Body of European Regulators for Electronic Communications
BEREC

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Draft 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. As set out in Article 22, the results of the GS may be used by NRAs and/or OCAs for several purposes or functions, specifically:

   - For the application of state aid rules[3] (Article 22(1), 2nd subparagraph);
   - To 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) and (3));
   - For verifying the availability of services falling within the universal service obligations ('**USOs**') (Article 22(5));
   - 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; (Article 22(5))
   - For defining coverage obligations attached to the rights of use for radio spectrum (Article 22(5));

[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"*.

[3] 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.

- For making available on the market, (if they are not already available) information tools enabling 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));
- Where relevant, in defining relevant geographic markets, (Article 64(3));
- To impose appropriate universal service obligations (Article 86(1));
- For making the results of the survey available to BEREC and the European Commission ('**EC**') upon their request and under the same conditions (Article 22(5)).

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] and the obligation 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. Secondarily, BEREC must also seek to ensure a level of consistency of these data, as Article 22(7) refers to guidelines on *"the consistent application"* of Article 22.

7. The harmonization at EU level of some indicator 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 Member States, 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.

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

9. In order to deliver these Guidelines, BEREC has issued out 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

[4] Coupled with Article 20.

Guidelines. BEREC has also organized, in cooperation with the EC, a joint EC-BEREC workshop with other relevant authorities, which discussed the scope of the Guidelines, as well as a BEREC workshop with stakeholders, other relevant authorities and the EC where all parties were able to provide their input into the process.

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 indicators.[5] Firstly, the Guidelines will use QoS-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 kind. Physical infrastructures support and enable the provision of

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

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

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 of the end user and availability of connectivity in places of public interest, 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 QoS-2 and QoS-3 information 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).

2 Content of the Guidelines

15. 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 of the calendar (see 1.4).

16. In the context of these Guidelines, in 2019, BEREC 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 EECC. As a result, a series of information

[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).

points and key characteristics stand 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.

17. For mobile broadband, these information points and key characteristics are:

a. broadband service availability in a certain area,

b. download and upload speed,

c. user location and

d. a high resolution of data.

18. With the present Guidelines, BEREC aims to harmonize these characteristics and information points in a manner which is both 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 request this information from operators and use it 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 be 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). This is an issue for each MS to decide (for both fixed and mobile indicators). However, irrespective of who provides the indicators, the definitions to use and the indicators to calculate for each technology (fixed or mobile) are the same, and defined in the different subsections of the Guidelines.

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 the fixed location of a 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 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.

[8] This broadband access refers to the European Commission 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"*.

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 have a 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 available speed: The maximum speed is the speed that an end user at the address/grid could expect to receive at least some of the time (e.g. at least once a day).[9] The parameters should describe the capability of the network.

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.

Normally available speed: The normally available speed is the speed that an end user in the address/grid could expect to receive 95% of the time over the whole day when accessing the service. The parameters should describe the capability of network.

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, will 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: The number of ‘Premises Passed’ is the potential number of premises that an operator can connect in a service area within a short period of time at affordable prices for the end user (connection fees), regardless of whether these premises are connected to the network. Typically, for a premise to be passed, this requires an existing network or network components (e.g. fiber splitter) deployed in close proximity to the premises.

An operator may report a premise as passed only if, following a request from an end user, it commits to connect the house within normal connection fees, i.e. without any additional or exceptional cost if it is the standard commercial practice and, in any case, not

[9] BEREC Guidelines on the Implementation by National Regulators of European Net Neutrality Rules (BoR (16) 127), §145.

exceeding the usual cost in the Member State, which may be defined by the 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.

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.

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.

Question 1
In BEREC's current Public Consultation on the implementation of the Open Internet Regulation (paragraph 140), BEREC is requiring that the speed values required by Article 4(1) (d) of the Regulation EU 2015/2020[11] should be specified on the transport layer protocol payload, and not based on a lower layer protocol. Is there any reason why this layer should not be used in proving information about speeds in the context of a Geographical Survey of Broadband reach?

