Body of European Regulators for Electronic Communications

BEREC

Handbook of BEREC Guidelines on Geographical surveys of network deployments

June 2021

The Handbook presents, in one document, the compilation of the three Guidelines that BEREC produced to support the consistent implementation of the provisions of Article 22 of the European Electronic Communications Code. The documents contained here within are the following:

1) The BEREC Guidelines to assist NRAs on the consistent application of Geographical surveys of network deployments – document BoR (20) 42 (the "Core Guidelines");
2) The BEREC Guidelines on Geographical surveys of network deployments Article 22 (2), 22 (3) and 22 (4) – document BoR (21) 32 (the "Procedural Guidelines");
3) The BEREC Guidelines on geographical surveys of network deployments - Verification of information – document BoR (21) 82 (the "Verification Guidelines").

Body of European Regulators for Electronic Communications
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BoR (20) 42

BEREC Guidelines on Geographical surveys of network deployments

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1 Introduction

1.1 Legal Framework

1. Article 22(1) of the European Electronic Communications Code ('**EECC**') establishes that National Regulatory Authorities ('**NRAs**') and/or Other Competent Authorities ('**OCAs**') shall, by 21 December 2023, conduct a geographical survey of the reach of electronic communications networks[1] capable of delivering broadband, and shall update it at least every three years thereafter. This geographical survey ('**GS**') may also include a forecast of the reach of broadband networks, including very high capacity networks ('**VHCN**'), for a period determined by the relevant authority.

2. The rationale underlying Article 22 is the idea that geographical information on the reach of broadband networks will become an important tool to enable the effective design, implementation and monitoring of broadband policies and related regulation. Accordingly, the GS must be designed and conducted so that it can be used for the relevant regulatory obligations and policy functions carried out at Member State ('**MS**') and/or EU level.[2]

3. The GS shall include a survey of the current geographic reach of broadband networks as required for the tasks of NRAs/OCAs under the EECC, and for the surveys required for the application of State Aids[3] (Article 22 (1)). While the provisions of the EECC would anticipate and foster also state aid compliance, it is not their main objective to ensure compliance with state aid rules. NRAs/OCAs can use information collected under Art 22 to assist the state aid process but may also need to collect complementary information in line with the State Aid guidelines.

   Moreover, Article 22 (5) requires that the GS be taken into account by authorities:

   - For verifying the availability of services falling within the universal service obligations ('**USOs**'),
   - For the allocation of public funds for the deployment of electronic communications networks and the design of national broadband plans, including also an adequate identification of market failure areas,
   - For defining coverage obligations attached to the rights of use for radio spectrum;

[1] ECN, as defined in Article 2.1 of the EECC.

[2] According to Article 20(1) of the EECC, NRAs and OCAs have the power to require information on electronic communications networks and associated facilities, which is disaggregated at local level and sufficiently detailed to enable the geographical survey and designation of areas in accordance with Article 22. According to Article 21, NRAs and other competent authorities *"may require undertakings to provide information with regard to the general authorisation, the rights of use or the specific obligations referred to in Article 13 (2), which is proportionate and objectively justified in particular for the purposes of […] conducting geographical surveys"*.

and that the GS results shall be made available to BEREC and the European Commission ('**EC**') upon their request (ensuring the same level of confidentiality and protection of business secrets as the originating authority).

NRAs/OCAS shall, on the basis of the GS results designate an area with clear territorial boundaries where no undertaking or public authority has deployed or is planning to deploy a VHCN or significantly upgrade or extend its network to a performance of at least 100 Mbps download speeds (Article 22(2));

The results of the GS shall be used to make available on the market, (if they are not already available) information tools that enable end users to determine the availability of connectivity in different areas, with a level of detail which is sufficient to support their choice of operator or service provider. (Article 22(6));

Finally, where relevant, NRAs shall take into account the results of the GS, when defining relevant markets, (Article 64(3)); and where available, to impose appropriate universal service obligations (Article 86(1));

4. According to Article 22(7), by 21 June 2020, BEREC shall, after consulting stakeholders and in close cooperation with the EC and relevant national authorities, issue guidelines to assist NRAs and/or OCAs on the consistent implementation of their obligations under that Article.

1.2 Subject matter

5. Article 22 provides the legal grounds[4] to improve the information on geographical broadband reach in Europe. The main goal of the GS described in Article 22 is to enable the production of data on the reach of broadband networks, geographically referenced and relevant to regulation and policy in each MS.

6. The harmonization at EU level of some indicator definitions categories and data-related practices (notably, collection and publication) would result in substantive benefits, such as allowing the EC to collect more standardised data from MS and make use of better information in setting pan-European policies, promoting the consistent application of regulatory obligations and improving the transparency for public authorities regarding the economic conditions for network deployments.

7. Therefore, the BEREC's Geographic Survey Guidelines (hereafter, '**the Guidelines**') should provide a level of harmonization across the European Union but, in doing so, should also take into account the potentially significant costs that any new or modified data requirements may place on data providers and authorities. Information requests to

[4] Coupled with Article 20.

operators must be reasonable and proportionate to the range of needs they are meant to satisfy (Article 20).

8. In order to deliver the Guidelines, BEREC issued two different questionnaires directed to NRAs and other relevant authorities, requesting information about their existing surveys and needs, and also their views about the content of the proposed Guidelines. BEREC also organized, three workshops (two in cooperation with the EC) with the participation of OCAs and stakeholders.

9. The draft BEREC Guidelines on Geographical Surveys of network deployments were approved for public consultation at the 40th BEREC ordinary meeting in October 2019. Stakeholders were invited to submit their inputs by 21 November 2019. Contributions received were considered in the current version of the Guidelines. All contributions are published on the BEREC website, considering requests for confidentiality and restricted use of personal data.

1.3 Scope of the Guidelines

10. A geographical survey of broadband reach is **a collection of data which characterises the capability of an ECN to deliver a broadband service of a certain quality that can be displayed with the use of a digital tool on a layer-based map, and at an appropriate resolution.**

11. The Guidelines must provide NRAs and OCAs with:

    a) the specification of the relevant data to be produced by the Authority, using data collected from different data sources, mainly network operators (differentiating the specifications related to the current network reach on the one hand, and the future/forecasted reach on the other hand; similarly, specifying, when relevant, where fixed and mobile service approaches need to be distinct);
    b) guidance on how to collect these data;
    c) guidance on how to aggregate these data;
    d) guidance on which data/aggregations of data should be deemed public or confidential;
    e) guidance about the procedure to identify the intentions of agents to deploy VHCN or significantly upgrade or extend their networks to a performance of at least 100 Mbps download speeds in each area, so that this procedure ensures full transparency and non-discrimination with respect to relevant stakeholders.

12. Concerning the collection and use of data in respect of point a), BEREC distinguishes three different quality of service indicators.[5] Firstly, the Guidelines will use QoS-1

[5] The European Broadband Mapping project developed three data categories for 'Quality of Service' ('**QoS**'): QoS1/QoS2/QoS3. See definitions in section 2.1.

indicators to characterise the reach and performance of broadband networks. Secondly, the Guidelines will use QoS-2 and QoS-3 indicators as a means of verifying QoS-1 data.[6]

13. Moreover, BEREC considers that data on physical infrastructures (such as ducts, conduits, masts, manholes and so on) and data on broadband demand or take up do not fall within the scope of these Guidelines, because they do not fall within the concept of broadband reach. These kinds of data can also be geo-referenced, and it would be advisable for NRAs and OCAs to consider the value of maintaining a system of integrated spatial data of different kinds. Physical infrastructures support and enable the provision of electronic communication services, but the presence of a physical infrastructure does not imply the presence of an electronic communication network.[7] Information on broadband take-up or demand can be very relevant for regulatory and policy functions, but broadband reach is a wider concept, as it implies the availability of connectivity, regardless of whether this connectivity is demanded or not.

1.4 Calendar of delivery of the Guidelines

14. In accordance with the BoR decision taken in the second Plenary meeting of 2019, BEREC will issue these Guidelines in two phases.

Phase one (foreseen approval in March 2020).
Guidelines on the consistent application of geographical surveys and forecasts, regarding QoS-1 information.

Phase two (foreseen approval in December 2020).
Guidelines on the consistent application of geographical surveys and forecasts, regarding verification of QoS-1 information, for example by QoS-2 and QoS-3 measurements, and the procedures to invite undertakings and public authorities to declare their intention to deploy VHCN over the duration of the relevant forecast period for Article 22(3). The verification of QoS-1 information is very important to assess the validity of submitted data.

[6] QoS-2 and QoS-3 may be used in some Member States to characterize broadband reach, but this is not a common occurrence.

[7] The Broadband Cost Reduction Directive ('**BCRD**') contains provisions related to physical infrastructure without generically mandating their mapping, as it establishes an obligation to make available to the single information point (but not as such to map) information regarding all existing physical infrastructures (not only those related to ECNs) for which the information has been requested by operators (not the rest).

1.5 Guidelines revision

15. The Guidelines shall be revised in the future. BEREC will prepare an Implementation Report to examine how different MS have transposed and enabled the Article 22 provisions. Afterwards, BEREC will consider to revise and update the Guidelines.

2 Content of the Guidelines

16. The following subsections describe the different elements of the BEREC Guidelines on geographical surveys of broadband reach to characterise the reach and performance of broadband networks. These subsections deal with QoS-1 information. NRAs should verify the reliability of reach and performance information using, where relevant, appropriate measurement tools. BEREC will provide Guidelines on verification in the second phase see 1.4).

17. BEREC began by issuing a questionnaire to consult NRAs and OCAs with respect to the survey elements that they consider mandatory or important to deliver on the different functions referenced in Article 22 EECC. From its results, a series of information points and key characteristics stood out as being considered important for many functions and in many Member States.

    These are, for fixed broadband:

    a. the concept of homes passed,

    b. download and upload speed information,

    c. the access technology used and

    d. a high resolution of data.

    And for mobile broadband:

    a. broadband service availability in a certain area,

    b. download and upload speed information,

    c. user location and

    d. a high resolution of data.

18. With the present Guidelines, BEREC aims to harmonize these characteristics and information points wherever this is reasonable and proportionate.

19. There are also some other characteristics and information that are considered relevant by some, but not all, Member States in relation to some functions. These include, for example, the geolocalization of some electronic network infrastructure data (mainly

access infrastructure, but sometimes transmission or backhaul infrastructure). Indeed, some NRAs/OCAs may legitimately request this information from operators for many reasons for example to calculate the reach and performance of broadband in their territory, as opposed to requesting reach and performance indicators from operators.

20. To satisfy the obligations underpinning these Guidelines, the responsibility of providing reach and performance indicators may rest directly with the operators (while NRAs/OCAs collect and process this information), or indirectly with the NRAs/OCAs (where authorities perform calculations on the basis of their knowledge of infrastructure data or according to assumptions as described in the these GL). This is an issue for each MS to decide (for both fixed and mobile indicators).

2.1 Definitions

21. In the context of the Guidelines, BEREC is adopting all the definitions included in Article 2 of the EECC. Of particular importance to the Guidelines are EECC definitions of electronic communication network ('**ECN**') and of very high capacity network ('**VHCN**').

22. Additionally, within these Guidelines, BEREC also adopts the following definitions:

Address: An address is an identification of a fixed location, where there may exist one building or a group of buildings. The address may be a hierarchy consisting of components such as geographic names, with an increasing level of detail, e.g.: town, then street name, then house number or name. It may also include a postal code. Alternatively, it may be uniquely identified by some code in the building cadastre.

The address typically identifies the main door of a building or a set of buildings. The address may also serve to identify the building in the context of building registration.

Address passed: An address is passed when at least one premise at the given address is passed.

Broadband access: for the purposes of Article 22, Broadband access is an access in which the connection(s) capabilities support download data rates of at least 2 Mbit/s.[8]

Broadband service mapping: Broadband service mapping describes systems that gather, analyse and present information on the supply side of broadband service

[8] This broadband access refers to the EC Digital Single Market glossary definition which specifies that broadband is *"a term applied to high speed telecommunications systems, i.e. those capable of simultaneously supporting multiple information formats such as voice, high-speed data services and video services on demand. The Digital Agenda defines three levels of broadband speeds: 2, 30, and 100 Megabit per Second"*.

provision, including the available bandwidths (speed), technologies, operators/service providers and quality of service in a specific area.

Building: Eurostat definition applies. A building is a roofed construction which:

- can be used separately;
- has been built for permanent purposes;
- can be entered by persons; and
- is suitable or intended for protecting persons, animals or objects.

Geographical Information System: A geographical information system ('**GIS**') is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modelling, representation and display of georeferenced data to solve complex problems regarding planning and management of resources.

Households: Eurostat definition applies. Either a one-person household, defined as an arrangement in which one person makes provision for his or her own food or other essentials for living without combining with any other person to form part of multi-person household, or a multi-person household, defined as a group of two or more persons living together who make common provision for food or other essentials for living.

The persons in the group may pool their incomes and may be related or unrelated persons or a combination of persons both related and unrelated. This arrangement exemplifies the housekeeping concept. In an alternative definition used in many Member States exemplifying the so-called household-dwelling concept, a household consists of all persons living together in a housing unit.

Maximum achievable speed: The maximum achievable speed is the speed that an end user at the address/grid could achieve at least some of the time (e.g. at least once a day) when using a broadband service.[9] The speed should describe the capability of the network (equipment, technology and medium) and not be related to any particular retail service offered at the address/grid. This is, the maximum achievable speed is the highest speed that could be offered by the operator.

Mobile broadband: Mobile broadband refers to third generation technologies (3G) and higher speed mobile technologies (i.e. HSPA or LTE, 5G), while excluding GSM/GPRS/EDGE technologies.

Expected peak time speed: The expected peak time speed is the speed that an end-user in the address/grid could expect to receive when using a broadband service under

[9] Note that the maximum achievable speed should be calculated taking into consideration the currently installed equipment (as opposed to any equipment that could be installed); the current capacity in the backhaul network and the distance of the end-user from the last node.

the whole peak-time period. The speed should describe the actual capability of the network and not be related to any particular retail service offered at the address/grid.

"Peak time" is defined by BEREC in BoR (20) 165 as "the time of the day with a typical duration of one hour where the network load usually has its maximum". Peak time may vary among networks and regions. NRAs should (if they find this necessary) provide guidance on this aspect.

Premises or building parts: A premise is a separate functional unit of a building which is suitable for independent use. It may be a residence or a place of business. Every address, as defined above, may identify a building or a set of buildings. These may have one premise or several premises. For example, multi-storey buildings with several apartments consist of several 'premises'.

Premises passed:

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[10] the end user, usually within 4 weeks from the date of the request.

BEREC notes that generally, for a premise to be passed, the broadband network must be deployed up to the boundaries of the private domain of the address (i.e. the borderline between the public and private domain).

In case of FWA networks, a given premise is passed when there is an existing access point (typically the mast with antenna) nearby, typically with direct visibility to the end-user location and that a potential commercial offer can be accessible for end-users.

Reach of Fixed Broadband Networks: The reach of fixed broadband relates to the number of addresses passed by a network capable of delivering broadband.

Reach of Mobile Broadband Networks: The reach of mobile broadband is the availability of a mobile broadband network that permits the delivery of a broadband service with a specific mobile technology available at a specific location.

[10] 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).

Spatial Resolution: Resolution expresses the size of the smallest object in a spatial dataset that can be described. It refers to the amount of detail that can be discerned. It is also known as granularity.

QoS 1/QoS 2/QoS 3: The European Broadband Mapping project[11] developed three data categories for 'Quality of Service' ('**QoS**'):

- Data category QoS-1: Calculated availability of Service - Theoretical network performance of existing infrastructure
- Data category QoS-2: Measured provision of Service - Measurements *via* panel probes or drive tests, excluding end user's environment.
- Data category QoS-3: Measured experience of Service - Measurements using internet access service including end user's environment, for example via online speed tests.

2.2 Data sources and frequency of data collection

23. Article 20(1) of the EECC provides NRAs and OCAs with the power to require information on electronic communications networks and associated facilities, which is disaggregated at local level and sufficiently detailed to enable the geographical survey and designation of areas in accordance with Article 22. According to Article 21, NRAs and other competent authorities *"may require undertakings to provide information with regard to the general authorisation, the rights of use or the specific obligations referred to in Article 13(2), which is proportionate and objectively justified in particular for the purposes of […] conducting geographical surveys"*.

24. Operators who are able to control any part of the access network are the main source of information for the geographical surveys of broadband reach (from now on "operators"). For many functions,[12] it is necessary to gather information from all these operators, regardless of their size, or the technologies they use. Because of this, for the current task (QoS-1), these operators shall provide the information that NRAs/OCAs request, in order for the NRAs/OCAs to fulfil their duties along these Guidelines."

25. In cases where a broadband service is provided on the basis of wholesale access, NRAs/OCAs may decide to request information only from the wholesale provider. NRAs/OCAs should consider whether the information from the wholesale provider would be sufficient. In case of sufficient information provided by the wholesale provider, access seekers could be released from the obligation to provide such information.

26. National Statistical Offices and Land and Property Registries may also provide data relevant to the geographical surveys of broadband reach. In particular, they may provide

[11] https://ec.europa.eu/digital-single-market/en/broadband-and-infrastructure-mapping-project.

[12] State aid proceedings, national broadband plans, spectrum licensing, etc.

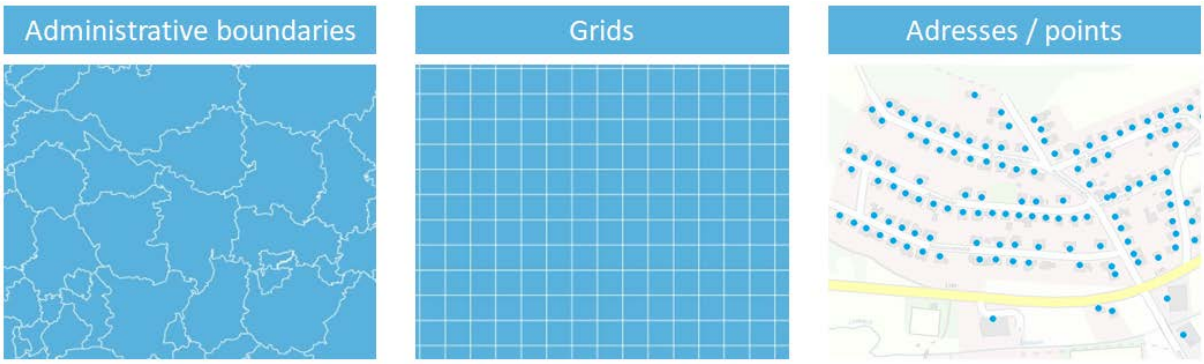
address databases, basic cartography, and information on the distribution of population and households across the national territory, as well as identification of all public buildings such as hospitals, schools, major transport hubs, public administration premises, and highly digitalized industries.

27. The GS survey of current broadband reach should be carried out at least once a year.

2.3 Geographical spatial resolution of data

28. According to the 1st paragraph of Article 22 of the EECC *"The information collected in the geographical survey shall be at an appropriate level of local detail and shall include sufficient information on the quality of service and parameters thereof and shall be treated in accordance with Article 20(3)"*.

29. Several spatial resolutions can be used for data collection (for example, geocoded information[13] (points or addresses), grid level data, local administrative unit level data, and NUTS level data). The most important levels of resolution are shown in the graphs below.[14]



30. As shown by the responses to one of the BEREC questionnaires, according to most Member States, a high resolution is necessary for most of the regulatory and policy functions that the survey of broadband reach and performance is intended to provide information for. **For fixed networks,** the level of resolution should be **the address**. **For mobile networks**, the level of resolution should be **a 100m x 100m or smaller grid** (or equivalent polygon). Note that this refers to the calculation used for the production of

[13] Geographical coordinates.

[14] A summary of the advantages and disadvantages of each spatial resolution unit (included in the *"Broadband and infrastructure mapping study / SMART 2012/0022")* is presented in Annex 1.

results, not to the resolution that operators may use in order to perform their coverage and performance calculations.

31. **For fixed broadband**, exact geocoded points offer the best quality/accuracy and the most valuable insight for the survey itself, and also validation of the survey. Thus, NRAs and OCAs **should collect information at the address level with exact geocoding**. The address database may be owned by the NRA/OCA, or be available from another public institution.[15] The databases should be updated at least annually.

