAs to follow the definitions to be included in BEREC VHCN Guidelines. These guidelines were recently reviewed and the latest version is available here: BoR (23) (23) 164

[22] Class 1, corresponds to criteria 1: “Any network providing a fixed-line connection with a fibre roll out at least up to the multi-dwelling building”; Class 2 corresponds to criteria 2 “Any network providing a wireless connection with a fibre roll out up to the base station”; Class 3 corresponds to criteria 3 “Any network providing a fixed-line connection which is capable of delivering, under usual peak-time conditions, services to end-users with the quality of service performance beyond thresholds 1 as defined within the document ; and class 4 corresponds to criteria 4: “Any network providing a wireless connection which is capable of delivering, under usual peak-time conditions, services to end-users with the following quality of service (performance thresholds 2).

[23] Please note that this does not imply that they collect information on all VHCN classes, as in several cases data on VHCN Class 3 and Class 4 is not being collected, as will be explained later on.

performance thresholds of BERECs' VHCN definition are in practice not applicable or respected by operators, in particular for VHCN classes 3 and 4. The difficulty to apply the definitions in practice seems to be one of the major issues for a lack data collection for VHCN classes 3 and 4, leading some NRAs and operators to rely only on data for classes 1 and 2 for the classification. This may merit the need for an update of those definitions. In fact, the BEREC Fixed Network Evolution Working Group will provide an update of criterion 3 of the BEREC Guidelines on very high capacity networks with adoption foreseen in 2025[24] (BEREC already updated criterion 4 in 2023 (BoR (23) 164)[25]).

Finally, one NRA has pointed out that operators in their country have detected an ambiguity between the concept of premises passed as defined in the BEREC Core Guidelines (where a premise is passed even if not connected if it is possible to provide a broadband service in less than one month and at no additional cost to the end-user) and the fact that in the BEREC VHCN Guidelines the criteria to classify a network as Class 3 or 4 allow for no investment.

This "ambiguity" can be solved with the following consideration: Para. 21 of the VHCN Guidelines[26] relates to the classification of a network as VHCN acc. to criterion 3 and 4, and states that a network is deemed to be a VHCN if it is *capable* to provide a service which meets the performance thresholds 1 in case of fixed-line connection or performance thresholds 2 in case of wireless connection without any further investment. Thus, the qualification "without further investments" refers to investments into the network for example by upgrading the active equipment to increase network performance. In contrast, the Art. 22 GL deal with the reach of a network following the "premises passed" principle. When stating that "on request from an end-user" the premises can be connected at little or no cost, this does not refer to any investment into the network to increase its performance so that it meets the performance thresholds but rather the mere connection of the network to the end-user premises. In conclusion, there is no contradiction between the two BEREC Guidelines as they refer to different types of investment.

6. Forecasts

As mentioned in the BEREC Guidelines, the collection of forecast data is not mandatory under Article 22. Nevertheless, 20 MS collect forecast data on a regular basis. The other 7 MS don't currently collect forecast information and 2 specified they are not planning to do so in the foreseeable future.

Of these 20 MS that collect information about forecasts about one half collect data with a planning horizon of three years, 6 MS collect information up to 6 years in the future, while the

[24] See BEREC Work Programme 2024, item 1.13., page 19: Update of criterion 3 of the BEREC Guidelines on very high capacity networks
[25] BEREC Guidelines on Very High Capacity Networks (2023)
[26] BoR (20) 165

others either distinguish between mobile and fixed network deployment or collect data for the next 12 months.

9 MS reported to collect forecast data at the same time as the coverage data. 6 have adopted a different frequency to collect the forecast data and in one MS the Ministry is responsible for forecasts and not the NRA. The other MS didn't report on the collection frequency.

MS reported that operators usually don't have problems providing the information about planned network deployments. Some operators don't want to reveal their plans because they are not sure they have finance, miss permits or set their deployment goals higher than they can realise.