QoS 1/QoS 2/QoS 3: The European Broadband Mapping project[12] 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.

[10] This four-week period does not take into account any possible delays due to external, non-technical factors, such as delays from the end user side, delays arising from operator administrative reasons, or external factors (such as extreme weather conditions).

[11] Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open internet access and retail charges for regulated intra-EU communications and amending Directive 2002/22/EC and Regulation (EU) No 531/2012, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02015R2120-20181220

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

2.2 Data sources

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 surveying and designation of areas in accordance described in 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. Network operators are the main source of information for the geographical surveys of broadband reach. For many functions,[13] it is necessary to gather information from all network operators, regardless of their size, or the technologies they use. Because of this, for the current task (QoS-1), **all network operators should provide the information that NRAs/OCAs request, in order to fulfil these Guidelines**.

25. 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 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.

2.3 Geographical spatial resolution of data

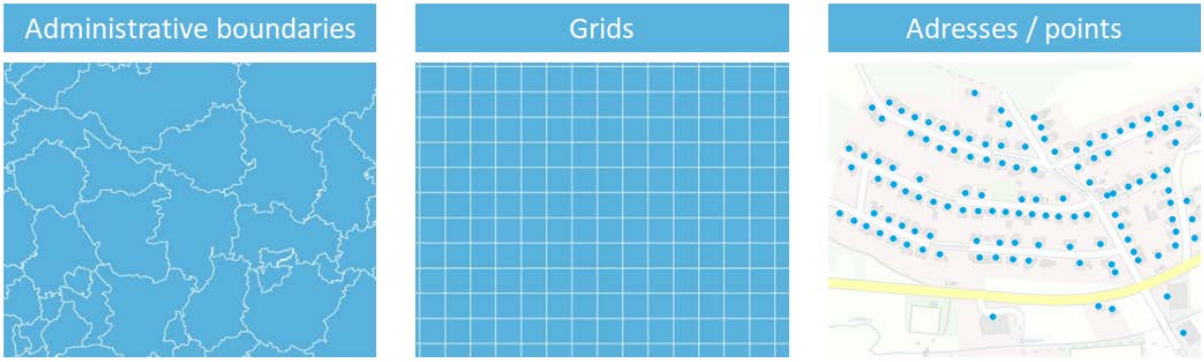
26. According to the 1st paragraph of Article 22 of the EECC *"The information collected in the geographical survey shall be at an appropriate level of local detail and shall include sufficient information on the quality of service and parameters thereof and shall be treated in accordance with Article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

27. Several spatial resolutions can be used for data collection (for example, geocoded information[14] (points or addresses), grid level data, local administrative unit level data,

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

[14] Geographical coordinates.

and NUTS level data). The most important levels of resolution are shown in the graphs below.[15]



28. 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. There is substantive agreement amongst Member States that, **for fixed networks,** the level of resolution should be **the address**. **For mobile networks**, the level of resolution should be **(at least) a 100m x 100m grid** (or equivalent polygon). Note that this refers to the calculation used for the production of results, not to the resolution that operators may use in order to perform their coverage and performance calculations.

29. Therefore, **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 publically from another public institution.[16] The database should be updated at least annually.

30. For **mobile broadband**, **data should be collected at a level of an (at least) 100m x 100m grid (or polygons of an equivalent resolution)**.[17] This is also the level recommended to publish data by BEREC's Common Position[18] on Information to

[15] 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 2.

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

[17] 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.

[18] BoR (18) 237.

Consumers on mobile coverage and the minimum resolution to attain when collecting data.

31. 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.

32. In such situations, NRAs/OCAs may temporarily apply (at least) a 100m x 100m grid, or polygons with similar accuracy, also for fixed broadband. However, 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 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.

33. 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. 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

34. 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.