32. For **mobile broadband**, **data should be collected at a level of a 100m x 100m or smaller grid (or polygons of an equivalent resolution)**.[16] This is also the level recommended to publish data by BEREC's Common Position on Information to Consumers on mobile coverage[17] and the minimum resolution to attain when collecting data.

33. For **fixed wireless broadband (FWA)**, data should be collected at least at an address level or at a level of a 100m x 100m or smaller grid (or polygons of an equivalent resolution), as one wireless access point deals with a group of addresses in a certain area. NRAs/OCAs shall determine the appropriate level of resolution. Address level resolution is well suited, for example, in specific FWA applications (e.g. the case of point to point radio connection).

34. However, some NRAs/OCAs are currently collecting data at a less granular level, in some cases even at the level of municipality. BEREC acknowledges the difficulties and the time that it may take to reach the situation where most information is collected at the proposed level of granularity, especially for fixed broadband (address level). Also, the following problems with address databases may arise:

    - There is no complete address database with all addresses geocoded;
    - Different address databases are used by different operators and/or the NRA/OCA.

35. In such situations, NRAs/OCAs may temporarily[18] apply a 100m x 100m or smaller grid, or polygons with similar accuracy, also for fixed broadband.

36. In the medium/long term, to ensure the reliability and comparability of the mapping project, in each Member State one common database with geocoded addresses should be used

[15] In this case other administrative bodies should be required to provide these data to NRA/OCAs.

[16] The areas that divide the territory must be the same for all technologies and do not overlap each other. NRAs should provide such grids or polygon systems to operators.

[17] BoR (18) 237.

[18] BEREC is not determining the length of this transitional period. In the future it will be necessary to examine how different MS have transposed and enabled the Article 22 provisions and then consider the need to revise and update GL. In that context BEREC will consider the need to extend or end the transitional period.

by both the NRA/OCA and, as far as possible, the operators. Thus, the NRA/OCA must use a single database that identifies each address or grid with a unique code (see Annex 4 for reference). Ideally, these address and grid codes should be at the disposal of the operators, so that they can all submit information with a common reference, although this may not be possible in all Member States. Moreover, BEREC recommends that, where available, the address database identifies the locations of hospitals, schools, major transport hubs, public administration premises and highly digitalized businesses. This information may be important for the design of national broadband plans.

37. The choice of the correct spatial resolution also has an impact on the ability of operators to provide data, as well as on the effort required by the NRA/OCA to process and aggregate the data.[19] Operators may lack the necessary GIS software and/or skills in order to provide data at this level of resolution, and some operators may not have, or may have only partially, geocoded their network.[20] In order to assist operators who lack the appropriate GIS resources, NRAs/OCAs may consider making geographical information tools available to these operators.

2.4 Elements of characterization of network connectivity or services

38. This subsection of the Guidelines describes the types of information that the NRA/OCA must gather in order to characterize the reach and performance of broadband networks.

39. BEREC understands that Article 22 requires the BEREC Guidelines to seek harmonization and make mandatory a minimal number of QoS-1 indicators (calculated theoretical coverage and performance information), which are relevant to most Member States, and many regulatory functions. These data should be collected according to common definitions and at the minimal resolution level, specified respectively in subsections 2.1 and 2.3 above. NRAs/OCAs may increase the number of indicators and/or of categories per indicator, if they consider that it is necessary to do so, in order to fulfil their duties.[21]

40. To characterize the reach of the network, according to the Guidelines, NRAs or OCAs must produce a normalized structured subset of the data, which are detailed in

[19] At the same time, exact geocoded points require better data protection and raise confidentiality issues and a more complex management of data.

[20] BEREC acknowledges the difficulties that some of the operators may face, in particular those with no GIS system or proper trained staff in this area. NRAs/OCAs might request the data in the simplest format in cases where specific difficulties are identified and as requested by operators, so that it is as easy to provide information as possible.

[21] In the case of increasing the number of categories of indicators proposed in these Guidelines, it would be required that the new splits or classes could be aggregated to fulfil the Guideline's categorization.

subsections 2.4.1 and 2.4.2 below. It is important to note that the NRA/OCA may choose to:

a) generate its own coverage and performance information using its knowledge of existing infrastructure;
b) obtain this information from operators; and
c) if necessary, use a third party to generate the information.

41. All these options are acceptable, in so far as the relevant definitions are used and the information obtained is as described in section 2.

42. NRAs/OCAs who perform QoS-1 coverage and performance calculations may request information about the characteristics of infrastructures and their positions (or distances from any address to a network element or a boundary area around a network element)) either in mobile or in a fixed broadband context[22].

2.4.1 Fixed broadband

43. This subsection of the Guidelines describes the types of information that should be produced in order to characterize the reach and performance of fixed broadband networks.

44. BEREC has consulted NRAs and OCAs with respect to the survey elements that they consider mandatory or important to deliver on the different functions referenced in Article 22. The information and characteristics that stand out as deemed important for many functions and in many Member States, with respect to fixed broadband are described in paragraph 17.

2.4.1.1 Data to be collected in order to characterize the reach and performance of a fixed network

45. As subsection 2.3 on data resolution explained, two different resolution levels are allowed for fixed networks: address level and 100m x 100m grid level or smaller (or similar polygon). **Therefore, BEREC distinguishes the data requirements on the type of resolution approach chosen by the NRA/OCA.**

a) Subset of data that characterize the reach and performance of a network – precision at the address level

[22] For example, where there is a passive fiber network, where the optical line termination point is not at the address and distances may be collected.

46. The reach of the network is characterized by structured data, which mainly describes the addresses passed[23] by the different operators.[24]

47. **Thus, for each address passed, the following information must be produced by the NRA/OCA from the operator's data, in the format specified in Table 8 of Annex 3.**[25]

- **Operator code**
- **Technology code categorized per subsection 2.4.1.3**
- **Maximum Download speed class per subsection 2.4.1.4.**
- **Maximum Upload speed class per subsection 2.4.1.4.**
- **Expected Peak Time Download speed class per subsection 2.4.1.4.**
- **Expected Peak Time Upload speed class per subsection 2.4.1.4.**
- **Number of premises passed by the operator at the address (Optional)**
- **Determine VHCN class at the address per Table 1**

Additionally and optionally, other parameters may also be required when NRAs/OCAs decide to collect further performance information, such as an NGA boolean (0- address not served by NGA, 1- address served by NGA)[26].

48. Thus, for each address passed the operator should provide the aforementioned information for all the technology codes that apply to each address, i.e., if an address has access to more than one technology for one operator, the information will need to be provided for each technology. Optionally, for the number of premises passed at the address the operator can provide a figure based on its assumptions.

49. For the submission of VHCN class information relevant to the denomination of designated areas (Article 22 (3)) and within the state aid context, operators[27] will need to follow the definition provided in Article 2 of the EECC and the definitions to be provided in future BEREC Guidelines by the end of 2020. To qualify their networks operators will need to provide one VHCN class code as reported in Table 1. Even if the networks qualify as

[23] See the relevant definition in subsection 2.1.

[24] These data must also be provided by wholesale-only access network providers. In addition, note that if dark fiber can be lit at an address within a one month period and according to the premises passed definition, then the information for this address must also be provided.

[25] Or alternatively, this may be calculated by the NRA/OCA, although this may not be very usual.

[26] According to paragraph 58 of the EU State Aid Guidelines, NGA networks are understood to have at least the following characteristics: (i) deliver services reliably at a very high speed per subscriber through optical (or equivalent technology) backhaul sufficiently close to user premises to guarantee the actual delivery of the very high speed; (ii) support a variety of advanced digital services including converged all-IP services; and (iii) have substantially higher upload speeds (compared to basic broadband networks).

[27] Or NRAs/OCAs in the case they take the responsibility to provide for this information (see paragraph 20).

VHCN under more than one criterion, operators just need to provide one code. A declaration that an address is covered by a VHCN network in class 3 or 4, will require and imply that all of the relevant QoS thresholds for peak time conditions are satisfied in that address.[28]

Table 1 – VHCN classes

Class of VHCN	VHCN Code
Not covered by VHCN	0
Fiber roll out to the address	1
Fiber roll out up to the base station (relevant for FWA)	2
No fiber roll out to the address, but all performance thresholds in criterion 3 of the VHCN Guidelines are satisfied	3
No fiber roll out up to the base station but all the performance thresholds in criterion 4 of the VHCN Guidelines are satisfied (relevant for FWA).	4

For FWA, if the performance thresholds of criterion 3 of the BEREC VHCN Guidelines are satisfied, then the operator shall inform class 3 rather than class 4 or 2 (even if these criteria are satisfied) [29]. As stated in paragraph 20 of the draft BEREC Guidelines on VHCN in this case, FWA may be considered equivalent to a 'fixed very high capacity network'[30]

50. Note that the NRA/OCA can choose the format for the data collection from operators, as long as it provides the data necessary to produce this minimal set of information.

51. Moreover, the Guidelines also require NRAs/OCAs to **use a unique address database in order to compile consistent information from operators, and also to aggregate information.** This is a supplementary address database that details the list of addresses in the MS, their unique identifying codes and some address-related information.[31] NRAs/OCAs can source address database information preferably from publicly available data sources, but they can also rely on private information (including operator information)

[28] These thresholds will be determined by the BEREC Guidelines on VHCN. Article 2 EECC determines that those will regard: uplink and downlink bandwidth, resilience, error-related parameters and latency and its variation.

[29] The VHCN Guidelines will be approved by the end of 2020. If there are changes to the 4 criteria that identify VHCN networks or the notion of wireless networks that may be considered equivalent to fixed VHCNs, these should be reflected in Tables 1 and 3 in these Guidelines. If this is necessary BEREC will consider these changes in the context of phase 2 guidelines.

[30] In this case, it would be expected that all the thresholds of criteria 4 in the VHCN Guidelines are satisfied as well, as in the draft VHCN Guidelines those are less demanding than for fixed-line.

[31] The addresses coordinates, their number of premises, the smallest administrative area to which they belong, the number of households in the address (optional) and an identifier of the address being a site of public interest as described in the resolution subsection 2.3 (optional).

if they consider this more suitable[32]. The format of this address database is specified in Table 9 (Annex 3).

52. Where possible, NRAs/OCAs may share with operators their reference address database and ask them to link their network data to it via address codes. This would allow NRAs/OCAs to unify information that comes from different access network providers in various formats in a very efficient manner, and is useful for aggregation purposes. However, sometimes NRAs/OCAs may find it better to allow operators to provide data according to the different address information they hold, and then work in-house to combine operators' data to assign a common code to each address. In such cases, the address database will be useful for aggregation purposes.

b) Subset of data that characterize the reach and performance of a network – precision at a grid level

53. As indicated in subsection 2.3, data can also be gathered at the grid level temporarily with the ambition to gather data at the address level as soon as a geocoded address is available.

54. As for addresses, the Guidelines require NRAs/OCAs to maintain a 'grid database' (Table 11 in Annex 3), which details the grid identifier and information relevant to the grid. This grid identifier can be used to request information from operators. The information on premises in the grid should be sourced from public sources, but could be sourced elsewhere (from private sources), or estimated by NRAs/OCAs, if necessary.

55. **For each grid (or polygon), the following information has to be provided by the NRA/OCA from the operator's data, in the format specified in Table 10 , Annex 3:**

- **Operator code**
- **Technology code categorized per subsection 2.4.1.32.4.1.2**
- **Maximum Download speed class per subsection 2.4.1.4.**
- **Maximum Upload speed class per subsection 2.4.1.4.**
- **Expected Peak Time Download speed class per subsection 2.4.1.4.**
- **Expected Peak Time Upload speed class per subsection 2.4.1.4.**
- **Number of premises passed by the technology in the area[33]**

[32] The address database is to be compiled by the NRA/OCA. Operators should not be expected to collect this information, yet if they know this information, NRAs/OCAs may consult them in order to complete the database. In the future, in the context of the Implementation Report, BEREC will consider whether to further elaborate on the need of a unique database by country.

[33] The "premises passed" information in the case of grid will allow NRAs/OCAs to have information on the reach of the network in each grid cell and also simplify the aggregation of operator data in a grid by taking as a proxy for overall reach the information of the maximum "premises passed" amongst operators (see paragraph 130). In the case of address information, the reach of the network in an area can also be derived from the number of "addresses passed", so that "premises passed" information can be made optional.

- **Determine VHCN class at the relevant grid per Table 1**

Additionally and optionally, other parameters may also be required when NRAs/OCAs decide to collect further performance information, such as NGA boolean (0- grid not served by NGA, 1- grid served by NGA)[34]. For a grid to be declared as served by an NGA network, the conditions associated with this condition must be satisfied in at least 95% of the addresses in the grid.

56. Note that the NRA/OCA can choose the format for the data collection from operators, as long as it provides the data necessary to produce this minimal set of information.

Moreover, the Guidelines also require NRAs/OCAs to use a unique grid database and code (see Table , Annex 3) **in order compile information from operators and also to aggregate information**. The grid code should be the same in the Grid coverage and performance database *(*Table *,* Annex 3) and in Table , Annex 3.For the submission of VHCN class information, operators will need to follow the definition provided in Article 2 of the EECC and the definition to be provided in future BEREC Guidelines by the end of 2020. To qualify their networks, operators will need to provide a VHCN class as reported in Table 1. For a grid to be declared as served by a VHCN of a given class, the conditions associated with this class must be satisfied in at least 95% of the addresses in the grid. This is, for example, 95% of the addresses in the grid are reached by a fiber access, or 95% of the addresses in the grid is served by base stations with a fiber roll out. Even in case networks qualify as VHCN under more than one criterion, network operator need to provide one code. In the case of FWA, if all the performance thresholds of criteria 3 in the VHCN Guidelines are satisfied (as per class 3 in Table 1), then the operator shall inform class 3 rather than class 4 or 2. Only in this case, FWA may be considered equivalent to a 'fixed very high capacity network'[35].

2.4.1.2 Data to be collected in order to characterize the reach and performance of a FWA network

57. FWA architecture is different than fixed due to the intrinsic characteristics of wireless connectivity.

[34] According to paragraph 58 of the EU State Aid Guidelines, NGA networks are understood to have at least the following characteristics: (i) deliver services reliably at a very high speed per subscriber through optical (or equivalent technology) backhaul sufficiently close to user premises to guarantee the actual delivery of the very high speed; (ii) support a variety of advanced digital services including converged all-IP services; and (iii) have substantially higher upload speeds (compared to basic broadband networks).

[35] In this case, it would be expected that all the performance thresholds in criteria 4 of the VHCN Guidelines would be satisfied as well, as those are less demanding than those of criteria 3.

58. End-users traditionally consider FWA as a substitute of “traditional” fixed line solutions as end-users are receiving similar services over FWA infrastructure. In line with technological neutrality principle, fixed and FWA architectures can both be used for the provision of fixed services. Moreover, NRAs/OCAs tend to include in their GS, FWA infrastructure into fixed broadband rather than mobile broadband.

59. In Table 2, BEREC splits FWA technologies into FWA in licensed spectrum and FWA in unlicensed spectrum (see Table 2). NRAs/OCAs may further split these classes if they find it suitable for their needs. The FWA with licensed spectrum (for example, P2P direct connection but probably also fixed LTE) usually provides access with better quality because there is no (or very low) interference, while the FWA with unlicensed (free) spectrum (typically, Wi-Fi) provides lower quality access which can be significantly cheaper for the end-users. Note that, services based on mobile networks may be classified as FWA by NRAs/OCAs by taking into consideration their characteristics[36].

60. BEREC wants to ensure that any GIS could make possible the merging of information coming from fixed and FWA architectures and establishes that the same speed classes and QoS parameters defined for fixed also apply also to FWA.

2.4.1.3 Technology

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

62. Column 2 in Table 2 specifies the **codes** that should be used in this respect to reflect the technologies in the last mile. The reason for this level of granularity is to allow NRAs/OCAs to better understand what technologies are available on their national territory. Alternatively, some NRAs/OCAs may wish to collect this information at the level of medium and use the medium codes when the data are being collected at a grid level and/or there are many operators providing the data.

63. Note that these options may change over time, so NRAs/OCAs may include new options as they become available in their territory.

Table 2 – Technology/medium codes[37]

[36] For example, where it’s demonstrated that the risk of high load from mobile or nomadic users is very low and where the service is locked to the specific area through geo-locking and/or permanently mounted outdoor antennas.
[37] The provision of broadband with a satellite connection is important in Europe, but all European premises are passed with satellite. Therefore, this option should not be considered in Table 2.

Description	Codes	Medium Codes
DSL on the copper line*	**DSL**	COPPER
VDSL on the copper line*	**VDSL**	
VDSL-Vectoring on the copper line*	**VECT**	
DOCSIS 1.0 or 2.0 on coaxial cable	**DOC1**	COAXIAL
DOCSIS 3.0 or 3.1 on coaxial cable	**DOC3**	
FTTH/FTTB	**FTTH/B**	FIBER
FWA in licensed spectrum	**FWA**	AIR
FWA in unlicensed spectrum	**WIFI**	
Others	**OTHER**	OTHER

*These options do not include any FTTB component. For the avoidance of doubt, the type of wiring within a building is not relevant to Table 2.

2.4.1.4 Speed Classes

64. Both the maximum and the expected peak time speed as defined in subsection 2.1 must be provided. Information on expected peak-time speeds is more relevant to consumers, while maximum speeds provide a more comparable measurement of network quality in each address since, normally, they are related to the medium and active equipment available at the location. Please see **Annex 2** for the speed classes to be provided, which apply to all speed definitions and technologies. These classes allow the identification of speeds above 30 Mbps (relevant for NGA classification), 100 Mbps (relevant for the designation of areas according to Article 22 (3) and EU broadband targets) and 1000 Mbps (relevant for EU broadband targets). There are additional breaks at 10 Mbps (which is relevant in the case of upload speed) and 300 Mbps, which will allow a richer monitoring of broadband networks in Europe as the difference between 100 Mbps and 1000 Mbps is substantive.

65. Note that the submission of speed class information, requires the calculation of 4 (download/upload maximum and download/upload expected peak-time) different speed indicators per address (or grid, where relevant). NRAs/OCAs may require that each speed indicator is based on a different and independent calculation. Alternatively, in view of an efficient data provision, NRAs/OCAs can use reasonable and appropriate assumptions[38] to derive one speed information from another or accept those used by operators. In the latter case, operators have to inform the relevant NRA/OCA about the assumptions they make and to provide evidence of their plausibility. NRAs/OCAs will make an informed

[38] For example, for download expected peak-time speed for a given technology to be calculated as a percentage of the calculated maximum download speed (or vice-versa).

decision about the suitability of the data provided. In view of harmonizing at European Level, BEREC will carry out further analysis on assumptions to provide speed class information for conducting a geographical survey.

66. QoS-1 speed indicators relevant to Article 22 should be reflective of the speed achievable rather than the speed actually experienced by end-users. Also, the need to designate areas (Article 22 (2)) requires a consistency of the VHCN class information and the information about speed classes, specifically in reference to the 100 Mbps threshold (class 100 or above). Therefore, the layer where speeds need to be calculated shall be the layer indicated in the VHCN Guidelines. Thus, BEREC suggests to calculate speed based on the IP packet payload layer (network layer)[39]. Today, nearly all data communication networks are based on the Internet Protocol (IP).

2.4.2 Mobile broadband

67. Following BEREC's consultation, the information/characteristics that many Member States mentioned as mandatory or important for many of their functions referenced in Article 22, and with reference to the mobile broadband are described in paragraph 17.

68. Moreover, BEREC published in 2018 its *'Common Position on information to consumers on mobile coverage'*[40] that describes in detail the concepts of both service availability and resolution.

69. BEREC considers that a first approach to characterize the reach of the mobile network is to determine the availability of broadband service, depending on the technology served at a specific location (section 2.4.2.1). Additionally and optionally, NRAs/OCAs may want to refine the characterization of the service and its performance by using multiple categorisations such as speed classes (see section 2.4.2.2). Finally, the qualification of a mobile network as a VHCN is also an important piece of information that NRAs/OCAs should seek (see section 2.4.2.2).