On the other hand, operators understand the importance to protect their planned network deployments, especially in case of state aid programmes.

The MS handle the supervision of forecast information differently. Some collect the data as it is, some monitor the progress of forecasts, and a few MS even have possibilities to penalize operators for not fulfilling the forecasts they provided. These penalties range from warnings to deleting forecast data from the public maps to defining locations as designated areas for state aid. No information about monetary penalties was provided by the MS. However, in the case of forecast information collected in connection with state aid programmes monetary penalties are usually implied.

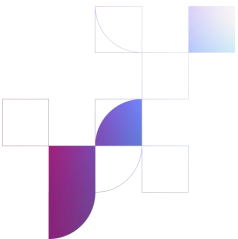
In about half the MS collecting forecast information there is no verification of the data put in place so far. Six MS cross check the information with either coverage information after some time or with information from other authorities (e.g. construction permits). Three MS request additional verification data like project plans, milestones, financial plans or a binding statement of the operators or their board of directors.

Only one MS checks the forecast data individually per project. If forecasts are too unspecific the authority gets back to the operator.

All in all, forecasts are treated differently across the MS as the collection of forecast data is not mandatory acc. to Article 22 EECC.

7. Publication and sharing of data

According to the BEREC Guidelines the publication of GS data on broadband is an important tool by means of which end users can get information on service availability and choice. Yet, in accordance with EU and national rules on commercial confidentiality and protection of personal data, some information gathered for GS may be considered to be confidential and NRAs/OCAs shall then safeguard such confidentiality. At the same time, NRAs/OCAs shall ensure that confidential information from GS can be made available to another such authority,



to the Commission and to BEREC, after a substantiated request, where necessary to allow those bodies to fulfil their responsibilities.

Here BEREC reviews the extent to which the NRAs and relevant OCAs adhered to the Guidelines with regard to the publication and sharing of GS data.

Publication of broadband maps

24 NRAs/OCAs publish broadband maps, 3 are planning to publish them soon, while 2 do not. In one of this countries the relevant regulations have not been adopted.

The links to the published broadband maps can be found in the following table:

Country	Link to geographical platform / broadband map:
AT	https://www.breitbandatlas.gv.at/
BE	https://www.bipt-data.be/
BG	https://sipbg.gov.bg/Web/?configUrl=https://sipbg.gov.bg/Web/BaseProject/Configs/config.json
CY	(As being in the process of unifying different types of information, including coverage, a new portal is under construction. - To be published Dec 2024)
CZ	Fixed and mobile by NRA: https://vportal.ctu.cz/intro?l=en Current designated areas by OCA: https://www.verejnakonzultace.cz/verejna-konzultace-2023-ii-kolo/ii-kolo-mapa/
DE	https://gigabitgrundbuch.bund.de/GIGA/DE/Breitbandatlas/Vollbild/start.html
EE	Fixed network coverage map: https://xgis.maaamet.ee/xgis2/page/app/netikaart
EL	https://www.broadband-assist.gov.gr/
FI	https://kartat-tieto.traficom.fi/?langID=en
FR	Mobile broadband: https://monreseaumobile.arcep.fr/ Fixed connectivity: https://maconnexioninternet.arcep.fr/ Fiber roll-outs : https://cartefibre.arcep.fr/
HR	http://mapiranje.hakom.hr/
HU	(To be published soon)
IS	https://kortasja.lmi.is/mapview/?application=fjarskiptastofa
IE	Fixed Broadband: https://www.comreg.ie/broadbandchecker/ Mobile Coverage: https://coveragemap.comreg.ie/map
IT	http://geo.agcom.it
LT	https://placiajuostis.rrt.lt/
LU	https://web.ilr.lu/FR/Particuliers/Communications-electroniques/Releve-geographique-du-deploiement-des-reseaux?mtm_campaign=pubcouverture23&mtm_kwd=MyILR
NL	https://ez.maps.arcgis.com/apps/webappviewer/index.html?id=ebafcc07e45345859305a2c259314928

PL	www.internet.gov.pl
PT	https://geo.anacom.pt/publico/home
RO	http://vhcn.ancom.ro
SE	https://bredbandskartan.pts.se/
SI	https://gis.akos-rs.si/
SK	https://bco.teleoff.gov.sk/stav-pokrytia-sirokopasmovym-internetom/

Table 3 Links to published broadband maps

Public broadband maps vary in resolution (address, grid, municipality etc.) and the type of information that is delivered (speed, technology, location, operator, etc.).