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

35. 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.[20]

36. 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 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.

37. All these options are acceptable, in so far as the relevant definitions are used and the information that the NRA obtains is as described in section 2.

2.4.1 Fixed broadband

38. 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.

39. 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:

    a. the definition of households passed,

    b. download speed,

    c. upload speed,

[20] 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.

d. access technology and

e. a high resolution of data.

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

40. 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 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 extent and performance of a network – precision at the address level

41. The reach of the network is characterized by structured data, which mainly describes the premises passed[21] by the different broadband access network providers.[22]

42. **Thus, for each address passed, technology and network provider, the following information must be produced by the NRA/OCA from the operator's data, in the format specified in Table 7 of Annex 4[23]**

- **Network provider code**
- **Technology code categorized per subsection 2.4.1.2**
- **Maximum Download speed class per subsection 2.4.1.3.**
- **Maximum Upload speed class per subsection 2.4.1.3.**
- **Normal Download speed class per subsection 2.4.1.3.**
- **Normal Upload speed class per subsection 2.4.1.3.**
- **Number of premises passed by the operator at the address (Optional)**
- **Determine if that network is VHCN at the address considered**

43. 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

[21] See the relevant definition in subsection 2.1.

[22] 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.

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

provided for each technology. For the number of premises passed at the address the operator can provide a figure based on their assumptions.

44. For the submission of VHCN information, network 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.

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

46. Moreover, the Guidelines also require NRAs/OCAs to **use a unique address database in order to compile 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.[24] NRAs/OCAs can source address database information preferably from publically available data sources, but they can also rely on private information (including operator information) if they consider this more suitable. The format of this address database is specified in Table 8 (Annex 4).

47. 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 are characterizing the extent and performance of a network – precision at a grid level

48. 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.

49. As for addresses, the Guidelines require NRAs/OCAs to maintain a 'grid database' (Table 10 in Annex 4), 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

[24] 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).

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.

50. **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 9, Annex 4:**

- **Network provider code**
- **Technology code categorized per subsection 2.4.1.2**
- **Maximum Download speed class per subsection 2.4.1.3.**
- **Maximum Upload speed class per subsection 2.4.1.3.**
- **Normal Download speed class per subsection 2.4.1.3.**
- **Normal Upload speed class per subsection 2.4.1.3.**
- **Number of premises passed by the technology in the area**[25]
- **Determine if that network is VHCN at the relevant grid reference**

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

52. Moreover, the Guidelines also require NRAs/OCAs to use a unique grid database and code (see Table 10, Annex 4) **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 9*,* Annex 4) and in Table 10, Annex 4.

53. For the submission of VHCN information, network 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.

2.4.1.2 Technology

54. In order to characterize the theoretical coverage of 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.

55. Column 2 in Table 1 specifies the **codes** (column 2) that should be used in this respect to reflect the technologies on the last mile. The reason for this level of granularity is to

[25] 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 122). 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.

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.

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

Table 1 – Technology/medium codes[26]

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 (for example, Wimax, 4G, 5G)	**FWA**	AIR
FWA in unlicensed spectrum (for example, WLAN (Wi-Fi))	**WIFI**	
Other	**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 1.

2.4.1.3 Speed Classes

57. Both the maximum and the normal speed as defined in subsection 2.1 must be provided. Information on normal 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. Both types of information can be relevant to consumers and both are included (for a particular service) in BEREC Regulation 2015/2120. Please see **Annex 3** for the speed classes to be provided.

58. **Further elaboration**: In the future, it may be appropriate to recommend that BEREC consider the value of working on the methods to calculate speed information according to

[26] 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 1.

the relevant fixed network. Indeed, some NRAs/OCAs provide some specifications (with varying degrees of complexity) that operators must follow in generating their speed estimates so that their estimations follow similar rules. For example, with copper and DSL fixed networks, the distance to the street cabinet or the switching centre and the number of users impact on the speed availability.