2.4.2.1 Mobile broadband service and technologies

70. BEREC considers that a first approach to characterize the reach of the mobile network is to determine the availability of a broadband service depending on the technology served

[39] This layer shall be the layer indicated in the VHCN Guidelines. Thus, in case VHCN guidelines consider a different layer, the later should also be considered for the purpose of speed calculations under these Guidelines.
[40] BoR (18) 237

at a specific location (for resolution, see Section 2.3). 3G, 4G and 5G generations offer distinct services and performances and may be mapped accordingly[41].

71. BEREC uses ITU standards and definitions when mentioning 3G, 4G and 5G[42] and they could be resumed as follow:

    - 3G UMTS and HSPA technologies
    - 4G LTE or LTE–advanced technologies
    - 5G either the 3GPP release 15 (*New Radio* (NR) non -standalone- the core network is 4G) and NR standalone (the core network is 5G) and further developments - 3GPP release 16 under development and will include new specifications for 5G.

72. For the purpose of these Guidelines, 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%.

73. Additionally, and optionally, NRAs/OCAs may want to refine the characterization of the service and its performance by using multiple speed classes, not only a minimum download speed of at least 2 Mbps (see 2.4.2.2).

2.4.2.2 Theoretical mobile broadband coverage calculation

74. Some NRAs may refine the service availability or the performance of the network by estimating the local value of the signal received in each pixel (100m x 100m grid minimum), alongside other assumptions. Such an approach implies the use of mathematical models to carry out the theoretical simulations; these models are described in multiple dedicated reports and recommendations of international bodies including the ITU, ETSI, CEPT, which provide useful methodologies for theoretical calculations of mobile broadband coverage. Such models may, accordingly, be of use for the purposes of these Guidelines.

75. Regarding the methodologies and the models used to calculate QoS-1 indicators for mobile broadband coverage, the parameters and tools to be applied may differ, depending on the mobile network operator or the NRA in question.

76. A BEREC 2018 enquiry revealed that operators, NRAs and OCAs use multiple thresholds to characterize mobile broadband coverage (see figure at page 7 in BoR (18) 237). This

[41] It should be noted that to have broadband service availability first the mobile network needs to be available, as without mobile network availability no service is delivered. Also for each specific service (e.g. different data rates) different conditions of the mobile network need to be available, including the performance of the mobile terminal.

[42] 3G as mentioned in the Recommendation ITU-R M.1457-14 specifying IMT – 2000 standard; 4G as mentioned in the IMT – Advanced documentation; 5G as the IMT – 2020 specifications will state.

could be relevant as long as each threshold is justified and consistent for the overall survey. Further, the same document indicates that 7 out of 33 NRAs use multi-level thresholds to define coverage. BEREC estimates that this practice gives more accurate and useful information to consumers. Different download speeds also imply that different signals are received – the higher the download speed, the higher the needed signal available, (keeping other factors unchanged).

77. Information regarding QoS-1 data services speed and, more specifically, speed classes (Annex 2) may also be important for a number of reasons. For example, this information enables setting a grid to a specific broadband category (basic, NGA, VHCN) which would be helpful to establish the mobile coverage gap and to program and implement EU funds for mobile network rollout.

78. The mobile broadband speed classes to be provided by operators or calculated by NRAS/OCAs should focus mainly on outdoor spaces and a static environment (i.e., outside buildings or places where there is usually no extra attenuation for radio signal penetration, compared to indoor spaces). For the purpose of these Guidelines, it is recommended to calculate the maximum data service speeds per grid and to allocate these maxima in the appropriate speed class.

79. Moreover, to qualify their networks, operators will need to provide a VHCN class as reported in Table 3. For a grid to be declared as reached by a VHCN of a given class, the conditions associated with this class must be satisfied in at least 95% of the grid. This is, e.g., that at least 95% of the grid is reached by base stations connected to fiber lines.[43]. If the networks qualify as VHCN under more than one criterion, operators need to provide one code.

Table 3 – VHCN classes for mobile broadband

Class of VHCN	VHCN Code
Not covered by VHCN	0
Fiber roll out up to the base station	2
No fiber roll out up to the base station but but all the performance thresholds in criterion 4 of the VHCN Guidelines are satisfied	4

Additionally and optionally, NRAs/OCAs may include another class to identify mobile networks that meet the performance thresholds of criterion 3 of the BEREC VHCN Guidelines (class 3 to be included in Table 3). Nowadays such networks do not exist, but in the future technological developments may allow for this situation. When a mobile network meets the performance thresholds of criterion 3 of the VHCN Guidelines, class 3

[43] These thresholds will be determined by the BEREC Guidelines on VHCN. See footnote 27.

should be declared rather than class 2 or 4. As stated in paragraph 20 of the draft BEREC Guidelines on VHCN in this case, this network may be considered equivalent to a “fixed VHCN”.

80. Additionally, mobile operators and authorities use different tools to support their coverage simulations; but their minimum common functionalities/features should take into account international standards and recommendations (ITU, ETSI, CEPT). The mobile operators, in supplying QoS-1 and other network performance data, shall use their radio coverage and other network related calculations, as used for the routine planning and management of their operational mobile networks. Upon request by the NRA/OCA, the mobile network operator will transparently and fully disclose the tools, methods and assumptions used in generating the mobile broadband data provided to the NRA/OCA.

81. The minimum assumptions which are needed as input to the theoretical calculation of speeds are the following:

    a) a reception height of 1.5 metres above the ground at each pixel
    b) the used GIS layers should include not only the morphology of the terrain but also the characterization of the surface and the sizes of buildings, if and where appropriate, and if the maps are already available.

82. In order to calculate/estimate a broadband service coverage map the following two parameters should be used, as appropriate:

    a) data traffic demand on the network, based on realistic cell load estimates, as given by statistical models that take into account demand for broadband services; and
    b) the minimum radio coverage threshold per technology and/or per broadband service.

2.4.2.3 Data to be collected in order to characterize the reach and performance of mobile broadband

83. Ultimately, the dataset to be collected in order to characterize the mobile network is presented in Table 13 (Annex 3). For each 100m x 100m (or smaller) area, **the following information has to be provided by the NRA/OCA from the operator’s data :**

- **Operator code**
- **Grid code or polygon ID**
- **Technology availability**
- **VHCN class per Table 3**

Additionally and optionally, other parameters may also be required when NRAs/OCAs decide to collect further performance information, such as QoS-1 speed information

- **Upload Maximum Speed classes (according to Annex 2)**
- **Download Maximum Speed classes (according to Annex 2)**

Please see Annex 3 for the tables with information to be sought and some indication on the means to gather the information.

84. When the required 100m x 100m (or other) grid information is aggregated from smaller sized cells (because the operator is providing the 100m x 100m (or other) grid information on the basis of smaller cells), the following points should be considered. For the operator to confirm that a 100m x 100m (or other) grid area is covered, it should guarantee that, in 95% of the grid territory, there is a high likelihood of reception of a broadband service. That is, operators should convert their own maps to the required resolution (100m x 100m or other).

85. QoS-1 speed indicators relevant to Article 22 should be reflective of the speed achievable rather than the speed actually experienced by end-users. BEREC suggests to calculate speed based on the IP packet payload layer (network layer) or the transport layer protocol payload (transport layer).

86. The proposed approach is a graded approach that suggests to use the technology as the minimum requirement and that allows NRAs/OCAs to complement it with other performance classes such as speed classes. This approach to describing technology information will bring some level of comparability between MS and will also enable NRAs/OCAs to choose how to measure broadband service performance. Moreover, BEREC's proposal is reflective of service availability, and is consistent with BEREC's common position on mobile coverage.

87. However, a more ambitious approach would also require the comparability of some performance estimations across Europe, for example by QoS-1 speed information. However, QoS-1 speed data is only a broad qualifier used to compare data service performance. Yet, it is somehow unrelated to end user experience, and comparison of these metrics can be deceptive[44] when compared with other metrics such as QoS-2 speed information which NRAs/OCAs may prefer.[45]

88. Further elaboration: In the future, it may be appropriate that BEREC researches into the methodologies and assumptions used to calculate mobile speed indicators, with views to further considering some European harmonization. Any development on this respect would need to be cognisant of existing national approaches and would require a thoughtful assessment of its proportionality.

[44] Although some NRAs/OCAs collecting QoS 1 information may provide information to the consumer related to service availability and kinds of use that an end user may expect, rather that speeds themselves.

[45] QoS-2 and QoS-3 approaches only give information on the locations where the measurements are undertaken, at a specific time. Therefore, it would be difficult for QoS-2 and QoS-3 speed approaches to provide speed information at the level of granularity required in these Guidelines.

2.5 Data and characterization of a GIS system

89. A broadly accepted definition of GIS[46] is the one provided by the National Centre of Geographic Information and Analysis (1990): *"GIS is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modelling, representation and display of georeferenced data to solve complex problems regarding planning and management of resources"*.

90. The functions of GIS include: data entry, data display, data management, information retrieval and analysis.[47] This subsection provides information how to start the mapping process and which data are relevant to these Guidelines.

91. The usage of GIS is an important tool to fulfil the obligations of Article 22. A GIS facilitates the conduct of a geographical survey of the reach of electronic communications networks, both for the tasks under EECC, and for the surveys required for the application of State aid rules. Because of the importance of GIS systems, BEREC should consider supporting the development of GIS expertise across Member States with a series of activities, such as the adoption of some common methodologies, the sharing of best practices across NRAs, and the provision of some GIS utilities (working grids, dedicated layers, etc.). Please see Annex 5 for a description of the stages that may be followed in order to establish a GIS that is useful in the context of Article 22.

2.5.1 Layers and their relevance to these Guidelines

92. A map layer may contain groups of point, line, or area (polygon or multipolygon[48]) features representing a particular class or type of real-world entities such as customers, streets, postal codes and so on. A layer contains both the visual representation of each feature and a link from the feature to its database attributes.

Table 4 - Layers

Kinds of layers	Layers NRAs/OCAs may have	Layers relevant to Guidelines

[46] Please see Annex 4 for more details on GIS.

[47] http://www.geogra.uah.es/patxi/gisweb/GISModule/GISTheory.pdf

[48] Polygon: On a map, a closed shape defined by a connected sequence of x,y coordinate pairs, where the first and last coordinate pair are the same and all other pairs are unique. Multipolygon: a two dimensional geometric collection of polygons, where the interiors of these polygons do not intersect.

Reference layers	• Administrative division (Polygons) • Rural and urban areas (Polygons or raster) • Public interest locations (e.g. universities, schools, hospitals, public areas, etc.) • Land cover (Polygons or raster) • Transport routes (Lines or polygons) • Environmental data (Polygons or raster) • Census areas with social demographic data (Polygons) • Base maps	o Addresses (Points), o Grids, 100m x 100m or smaller (Polygons that can be processed to raster)
Inventory raw data layers		o Premises passed per operator, medium, technology, speed, VHCN class and other parameters for fixed broadband in reference address points o Area covered per operator, medium, technology, VHCN class, speed and other parameters for - fixed and mobile broadband – in reference grids
Analysis results layers		o Aggregated grid coverage, 1x1 km o Aggregated grid speed, 1x1 km o Others to be decided by NRAs or BEREC[49]

2.6 Forecast specificities

93. Article 22 imposes the obligation for Member States to carry out a survey of the current geographic reach of broadband. It also establishes that such a survey may include a forecast of the reach of broadband networks for a period determined by the relevant authority, including for VHCN. The collection of forecast data is therefore not mandatory under Article 22.

94. However, forecast data are indispensable to authorities in several contexts identified below. Therefore, this subsection includes a series of **recommendations** on information to request in order to implement surveys of forecasts of broadband reach that are relevant for the needs of the regulatory and policy functions referenced in Article 22.

95. In providing these recommendations, BEREC has recognised that operators' rollout plans may change over time, due to unforeseen events, or as a result of changes in the strategies of investors. Because of this, longer term forecasts are more uncertain in nature than forecasts over a shorter period of time. Having established this, NRAs and OCAs who carry out surveys of forecasts of broadband reach would benefit from establishing verification mechanisms so that the forecast information is as reliable as possible.

[49] See subsection 2.7.4.

96. BEREC has identified two main areas of public intervention where information from broadband forecasts is important. These are:

a) **Identification of designated areas**. Article 22(2) EECC establishes that NRAs/ OCAs may designate an area with clear boundaries where, on the basis of the information gathered and any forecast prepared pursuant to paragraph 1 in the same Article, it is determined that, for the duration of the relevant forecast period, no undertaking or public authority has deployed **or is planning to deploy a VHCN or significantly upgrade its network to a performance of at least 100 Mbps download speed.** Moreover, Article 22(3) also provides for an (optional) mechanism, by which authorities, once an area has been 'designated', may call for further information on the intentions of parties to deploy VHCN or upgrade their networks to a performance of at least 100 Mbps download speed. It should be noted that the survey of broadband forecasts and the aforementioned mechanism are instruments which have different objectives,[50] and the information required in respect of each of these mechanisms is gathered at different times.[51]

b) **State aid proceedings:** In the context of state aid, it is necessary to identify the areas of a Member State that do not satisfy different standards of 'broadband availability.'[52] Moreover, to provide for public financing of broadband deployments in these areas, it is indispensable to ensure that such financing will not distort the incentives of private investors with concrete rollout plans for the near future in such zones, and the future competition that may thereby result. The State Aid Guidelines[53] oblige the relevant authorities to carry out a public consultation, which may enable them to find out about operators' investment plans. In this context, a detailed and updated survey of forecasts of appropriate characteristics may assist the relevant authority to anticipate some of this information, providing complementary information in state aid proceedings. NRAs/OCAs may, on the contrary, decide that it is sufficient to gather information about

[50] Article 20(1) of the EECC provides NRAs and OCAs with the power to require information on electronic communications networks and associated facilities, which is disaggregated at local level and sufficiently detailed to enable the geographical survey and designation of areas in accordance described in Article 22. On the contrary, for operators, responding to a public consultation is voluntary.

[51] Paragraph 3 in Article 22 requires authorities to specify the information to be included in the public consultation submissions to be at least of a similar level of detail as that of the optional forecast survey cited in paragraph 1.

[52] White areas are those in which there is no broadband infrastructure and where it is unlikely to be developed in the near future. Grey areas are those in which one network operator is present, and another network is unlikely to be developed in the near future. Public support in these areas is possible when it can be demonstrated that there is a market failure and subject to certain compatibility conditions. Similarly, white NGA areas are those areas with no NGA network and where it is not unlikely that one is built within 3 years on a commercial basis. A grey NGA area is one where there is only one such network (or it is being deployed) and there are no plans by a private company to build another one in the succeeding 3 years.

[53] EU Guidelines for the application of State Aid rules in relation to the rapid deployment of broadband networks (2013/C 25/ 01).

forecasts solely by means of the public consultation mechanism on the areas where they envisage some public intervention, or where they see this as justified.

97. Other areas where forecasts may be used are to provide information to the public (e.g. where and when higher speeds can be expected) include market analysis procedures, or the design of national broadband plans. However, various possible forms of implementation with regard to these areas arise, depending on Member State specific situations and the goals pursued. The Guidelines are without prejudice to forecasts related to these functions which may be implemented at national level for other purposes than article 22.

2.6.1 Forecasts of broadband reach

98. This subsection specifies how forecasts for the use of Article 22(2) - designated areas - and for the purpose of state aid should look. In all cases, it is advisable that the NRA's or OCA's GIS systems enable different layers information on broadband reach, and information on forecasts of broadband reach.

A) Agents providing the information

99. **In order for a survey to be useful in terms of designating areas and for state aid, NRAs/OCAs must request information from all potential investors (network operators, public authorities, and other investors, if relevant).**[54] Small actors are also relevant, and it is in their own interests to provide this information so that their investment plans are not distorted by any subsequent public intervention.

B) Areas where information is to be collected

100. In the context of Article 22, information about forecasts should be requested using the Article 22(1) forecast survey, wherever the authority intends to designate an area as defined in Article 22(2). That is, the information is necessary if, in that area, there is no VHCN or network with a performance of at least 100 Mbps of download speed, and where, at the time, there are no known deployment plans.

In the context of state aid, the information about forecasts should be collected wherever public authorities intend to intervene.

[54] Article 20 EECC provides NRAs/OCAs with the right to request information from undertakings other than providers of ECN and ECS when the information provided by this latter kind of agent is insufficient to carry out regulatory and policy tasks under EU law. The identification of areas with market failure (white, grey, white-NGA, grey NGA areas as defined in the state aid areas and 'designated areas' as defined by Article 22(2)) is an important policy in Member States which requires gaining knowledge of the rollout plans of different undertakings, including those that are not ECN/ECS providers. These requests need to be proportionate to the need fulfilled, and well-reasoned.

C) Frequency of data collection

101. BEREC **recommends** that the frequency of collection of forecast data of areas of interest be annual. Annual collection of data (for relevant areas) is suggested because it allows some monitoring of the forecast data. Some NRAs/OCAs may deem this excessive and may decide to engage in this activity only once they intend to designate areas (Article 22); or when they plan public interventions (state aid). On the contrary some other NRAs/OCAs may find necessary to collect forecast data more frequently, on the basis of specific national requirements.

D) Resolution of the data collection

102. For the purposes for which the data are collected (state aid proceedings and the identification of designated areas), a high resolution (address level or 100x100m squares or smaller) is necessary. Forecast data should be available to the extent that the information is available at the stage of request (independently of the period when the deployment will take place) and can be provided with reasonable effort.

F) Data to collect

103. The **information on forecasts should be provided according to the following table** (same for fixed and mobile forecasts):

Table 5 – Data to collect on forecasts

Variable	Grid or address	Zone code (optional)	Operator	Technology code	Maximum Download speed category	VHCN class	(Expected) Start date of the rollout	Expected end date of the rollout
			Data to be requested from network providers					
Description	Information identifying the grid or address provided by the NRA/OCA	Code of the zone, considering the lowest administrative unit in the Member State	Operator code according to a list provided by the NRA/OCA	Codes in Table 2 (column 2) (fixed) and classes in Table 13 (mobile), Annex 3	Speed category after rollout. Code in Table , Annex 2.	Codes according to Table 1 (fixed and wireless)	Date (may be in the past)	Date (before the end of the three year period)

It may also be useful to gather information from the operator on the number of premises that are intended for coverage and on the main milestones of the plan within the planned project timeline.

The information included in Table 5 (at address or grid level) is indispensable for the Article 22 forecast survey. Nevertheless, operators ought to complement this information with other forecast information, as soon as the data that could be used to devise these forecast information is available. These forecast information encompass all relevant information, including information on VHCN roll-out and information on network upgrades or extensions aiming at providing download speeds of at least 100 Mbps. NRAs/OCAs might detail the conditions under which operators should provide these forecast information.

2.6.2 Verification of forecast data

104. The reliability of forecast information is important in many respects. In the context of state aid, and for designated areas, rollout plans which are ultimately not carried out may imply that an area goes with no public funds when this would have been funded by means of state aid. If private investors do not declare their future rollout plans, they run the risk of being overbuilt with public funding. This can create an unwanted litigiousness and uncertainty, which could have been prevented if the declarations to invest had been completed in due time. For all of these reasons, NRAs/OCAs should aim to verify the information on forecasts of broadband reach, as far as this is reasonable and legally available.

105. Two types of verification can be thought of: *ex ante* verification (that is, at the time the information is requested) and *ex post* verification (i.e. after the period for which the forecast was made has passed). *Ex post* verification is more costly to carry out as it entails providing the technical and legal means to collect future information about the implementation of the rollout projects. However, this may be justified in some circumstances.

106. BEREC lists for guidance a series of possible verifications, which may be carried out by the NRA/OCA, whenever the information is held by the authority or there is a legal right to request it in order to assess the reliability of the forecast information.[55]

107. *Ex ante* verification:

- Looking at the operator's investment track record (e.g. size, population density and location of past investments), compared with the proposed investment.
- Comparing the size of the investment to the size of the operator.
- Comparing investment forecasts of different operators to detect 'outliers' (e.g. in terms of investment size related to company size).

[55] Which forecasts to verify, which verification methods to use, whether to record or not repeated failures to provide accurate information should be a choice of the NRA/OCA.