Publication of operators' names in the public broadband maps

15 NRAs/OCAs indicate that they are publishing the names of the operators in their maps while 9 NRAs/OCAs do not.

Among those publishing the operators' names, 6 authorities are doing so at address level and 4 at grid-level. In one MS all the operators within a radius of 500 meters from a specific address are shown. More specific data is not shown because of confidentiality reasons.

Amongst those NRAs not publishing the operators' names, EE explains that since the dataset is open data, some operators do not want their named data to be made available in its entirety. In the future, the NRA would like to display the operator's name in the address point popup.

Handling of confidential information

21 NRAs/OCAs collect some information in the context of the broadband map that is considered a commercial secret by the respective NRA/OCA and which is therefore not published, 6 NRAs/OCAs consider that all the information that they collect is non-confidential.

What is considered to be confidential varies though. For example, 6 NRAs/OCAs consider forecasts on planned deployments as being confidential. Other information treated as confidential is the availability of free fiber, to what standard and price it is rented out, the investments that are financed exclusively by the operator's own funds, for fixed networks the number and existence of active accesses (provided services, number of premises passed at address level), information about the exact number of premises per building in the databases the operators use, data on how many customers including the bandwidth of the sold product the operators have on municipality level, information on the exact location of the buildings and data on fixed coverage by operator, for fixed networks operator-data at address-level, exact

geographical location and intervention plans, exact coverage/service availability of each operator individually.

Sharing of information with public authorities:

14 NRAs/OCAs have shared the GS information (this is, the raw data or any data that is more detailed than the data included in the public maps) with other authorities, 12 NRAs/OCAs have not.

Conclusion:

The vast majority of NRAs/OCAs publish broadband maps, by means of which end users can get information on service availability and choice. Those maps vary in resolution (address, grid, municipality etc.) and type of information that is delivered (speed, technology, location, operator, etc.), though. Most NRAs/OCAs collect information in the context of the broadband map that is considered a commercial secret and therefore is not being published. The majority of those are sharing this information with other public authorities, while no one has explained that there has been an instance where data has been requested and not shared.

8. Verification

Paragraph 7 of the Verification Guidelines[27] stated that: "BEREC considers that the process of assuring the quality of the data provided by operators is intrinsic to a consistent implementation of the obligations under Article 22 (…)". These guidelines described different verification methods and provided recommendations to be considered by Authorities when assessing the quality of QoS-1 information.

According to the information gathered in 2024, 23 NRAs/OCAs (out of 27 collecting information) carry out some systematic verification of their fixed broadband GS[28]. For mobile broadband, 17 NRAs/OCAs (out of 22 collecting coverage information from operators[29]) carry out some systematic verification. This is a substantive increase in numbers with respect to the situation in 2020, where according to a BEREC survey 9 (out of 16) NRAs/OCAs verified the fixed broadband coverage maps and 10 (out of 16) NRAs/OCAs carried out checks on mobile coverage maps[30].

[27] BEREC Guidelines on geographical surveys of network deployments - Verification of information –BoR (21) 82
[28] One NRA verifies data only if the need arises.
[29] 4 NRAs/OCAs undertake the calculations/simulations needed for the delivery of the mobile broadband GS and collect no technology coverage information from operators. One NRA has not implemented the mobile broadband GS.
[30] 10 NRAs/OCAs (out of sixteen) carried out checks on 3G and 4G coverage and no NRA/OCA carried out verification of 5G availability.