Question 2

Berec has considered several methods to calculate speed information according to the relevant fixed network. The development of these methods often requires information on the position of network infrastructure (for example, collecting the distance to the street cabinet or the switching centre). Do you consider information on location of infrastructures strictly required for the purpose of art 22? If so, what is the minimum information level related to network infrastructure that the Geographic Survey should collect and why?

2.4.2 Mobile broadband

59. Following BEREC's consultation with the Member States (NRAs and OCAs), 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:

    a. broadband service availability,

    b. speed information,

    c. user location and

    d. a high resolution of data.

60. Moreover, BEREC published in 2018 its *'Common Position on information to consumers on mobile coverage'*[27] that describes in detail the concepts of both service availability and resolution.

61. 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

[27] BoR (18) 237, available at https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/common_approaches_positions/8315-berec-common-position-on-information-to-consumers-on-mobile-coverage

categorisations such as speed classes (see section 2.4.2.2) or other physical quantities. 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

62. 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 at a specific location (for resolution, see 2.3). 3G, 4G and 5G generations offer distinct services and performances and may such be mapped accordingly[28].

63. BEREC uses ITU standards and definitions when mentioning 3G, 4G and 5G[29] 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

64. 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%.

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

2.4.2.2 Theoretical broadband radio coverage calculation

66. 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

[28] 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.
[29] 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.

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.

67. Regarding the methodologies and the models used to calculate QoS-1 indicators for mobile radio coverage, the parameters and tools to be applied may differ, depending on the mobile network operator or the NRA in question. In order to progress towards a significant level of harmonization of the theoretical mobile coverage calculations, some basic network design assumptions in the theoretical calculations should be taken into account.

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

69. Information regarding QoS-1 data services speed and, more specifically, speed classes (Annex 3) may also be important for a number of reasons. For example, this information enables setting a grid to a specific broadband category (basic, NRA, VHCN) which would be helpful to establish the mobile coverage gap and to program and implement EU funds for mobile network rollout.

70. The broadband speed classes to be provided by operators or calculated by NRAS/OCAs should focus firstly 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.

71. The calculation of theoretical broadband service coverage when the user is in movement, as well as indoors, could be considered where appropriate and where such estimations take into account the technical specificities of such medializations (for example by implementing a penalty factor to estimate indoor radio coverage from outdoor radio coverage).

72. Moreover, NRAs/OCAs should provide information about the area being covered by a VHCN. For the submission of VHCN information network 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.

73. Additionally, mobile network 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).

74. 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.

75. 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 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 of mobile broadband

76. Ultimately, the dataset to be collected in order to characterize the mobile network is presented in Table 12 (Annex 4). For each 100m x 100m (or smaller) area, **NRAs maintain a structured data to characterize the reach of the mobile broadband network and collect the following information, on a per operator basis:**

    - **Grid code or polygon ID**
    - **Technology availability**
    - **Qualification as a VHCN**

    Additionally, other parameters may also be required when NRAs/OCAs decide to collect performance information, such as QoS-1 speed information or other technical parameters regarding signal strength:

    - **Upload Maximum Speed classes (according to Annex 3)**
    - **Download Maximum Speed classes (according to Annex 3)**
    - **Other technical parameters regarding signal strength**

    Please see Annex 4 for the tables with information to be sought and some indication on the means to gather the information.

77. 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 or other).

Question 3:

As explained above, BEREC considers that the characterization of the mobile network is reliant mainly on technology (subsection 2.4.2.1), and that NRAs/OCAs may collect performance information, such as QoS-1 speed information (subsection 2.4.2.2.) as they see fit for their own needs.[30] **That is, each MS may decide on the performance information suitable for its own national circumstances.**

However, BEREC would like to hear views on the following issues:

A) Does such optionality compromise the purposes of Article 22, or should BEREC consider making some performance information non-optional? If so, why, and which information should be mandatory?