- Considering the realisation of the main milestones of the investment plan within the planned project timeline (taking into account the size of the project, granting of permits, realisation of civil engineering work).

108. *Ex post verification* entails comparing forecasts with actually implemented network deployments[56] by verifying the level of adherence of the operator with the planned timeline in terms of achievement of the main milestones of the project.

109. In case of large deviations the operator may be asked for a reasonable justification and;

- NRAs/OCAs may check whether large deviations occur repeatedly for the same operator
- Understand whether there was an incentive to deliberately provide a wrong forecast, e.g. due to effects on state aid and/or competition.

2.7 Publication, confidentiality issues and aggregation of data to provide information to third users

110. The publication of geographical survey data on broadband is an important tool by means of which end users can get information on service availability and choice. Indeed, the EECC requires NRAs/OCAs to make GS data which are not subject to commercial confidentiality directly accessible to allow for its reuse. In addition, Article 22 requires NRAs/OCAs to provide information tools that enable end users to determine the availability of connectivity in different areas, with a level of detail that is useful to support their choice of service provider, where such tools are not yet available on the market. In doing so, NRAs/OCAs contribute to an open and competitive market.

111. Moreover, Directive 2019/1024 on open data and the re-use of public sector information states that Member States shall ensure that public documents (including data) shall be re-usable for commercial or non-commercial purposes, where possible, through electronic means.

112. At the same time, in accordance with EU and national rules on commercial confidentiality and protection of personal data, some information gathered for geographical surveys (GS) may be considered to be confidential, and NRAs/OCAs shall then safeguard such confidentiality.

[56] The actually implemented network deployments can be calculated by comparing the network reach of an operator at different points in time.

113. 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.

114. Finally, it should be noted that the requirements of the GS information system should reflect the guidelines of the INSPIRE Directive[57], given that all public institutions of a Member State that have spatial information are obliged to manage and make available the data and the GIS in accordance with common principles and rules.

2.7.1 Publication of data

115. One of the key objectives of publishing mapping information for NRAs/OCAs is to create transparency for customers with respect to broadband access product characteristics. Transparency is perceived as an important means to motivate operators to improve the quality of their internet access products. In addition, it supports better-informed decision-making by consumers.

116. According to Article 22 NRAs/OCAs shall (where the relevant tools are not available on the market), make available information tools enabling end users to determine the availability of connectivity in different areas, with a level of detail which is useful to support their choice of operator or service provider. Indeed, mapping initiatives for end users are often constructed as an online platform for consumers to be able to know if and what type of broadband is available at their (future) home. Along with the available speed class, the available technologies in a specific area provide important information for consumers.[58] One particular group of consumers in this regard is those without internet connectivity.

117. NRAs/OCAs have several options to publish the GS data:

- Interactive maps published in a dynamic web application;
- Interactive address lookup published in a dynamic web application;
- Application programming interfaces ('**API**') providing access to the data;
- Datasets in open and generalised formats, such as CSV; and
- Statistical reports, including tables and analysis.

118. Interactive maps published in dynamic web application seem to be the most promising publication format to gain impact and attention from a wide range of audiences, including

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

[58] Study on Broadband and Infrastructure Mapping, European Commission, https://ec.europa.eu/digital-single-market/en/news/mapping-broadband-and-infrastructure-study-smart-20120022

end users. Nevertheless, a multi-publication approach also seems to be a good practice as publications can be complementary and can improve dissemination of information between end users, associations, public entities, and civil society.

2.7.2 Confidentiality

119. When publishing or granting access to GS data, NRAs/OCAs should have regard to the legitimate interest of operators in the protection of their business secrets and other confidential information, such as the protection of personal data of the end user.

120. Business secrets are defined as confidential information about a company's business activity, the disclosure of which could result in serious harm for the same undertaking.

121. The interests liable to be harmed by disclosure must, objectively, be worthy of protection.[59] It is highly recommended that operators establish their claims for confidentiality, and that the NRAs/OCAs settle those claims according to clear and non-discriminatory criteria. The assessment of whether a piece of information constitutes confidential information should be made on a case-by-case basis by the relevant authority (depending on the kind of information, and the circumstances).

122. Some examples of information that could qualify as business secrets and may be deemed to be confidential in the context of GS are:

- Operators' deployment forecasts;
- Operators' detailed information regarding the position and type of different network elements, with the exception of network elements that are subject to a wholesale access obligation that requires the publicising of this information; and
- Operators' production secrets and processes, as well as information relating to an undertaking's know-how, such as the tools and methods it uses to calculate coverage information.

123. Some examples of information that may not be considered confidential in the context of GS are:

- Information which is publicly available. The coverage area of an operator will usually be available to customers and should therefore not be considered to be confidential;
- Information that has lost its commercial importance, for instance due to the ageing of information because of the passage of time;

[59] See EC Guidance on the preparation of public versions of Commission Decisions adopted under the Merger Regulation.

- Information which is common knowledge among specialists in the field (for example, in relation to mobile propagation models); and
- Statistical or aggregate information, in so far as it does not allow for the identification of business secrets.

2.7.3 Spatial level and data resolution

124. GS data can be accessed at various levels of spatial resolution, such as points, grids, postal codes or NUTS. Excessively detailed resolution can lead to an exorbitant increase in the size of the dataset and create problems with confidentiality, while access to data at very high spatial levels is likely to create fewer confidentiality problems.

125. When granting access to GS data, NRAs/OCAs shall keep in mind that granting access to:

- Geocoded information (such as points or addresses) requires some solid motivation, since confidentiality concerns are more likely to arise at this very high geographic detail.
- Data at grid level typically implies different scopes and user requirements, compared to geocoded information. However, they may also have potential confidentiality challenges.
- Data at local administrative unit levels ('**LAUs**' or postcodes) are likely to imply medium disclosure risks. They will likely be a sufficiently small territorial unit in most circumstances.
- Data at NUTS levels is likely to imply low disclosure risks. They will likely be an insufficiently small territorial unit in most circumstances.

2.7.4 Data aggregation

126. In order to fulfil their responsibilities, NRAs/OCAs may calculate aggregated broadband coverage rates for different areas (for example, administrative boundaries, starting at the municipality up to the regional and national levels). The European Commission uses aggregated information at national level (based on NUTS 3 level data) in order to monitor and compare the digital performance of Member States. It is therefore important to make sure that NRAs/OCAs apply harmonised rules in order to calculate comparable coverage rates.

127. Data collected as exact points and lines allow NRAs/OCAs to calculate the most accurate representation of reality. Aggregation is rather straightforward and requires few, if any, GIS skills. Thus, when NRAs/OCAs collect data at address level, they can accurately calculate the aggregated coverage rates for various resolution levels, without any approximation, and it is possible to identify perfect overlaps between operators and

between technologies. This is also true when they are able to convert data collected at grid level into data at address level.

128. In the context of State Aid, although data may be collected on a fine granular basis – specifically, geocoded address data, normally[60], the data will need to be aggregated in order to enable the identification of white and grey areas, so that the market failures arising from the lack of commercial investment incentives in local or regional areas can be addressed with minimal distorting effect. Indeed, broadband networks cannot be efficiently deployed to target individual addresses. Accordingly, geocoded address data should be aggregated into areas which are large enough to ensure that that an efficient state-aided network deployment would be feasible.

129. Operators often decide to deploy their network on the basis of population density. Since this variable is the same for all operators in each grid, it is reasonable to assume that operators will all prioritise coverage in the same areas. Thus, the footprint of the operator having the highest coverage rate should, in theory, encompass the footprints of operators having lower coverage rates in the grid.

130. Therefore, in order to treat overlaps,[61] NRAs/OCAs shall estimate the aggregated coverage at grid level using the highest coverage rate in the grid. This corresponds to the coverage rate of the operator having the highest coverage rate in the grid. The same assumption shall be applied when estimating aggregated coverage rates per technology.

131. If authorities request or calculate mobile information on a grid smaller than the 100m x 100m (for example 20m x 20m), it would be recommended that when aggregating information to a 100m x 100m grid, they take into account that, to be considered as covered, they should ensure that a broadband service is available at least in 95% of the 100m x 100m grid area.

2.7.5 Access to information by public authorities

132. Article 22 (5) clearly states that public authorities with nominated responsibilities[62], must take into account the results of the geographical survey and that MS shall ensure that the NRA/OCA conducting the GS provide the results to other authorities, ensuring the

[60] Exceptions happen in the case of very isolated addresses that may require a specific intervention.

[61] There is an overlap when more than one operator provides access to broadband for a single spatial unit (e.g. a grid cell); when one operator provides access to broadband for a single spatial unit (e.g. a grid cell) through more than one technology.

[62] Allocation of public funds for the deployment of electronic communication networks, for the design of national broadband plans, for defining coverage obligations attached to the use of radio spectrum and for verifying availability of services falling within the universal service obligations in their territory.

same level of confidentiality. Moreover, Article 22 (59 also requires that NRAs/OCAs facilitating the information to other public authorities inform operators when doing so.

133. Confidentiality concerns and data aggregation may differ according to which authority is accessing the information, or for what purpose. Different purposes might generate different needs for transparency, but also different needs for confidentiality by data providers.

134. In any case, as provided by Art 20 (3) when information gathered in the context of a GS is considered confidential by an NRA/OCA, the EC, BEREC and any other competent authority shall ensure such confidentiality. However, such confidentiality shall not prevent the sharing of information between the NRA/OCA and the other authority in a timely manner for the purposes of reviewing, monitoring and supervising the application of the EECC.

135. Before providing access to GS data, NRAs/OCAs shall, on a case-by-case basis, make sure to obtain a good understanding of the expectations of the authority and its requirements. NRAs/OCAs shall always analyse the disclosure risk of information and consider reasonable aggregations.

136. NRAs/OCAs may publish the terms of public access to GS information, including the procedures for obtaining such access by other public authorities. In any case, other authorities must demonstrate that their request is in line with one of the purposes of the GIS. Based on the reasons for access, NRAs/OCAs can define a geographical scope and eventually grant access only for certain areas specified by the authority.

137. NRAs/OCAs shall check the spatial resolution of the provided data against the required level of outcome granularity, in order to determine the fitness for purpose of each dataset provided to the other public authorities.

138. Some examples[63] of fit-for-purpose spatial aggregations of the collected data are:

- NUTS 3 level :
    - For monitoring the European Gigabit Society targets
    - For the European Broadband mapping portal (public view)
- LAU (municipalities) level :
    - For verifying the availability of services falling within the universal service obligations (Article 22(5)), or to impose appropriate universal service obligations (Article 86(1))
    - For defining coverage obligations attached to the rights of use for radio spectrum (Article 22(5))

[63] This is not a comprehensive list of examples, but rather some usual ones.

- 1 km grid square level :
    - For the designation of an area with clear territorial boundaries where no undertaking or public authority has deployed, or is planning to deploy, a VHCN or significantly upgrade or extend its network to a performance of at least 100 Mbps download speeds (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), 2nd subparagraph)
    - For the allocation of public funds for the deployment of electronic communications networks and the design of national broadband plans, including an adequate identification of market failure areas (Article 22(5))

ANNEXES

Annex 1 - Assessment of spatial resolution units

Table 6 - Spatial resolution units

EXACT POINTS Data are collected as exact points representing addresses.	
Pros ▪ Highly accurate representation of reality	**Cons** ▪ High data security requirements have to be met ▪ High efforts for mapping ▪ Possibly high reluctance on the part of network operators / internet service providers to provide data due to business confidentiality
GRIDS Data on broadband services are often collected at the level of grid cells.	
Pros ▪ Sufficient level of confidentiality for infrastructure owners (data suppliers) ▪ Relatively accurate data with low margin of error for data aggregated on administrative levels	**Cons** ▪ Effort is required to translate address or other geographical data to the grid level
AGGREGATION Data can also be collected with reference to an existing geographical aggregation system such as NUTS or postal codes.	
Pros ▪ Potentially very little effort for data suppliers, depending on the chosen level of aggregation	**Cons** ▪ Little or no options for further analysis of the data, depending on the chosen level of aggregation ▪ No possibilities to detect overlapping availabilities and, therefore, higher margin of error

Source: EC study *"Mapping of Broadband Services in Europe – SMART 2014/0016"*, based on the *"Broadband and infrastructure mapping study / SMART 2012/0022"*

Annex 2 - Speed classes

The following are the speed classes (download and upload) which should be considered in the submission of information:[64]

Table 7 – Speed codes

Speed	***Code***
More or equal to 1 Gbit/s	*1000*
≥300 Mbit/s < 1 Gbps	*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*

It should be noted that, even if the classes are identical for upload and download speeds both speeds can belong to a different class, depending on the performance of the network.

[64] Note that these speed categories may change at the time of the publication of the Guidelines, following any update of the work undertaken by BEREC on the definition of VHCN.

Annex 3 - Structure/format of the data

1) For fixed broadband

At the address level

The data are divided into 2 tables: address database table (to be created by the NRA/OCA) and address coverage and performance database (collected from operators (unless NRA/OCA performs calculations)).

Table 8 – Address coverage and performance database

Variable	Technology	Operator	Max download speed class	Expected download peak time speed class	Max upload speed class	Expected upload peak time speed class	Number of premises passed	VHCN class
Description	Codes in Table 2	Operator code (according to a list provided by the NRA/OCA)	Codes in Table , Annex 2	Codes in Table , Annex 2	Codes in Table , Annex 2	Codes in Table , Annex 2	Number of premises passed at this address. **This entry is optional**	Codes in Table 1
Data type	Character varying (6)	Character varying (6)	Integer	Integer	Integer	Integer	Integer	Integer

Table 9 – Address database

Variable	Address coordinate (1)	Address code	Address (2)	Zone code	Number of premises	Number of households	Public services buildings
Description	Coordinate of the address in the WKT format[65]	Code of the address. Has to be unique per address	Full address in a string form (Street number, Street name, locality code), in the standard	Code of the zone, considering the lowest administrative unit in the Member State. For aggregation usage	Number of premises at this address.	Number of households at this address. **This entry is optional**	Code of public building: 0 – no public 1- school/ university 2- hospital 3 – other public administration premises

[65] For instance “SRID=2145;POINT(-44.3 60.1)”

			format of the Member State				4- main transport hubs 5- highly digitalized businesses **This entry is optional**
Data type	Point	Character varying (50)	Character varying (100)	Character varying (50)	Integer	Integer	Integer

(1) Some NRAs/OCAs may want to add information regarding the projection system used, if needed due to their national circumstances.

(2) Some NRAs/OCAs may find useful to split the address code into separate fields, e.g. street name, number, zip code etc.

At the grid level

The data are divided into 2 tables: grid database table (to be created by the NRA/OCA) and grid coverage and performance database (collected from operators (unless NRA/OCA performs calculations)).

Table 10 – Grid coverage and performance database

Variable	**Technology**	**Operator**	**Max upload speed class**	**Max download speed class**	**Expected peak time upload speed class**	**Expected download peak time speed class**	**Number of premises passed**	**VHCN Class**
Description	Codes in Table 2	Operator code (according to a list provided by the NRA/OCA)	Codes in Table 7, Annex 2	Codes in Table 7, Annex 2	Codes in Table 7, Annex 2	Codes in Table 7, Annex 2	Number of premises passed in this area.	Codes in Table 1
Data type	Character varying (6)	Character varying (6)	Integer	Integer	Integer	Integer	Integer	Integer

Table 11 - Grid database table

Variable	**Coordinate**	**Grid code**	**Zone code name**	**Number of premises**	**Number of households**
Description	Coordinate and geometry of the polygon	Code of the grid. Has to be unique per grid	Code of the zone, considering the lowest administrative unit in the Member State. For aggregation usage	Number of premises in this area	Number of households in this area. **This entry is optional**

	in the WKT format.[66],[67]				
Data type	Multipolygon	Character varying (50)	Character varying (70)	Integer	Integer

2) For mobile broadband

Table 12 - Grid database table

Variable	Coordinate	Grid code	Zone code name
Description	Coordinate and geometry of the polygon in the WKT format.[68],[69]	Code of the grid. Has to be unique per grid	Code of the zone, considering the lowest administrative unit in the Member State. For aggregation usage
Data type	Multipolygon	Character varying (50)	Character varying (70)

Technology and speed table information

Note that this information can be collected in GIS form (can be a shapefile or a raster/grid) or a table form.

- **GIS form**
  - Technology digital maps with resolution of 100m x 100m or smaller, preferably using multiple designations or more to characterize each geographical point
  - This grid can be enriched with speed coverage, as explained in Section 2.4.2.2 .

- **Table form which can be also a maps legend**

[66] That polygon could be a grid.

[67] For instance: "SRID=2154;MULTIPOLYGON (((30 20, 45 40, 10 40, 30 20)),((15 5, 40 10, 10 20, 5 10, 15 5)))"

[68] That polygon could be a grid.

[69] For instance: "SRID=2154;MULTIPOLYGON (((30 20, 45 40, 10 40, 30 20)),((15 5, 40 10, 10 20, 5 10, 15 5)))"

Table 13 – Data to be collected

Grid Code Or polygon ID	**Resolution (1)**	**Operator Code (according to a list provided by the NRA/OCA)]**	**Technology**				**Max Download speed, see subsection 2.4.2.2 (optional)**	**Max Upload speed, see subsection 2.4.2.2 (optional)**	**VHCN class (see subsection 2.4.2.2)**
			3G availability, high likelihood of service reception, see subsection 2.4.2.1	**4G availability, high likelihood of service reception, see subsection 2.4.2.1**	**5G non-standalone availability high likelihood of service reception see s. 2.4.2.1**	**5G standalone availability high likelihood of service reception, see subsection 2.4.2.1**			
Integer	string	Character varying (6)	Boolean	Boolean	Boolean	Boolean	Codes in Table 7 Annex 2. **This entry is optional**.	Codes in Table 7 Annex 2. **This entry is optional.**	Codes in Table 3

(1) Polygon resolution or grid size

Annex 4 – GIS

1. Data formats / type of data

GIS data can be separated into two categories: spatially referenced data, which are represented by vector and raster forms (e.g. orthophotos), and attribute tables, which are represented in tabular format.

Some advantages and disadvantages of vectors and raster representations are:

- placement accuracy and accuracy of representation are significantly higher in vector representations;
- the storage of raster entities requires more space;
- handling vector representation in GIS applications is much faster (saving, loading, displaying, editing, copying, deleting);
- free and generous symbolization of vectors entities (practically unlimited applicability of colours, fillings, shades and so on);
- geometric flexibility of vector entities (e.g. drag and drop are easily done);
- possibility to perform complicated calculations and determinations (e.g. area, perimeters and so on);
- vector representation is independent of resolution and can be used in schemes that require smooth curved lines;
- vector can be easily converted to raster;
- some processes cannot use raster formats;
- it is more difficult to print raster images using a limited amount of spot colours;
- vector images are very complex, and the implementation of these formats on different devices is, accordingly, problematic. Conversion from one format to another is also difficult.
- creating new vector entities or modifying / updating existing entities can be done easily.

1.1. Vectors

Vectors model are points, lines (arcs) and polygons (areas). Each of these units is composed simply as a series of one or more coordinate points. For example, a line is a collection of related points, and a polygon is a collection of related lines.

The most popular vector data file formats in GIS are:

Shapefile format is a popular geospatial vector data format for geographic information system ('**GIS**') software for storing the location, shape, and attributes of geographic features. It is developed and regulated by ESRI as a (mostly) open specification for data interoperability among ESRI and other GIS software products.

GeoJSON is a lightweight format based on Java Script Object Notation ('**JSON**'), used by many open source GIS packages. GeoJSON's feature includes points, line strings, polygons and multipart collection of these types. Therefore, it represents addresses, locations, streets, highways, counties, tracts of lands, and so on. GeoJSON features do not only represent physical world, but also mobile routing and navigation apps describe their service coverage using GeoJSON.

Keyhole Markup Language (KML) is a file format used to display geographic data in an Earth browser such as Google Earth. It is an XML–based language schema for expressing geographic annotation and visualization on existing or future Web-based, two-dimensional maps and three-dimensional Earth browsers.