However, the methods of verification vary from authority to authority, as shown by TABLE 4. Quite generally authorities check on the internal consistency of the broadband map databases. However, in a handful of cases this is the only verification that they carry out[31]. For all the remaining MS and GS this internal validation is supplemented with additional verification methods.

For fixed broadband the most used verification methods are the validation of data with information from state aid proceedings and the resorting to external agents' declarations, like end-users, to report data inaccuracies. For mobile broadband the most used method is carrying out QoS-2 measurements to assess the reliability of the declared information, followed by external agent' declarations.

	Fixed cabled broadband	FWA	Mobile broadband
NRAs/OCAs collecting coverage information from operators	27	17	22
NRAs/OCAs carrying out some verification	23	15	17
Methods of verification			
Validation of the internal consistency of the broadband map database	23	15	15
Resorting to external agents' declarations, like end-users, to report data inaccuracies	9	4	6
External validation of the broadband map database with georeferenced information on active access connections and their characteristics	5	3	2
External validation of the broadband map database using information on the location of access nodes or other relevant network infrastructures (for example, locations of BTS and its characteristics)	3	3	2

[31] The number of authorities that rely only on internal validation are: 4 for fixed cabled broadband, 6 for FWA, and 4 for mobile broadband.

External validation of the broadband map database with general telecom databases (which may allow, for example, to check regional aggregates);	5	1	3
External validation of the broadband map database with information gathered through state aid proceedings and others	10	4	3
QoS-2 measurements	4	2	10
QoS-3 measurements	3	2	3
Other methods	5	2	3

Table 4 Types of verification

BEREC sought information regarding the verification of expected peak time speed information for fixed broadband. Out of 16 authorities collecting this information from operators, only 5 carried out some verification[32]. In 2 cases authorities carried out QoS-2 measurements to verify the speeds declared and in the other 3 cases the methods varied and included the comparison of such declarations with maximum achievable speed declared at each address, with the information reported by operators to industry and a recalculation of the speeds declared for a sample of points in the GS.

A small number of NRAs/OCAs use the location of access nodes to assess the reliability of the information provided by operators. Two NRAs have plans to use such information for verification. Among those using this kind of information, one assesses that the information is useful for verification purposes, another that it is useful in some cases and another that it is partially useful[33].

Several NRAs/OCAs routinely resort to QoS-2 measurements for fixed broadband and drive tests for mobile broadband to check their coverage information, although this is more extended in the latter case (10 NRAs/OCAs). Another OCA performs QoS-2 measurements if data seems suspicious and cannot be explained by the operator and one NRA plans to use such measurements in the future. One NRA that engages in QoS-2 measurements for fixed wired broadband, FWA and mobile broadband describes this as “an extremely technical activity, and certainly not an ordinary administrative activity”.

Resorting to external agents‘ declarations to report data inaccuracies is another established method of verification. On top of the figures reported in Table 4, another NRA has just published a feature, on its broadband web map, allowing end-users to report discrepancies and errors in the reported data in the public evidence, focusing on capacity, technology,

[32] 6 informed that they did not verify this information and the remainder did not provide information.
[33] It is “useful for Fixed Wireless Access (FWA), but not for cellular or FWA based on cellular stations.”

provider data, etc. A feature is available for fixed cabled broadband, FWA and mobile broadband. One OCA has no systematic method to resort to external agents' declarations, but receives complaints from municipalities, which are then reported to the operator. Quite generally, the authorities with such systems in place, report the data to the operator to find a justification and in some cases, they investigate the situation. One authority may carry out drive tests when it receives numerous complaints about an area and another investigates every inaccuracy reported. An NRA hosting a detailed reporting system for municipalities reports that "*This direct connection with municipalities has significantly improved the data quality and increased the effort required for updates. Undoubtedly, it has been an important improvement*."