B) Which kind of performance information may be better to inform end users? (Note that in all circumstances NRAs/OCAs should consider that BoR (18) 237 has already recommended that *"In order to improve the information on mobile coverage given to the public, NRAs may want to consider specifying at least four levels of mobile coverage. Generally, the levels of mobile coverage could be chosen to reflect the different probabilities of successful service reception which equates to service availability"*. As an example, a service could be characterized by the following graded approach: capability to the end user to: 1.) browse traditional web pages and consult emails, 2) to view enriched web content and to stream standard quality video, 3.) to stream high definition videos.

78. 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 Member States 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.

[30] In any case, BEREC would consider the specifications described in subsections 2.4.2.1 to 2.4.2.2.

79. 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 unrelated to end user experience, and comparison of these metrics can therefore be deceptive,[31] especially if compared with other metrics such as QoS-2 speed information which NRAs/OCAs may prefer.[32]

Question 4

Should BEREC seek to harmonize the assumptions made by operators and NRAs throughout Europe? Should BEREC encourage NRAs/OCAs to seek this harmonization at a national level? Which assumptions should be considered to be harmonized and how? (For example, should BEREC consider data service speed coverage calculations without cell load, considering that the network is available for at least one user at a specific location at a specific time? Or should BEREC consider network load and, if so, based on which parameters?)

2.5 Data and characterization of a GIS system

80. A broadly accepted definition of GIS[33] 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"*.

81. The functions of GIS include: data entry, data display, data management, information retrieval and analysis.[34] This subsection provides information how to start the mapping process and which data are relevant to these Guidelines.

[31] 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.

[32] 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.

[33] Please see Annex 5 for more details on GIS.

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

82. 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.).

83. Please see Annex 6 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

84. A map layer may contain groups of point, line, or area (polygon or multipolygon[35]) 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 2 - Layers

Kinds of layers	Layers NRAs/OCAs may have	Layers relevant to Guidelines
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, at least 100m x 100m (Polygons that can be processed to raster)
Inventory raw data layers		o Premises passed per operator, medium, technology, speed and other parameters for fixed broadband in reference address points o Area covered per operator, medium, technology, speed and other parameters for - fixed and mobile broadband – in reference grids

[35] 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.

Analysis results layers		o Aggregated grid coverage, 1x1 km o Aggregated grid speed, 1x1 km o Others to be decided by NRAs or BEREC[36]

2.6 Forecast specificities

85. 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.

86. 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.

87. 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.

88. 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

[36] See subsection 2.7.3.

objectives,[37] and the information required in respect of each of these mechanisms is gathered at different times.[38]

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.'[39] 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[40] 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 this information and may provide a powerful tool in the context of the state aid procedure. NRAs/OCAs may, on the contrary, decide that it is sufficient to gather information about 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.

89. 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.

[37] 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.

[38] 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.

[39] 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.

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

2.6.1 Forecasts of broadband reach

90. 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 as different layers information on broadband reach, and information on forecasts of broadband reach.

A) Agents providing the information

91. **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).**[41] 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

92. 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.

C) Frequency of data collection

93. 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.

[41] 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.

D) Forecast period

94. The State Aid Guidelines establish a forecast period of 3 years. BEREC recommends that the forecast period to designate areas (Article 22(2)) should be in line with the period mentioned in the State Aid Guidelines, in order to achieve consistency with such Guidelines, so that the forecast period should be at least of 3 years.

E) Resolution of the data collection

95. The resolution of the data provided should be as follows:

- For network deployments expected to be finished within the first year, detailed forecasts with the same resolution as for broadband reach (see subsection 2.3) should be provided.
- For network deployments expected to be finished within the second and third year (or any subsequent years), where the deployment plans are likely to be less concrete, the granularity of the data can be lower but should be (at least) at a level of grids of 1,000m x 1,000m (or polygons achieving the same accuracy of information).