Other important common formats for handling information that can be made into vector formats, if they include geographical coordinates are:

XML is a markup language created by the World Wide Web Consortium ('**W3C**') to define a syntax for encoding documents that both humans and machines can read. XML is playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere. Along with CSV, XML format is most used in interactions between NRAs and operators.

CSV is a comma-separated values file, which allows data to be saved in a tabular format. CSV files that contain addresses or latitudes/longitudes can be imported very easily as layers in many of the GIS currently used.

1.2. Raster

A Raster data model consists of rows and columns of equally sized pixels interconnected to form a planar surface. Raster are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps.

1.3. Tabular format data

Tabular format data is simply information presented in the form of a table with rows and columns.

To transform any type of files model into a data model which is needed for any GIS application, it is necessary to have a spatial ETL (extract, transform, load) tool. Spatial ETL tools are capable of a wide range of processes and dataflows, from simple format translations to complex transformations that restructure geometry and attributes.

An example of spatial ETL tools for GIS is Feature Manipulation Engine ('**FME**') which is an engine that supports an array of data types, formats, and applications: Excel, CSV, XML, and

databases, as well as various types of mapping formats including GIS, CAD, BIM, and many more.[70]

2. Projection coordinate system

A projected coordinate system provides mechanisms to project maps of the earth's spherical surface onto a two-dimensional Cartesian coordinate (x, y coordinates) plane. Projected coordinate systems are referred to as map projections. This approach is useful where accurate distance, angle, and area measurements are needed. The term 'projection' is often used interchangeably with projected coordinate systems.[71]

Commonly used projected coordinate systems include:

Universal Transverse Mercator

A widely used two-dimensional Cartesian coordinate system is the Universal Transverse Mercator ('**UTM**') system which represents a horizontal position on the globe and can be used to identify positions without having to know their vertical location on the 'y' axis. The UTM system is not a single map projection. It represents the earth as sixty different zones, each composed of six-degree longitudinal bands, with a secant transverse Mercator projection in each.

Lambert azimuthal equal-area projection

Lambert azimuthal equal-area projection is a particular projection from a sphere to a disk (that is, a region bounded by a circle). It accurately represents area in all regions of the sphere, but it does not accurately represent angles. Further references on projected systems are provided below.[72]

The European Terrestrial Reference System 1989 ('**ETRS89**') is the standard coordinate system for Europe. It is the reference system of choice for all international geographic and geodynamic projects in Europe. The ETRS89 was established in 1989 and is maintained by the sub-commission EUREF ('**European Reference Frame**') of the International Association

[70] For more information see. https://s3.amazonaws.com/gitbook/Desktop-Basic-2019/Desktop-Basic-2019.pdf

[71] For more information see: http://resources.esri.com/help/9.3/arcgisengine/dotnet/89b720a5-7339-44b0-8b58-0f5bf2843393.htm

[72] For more information see: https://ec.europa.eu/eurostat/documents/4311134/4366152/Map-projections-EUROPE.pdf/460d90e4-b7f2-49b7-8962-5c860c76757d (pp. 110-130)

of Geodesy ('**IAG**'). ETRS89 is supported by EuroGeographics and endorsed by the European Union ('**EU**').

A coordinate system is a reference system used to represent the locations of geographic features and observations such as GPS locations within a common geographic framework. Coordinate systems enable the integration of datasets within maps, as well as the performance of various integrated analytical operations, such as overlaying data layers from disparate sources and coordinate systems.

The data are defined in both horizontal and vertical coordinate systems. Horizontal coordinate systems locate data across the surface of the earth, and vertical coordinate systems locate the relative height or depth of data. Horizontal coordinate systems can be of three types: geographic, projected, and local.

Geographic coordinate systems ('**GCS**') most commonly have units in decimal degrees measuring degrees of longitude (x-coordinates) and degrees of latitude (y-coordinates). The location of data is expressed as positive or negative numbers: positive x- and y-values for north of the equator and east of the prime meridian, and negative values for south of the equator and west of the prime meridian.[73]

The most recent geographic coordinate system is the World Geodetic system 84, also known as WGS 1984 or EPSG:4326 (EPSG- European Petroleum Survey Group). It consists of a standard coordinate system, spheroidal reference (the datum or reference ellipsoid) and raw altitude.[74]

Numerous free software applications are available which can transform any coordinate system into WGS84 system. Accordingly, if one Member State makes use of a different type of coordinate system, this is unlikely to be inherently problematic.

[73] For more information see: https://pro.arcgis.com/en/pro-app/help/mapping/properties/coordinate-systems-and-projections.htm

[74] For more information see: https://zia207.github.io/geospatial-data-science.github.io/map-projection-coordinate-reference-systems.html

Annex 5 – Stages for GIS

The text below sets out a description of the stages that may be followed in order to establish a GIS that is useful in the context of Article 22:

a) Choose an appropriate GIS system and means to store the data, where it is best to store it into a database

b) Examine what kind of spatial information (data) are available in the MS, cadastral and land registration authority or other national authorities and decide what is needed for broadband mapping purposes

c) Choose a geographic coordinate system

d) Collect selected vector spatial data (city, county, streets, addresses, building, cadastre etc.) and import into database

e) Choose a free or purchased basemaps for use the GIS application

f) Standardize the format to be able to process operator data – and make it easy to share. Specify the protocol for receiving the data (calendar, sharing tools)

g) Receive data files with information from operators in the set format (for example in xml-GML, shp or CSV+WKT formats). For these data exchanges, it may be necessary to establish a secure communication channel

h) Transform these files into GIS application format, if necessary

i) Validate these data files with rules previously established with operators

j) If the data are problematic, return them to the operators for correction. Establish with operators a new period to receive corrected data

k) Validate received files again with rules previously established – until results are acceptable

l) After validation, these data files should be imported into the GIS database. The database has the format previously set

m) Open spatial data (vector and raster) in the GIS application and preview data from operators in the GIS

n) Use free or purchased modules or tools to analyse the data

o) Choose map scales for fixed and mobile data presentation (for example 1:1000, 1:2000 for urban areas and 1:5000 for rural area) using paper printing

p) Presentation of gathered data and results by open network protocols such as WMS or WFS enabling download using open format

Body of European Regulators for Electronic Communications
BEREC

BoR (21) 32

BEREC Guidelines on Geographical surveys of network deployments Article 22 (2), 22 (3) and 22 (4)

11 March 2021

Table of Contents

1 Introduction

1. According to Article 22(7) of the European Electronic Communications Code ('**EECC**'), by 21 June 2020, BEREC shall, after consulting stakeholders and in close cooperation with the EC and relevant national authorities, issue guidelines to assist National Regulatory Authorities (NRAs) and/or Other Competent Authorities (OCAs) on the consistent implementation of Article 22 **EECC.**

2. In March 2020 BEREC issued the core Guidelines (BEREC Guidelines on Geographical surveys of network deployments[1]) which dealt with the consistent application of the obligation for NRAs/OCAs to provide for geographical surveys of the reach of electronic communications networks[2] capable of delivering broadband, and the forecasts of the reach of broadband networks, including very high capacity networks ('**VHCN**'), that the authorities may undertake.

3. BoR (20) 42 (hereafter "Core Guidelines") establishes the definitions for all the indicators that NRA/OCAs must provide for and as well the minimal granularity for the information. They also explain which operators are subject to provide information, deliver important classifications, namely on the kinds of technologies, speed tiers to consider and types of VHCN networks. The guidelines also recommend the frequency of data provision and stress the importance to NRAs/OCAs of using geographic information systems. Moreover, the Guidelines deliver on aggregation methods and on considerations to make in order to provide public information and safeguard business secrets.

4. In the current Guidelines, BEREC deals 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.

5. These Guidelines aim at providing 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).

6. In order to deliver these Guidelines, BEREC issued a questionnaire directed to NRAs/OCAs in order to obtain information about their current practices and views

[1] BoR (20) 42.
[2] ECN, as defined in Article 2.1 of the EECC.

regarding Art 22 (2-4) of the EECC and also questioning about NRA/OCA experience in defining areas in other contexts, such as within a state aid or a market analysis procedure. BEREC obtained information from 22 Member States (hereafter, MS), and found out that no authority was "designating areas" or engaging on the procedures to invite agents to declare their intentions to deploy VHCN networks as required by Article 22. A few authorities were planning for this, and many had relevant experience in the context of state aid proceedings, where different kinds of areas are defined (white, grey, white-NGA, grey-NGA) and public consultations are carried out to find out about private agent's plans to deploy broadband networks.

7. Moreover, in July 2020 BEREC organized a workshop were NRAs, OCAs and the EC were invited to discuss the key elements in the Guidelines.

1.1 Legal background

8. BEREC has the exclusive EECC mandate to deliver on Article 22 Guidelines and the BEREC Guidelines (BoR (20) 42, BoR (21) 32 and the BEREC Guidelines on the verification of information[3]) constitute the unique basis for the consistent implementation of broadband mapping activities within the purposes of Article 22 EECC and other related Article 22 activities.

9. The ability to designate areas and to invite undertakings and public authorities[4] to declare their intention to deploy very high capacity networks (VHCN) and/or to enhance the network capacities to at least 100 Mbps download speed are optional activities. They give NRAs and OCAs a new tool to provide information to potential investors and thus create a more transparent environment for investment in VHCNs. The procedures described in the following guidelines shall help to fulfil the goals of the Article 22, parts 2, 3 and 4, i.e. to give undertakings and public authorities sufficient time to thoroughly consider investments in VHCN in light of the likely competition they will face from other networks (cf. Recital 63 of the EECC).

10. In addition to the increased transparency for potential investments, the invitation process can also provide new information for NRAs and OCAs that could be relevant in different contexts. According to Article 22 paragraph 5 EECC, the results of the geographical survey and any designated areas pursuant to Article 22 paragraphs 1, 2 and 3 EECC shall be taken into account by NRAs and OCAs, and local, regional and national authorities with responsibility for the allocation of public funds, for the deployment of electronic

[3] BoR (20) 230, the BEREC Guidelines on the verification of information were on public consultation until the 27th of January 2021. The final approval is expected by June 2021.
[4] Within these Guidelines the term "public authorities" refers to both public authorities and public bodies.

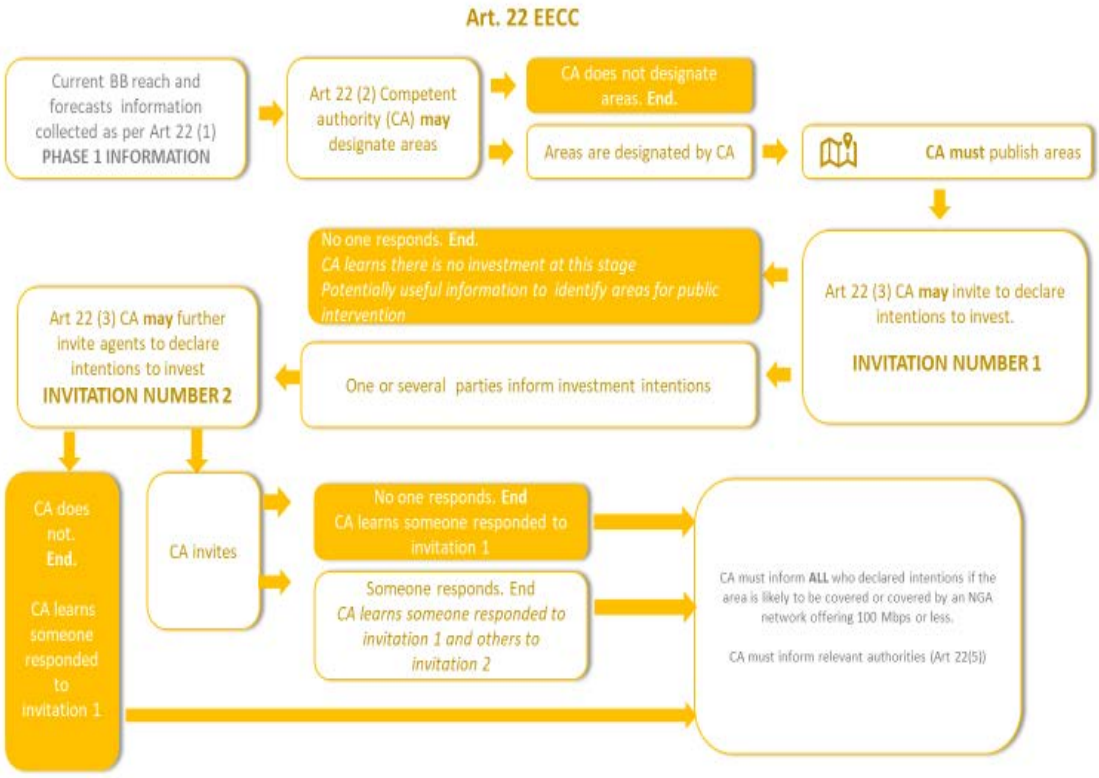
communications networks, for the design of national broadband plans, for defining coverage obligations attached to rights of use for radio spectrum and for verifying availability of services falling within the universal service obligations in their territory.

11. The procedures according to Article 22 paragraphs 2 - 4 EECC must not be confused with state aid procedures, as Article 22 and state aid proceedings are instruments with different objectives However, the information gained as a result of the invitation procedure according to Article 22 paragraph 3 EECC could be useful within a state aid context, especially if no interest in investments is expressed (see Figure 1).

12. While the provisions of the EECC would anticipate and foster also state aid compliance, it is not their main objective to ensure compliance with state aid rules. NRAs/OCAs can use information collected under Article 22 to assist the state aid process but may also need to collect complementary information in line with the State Aid guidelines rules.

13. The procedure to designate areas and to invite declarations of intent to invest are broken down into a step-by-step flux diagram below (figure 1). The diagram contains the process of designating and publishing areas, the possible one or two rounds of invitations to declare interest to invest in VHCNs and concludes with the final information on the outcome of the process.

Figure 1



Source: BEREC

14. The transparency which the measures of Article 22 paragraph 2 – 4 EECC aim for can only be achieved if market participants respond truthfully and in good faith. While market participants can change their deployment plans for unforeseen, objective and justifiable reasons, competent authorities should intervene, including if public funding is affected (cf. Recital 63 and 64 of the EECC) and where appropriate according to Article 29 (2) EECC, impose penalties if, in the context of the procedures referred to in Art. 22 (3), an undertaking or public authority knowingly or grossly negligently provides misleading, erroneous or incomplete information.

2 Designation of areas

15. 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).

16. The designation and publication of these areas are an important optional tool by which competent authorities can inform public and private agents of the non-availability of these networks in different areas of the national territory.

17. The detailed disclosure of designated areas may enable potential public and private investors to better plan where and how to deploy broadband networks, in particular VHCNs&100Mbps networks. This information could promote new deployment plans or allow for an informed reconsideration of existing ones.

18. The disclosure of information will enable for all kinds of agents, regardless of their size or their knowledge of the market to have common basic information that may enable investment. This release of information can be quite relevant for agents with lesser knowledge of market conditions.

19. The publication of designated areas has an important role, especially if the relevant authority does not provide information on VHCNs&100Mbps coverage by other means, for example by releasing public maps of good granularity of VHCNs&100Mbps coverage.

20. The Core Guidelines provide the information gathering of conducting geographical surveys of broadband reach in detail and therefore, by 2023, NRAs/OCAs should have substantive information in order to allow for the designation of areas.

21. The delineation of designated areas is also instrumental to competent authorities that wish to invite agents to declare their intentions to deploy VHCN networks as described in Article 22 (3) EECC.

2.1 Information required to designate areas

22. This section details the main information to consider when designating areas. The definition of their territorial boundaries is dealt with in section 2.2.

23. The Core Guidelines describe the information gathering of conducting geographical surveys in more detail. Considering the data collected in the geographical survey, the following information should be used to designate an area:

    - Availability to fixed broadband service that delivers at least 100 Mbps download speed;
    - Availability to mobile broadband that delivers at least 100 Mbps download speed;
    - Availability to a VHCN fixed broadband service;
    - Availability to a VHCN mobile broadband service.

24. The speed tiers informed in table 7 of the Core Guidelines allow the identification of broadband connections of at least 100 Mbps. In the Core Guidelines, BEREC required that for fixed broadband services NRAs/OCAs provide speed information in the MS territory for two different speed definitions: maximum achievable speed and expected peak time speed either at address level or for small grids[5]. For mobile broadband, BEREC recommended as optional the use of maximum achievable speed to qualify the service small grids for the whole of the MS territory.

25. While designating areas, the competent authority (hereafter, the authority in charge of designating areas and issuing invitations to declare investment intentions) can consider to use maximum or expected peak-time speed depending on the availability of information and in consideration of national specificities (for example, the existing coverage of VHCNs in their territory)[6]. However, it is required that when publishing designated areas, the type of speed definition is published so that agents can understand the characteristics of the designated area.

[5] Hereafter, small grids are used to define grids of 100 x 100 meters or smaller grids.

[6] For example, it should be noted that according to the EC's Digital Economy and Society Index (DESI) 2020, Connectivity report, in July 2019 there were substantial differences in the coverage of fixed VHCN networks in European countries. Malta was leading with 100% coverage, followed by Denmark and Luxembourg with above 90% coverage. Germany stood at 33%, and Italy at 30%, whilst Austria, Ireland and Czechia were below 30%. The lowest figures were for Greece (7%) and Cyprus (10%), In this report, fixed VHCN coverage was approximated as the combined footprint of Fiber to the Premises and DOCSIS 3.1 (Data Over Cable Service Interface Specification 3.1) cable networks.

26. Article 2(2) of the EECC defines the term 'very high capacity network'and the BEREC Guidelines on Very High Capacity Networks[7] (hereafter "VHCN Guidelines") define the characteristics that electronic communication networks have to satisfy in order to qualify as VHCNs. Based on the specification in the VHCN Guidelines, Table 1 (fixed broadband) and Table 2 (mobile broadband) in the Core Guidelines specify different VHCNs classes which need to be identified at address or small grid level, respectively for fixed broadband and mobile broadband.

27. The data used by competent authority to define designated areas should be in line with the definitions and granularity levels[8] included in the Core Guidelines. The information should also be up to date[9]. Note that this applies to the information needed to designate areas, not to the designation of areas themselves (i.e. their geographical definition or publication).

28. In addition to current broadband reach and quality of service information, competent authorities may use forecast information to define designated areas. Article 22(1) paragraph 4 defines the forecast information as follows: "…*forecast shall include all relevant information, including information on planned deployments by any undertaking or public authority, of very high capacity networks and significant upgrades or extensions of networks to at least 100 Mbps download speeds. For this purpose, national regulatory and/or other competent authorities shall request undertakings and public authorities to provide such information to the extent that it is available and can be provided with reasonable effort*."

29. Whilst forecast information gathered as per Art 22(1) is not mandatory, reliable information about forecasts allows a more accurate and prospective definition of designated areas and can serve a better planning of agents' deployments.

30. The Core Guidelines detail the information to be included in forecasts, and if available and assessed as reliable by the competent authority[10], this information must be used to designate areas.

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[7] BoR (20) 165.

[8] According to the Core Guidelines: **For fixed networks,** the level of resolution should be **the address**. **For mobile networks**, the level of resolution should be **a 100m x 100m or smaller grid** (or equivalent polygon). For **fixed wireless access (FWA)**, data should be collected at least at an address level or at a level of a 100m x 100m or smaller grid (or polygons of an equivalent resolution), as one wireless access point deals with a group of addresses in a certain area.

[9] According to the Core Guidelines the databases should be updated at least annually.

[10] Section 2.6.2 in BoR (20) 42 deals with the verification of the main survey forecast data. Paragraph 104 states that "*NRAs/OCAs should aim to verify the information on forecasts of broadband reach, as far as this is reasonable and legally available".*

31. In addition, the competent authority should use information from state aid registry of funded very high capacity network investments when it is considered appropriate.

32. The information gathered via forecasts includes uncertainties. According to EECC Article 22(1) subparagraph 5: *"The national regulatory authority shall decide, with respect to tasks specifically attributed to it under this Directive, the extent to which it is appropriate to rely on all or part of the information gathered in the context of such forecast."*

33. The reliability of forecast information is important in many respects. For designated areas, this could mean that the roll-out plans which were planned will not be carried out and the areas are left without VHCNs or networks offering at least 100 Mbps speed deployments. If private investors do not declare their future roll-out plans, they run the risk of further network overlaps. Therefore, the competent authority should make reasonable efforts to verify forecasts of broadband reach.