Finally, 21 authorities explained that they interact with the operator when data does not look right, to ultimately correct it if necessary. Authorities detect such data by finding out inconsistencies with the data declared previously or in operators' public statements and websites. Authorities also check that speed declarations correspond to technology declarations (e.g. the operator owns a fiber line, but the download speed is only 100 Mbps) or compare the declarations of operators using the same technologies and having stations in similar locations, thus sharing the geographical constraints of the territory. An authority compares the VHCN declarations with the information in their infrastructure database and some authorities use the results of QoS-2 measurements to question the operator if necessary. In one of these cases, the authority requests the operator to re-simulate the coverage map if the success rate when testing covered areas fails.

In conclusion, most authorities verify their broadband coverage maps in a systematic way, although a very small number do not and some only check for internal consistency. In any case, this is a substantial improvement in numbers with respect to the authorities engaged in verification in 2019 as today many authorities are verifying and with different methods. The fact that some authorities are still not verifying reflects that not all MS started implementing their GS at the same time, so some MS are far more experienced and have had more time to provide for verification methodologies.

9. Delimitation of Designation Areas and State Aid

A designated area is an area with clear boundaries, where no undertaking or public authority has deployed or is planning to deploy a very high-capacity network or significantly upgrade or extend its network to a performance of at least 100 Mbps download speeds (here after, this document refers to VHCNs and networks offering more than 100 Mbps download speed as: VHCNs&100Mbps).

The BEREC Guidelines[34] dealt with the consistent implementation of Article 22, paragraphs 2, 3 and 4. These parts in the article describe some optional policies that NRAs/OCAs may undertake in order to inform private and public agents of the non-availability of existing or planned VHCN networks or networks offering at least 100 Mbps download speed in areas with precise boundaries ("designated areas"), and furthermore to invite agents to declare their intentions to deploy VHCNs in these areas.

The BEREC Guidelines provided a common understanding of these provisions, guidance on how to designate areas and on the procedures to be followed in publishing information and inviting agents to declare their intentions to invest in order to ensure that such procedures are efficient, objective, transparent and non-discriminatory, whereby no undertaking is excluded a priori (as required by Art 22 (4) EECC).

In 14 MS areas are designated following the Article 22 EECC (paragraphs 2, 3 and 4) procedures, by declaring designated areas and inviting agents to declare intentions to deploy VHCNs in these areas.

In two MS these areas were designated before the publication of the Guidelines and thus, did not use any of BEREC recommendations and 10 MS did not declare any designated areas.

One MS refers that the terms and definitions of VHCN are not explicitly used in the target areas for state aid as this is not foreseen by the state aid regulations[35].

All the 14 MS that designated areas using Article 22 procedures, followed the BEREC recommendations or most of them, to carry out these tasks. Two MS refer that they use it indirectly and as defined by the State Aid guidelines from the Commission.

The **main criteria** used to identify the target areas for state aid are:

- The one defined by the recommendations of the European Commission on the State Aid Guidelines for Broadband[71]:
    - on the basis of the results of a geographical survey, designate areas with clear territorial boundaries in which a high-capacity network is not present and is not foreseen to be deployed, significantly upgraded or expanded during the designated forecast period to allow data download speeds of at least 100 Mbit/s.
- Based on the mapping exercise for actual coverage and planned broadband coverage data for a time frame of future investments from 2 to 6 years, depending on the MS.
- Based on speed levels and the used technology.

[34] BoR (21) 32
[35] Guidelines on State aid for broadband networks 2023/C 36/01

- The MS defines a threshold (e.g. less than 20% or 10%) of households passed by a network capable of providing at least 100 Mbps and no operator declares the intention to deploy such network within the next years (e.g. 3 years).

The areas are then concentrated into clusters of “intervention areas” or aggregated by statistical subsections, which are available for state aid intervention.

- There is a public consultation where MS publishes areas without VHCN networks and invite agents to declare their intention to deploy such networks in these areas. Only those credible forecast networks (with support of requested documentation), are used to identify the designated areas.