F) Data to collect

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

Table 3 – Data to collect on forecasts

Variable	**Grid or address**	**Zone code (optional)**	**Operator**	**Technology code**	**Maximum Download speed category**	**VHCN**	**(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	Network provider code according to a list provided by the NRA/OCA	Codes in table 1.	Speed category after rollout. Code in table 6, Annex 3.	Boolean (0/1) that characterizes if the rollout is of a VHCN	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.

2.6.2 Verification of forecast data

97. 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.

98. 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.

99. 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.

100. *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).
- Considering the realisation of the main milestones of the investment plan within the planned project timeline (taking into Q the size of the project, granting of permits, realisation of civil engineering work).

101. *Ex post verification* entails comparing forecasts with actually implemented network deployments[42] by verifying the level of adherence of the operator with the planned timeline in terms of achievement of the main milestones of the project.

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

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

- NRAs/OCAs may check whether large deviations occur repeatedly in the case of 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

103. 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.

104. Moreover, Directive 2003/98/EC on 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.

105. 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.

106. 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.

107. Finally, it should be noted that the requirements of the GS information system should reflect the guidelines of the INSPIRE Directive, 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

108. 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.

109. 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.[43] One particular group of consumers in this regard is those without internet connectivity.

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

- Interactive maps 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.

111. 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 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

112. 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.

113. 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.

114. The interests liable to be harmed by disclosure must, objectively, be worthy of protection.[44] It is highly recommended that operators establish their claims for confidentiality, and that the NRAs/OCAs settle those claims according to clear and non-

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

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

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).

115. Some examples of information that could qualify as business secrets and are 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.

116. 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;
- 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

117. 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.

118. 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

119. In order to fulfil their responsibilities, NRAs/OCAs may calculate aggregated broadband coverage rates for each administrative boundary, 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.

a) <u>At address level</u>

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

121. In the context of State Aid, although data may be collected on a fine granular basis – specifically, geocoded address data[45] - 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.

[45] 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, the design of national broadband plans including also an adequate identification of market failure areas (Article 22 (5)).

122. Broadband networks cannot be efficiently deployed to target individual addresses. Accordingly, geocoded address data should be aggregated into areas consisting of aggregated address points which are large enough to ensure that an efficient state-aided network deployment would be feasible.

123. When aggregating data produced at grid level, NRAs/OCAs must aggregate data between several operators and technologies. However, since they cannot identify the exact overlaps between operators and technologies, they have little or no option, other than to make reasonable aggregation assumptions.

124. 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.

125. Therefore, in order to treat overlaps,[46] 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.

126. Note that if authorities request or calculate mobile information on a grid smaller than the 100m x 100m grid (for example 20m x 20m), it would be recommended that when aggregating information to a 100m x 100m grid, they take into account that, for it 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

127. 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.

128. 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

[46] 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.

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.

129. 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. If the disclosure risk is low, they may release the data without any aggregation. If the disclosure risk is high, the information shall be provided ars argued by thirs authorities who shall be legally obliged to protect this information.

130. NRAs/OCAs shall 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 motivate 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.

131. 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.

132. Some examples[47] of fit-for-purpose spatial aggregations of the collected data, in order to perform specific tasks 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 relevant geographic markets, (Article 64(3))
  - For defining coverage obligations attached to the rights of use for radio spectrum (Article 22(5))
- 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

[47] This is not a comprehensive list of examples, but rather the most usual ones. For example, in the domain of defining relevant markets the footprint of the central exchange may also be relevant.

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 rules1 (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 - Quality of Service (QoS) concepts

- QoS-1: Calculated availability of service and network performance of existing infrastructure.
- QoS-2: Measured provision of service, excluding end user's environment.
- QoS-3: Measured experience of service, including end user's environment.