34. The Core Guidelines recognize that operators' roll-out plans may change over time, due to unforeseen events, or as a result of changes in the strategies of investors. Because of this, longer term forecasts are more uncertain in nature than forecasts over a shorter period of time. NRAs and OCAs who carry out surveys of forecasts of broadband reach would benefit from establishing verification mechanisms so that the forecast information is as reliable as possible.

35. Two types of verification can be thought of: *ex ante* verification (that is, at the time the information is requested) and *ex post* verification. Section 2.6.2 in the Core Guidelines gives guidance to the verification of forecasts.

36. Additionally, the Core Guidelines (paragraphs 27 and 101) recommend that the frequency of collection of current broadband reach data and forecast or planned deployment data of areas of interest to be annual. Annual collection of data (for relevant areas) is suggested because it allows some monitoring of the forecast data.

2.2 Definition of area boundaries and sizes

37. Following article 22(1) EECC, the competent authority should be in possession of a certain local detail on quality of service parameters through the survey of networks and any relevant forecasts by network providers.

38. According to article 22(2) EECC, the competent authority may designate an area thereafter with clear territorial boundaries, which will be highlighting places where there is no immediate known prospect of service by VHCNs or networks offering more than 100 Mbps download speed. Yet, the size and characteristics of the defined area are not specified in the article.

39. Depending on the local specificities, the appropriate size, boundaries and defining elements of the area, but also the accompanying information, may vary.

40. Actually, answers to the questionnaire issued by BEREC reveal that generally the purpose of the relevant policies is strongly influencing the practical definition of the areas: for a call for interest in future deployments, competent authorities might only need to display addresses with no relevant service, but when more complex territorial planning and development is involved the definition of relevant areas is likely to consider multiple parameters.

41. The two following sections respectively present BEREC's recommendations on the definition of the borders of a designated area, and display further criteria that may be considered in order to define these areas in accordance with the objectives with the process.

2.2.1 Delimitation of designated areas

42. Designated areas should meet the definition of Article 22(2) EECC. This means that they should:

    i. include addresses/grids which are not covered, (and in case this information is known and reliable, also not planned to be covered) by a VHCN or by a network offering more than 100 Mbps download speed;
    ii. have clear territorial boundaries.

43. Article 22(2) also establishes that the designated areas' list shall be published. Recommendations related to publishing modalities are specified in section 2.4 of the present guidelines.

44. In order to comply with Article 22(2) EECC and achieve transparency when publishing the designated areas, BEREC recommends that the competent authority designates areas based on geographic units with clear and stable geographical boundaries.

45. The competent authority may choose their way of defining a type of territorial boundaries depending on their interests, local specificities and on the purpose of the designation of areas' process. Clear boundaries can be defined based on geographic units inducing no ambiguity, and can, for example, refer to administrative units, postal code sectors or statistical units.

46. The present guidelines thus recommend that the competent authority make sure that the size or geographic level of designated areas is appropriate, i.e.:

    i. small enough to avoid significant differences in the level of broadband services provided within the considered areas;

ii. large enough to avoid changes of area boundaries in time and to prevent providing the market with very fragmented information.
iii. moreover, if the competent authority wants to consider sociodemographic information or information related to the availability of physical infrastructures when designating areas, this would imply that areas cannot be too small, since these kinds of information are not available at a very granular level.

2.2.2 Further criteria for the definition of a designated area

47. The competent authority might be interested in grouping addresses/grids, according to the expected profitability of the network. Note though that the main objective of the designation of areas is to provide information to potential investors, so that this promotes investment in VHCNs. In this sense, the competent authority may wish to consider grouping "contiguous or related" addresses/grids with similar expected profitability levels in the same designated areas.

48. In designating areas, the competent authority may consider that zones with a larger expected profitability may compensate for zones with a lower profitability, so that overall the whole of a designated area is attractive to investors.

49. Hence, in addition to performance of existing and planned networks, competent authorities may take into account, if available, further criteria to delineate designated areas. These criteria may include structural socio-economic and demographic characteristics, such as population density, as well as urban or morphological characteristics, such as the typology of buildings (single dwelling or multi-dwelling buildings) and thus of neighborhoods, or whether an area is a residential or business one. They can also include economic and investment conditions, such as number of operators with networks in the area, passive infrastructures' availability or existing wholesale offers.

50. These parameters can be useful to competent authorities, for example to adjust zones' contours to have contiguous areas of buildings, which operationally can be more relevant for network roll-outs.

51. Competent authorities should be, in their chosen approach of the designation of areas, aware of the considerations of the deployments' process. In particular, it is recommended to consider the potential coverage of the existing or planned VHCNs&100Mbps, and/or to consider the potential coverage of their underlying infrastructure.

52. In order to realize this assessment and the designation of each area, and given the high number of resulting areas' units to be analyzed in order to obtain designated areas, competent authorities can rely on indicators based on the further criteria suggested at the beginning of this section.

53. A competent authority may know that within an area there is a small number of addresses/grids that are already covered or with plans to be covered by VHCNs or

networks offering more than 100 Mbps download speed (for example, specific business sites). Depending on the geographical distribution of the covered addresses/grids within the area and if the coverage proportion of the area is sufficiently small, the competent authority should assess whether it is proportionate to include those addresses/grids in the designated areas or not. In the case in which those addresses/grids are included, the competent authority should provide information on the covered addresses or grids within the designated areas. BEREC recommendations on the publication of designated areas, which is mandatory, are detailed in section 2.4.

2.3 Frequency of area designation

54. The periodicity of designating areas depends on the competent authority's needs and circumstances. Competent authorities may decide on whether and how often they want to define designated areas.

55. If a MS is planning some policy measure to boost VHCNs&100Mbps deployments the area designation can be carried out on an ad hoc basis.

56. In case a MS has an active policy measure already in force, the area designation may be done more frequently, for example, annually, to check the progress of the measures and to ensure they target the right areas.

57. By designating areas, the competent authority strives to provide incentives for investments in and increase transparency of VHCNs&100Mbps deployments. If areas' designation is implemented too infrequently, it might give misleading information to investors and even turn against its goals. Therefore, the frequency of designating areas should be considered by the competent authority carefully.

58. The geographical survey of broadband reach is recommended to be carried out at least once a year according to the Core Guidelines. Hence, the regularly conducted for geographical surveys allow for the designation of areas to be carried out with up to date information.

2.4 Publication of designated areas

59. The publication of designated areas is obligatory if they have been defined by the competent authority. One of the key objectives of publishing designated areas is to create transparency for investors with respect to VHCNs&100Mbps deployments. Transparency is an important means to motivate improvement of the quality of internet access products and to decrease investment risks. In addition, it supports better-informed decision-making by network investors.

60. In order to achieve such transparency, when designated areas include some addresses or grids that are already covered or with plans to be covered by VHCNs or networks offering more than 100 Mbps download speed, the competent authority should provide sufficient information to allow agents to find out the localization of these covered addresses or grids within the designated area (see paragraph 53).

61. As mentioned in paragraph 19, the publication of designated areas is not the only means by which NRAs/OCAs can provide information to the market. In addition to designated areas, NRAs/OCAs may find it useful to provide other information to market players, for example information on areas covered by the different VHCN classes for fixed and mobile broadband[11].

62. The published information related to designated areas must enable interested parties to detect their exact boundaries. Competent authorities have several options for publication, for example:

    - 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;
    - If boundaries are administrative ones, and can be easily understood by all agents, by publishing reports.

63. The competent authority may consider the best system and format of publication by taking into consideration the type of boundaries of designated areas, the efforts of releasing this information and considering data openness, ease of access and the cost-effectiveness of the public exercise.

64. In order to be easily available to all relevant undertakings and public organisations, the information describing the designated areas must be made accessible on the competent authority's website or its related web portals.

65. In addition to the relevant competent authority website, competent authorities can decide to make information available also via local municipalities' or regional councils' websites, official journals, or any relevant ministry's website, etc.

66. The competent authority might also inform undertakings and public bodies of the publication of designated areas by press release or newsletter.

67. BEREC recommends to provide relevant metadata, regarding the characteristics of the basic information used in defining the designated areas. This would include: the date of the base information, whether forecasts have been used or not to designate areas, and

[11] See paragraphs 49 and 79 in the Core Guidelines for a classification and a description of these VHCN classes.

the kind of speed information considered (maximum achievable or expected peak time). Also, the validity period of designated areas, i.e. for how long the definition of designated area is valid, should be mentioned.

68. Moreover, competent authorities may optionally find it useful to provide other information on top of the area designation when they publish the designated areas so that potential investors can better assess the suitability of their investments. In this case, competent authorities can provide information on the area characteristics that might be relevant for investors to estimate the expected profitability of the deployment, for example, area classification (urban/sub-urban/rural), population density information, the existence of new residential or industrial developments in the area, the existence of protected sites within an area, for example because of heritage or environmental reasons, which have more restrictions with regards to the network deployment.

69. The Core Guidelines recommended that, if possible, NRAs/OCAs identified the locations of hospitals, schools, major transport hubs, public administration premises and highly digitalized businesses when publishing designated areas. This information may also be very useful for investors planning VHCNs&100Mbps deployments.

70. BEREC strongly recommends that, when publishing designated areas, competent authorities also provide information regarding the possibility that the designated area is covered or likely to be covered by a next-generation access network offering download speeds below 100 Mbps on the basis of the information of the broadband survey of current broadband reach as per Article 22(1) and any forecast information that the competent authority may hold. Note that Article 22 (5) requires that NGA network information be disclosed to any agents responding to invitations to declare intentions to invest as per Art 22 (3)[12]. An earlier and public disclosure of the availability of NGA networks will allow all potential investors to equally consider this availability in making investment decisions. Moreover, those responding to any invitations to declare intentions to invest will have been able to factor this information into their decision making, which will prevent a situation where, after responding to invitations, these agents find out the respective information and may reconsider their plans.

71. Finally, when publishing the designated areas, NRAs/OCAs have a duty not to disclose business secrets[13]. Therefore, the competent authority needs to assess whether the publication of designated areas reveals any commercially sensitive information or provides

[12] Recital 65 EECC points out the need for information sharing: *"In the interests of predictable investment conditions, competent authorities should be able to share information with undertakings and public authorities expressing interest in deploying very high capacity networks on whether other types of network upgrades, including those below 100 Mbps download speed, are present or foreseen in the area in question.*"

[13] For further reference, please check Section 2.7.2 in the Core Guidelines, which deals with confidentiality and business secrets.

information on an operators' strategy by eliciting that certain addresses/grids are covered or known as likely to be covered. The competent authority can avoid this revelation by carefully drafting the designated areas borders or by exceptionally including the covered address/grid in the designated area[14]. In this case, a possibility is to inform about the percentage of addresses covered with VHCNs&100Mbps without revealing the precise location of addresses in the designated area.

3 Invitations to declare investment intentions

72. Article 22(3) describes optional and staged processes by which the competent authority may invite undertakings and public authorities to declare their intention to deploy VHCNs in a designated area. First, within a designated area, the competent authorities may invite agents to declare their intention to deploy VHCNs over the duration of the relevant forecast period. Second, where this invitation results in a declaration of an agent to have intentions to invest, the relevant authority may invite other undertakings and public authorities to declare any intention to deploy VHCNs, or significantly upgrade or extend their network to a performance of at least 100 Mbps download speeds in the designated area.

73. Issuing invitations to declare investment intentions within an area, may further incentivize investment possibility, but at the same time will help the competent authority to improve its information about VHCNs forecasts, which in turn may enable identification of potential areas for state aid intervention.

74. BEREC recommends that if a public authority responds to a first invitation, the competent authority issues a second invitation to have a better safeguard that such public intervention does not overrun any planned private VHCN developments (or developments of networks capable of supporting 100 Mbps download speed or more).

75. The invitations must be released for public authorities and private entities. If an authority engages in the invitations' activity, it must ensure that procedures are efficient, objective, transparent and non-discriminatory, whereby no undertaking is excluded a priori.

76. The procedures to invite agents to declare intentions to deploy VHCN&100Mbps should follow existing national administrative law.

77. Finally, BEREC considers that in issuing the second invitation, the competent authority shall require information on intentions to invest in VHCN or in networks that are capable

[14] Note that the Core Guidelines established that "*For a grid to be declared as served by a VHCN of a given class, the conditions associated with this class must be satisfied in at least 95% of the addresses in the grid*".

of offering 100 Mbps download speed, where the speed is defined as the competent authority considers: maximum achievable speed or expected peak time speed. In any case when issuing the invitation, the competent authority should clearly inform the public of the speed definition.

3.1 Procedures for the first invitation

78. According to Article 22 (3) EECC, competent authorities may, after the designation of areas, invite undertakings and/or public authorities to declare their intention to deploy VHCN. The following subsections deal with the separate steps in the invitation process and their contents in more detail. In addition, BEREC would like to give guidance with regard to the addressees of the first invitation process.

3.1.1 Subjects of the invitation and procedures to publish the invitations

79. In general, article 22 (3) EECC states that the competent authority may invite undertakings and public authorities to declare their intentions to deploy VHCNs&100Mbps. The EECC does not define “undertakings” but “operators”. According to Art. 2 (29) EECC, “operator” means an undertaking providing or authorized to provide a public electronic communications network or an associated facility. Due to the omission of the reference to electronic communications network, BEREC is of the view that “undertakings” in Article 22 EECC addresses a broad range of entities. This means that all undertakings which are directly or indirectly involved in the expansion of broadband networks, including operators, should be seen as addressees for an invitation to declare their intention to deploy VHCNs&100Mbps. In particular, operators, civil engineering companies and utility network operators should have access to the procedures according to Article 22 (3) EECC.

80. The same applies to public authorities: all should be considered for the invitation. The targeted group for an invitation to declare an intention can be seen as wide and should not only include public authorities responsible directly for promoting broadband, but also all other public authorities, for example municipalities and public broadband offices.

81. Approaching (some) undertakings and public authorities directly does not meet the requirements of objective, transparent and non-discriminatory procedures of Article 22 (4) EECC. It could be thought that, with a view to increased commitment and therefore potentially faster deployments of VHCNs, a direct approach to the group of addressees would be suitable. Nevertheless, this would increase the necessary effort to carry out procedures according to Article 22 (3) EECC, as all relevant undertakings and public authorities to potentially invest in the designated area must be identified and contacted directly by the competent body. The likelihood of overlooking investors increases all the more. Therefore, the invitations need to take the form of a public consultation.

82. To address the broad target group mentioned before, BEREC is of the view that any invitation to declare the intention to invest in VHCN networks should be made accessible on the competent authority's website or its related web portals. Moreover, BEREC also recommends that the area boundaries are published by the means described in paragraph 62. If possible, it is useful to include the designated areas in the GIS containing the data collected according to Article 22 (1) EECC. Designated areas can be illustrated in the maps of the GIS and e.g. after clicking on a designated area the relevant meta data about the invitation procedure can be seen by the user.

83. Lastly, it should be clear when and over which period the invitation to declare an intention to invest in VHCNs should be published. The first and most important requirement to invite is to designate areas. After having designated areas, the competent authority may start the invitation procedure. There should be a minimal two-week period between the publication of designated areas and the first invitation public consultation so that investors can evaluate the information and draw investment plans.

84. After having started the procedure in accordance to recital 63 EECC, the parties who may declare their intention should have sufficient time to provide a thoroughly considered response. BEREC is of the view that a period of at least 60 days should be considered for potential investors to declare their intention.

3.1.2 Information to require in the first invitation

85. According to Article 22(3) EECC, the competent authority shall specify, when inviting to declare intentions to invest in designated areas, the information to be included in the responding submissions, in order to ensure at least a similar level of details as that taken into consideration in any forecast pursuant to paragraph 1 of Article 22 EECC. Since competent authorities will have a responsibility with respect to the information they provide in the invitations' procedure, and in order to ensure the accuracy and precision of the information, competent authorities should include in their requirement elements enabling them to verify the credibility of the statements made by the respondents.

86. Article 29 (2) of the EECC establishes penalties in case an undertaking or public authority knowingly or grossly negligently provides misleading, erroneous or incomplete information during these invitation procedures.

Forecast period

87. The required information should give a description of the investment intention and the planned deployments within one or a group of designated areas. Hence, this information should cover a forecast period defined by the competent authority launching the call for declaring investment intentions.

88. The forecast period depends mainly on the competent authority's objectives from the invitations' procedure and on the frequency of issuing the invitations. Thus, the definition of the appropriate forecast period is to be determined by the competent authorities and should be compliant with the pursued objective.

89. Although, in order to ensure a good quality level of transmitted information and deployments' planning, it is recommended to define a forecast period covering the submitted information for which the duration is comparable to the duration of any forecast period defined pursuant to Article 22(1) EECC.

Required information

90. In order to address the objectives cited in the introduction of this subsection, and in order to obtain sufficient knowledge on the planned deployments, it is recommended to require at least the following elements:

- respondent identity and contact;
- the exhaustive list of targeted designated areas where the investor plans to deploy;
- a project plan, as detailed as possible, on both geographical and technical levels (i.e. planned coverage by the responding undertaking of addresses/small grids and network topology);
- a timeline of networks' construction, including specific milestones of deployment, covering at least the fixed forecast period;
- technological suitability, with respect to VHCN service level;
- an indication of whether funds have already been committed to undertake the investment.

91. Primarily, the information on planned deployment should be provided at the address level or small grid level (grids of at most 100 m x 100 m or equivalent polygons). If the agent is not able to specify its plans at this level, it can be allowed to declare it on a lower level of granularity (e.g. street, part of the municipality, etc.). Such approach should be allowed also if the primary mapping is done on the lower level of granularity than the address points. Eventually, agents should specify in their answers to the invitation the number of addresses they consider they are able to cover.

92. Additionally, in order to ensure the credibility of the declared intention of the submitted deployment plan, and for any other objective considered as appropriate by the competent authorities, further information can be required, if available and when it can be provided with reasonable effort, such as:

- financial feasibility of the project (projected budget, financial liabilities, bank guarantees);
- commitment to accomplish the investment and to follow a timetable of deployment;
- marketing information on offers to retail customers;
- conditions available for competitive supply of electronic communications services (specifications of wholesale services, including technical information such as

supported access interfaces, or legal and financial conditions of the offers, e.g. non-discrimination agreements);
- description of backhaul network technology and specification of backhaul equipment, design of backhaul network and traffic assumptions.

3.1.3 Information to disclose after the first invitation when the competent authority is issuing a second invitation

93. This section deals with the information to disclose to the public after the first invitation, and only concerns the case in which the competent authority is planning to issue a second invitation[15]. Note that if a second invitation regarding a particular designated area is issued by the competent authority, this will be easily traceable by all public and private agents. Thus, the issuing of a second invitation is already informing any potential second-invitation respondents that at least one agent has intention to deploy a VHCN network in the designated area.

94. However, the competent authority may consider publishing additional information. This may be important when the information is relevant in allowing agents to better consider their investment intentions and to respond to the second invitation. Yet, at the same time, the competent authority must carefully consider their duty to safeguard business secrets of parties responding to the first (and second) invitation and because of this, such information can only be published in an aggregated or anonymous form.

95. In case that the competent authority considers making additional information available after the first invitation responses, some examples that BEREC would recommend are: number of parties who declared intentions to invest in the first invitation, status of the investments (announced, planned, financed, in progress), percentage of area (or addresses) to be covered within the designated area, or alternatively, qualitative information of the area coverage (for example: low coverage- less than a predetermined threshold coverage, medium- for coverages in between pre-determined thresholds, high- larger than a threshold coverage), announced presence of a wholesale operator, announced presence of a public undertaking, type of network (technology or medium used).

96. It should be noted that in order for procedures to be transparent and non-discriminatory, if any information is released or made available after the first invitation, the same level of public disclosure or availability should be ensured if there is an expression of interest to invest as a result of the second invitation.

[15] The information to be released after any invitation is accepted, either following the first invitation or the second invitation, is described in section 3.3.