- One MS conducts a market analysis each year, which is the base for specifying what areas should be part of the designated areas. In the most recent analysis, areas outside of localities of a certain size and areas without a certain degree of availability, were part of the designated areas.

The main challenges for the identification of target areas for state aid lie within the demanded forecast period of planned and privately financed infrastructure deployments and the credibility assessment of the data. Another challenge was dealing with undeclared intentions of deployment.

When asked whether MS used the broadband maps to prepare the state aid submissions, all of them replied they use the broadband coverage maps at address level or 100 m grid level. Some MS use it in conjunction with information obtained from the public consultation.

10. Conclusions

This implementation report has shown that overall Article 22 EECC and the BEREC Guidelines have contributed to a substantially increasing number of GS across the EU and improving their granularity and the quantity and breadth of information retrieved. At the time of drafting the BEREC Guidelines, many countries collected no geographical information or information which was not sufficiently granular, and the use of GIS was not widespread. In contrast, today all MS collect very granular information and all NRAs/OCAs use GIS. The BEREC Guidelines have also improved the comparability across national outcomes, especially for fixed wired networks and coverage information, since the definition of “premises passed” has been almost unanimously adopted and information is collected at a very granular level, so that there are no problems of data aggregation in producing national or regional connectivity statistics.

Moreover, most NRAs/OCAs publish broadband maps, by means of which end users can get information on service availability and choice. Those maps vary in resolution (address, grid, municipality etc.) and type of information that is delivered (speed, technology, location, operator, etc.), though.

Adding to this, most authorities verify their broadband coverage maps in a systematic way, although a handful do not and some of those engaging in verification only check for the internal consistency of the GS database. In any case, this is a substantial improvement in numbers with respect to the authorities engaged in verification in 2020 as today many authorities are verifying and are using different methods. The fact that some authorities are still not verifying reflects that not all MS started implementing their GS at the same time, so some MS are far more experienced and have had more time to provide for verification methodologies. Thus, BEREC expects that over time more verifications will be performed which will improve the quality of the GS and thus also increase the comparability of its results across MS.

Hence, overall, it can be concluded that the BEREC Guidelines and the NRAs/OCAs efforts in implementing these guidelines have resulted in a very solid foundation for a harmonized delivery of GS in European countries.

However, MS experience important problems in collecting QoS information at a sufficiently granular level and expected peak time speed plays out as a specially challenging indicator. More could be done to assist authorities regarding the QoS indicators in general and for FWA. Also, BEREC needs to think about the information to characterise mobile networks as the harmonization of the coverage of 5G networks calculated by the various NRA/OCA seems to be quite challenging. Indeed, the approaches adopted by the NRA/OCA could be very different, since the collections are mostly based on the distinction between 5G SA and 5G NSA, but also other distinctions (based on frequencies or BTS characteristics) are used.

BEREC Guidelines provided a first step towards a better mapping of broadband networks, but in the light of

- Technology developments
- More recent BEREC documents, in particular the VHCN GL[36]
- New EU legislation, in particular the Gigabit Infrastructure Act (GIA)[37]
- A multitude of more recent EU and EC soft law documents such as the Annex I in the EU State Aid Guidelines mapping[38] and measurement of the Digital Decade Key Performance Indicators[39]

BEREC considers it appropriate to update the BEREC Guidelines on Art. 22 broadband mapping. In particular, the existence of several more recently introduced broadband mapping methodologies that partly overlap can cause confusion for operators and authorities, a

[36] BoR (20) 165 and an updated version related to mobile VHCN BoR (23) 164; currently the VHCN GL are updated with regard to fixed VHCN.
[37] Regulation (EU) 2024/1309 of 29 April 2024 replacing the BCRD.
[38] See Annex I in Communication From The Commission Guidelines on State aid for broadband networks 2023/C 36/01 available at EUR-Lex - 52023XC0131(01) - EN - EUR-Lex (europa.eu).
[39] See Implementing decision setting out key performance indicators to measure the progress towards the digital targets | Shaping Europe's digital future (europa.eu) of 30 June 2023 (C(2023)4288_final).

situation that should be avoided. Also, as this implementation report has shown there is room for improvement regarding the approaches to implement the Guidelines to achieve further harmonization and with this increase the comparability across MS.

BEREC will work on the update once the outcome of the EC “Methodology on 5G Mobile and Fixed QoS Coverage Mapping”[40] is known, most likely in the second half of 2025.

[40] 1st Draft presented on 16th July 2024.

Annex I: List of tables

Annex II: List of countries and authorities that provided information to BEREC

Country	NRA	Country code
Austria	RTR	AT
Belgium	BIPT	BE
Bulgaria	CRC	BG
Croatia	HAKOM	HR
Cyprus	OCECPR	CY
Czech Republic	CTU	CZ
Estonia	ETRA	EE
Finland	TRAFICOM	FI
France	ARCEP	FR
Germany	BNetzA	DE
Greece	EETT	EL
Hungary	NMHH	HU
Iceland	ECOI	IS
Ireland	ComReg	IE
Italy	AGCOM	IT
Latvia	SPRK	LV
Lithuania	RRT	LT
Luxembourg	ILR	LU
Malta	MCA	MT
Netherlands	ACM	NL
Poland	UKE	PL
Portugal	ANACOM	PT
Romania	ANCOM	RO
Slovakia	RU	SK
Slovenia	AKOS	SI
Spain	CNMC	ES
Sweden	PTS	SE

Annex III: List of abbreviations

Acronym	Meaning
ADSL	Asymmetric digital subscriber line
BEREC	Body of European Regulators for Electronic Communications
BTS	Base Transceiver Station
CATV	Cable television
DOCSIS	Data Over Cable Service Interface Specification
DOCSIS3	Data Over Cable Service Interface Specification 3.0
DSL	Digital subscriber line
EC	European Commission
EDGE	Enhanced Data rates for GSM Evolution
EECC	European Electronic Communications Code Directive
ETSI	European Telecommunications Standards Institute
EU	European Union
FTP	Foil Twisted Pair
FTTB	Fibre-to-the-Building
FTTB/H	Fibre-to-the-Building/Home
FTTC	Fibre-to-the-Cabinet
FTTH	Fibre-to-the-Home
FTTP	Fibre-to-the-Premises
FWA	Fixed Wireless Access
GIS	Geographic Information Systems
GPON	Gigabit Passive Optical Network
GPRS	General Packet Radio Service
GS	Article 22 Geographical Survey
GSM	Global System for Mobile Communications
HFC	Hybrid fiber-coaxial
ISP	Internet Service Provider
ITU	International Telecommunication Union
LTE	Long-Term Evolution
MIMO	Multiple Input and Multiple Output
MIT	
MNO	Mobile Network Operator
MS	Member State (used for EU/EEA countries, i.e. includes Iceland)
MVNO	Mobile Virtual Network Operator
NA	Not Available
NGA	Next Generation Access Network
NRA	National Regulatory Authority
NUTS 3	Nomenclature of Territorial Units for Statistics (regions at NUTS 3 level)
OCA	Other Competent Authority
P2P	Peer-to-peer
THD Radio	Très Haut Débit Radio (French) = Very High-Speed Radio

UTP	Unshielded Twisted Pair
VDSL	Very High-Speed Digital Subscriber Line
VHCN	Very High Capacity Network
XGSPON	Also: 10G-PON = 10-Gigabit-capable passive optical network
5G DSS	5G Dynamic Spectrum Sharing
5G FDD	5G Frequency Division Duplex
5G NR	5G New Radio
5G SA	5G Standalone
5G NSA	5G Non-Standalone
5G TDD	5G Time Division Duplex