97. Moreover, note that any information releases need to be public, or if the information is provided under request, no agent can be excluded from making such requests and the processes to require the information should also be public. This will ensure equal treatment of all potential investors. Therefore, in order to be easily available to all relevant undertakings and public organisations, the information (or the process to require information) must be made accessible on the competent authority's website or related portals.

98. In addition, the competent authority can decide to make information available also via local municipalities' or regional councils' websites, official journals, or any relevant ministry's website, etc., and to inform undertakings and public bodies of the publication of designated areas by press release, newsletter or targeted messages.

3.2 Procedures for the second invitation

3.2.1 Subjects of the invitation and procedures to publish the invitations

99. Depending on the outcome of the first invitation procedure, the competent authority may start an optional second invitation process. As already described above in sub-section 3.1.1, this second invitation should also aim at a broad target group.

100. BEREC, with view to fast broadband deployments, planning security and reliability of the declaration of intent to invest in VHCN&100 Mbps, is of the opinion that the relevant authority should start the second invitation round immediately after the end of the first round. The period of this second invitation procedure should also be at least 60 days.

101. From BEREC's point of view, in cases where after the first invitation round no party has declared its intention to deploy VHCNs in the designated area, the procedure according to Article 22 (3) EECC ends. The competent authority should then assess whether a new procedure according to Article 22 (3) EECC would make sense to provide the designated area with broadband. In view of efficiency, a new procedure should not start before six months after the termination of the previous procedure to declare an intention to deploy VHCN in the relevant area.

3.2.2 Information to require in the second invitation

102. In order to treat equally all agents, it is necessary that the same information is required in the first invitation and in the second invitation.

103. For general reference on this topic, see paragraphs 85 and 86 in section 3.1.2.

104. Paragraphs 90, 91 and 92 in section 3.1.2, describe the information to require in the second invitation.

3.3 Information to be disclosed ex post, after the invitation process (regardless of whether it includes only one invitation or two)

105. This section describes the information to be released after the invitations' processes. This release takes place either after the second invitation when there is one, or after the first invitation when there is no second one.

106. First, as required by Art 22(3) EECC, some information should be provided to the agents that participated in the process (which expressed their interest to invest). Such parties should be informed whether the designated area is covered or likely to be covered by a next-generation access network offering download speeds below 100 Mbps. Note that in paragraph 70 BEREC exposes the reasons why this information may be better released to the public at the time of publishing designated areas.

107. Second, as per Article 22 (5), some information about the invitation procedure responses (as well as the designated areas and the results of the geographical survey defined in Article 22 (1)) should be accessible to other authorities with specific responsibilities so that they can take this information into account when performing their duties. These are: local, regional and national authorities with responsibility for the allocation of public funds for the deployment of electronic communications networks, for the design of national broadband plans, for defining coverage obligations attached to rights of use for radio spectrum and for verifying availability of services falling within the universal service obligations in their territory.

108. Detailed information (results of the process in the detailed form) should be also provided to BEREC and the EC, but only upon a properly substantiated request.

109. Section 2.7.1 of the Core Guidelines deals with the provision of information to such relevant public authorities. Its contents are relevant as well to the provision of information regarding responses to the invitation procedures. Article 22(5) EECC requires that NRAs/OCAs facilitating information to other public authorities inform operators when doing so.

110. When relevant public authorities need detailed data, the receiving competent authority must be aware of any confidentiality concerns of the parties responding to the invitations, and shall in all cases ensure the same level of confidentiality and protection of business secrets as for the originating authority. However, confidentiality concerns shall not prevent

the sharing of information between the competent authority and the other authority in a timely manner for the purposes of reviewing, monitoring and supervising the application of the EECC.

111. The competent authority shall, on a case-by-case basis, make sure to obtain a good understanding of the expectations of the authority and its requirements. The competent authority shall always analyse the disclosure risk of information and consider reasonable aggregations.

112. Finally, if the process consists of two invitations and if some information (possibly aggregates) regarding the first respondents' deployment plans has been published when issuing the first invitation (or made available by request), then the same information should be published (or made available under request) with respect to the deployment plans of the second set of respondents. See section 3.1.3.

Body of European Regulators for Electronic Communications
BEREC

BoR (21) 82

BEREC Guidelines on Geographical surveys of network deployments. Verification of information

10 June 2021

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1 Introduction

1. According to Article 22(7) of the European Electronic Communications Code ('**EECC**'), by 21 June 2020, BEREC shall, after consulting stakeholders and in close cooperation with the EC and relevant national authorities, issue guidelines to assist National Regulatory Authorities (NRAs) and/or Other Competent Authorities (OCAs) on the consistent implementation of Article 22 **EECC.**

2. In March 2020 BEREC issued the BEREC Guidelines on Geographical surveys of network deployments[1]) which dealt with the consistent application of the obligation for NRAs/OCAs to provide for geographical surveys of the reach of electronic communications networks[2] capable of delivering broadband, and the forecasts of the reach of broadband networks, including very high capacity networks ('**VHCN**'), that the authorities may undertake.

3. BoR (20) 42 (hereafter "Core Guidelines") establishes the definitions for all the indicators that NRA/OCAs must provide for and as well the minimal granularity for the information. They also explain which operators are subject to provide information and deliver important classifications, namely on the kinds of technologies, speed tiers to consider and types of VHCN networks.

4. In the Core Guidelines BEREC concluded that QoS-1 indicators[3] (i.e. theoretical network performance of existing infrastructure/calculated availability of service) would characterise the reach and performance of broadband networks.

5. In the current Guidelines BEREC deals with the verification of QoS-1 indicators as defined in the Core Guidelines. This is the verification of the current reach of broadband networks and the quality of the services that they could offer[4] as declared by the operator, including the verification of the declaration of an area or grid as being covered with a VHCN network. The validation of address databases and the verification of information regarding planned deployments[5] is out of the scope of the current guidelines.

6. It is indispensable that broadband maps of current broadband reach are accurate, since this information is used in the context of many regulatory and policy functions, as detailed in Article 22 (5). However, there are many reasons why the raw data provided by an operator may be partial or incorrect, ranging from unintentional errors made in the data processing, a misunderstanding of the Authority's requirements or inappropriate

[1] BoR (20) 42.
[2] ECN, as defined in Article 2.1 of the EECC.
[3] See definition in the Core Guidelines and in https://ec.europa.eu/digital-single-market/en/broadband-and-infrastructure-mapping-project.
[4] See paragraph 10 in the Core Guidelines.
[5] Section 2.6.2 in the Core Guidelines contains some guidance on how to verify information submitted by operators regarding planned network deployments.

assumptions in the modelling of QoS-1 data. Because of all of this, ensuring the quality of the data that nurtures broadband maps is an integral part of the processes leading to the publication and updating of broadband maps.

7. Consequently, 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 (as required by paragraph 7): collecting and relying on incorrect data would be detrimental to the correct fulfilling of the tasks of the authorities as prescribed by the EECC.

8. The purpose of the data quality assurance process can range from being very general (this is checking overall that an operator's submission is correct) or quite specific, for example when guided by particular needs (for example, checking the availability of broadband coverage in areas where there are complaints by end users or where some public deployment is being considered).

9. Authorities need to guarantee that the quality assurance process is objective, transparent and non-discriminatory. This is best achieved when the data assurance methodology and a description of the key findings of the verification outcome is published so that operators understand what to expect (see section 5).

10. The process of ensuring the quality of data has five steps:

    STEP 1) validation of the internal consistency of the database;

    STEP 2) resorting to external agents to report data inaccuracies;

    STEP 3) **the verification phase**, where the data is contrasted against external sources of data;

    STEP 4) deciding after external validation that the data is not correct and;

    STEP 5) changing the data if necessary and other consequences.

    These steps may overlap in time, for example, STEP 2 may happen along the whole process once some information on broadband availability is published, for example when a broadband map is made public.

11. The Guidelines focus on steps 1 to 4. The consequences of data misreporting (STEP 5) depend on national legislation and country specificities[6], and are therefore not part of these Guidelines.

12. The current guidelines describe different verification methods and provide recommendations to be considered by Authorities when assessing the quality of QoS-1

[6] Not all Member States have the same experience in broadband mapping and the volume and kinds of errors that an Authority may find in countries with lesser experience are different to those with more experience, where operators and Authorities will have already undergone several data checking rounds.

data provided by operators. Authorities may choose verification methods depending on the information available and their needs. The guidelines stress that Authorities should publish their verification methodologies and outline the verification results in order to establish transparency and help make their proceedings plausible to market participants.

13. Authorities should update their maps and databases at their convenience, when data is corrected by an operator or the Authority. NRAs' experience is that the process of quality assurance is ongoing and because of this the Geographical Survey information is "alive"- this is, past information may change with new submissions or as a result of verification.

14. It needs to be noted that the **Core Guidelines refer to network capability** and not to any retail service offered at the address/grid[7], so this challenges verification. For example:

    - For fixed broadband, addresses passed sometimes may have no connections or no connections of a certain type, so this makes it difficult to verify with measurements.

    - For mobile broadband, paragraph 72 in the Core Guidelines specifies that there should be a high likelihood of reception (with a speed of at least 2 Mbps available at least in 95% of the grid area with a successful reception of 95%), so instances of non-reception can happen, it is a matter of their order of magnitude and territorial dispersion.

    - In general, measurements made by end-users will depend, among other factors, on the characteristics of the broadband service they contract and may not reflect the network capability at a certain point or the best technologies available in a certain area.

15. In 2020, BEREC carried out a survey and found out that most NRAs/OCAs do not carry out verification of the QoS-1 indicators for the fixed broadband indicated in the Core Guidelines. Nine (out of sixteen) NRAs/OCAs carry out a verification of fixed broadband technologies, mainly by using crosschecks with other available databases like available data in public evidences, periodical statistical data collection databases, operators' homepages or publicly available rollout information. For mobile broadband, 10 NRAs/OCAs (out of sixteen) carry out checks on 3G and 4G availability, (high likelihood of service reception). At the time, no NRA/OCA carried out verification of 5G availability. Measured data (drive tests) is used by four NRAs/OCAs to verify mobile broadband service reception. In the case of fixed broadband the use of measurements is more scarce.

16. While the provisions of the EECC would anticipate and foster also state aid compliance, it is not their main objective to ensure compliance with state aid rules. NRAs/OCAs can use

[7] This is recognised in the Core Guidelines definitions of maximum achievable speed and expected peak time speed. Also, in BoR (20) 80, the BEREC VHCN guidelines, paragraph 18: "For the qualification as a VHCN, it is sufficient that a network (without any further investments) 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. Therefore, it is neither necessary that the network actually offers such a service nor that all services provided by the network have to meet the performance thresholds 1 or performance thresholds 2".

information collected under Article 22 to assist the state aid process but may also need to collect complementary information in line with the State Aid rules.

17. Finally, BEREC has the exclusive EECC mandate to deliver on Article 22 Guidelines and the BEREC Guidelines (BoR (20) 42, BoR (21) 32 and the current BEREC Guidelines on the verification of information) constitute the unique basis for the consistent implementation of broadband mapping activities within the purposes of Article 22 EECC and other related Article 22 activities.

2 What to verify?

18. Paragraph 20 in the Core Guidelines explains that the responsibility of providing reach and performance indicators may rest directly with the operators or with Authorities, when those perform calculations on the basis of their knowledge of infrastructure data or according to assumptions as described in the Core Guidelines. This Guidelines focus on the operator-delivered data, but Authorities may also find useful to carry out some verification of their own calculations to test the assumptions they use in their modelling.

2.1 Fixed broadband

19. According to the Core Guidelines, in case of fixed broadband, the indicators to verify are:

    a.) Technology availability categorized as per subsection 2.4.1.3 in Core Guidelines;

    b.) Maximum Download speed class as per Table 7 in Annex 2 of the Core Guidelines;

    c.) Maximum Upload speed class as per Table 7 in Annex 2 of the Core Guidelines;

    d.) Expected Peak-Time Download speed class as per Table 7 in Annex 2 of the Core Guidelines;

    e.) Expected Peak-Time Upload speed class as per Table 7 in Annex 2 of the Core Guidelines);

    f.) VHCN class declaration as per Table 1 in Core Guidelines (this is, criterion 1, 2, 3 and 4 in the VHCN guidelines, where criterion 2 and 4 are relevant for Fixed Wireless Access).

    As stated by the Core Guidelines, this information must be produced at address or small grid level (100m x 100m area or smaller). According to the BEREC Guidelines on Very High Capacity Networks (hereafter VHCN Guidelines)[8], paragraph 19, peak-time is the

[8] BoR (20) 80.

time of the day with a typical duration of one hour where the network load usually has its maximum. This is relevant to the VHCN class declaration under Criteria 3 and 4 and for the submission of expected peak-time upload and download speeds.

2.2 Mobile broadband

20. According to the Core Guidelines, in case of mobile broadband, the indicators to verify are:

    a.) Technology availability as per section 2.4.2.3 in the Core Guidelines;

    b.) VHCN declaration per Table 3 in the Core Guidelines (this is, criteria 2 and 4 in the VHCN Guidelines);

    c.) Upload Maximum Speed classes as per Table 7 in Annex 2 of the Core Guidelines;

    d.) Download Maximum Speed classes as per Table 7 in Annex 2 of the Core Guidelines.

As stated by the Core Guidelines, this information must be produced at small grid level (100m x 100m area or smaller) and the information on upload and download maximum speed classes (c and d above) are optional to Authorities.

According to the VHCN Guidelines, paragraph 19, peak-time is the time of the day with a typical duration of one hour where the network load usually has its maximum. This is relevant for the VHCN declaration under Criteria 4 in the VHCN Guidelines.

3 Internal validation (STEP 1)

21. All authorities should routinely check the internal consistency of QoS-1 data provided by operators.

22. This encompasses activities to ensure the quality of data using **only the main data base** (this is the data base that results from the collection of QoS-1 information as per the Core Guidelines), for example, checking missing data, looking for possible problems in reporting units (for example, speed or technology codes that have not been required by the Authority) or looking into inconsistencies within the information in the main data base. There could be some algorithms or automatic controls of provided data to assess its consistency to exchange formats / logical tests.

23. A detailed analysis of the main data base can allow identifying possible irregularities or anomalies in the data provided by the operator. For example, declarations as if the whole network of the operator is reported at one (or few) locations and one single broadband connection (network termination point, or a couple of them) which would often indicate that there was an administrative or typing error made by the operator while filling the data in. NRA/OCAs may look for discrepancies and irregularities and then confirm the correctness of such data with the operator.

24. Moreover, in so far the main data base allows comparing data declarations for different periods, the Authority can also check that there are no unreasonable discontinuities. In the particular case of georeferenced data, a good practise is to check visually the evolution of the maps to identify potential problems with the data that has been gathered.

25. Checking the integrity of the data base should be done by Authorities before any publication.

4 Use of third parties to find out about inaccuracies in data (STEP 2)

26. When data on the broadband coverage or characteristics on the terrain is made public by the Authority and interaction with the public is most welcome, information from third parties may enable the Authority to suspect that some particular data is inaccurate. For example, after data is publicly available through a Mapping tool, citizens who are not able to get the published speed have the possibility to contact the Authority[9].

27. These third parties can be end-users, other public administrations and even ECN and ECS providers. The display of public information of good territorial granularity also adds value to all these parties and may also discipline operators in ensuring that they deliver accurate data, as misreported data may upset end-users.

28. Generally, data from third parties is not conclusive on the accuracy of the data reported by an operator, as it may result from measurement or perception problems. Even when a third-party report of inaccurate data is right, in some cases, it can still be compatible with the operator's declared information, for example when the third-party report is explained by events which are beyond the operator's control[10] or because the two pieces of information are not exactly the same, and the differences can be explained by the measurement methodology, for example.

29. Yet, third-party information can provide an indication of areas, operators and/or technologies where there may be problems. In those instances, first of all, the Authority

[9] This section deals with the information provided by consumers as a means to understand the quality of the main data base. It does not deal with the processes that Authorities with consumer protection functions should follow after formal end-user complaints.

[10] Note for example, that in the VHCN Guidelines, paragraph 19 e.) it is stated that "events outside the network operator's control (e.g. force majeure) are excluded from the calculation of the IP service availability".

should contact the operator to see how he responds to the reported data discrepancies as in many cases this will prove sufficient to solve the problem.

30. When the information provided by third-parties is good and sufficient (for example, there is a number of complaints or those are recurrent) and the operator cannot reasonably explain the differences, this can trigger further investigation by the NRA.

31. For example, once a broadband map is published, direct end-user declarations (which may be sustained by some type of measurement done by the end-user) can help identify problematic data[11]. In order to facilitate the end-users' submission of geographically referenced data and to ease the internal cross-checking of information, it is good to integrate the third-party reporting of data inaccuracies in the broadband map itself, with a given format and detailed information request such as personal details, operator, mobile/fixed broadband, commercial retail offer name, contractual maximum speeds, measurements if available, technology if known.

32. Some NRAs find that allowing access to the mapping data for reuse by stakeholders enables a better diffusion of the information and more reporting of problems with data. For example, in one MS, an API function has been developed that allows the viewing of the broadband map on other websites. A large website displaying property for sale is using the API and is a source of reports for data inaccuracies.

33. It is advisable to provide this mapping information at the best granularity possible. However, if very detailed or granular maps cannot be published at a given time, either for legal or technical reasons, Authorities can publish information at a more aggregate level, municipal or sub-municipal administrative level, for example. Information on each zone being covered with a certain speed or broadband service of a given characteristic may enable the general public, other companies and other public administrations to respond to this and report discrepancies with their own experience or knowledge.

34. When there are confidentiality concerns and it is necessary and proportionate to do so, it is possible to share some information with other public authorities who have information of their own which may help assess the information of the operator. These other public authorities should safeguard the confidentiality of information and the operator should be informed of the information sharing (which information, with who, and with which purposes).

[11] Some NRAs (SI) have used sampling methods to create representative samples of end-users who are then questioned about their service availability. This is a method that provides statistical data that may be as robust as the quality of the sample allows, but typically requires the outsourcing of the field work.

5 Verification (STEP 3) and decision regarding data accuracy (STEP 4)

35. Verification is the external validation of the main database with other data sources, where data mainly will be placed within the Authority, but that in some cases may be placed with another public body or sourced from operators. Some examples of these data sources are:

    - georeferenced information on active access connections;
    - if available, information on the location of access nodes or other relevant infrastructures;
    - general telecom databases (which may allow checking regional aggregates);
    - information gathered through state aid proceedings and others.

36. In so far this is possible, BEREC encourages to carry out verification by re-using existing data bases, resident in the Authority or required from other public bodies. Whenever there is a need to require additional data to an operator, the Authority should carefully assess the proportionality of the data request, striking the right balance between the need for information and the burden these requests place upon providers.

37. Additionally, it is advisable that Authorities contact the relevant operators whenever they find discrepancies between their submissions to the main database and the verification information, so that they can provide an explanation for the discrepancies, to assess whether the main database needs to be updated. In any case, the decision to update the main database lies on the judgement of the Authority only.

38. To carry out the verification exercise effectively, it is necessary to integrate the main database and the secondary databases on different layers of the GIS. For new data sources, new databases could be created.

5.1 Network infrastructure locations and characteristics

5.1.1 Fixed broadband

39. Where this information is available, knowledge of the geographical coordinates of the active access nodes[12] (such as DPU in case of G.fast, DSLAM for DSL, CMTS in case of DOCSIS or OLT in case of FTTH*)* and their coverage radii, declared by the providers, makes it possible for the Authority to determine (with GIS tools) the coverage area of an electronic communications network and to carry out a certain quality assurance of the fixed broadband main database (premises/small grids passed with a broadband network and, to a certain extent, the characteristics of the broadband service that could be offered by that network)[13].

40. However, the granularity of the broadband reach data to be extracted in this way depends, to a great extent, on the availability and accuracy of information on administrative numbers, the outline of built-up areas and the boundaries of administrative-territorial units, information usually beyond the control of the Authority.

41. For this purpose, if the location of the active access nodes is known to the Authority, GIS systems may be used to calculate the distance following roads or pedestrian ways, not just the line of sight, between the nearest active access node and each premise or small grid. Like this, the Authority may verify information on available technologies, the categories of end-users served (business/residential), as well as, in certain circumstances, a number of quality parameters of internet access services that could theoretically be provided by the network (such as bandwidth speeds and VHCN declarations according to criteria 3 of the BEREC VHCN GL[14]).

42. In any case, if the Authority requires the position of or distances from premises/grids to active access nodes, such information shall be required primarily from the wholesale operators providing access, while the need for additional data requests directed to access

[12]The active access node is the first active equipment to which the end user's equipment (CPE) connects, sometimes called the first point of concentration. Although active access nodes are different depending on existing network architectures, they always form the "boundary" between the distribution segment ("backhaul") and the access segment ("local loop", "last mile").

[13] Considering the confidentiality of such data, please see Section 2.7.2. of the Core Guidelines, which deals with confidentiality and business secrets. Moreover, BEREC stresses the fact that access to systems/databases containing such data is also under the protection of confidentiality requirements, with respect to unauthorized access by any third parties, for instance.

[14] See document BoR (20) 165
https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/9439-berec-guidelines-on-very-high-capacity-networks

takers is subject to the Authority's judgement on necessity and proportionality. In any event, BEREC advises against the duplication of data requests.

43. If the information on the geographical coordinates of active access nodes is not available, a second-best option is to require the operators to provide, at least, the distance *(the farthest being the most relevant)* from the nearest active access nodes and antennas to the premises/small grids[15] served. These distances can serve as a means of verification for a declared bandwidth for wireless and DSL networks. Even if there are other factors such as line attenuation or vectoring frequency, which affect the performance of the broadband service offered by the network, a longer distance to the nearest active access nodes is, *ceteris paribus*, associated with a lower (maximum) data rate, and a sufficiently long distance may imply that the premise/small grid simply cannot be served.

44. Distance is also necessary for characterizing the availability of VHCNs as the endpoints for measuring latency or packet loss (CPE to OLT or metro POP, for example) should be declared in advance. Clearly, the latency depends on the propagation delay, which in turn depends on the distance (amongst other factors), which must be known to derive the latency due to congestion.

45. Furthermore, GIS software can be used to compare the QoS1 data with access node positions and equipment/access node type. Given both the coverage area and the network infrastructure locations, the characteristics on a map, using the spatial analyses tools in the GIS software, it is possible to verify the declared technology (for example, premises/small grids passed). So, for example, if addresses/ small grids have an exclusively copper infrastructure and the provider has declared FTTH in those, there are inaccuracies that may be checked. The first thing to do would be to question the operator about the discrepancy.

46. Also, with the spatial analyses tools in GIS software, it is possible to calculate the distance between the position of the access node and the premise/small grid[16] and to determine the admissible maximum speeds classes (as certain speeds will not be plausible) and compare those with maximum speed class declared by the operator.

47. It is advisable for the Authority to determine the admissible maximum speeds thresholds taking into account the engineering models and in collaboration with operators (what is the admissible maximum speed depending on the technology and the local loop distance, for example: for VDSL2, in case of a 500 m local loop, the speed cannot exceed 100 Mbps). Moreover, such thresholds should be published so that operators are informed on the Authority's reasonable expectations so that there are less complaints in the verification process.

[15] For example, to the geographical center of each grid.
[16] For example, to the geographical center of each grid.

48. Randomly or in some specific cases, the Authority's inspections on infrastructure may be needed, which should verify the infrastructure positions on field with or without operators. Authorities inspectors must establish with operators a day or a period of days to verify the data in the field. In this case, it is very useful to have a map with infrastructure (printed or on a device) to verify all the equipment by comparing them on the map with those in the field. The comparison must be done both by visualizing the equipment and by measurements performed with special devices. Even if Authorities have their special devices, inspectors should set a day or more with operators for verification, as most equipment is closed in specially designed spaces, most of the time locked.

5.1.2 Mobile broadband

49. The locations of BTS and its characteristics are important to carry out the theoretical calculation of the network coverage of the mobile networks.

50. The use of specialised tools is recommended, if the Authority decides to do theoretical calculations of the coverage of mobile networks to check the information submitted by operators. These tools could be different from the ones used by the mobile operators. Moreover, some information such as digital maps, are needed to perform these calculations.

51. Some other parameters/information that the Authority would need to calculate mobile coverages (e.g. 4G, 5G) are, amongst others: the location of BTS, the topographical information of the coverage zone and many of the BTS characteristics including their height above ground, and technological parameters such as: their power, the antenna diagrams, frequency, sensitivity per service, use of MIMO, carrier or site aggregation.

52. Additionally, and due to the availability of different propagation models, the mobile operators should provide the Authority with information about the ones they are applying. Other relevant parameters should be provided, for the Authority to be able to simulate the theoretical network coverage, and reflect as much as possible the network coverages calculated by mobile operators.

53. All of the information described in paragraphs 49 to 51, can also be used to carry out the estimation of the network's capacity (i.e. speeds), that could be calculated either without load in the network, or by simulating different levels of loads.

54. In particular, whenever checking VHCN declarations (a sample of those or specifically in some zone for a particular reason), the Authority should retrieve from the operator the network load that characterises peak-time, so that the speeds at these levels can also be re-calculated to understand if the VHCN thresholds for Criteria 4 are satisfied.

55. The complexity of this kind of analysis (theoretical network coverage and estimation of the network's capacity) will vary with the Authority's QoS-1 requirements (for example, whether maximum speed is required or not). BEREC recommends each Authority to use the methodology that better fits their needs.

56. When, and where possible, the Authority may carry out inspections on infrastructure in order to check whether the locations of the base stations are correctly reported and also in order to check a declaration of a VHCN network If the BTS is served by fiber (Criteria 2 in the VHCN Guidelines). Other infrastructure's information verification concerning the equipment placed in the BTS could be deemed appropriate.

5.2 Declared service data by operators

57. For fixed broadband, georeferenced data on active access connections and their characteristics, (sourced from operators), can be used to provide a partial check on the QoS1 information (as per the Core Guidelines). For example, address-based active access connections information (this is connections actually demanded by end-users) inform about the availability of certain broadband technologies and speeds on the terrain. Comparing this information and premises passed information on different GIS layers may allow, at least, the detection of areas where an operator declares the presence of an active service of a certain type (technology or speed), but where there is no declaration of its availability (premise passed).

58. Similarly, declared data regarding services offered to consumers in certain zones (i.e. municipalities or with more granularity) is a useful and cost-efficient means of verification (which is even more important if data regarding e.g. the location of the access nodes, of the FWA antennas, etc. is not available). This is, the operators' reporting of a specific broadband service (accompanied by a declaration of certain parameters of interest) being available in a particular zone, also provides a means of verification of QoS-1 information for mobile and fixed broadband.

59. According to Net Neutrality Rules (Regulation (EU) 2015/2120 of 25 November 2015) operators are obliged to provide speed information anyway (or at least provide such information to each end user): "*a clear and comprehensible explanation of the minimum, normally available, maximum and advertised download and upload speed of the internet access services in the case of fixed networks, or of the estimated maximum and advertised download and upload speed of the internet access services in the case of mobile networks…*" (Art. 4/d). So, the provisioning of such data to regulators would not be an excessive burden for operators.

60. It should be noted that the speed definitions used in the Open Internet Regulation differ from the ones provided in BoR (20) 42, as the former are speed definitions reflective of the speeds end-users could expect to receive, while the latter reflect network capabilities.

61. Declared service data can be used as a contrast on the QoS-1 data, just to find out about possible contradictions between the two databases, for which GIS cross checks may be useful. Such verification can help to find some doubtful QoS-1 data in terms of speeds (and other parameters) or network availability, e.g. if an operator is declaring a network

(QoS-1 data) in the area without any service provided, or if all services in the given area are provided on significantly lower speed than the speed class reported on QoS-1.

62. The declared service data by operators should correspond to reality and the operator or the Authority should be able to verify it with measurements.

5.3 QoS-2 measurements

63. As reported in BoR (19) 182, BEREC's response to the Core Guidelines public consultation, BEREC understands that QoS-1 theoretical (speed) data estimates will differ from QoS-2 and QoS-3 measurements, but also considers that measurements, and, in particular, QoS-2 information can be helpful to verify whether the QoS-1 estimates are within a reasonable margin of QoS-2 active network measurements.

64. QoS-2 information has the particularity that they are undertaken under a controlled environment (as opposed to data recovered from crowd-sourcing tools). This is, the tests can be carried out under certain conditions which are known to the tester. For example, for mobile broadband and drive tests, the type of measurement equipment used, the speed of the driving, the specific geo-coordinates and times of the measurements are known. In particular, QoS-2 campaigns carried out by the Authority or by operators under the Authority supervision can be a good means of verification.

65. The VHCN Guidelines specify that in order to determine whether a network has the capabilities specified in Criteria 2 or 4, an Authority may demand that a test service which meets the performance thresholds 1 or the performance thresholds 2 is implemented in the network.

66. However, QoS-2 measurements are costly to implement and because of this, the Authority should clearly define the scope of the verification exercise (area, size of the sample, time of the day, operator, technology) and consider a random sample of measurements, or if necessary, a more complex sample design which could guarantee (at a smaller expense), for example, that all types of areas (rural and urban) are measured or that certain areas of interest are over-represented in the sample.

67. Moreover, since measurements are costly to perform, existing information should be re-used as far as possible, for example by considering measurements that have been undertaken by operators or by the authority, if available and adequate for verification purposes.

68. An important point is that the data required in the Core Guidelines is not a point estimation (for example, an average or a median) but rather a declaration that a given parameter falls within a specific range in the area of interest (address or grid). These are, for example, the 6 different speed tiers in Table 7 of the Core Guidelines or for a VHCN declaration (under criteria 2 or 4 of the VHCN Guidelines), that a given variable is above a pre-determined

threshold. Therefore, if any QoS2 measurements are carried out, the Authority should expect a sufficiently large proportion of those to abide by the conditions required for the operator declaration.

69. In general, it would be advisable for the Authority to discuss with operators the conditions that the obtained sample of measurements needs to satisfy in order to conclude that a certain data is inaccurate (for example, a maximum percentage of measurements falling outside the specific class or the formulae leading to such conclusions).

70. Finally, it is also advisable to involve stakeholders in designing QoS-2 campaigns. On one hand, in the case of fixed broadband, the operator collaboration is indispensable to enter the specific locations where the measurements need to take place and on the other, this collaboration strengthens the outcome of the verification process and reduces the possible complaints that may rise. A pilot study is encouraged in the case of new QoS-2 campaigns.

5.3.1 QoS-2 for mobile broadband

71. In accordance with the Core Guidelines, the territory is divided in squares of at most 100 meters on each side, called pixels. Therefore, the QoS-1 information is to be provided for each pixel. All the information provided by the operators at pixel level should reflect the situation at a date specified by the Authority.

72. Section 2.2 describes the information to verify. This includes:

- Coverage: A pixel is covered by a mobile broadband technology if a broadband service (at least 2 Mbps) is available in at least 95% of the grid areas with a high likelihood of successful reception, where this means a probability of service reception of 95%

- VHCN declaration: For a pixel to be declared as reached by a VHCN, the conditions associated must be satisfied in at least 95% of the pixel, either by base stations connected to fiber lines or, if not, by other technologies, in this case all the performance thresholds specified in Criterion 4 of the VHCN Guidelines must be satisfied in 95% of the grid.

- Maximum speed classes, if the Authority has decided to request this information.

73. In particular, within the framework of mapping surveys for mobile coverage, the information to verify provided by operators, as identified in the previous paragraph, would usually be a file per technology, indicating the field strength for each pixel of the territory. Alternatively, operators may provide multiple files (one for each signal level indicated on the map) per technology, indicating if the network covers or not (0 or 1) each pixel.

74. Additionally, the Authority should verify the operator's information on whether a pixel is covered or not by a VHCN or a certain mobile broadband speed class.

75. The Authority can carry out field measures to check the validity of these files, i.e. the accuracy of the information provided by the operators. Yet, it should be noted that for technical and resourcing reasons it may not be possible to make widespread measurements over the country.

76. Measurements should be carried out systematically, with standardised procedures and without human intervention or decision (during the carry out of measurements), and under the same conditions for operators, to provide an objective verification procedure.

77. First, to carry out the verification process, there is a need to define sample areas that include routes that should be chosen randomly, but homogeneously, over the whole territory, in order to ensure a certain level of spatiotemporal statistical significance.

78. Second, to be able to compare the results from one campaign to the other, a number of routes/sample areas, randomly chosen, should remain identical from one campaign to the other.

79. The measurements should be performed by the Authority, or by some entities it recommends and would have to be carried out with a specific measurement tool such as an RF scanner.

80. For the verification of coverage, in order to be able to compare operators' results, it is important that MNOs are measured at the same time and in a same location (if covered). Moreover, it is necessary that mobile devices/scanners are blocked on the specific network of the operator for which information is verified or enable the identification of this information.

81. For the verification of VHCN it is important that the testing system always chooses the best technology available at the time of each test

82. On the other hand, for the verification of mobile broadband speed classes, it is important that the testing system always chooses the technology that is being checked by the Authority (e.g. 3G, 4G) at the time of each test.

83. All or part of the measurements can be made in a moving vehicle driving at a normal speed based on the type of roads. For each point of measurement, the related GPS coordinates have to be acquired. It is required that the measurements made in a vehicle report an external situation by means of an external antenna.[17]

84. The Authority must define several elements of the process, such as the optimal number of measurements per minute, which must be linked to a GPS position, the vehicle speed, the

[17] Whenever the scanner is inside the vehicle, the post processing of information should take into consideration the attenuation caused by the structure of the vehicle.

signal to keep, and the clustering algorithm. The NRA should also calculate a correction factor in order to compare the drive test's results with the operator's coverage files.

85. The Authority should inform each of the operators of the validation results for each file that was sent, precisely indicating which correction factor was applied so that operators could check their data and if necessary submit updated data to the Authority.

86. Moreover, it is good practice for the Authority to involve the mobile operators in the definition of some technical parameters (e.g. common signal strength limits) before the measurements are undertaken.

87. The number of measurements to perform by sample area/routes, should be defined by each Authority on a case by case basis, as well as the methodology to verify QoS-1 mapping. Authorities should publish their verification methodologies and the specifications of their drive tests.

5.4 QoS-3 measurements

88. QoS-3 measurements are defined as measured experience of service, including end-user's environment. For this purpose, end-users are generally required to download crowdsourced measurement tools in order to launch QoS measurements from their customer premise equipment or terminal equipment.

89. By doing so, the measurements will incorporate items from the end-user environment (for example the terminal equipment, cross-traffic, home network limitation in the case of Wi-Fi) and may be influenced by tariff-related speed-cap. Those items are meaningful to understand the real quality of end-users' access, however they can also lead to misunderstandings by end-users, if those are unable to tell apart the causes of a discrepancy between real speed and theoretical or contractual access speed (as most crowdsourced tools are unable to detect a potential environmental-based source of limitations).

90. QoS-3 measurements can also be associated to Quality of Experience (QoE) measurements, as the crowdsourced measurement tools grow in complexity. The concept is not only to measure the capacity or speed of end-users' access, but to mimic real-life experience through measurements of diverse online usages (for example by measuring the speed of a link to representative panel of websites, or by measuring not just downloading of files but also content browsing or streaming).

91. Given this, QoS-3 information can indicate that besides the general, theoretical capacity of an access, there can be issues further down or up in the internet chain (for example in the end-user environment, or, at the opposite, at interconnection level) that would go unnoticed under other measurement protocols; and yet those issues are relevant in order to assess to real quality of experience for each and every end-user.

92. Especially, as QoS-3 monitoring tools are generally crowdsourced, it is more likely that end-users facing connectivity problems perform those tests, and as a result, connectivity problems might be highlighted quickly to the eye of the Authority.

93. Authorities should be very careful when extrapolating the measurements of Internet users for verification purposes, as it is not possible to guarantee the necessary statistical representativeness of the group, given that the crowdsourcing tests are of a nature voluntary and not random. Moreover, their specific motivations for carrying out the tests are not controllable. In this context, it should be noted that the results may not necessarily reflect the reality of the Internet access service in each region.

94. Moreover, the test results, in addition to the contracted speed, are influenced by other factors, namely 1) the processing and communication capacity of the terminal equipment used which may also be affected by the possible presence of malware, viruses, among others; 2) the type of connection between the equipment and the network connection router (directly via cable or via Wi-Fi); 3) the possible existence of parallel traffic on the same access (existence of other Internet users or other equipment in activity) and 4) the tariff speed cap in the commercial offer that the end-user has contracted.

95. In the case of a mobile access, the speed result is subject to factors related to the quality or strength of the signal, coverage, reception antenna and the number of users who share the same antenna for a given operator at the time of testing.

96. Where Authority sponsored tools have been developed (or the Authority has struck partnerships with tools already on the market), these may enable retrieving useful information at a reasonable cost, acting as a signalling platform for network problems that Authorities can investigate. But for the sake of a more thorough regulatory monitoring of the state of networks, these tools might have downsides in terms of reliability.

97. Various procedures have been put in place by regulators or public bodies to enhance the reliability of these tools:

    - The practice of setting up representative pools of users is regularly applied. As an example, Ofcom’s Home Broadband Performance study, or the FCC’s Measuring Broadband America, have used sample of users chosen to attain statistic representativity, in terms of geographical coverage, access technologies etc. In these conditions QoS-3 measurement may produce a reliable output on the state of a network.

    - For the sake of verifying the transparency obligations in article 4 of Regulation 2015/2120, BNetzA has released a QoS-3 measurement tool that is accompanied by a measurement protocol for the end-user. This protocol prescribes the information that the end-user has to disclose (contractual speed, access technology, verification of cross-traffic) and the measurements that the end-user has to perform (a number of measurements during several different times of the day), in order to avoid random results.

- It is also possible to specifically diminish interferences stemming from end-users' environment. As an example, ARCEP has developed an "access ID card" in cooperation with major ISPs and measurement tool providers. This ID card is implemented as an API inside ISP set-top-boxes, and the measurement tools participating in this project can access the information on the ID card (e.g. contractual speed, access technology, cross traffic, set top box model) before each measurement, in order to make it more relevant and understandable by the end-user.

6 Transparency and accountability

98. The Authority should publish the method/s of verification (cf. section 5) that they implement. By publishing the principles of the how the data quality is assured NRAs establish transparency and help make their proceedings plausible to market participants.

99. This publication can include an explanation about which types of data are being verified (cf. section 2.1 and 2.2) or why a specific method has been chosen. The Authority could also indicate if they use data from third parties to verify operator data (cf. section 4).

100. Furthermore, if the Authority re-calculates mobile broadband availability information using its own models, it should publish its methodology, including a reference to the tools and assumptions made in the verification calculation (see section 5.1).

101. To ensure transparent proceedings, the Authority should report publicly and periodically on the outcome of the quality assurance. These reports should focus on the overall results of the verification process and main takeaways for future rounds. To maintain the necessary confidentiality, the Authority should aggregate information at operator level for publications.

102. If possible, the reporting on methods and on verification outcomes should preferably be published online in conjunction with the geographical survey itself (e.g. all on the same websites) so they are easy to find for interested parties.

Annex 1 - Glossary of terms

API – Application Programming Interface

BTS - Base Transceiver Station

CMTS - Cable Modem Termination System

CPE – Customer Premises Equipment

DPU - Display Processing Unit

DSL - Digital Subscriber Line

DSLAM - Digital Subscriber Line Access Multiplexer

ECN - Electronic Communications Networks

ECS - Electronic Communications Services

EECC – European Electronic Communications Code

FTTH – Fiber to the Home

GIS - Geographic Information System

IP – Internet Protocol

ISP – Internet Service Provider

MIMO - Multiple-input and multiple-output

MS – Member State

NRA - National Regulatory Authorities

OCA - Other Competent Authorities

OLT - Optical line termination

POP – Point of Presence

QoE – Quality of Experience

QoS1 - Quality of Service 1 - Calculated availability of Service - Theoretical network performance of existing infrastructure

QoS2 - Quality of Service 2 - Measured provision of Service - Measurements via panel probes or drive tests, excluding end user's environment.

QoS3 - Quality of Service 3 - Measured experience of Service - Measurements using internet access service including end user's environment, for example via online speed tests

VDSL - Very-high-bit-rate Digital Subscriber Line

VHCN - Very High Capacity Networks