Table 4 - Quality of Service (QoS) concepts

QoS-1: Calculated availability of service	**What**	Theoretical network performance of existing infrastructure (coverage, no pure infrastructure data)	
	How	**Wired** Assessment / calculation / marketed speeds by provider / geodata-based simulation models / prediction tools	**Wireless** Assessment / calculation via geodata-based simulation models / prediction tools / radio field planning
QoS-2: Measured provision of service	**What**	Provision of service measured at the Customer Premises Equipment (CPE), e.g. routers, mobile devices excluding end user´s environment	
	How	**Wired** Measurement through panel probes	**Wireless** Measurement through drive tests or speed tests
QoS-3: Measured experience of service	**What**	Actual user's experience when using Internet Access Service (IAS) tests including end user's environment	
	How	**Wired** Measurement via online speed	**Wireless** Measurement via online speed tests

Source: European Commission. Available at https://ec.europa.eu/digital-single-market/en/broadband-and-infrastructure-mapping-project

Annex 2 - Assessment of spatial resolution units

Table 5 - 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 3 - Speed classes

The following are the speed classes (download and upload) which BEREC proposes should be applied in the submission of information:[48]

Table 6 – Speed codes

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

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

[48] 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 4 - 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).

Table 7 – Address coverage and performance database

Variable	Technology	Network provider	Max download speed class	Normal download speed class	Max upload speed class	Normal upload speed class	Number of premises passed	VHCN
Description	Codes in Table 1	Network provider code (according to a list provided by the NRA/OCA)	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Number of premises passed at this address. (optional)	Boolean that characterizes if the service provided at this address with this technology and speed is VHCN.
Data type	Character varying (6)	Character varying (6)	Integer	Integer	Integer	Integer	Integer	Boolean

Table 8 – Address database

Variable	Address coordinate*	Address code	Address	Zone code	Number of premises	Number of households	Public services buildings
Description	Coordinate of the address in the WKT format[49]	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 format of the	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 4- main transport hubs

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

			Member State				5- highly digitalized businesses This entry is optional
Data type	Point	Character varying (50)	Character varying (100)	Character varying (50)	Integer	Integer	Character varying (50)

*Some NRAs may want to add information regarding the projection system used, if needed due to their national circumstances.

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).

Table 9 – Grid coverage and performance database

Variable	Technology	Network provider	Max upload speed class	Max download speed class	Normal download speed class	Max upload speed class	Number of premises passed	VHCN
Description	Codes in Table 1	Network provider code (according to a list provided by the NRA/OCA)	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	Number of premises passed in this area.	Boolean that characterizes if the service provided at this area with this technology and speed is a VHCN.
Data type	Character varying (6)	Character varying (6)	Integer	Integer	Integer	Integer	Integer	Boolean

Table 10 - 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.[50],[51]				
Data type	Multipolygon	Character varying (50)	Character varying (70)	Integer	Integer

2) For mobile broadband

Table 11 - Grid database table

Variable	Coordinate	Grid code	Zone code name	Number of households
Description	Coordinate and geometry of the polygon in the WKT format.[52],[53]	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 households in this area. This entry is optional
Data type	Multipolygon	Character varying (50)	Character varying (70)	Integer

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 lower, preferably using multiple designations or more to characterize each geographical point
  - Additionally and optionally, this grid can be enriched with radio coverage, as in Section 2.4.2.2.

[50] That polygon could be a grid.

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

[52] That polygon could be a grid.

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

- This grid can be enriched with speed coverage, as explained in Section 2.4.2.2 (see Table 12).

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

Table 12 – Data to be collected

Grid Code Or polygon ID	Resolution (1)	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	Max Download speed, see subsection 2.4.2.2 (optional)	Max Upload speed, see subsection 2.4.2.2 (optional)	*Other technical parameters regarding signal strength, see subsection 2.4.2.2 (optional)*	VHCN, see subsection 2.4.2.2
Integer	string	Boolean	Boolean	Boolean	Boolean	Codes in Table 6, Annex 3	Codes in Table 6, Annex 3	TBD by the NRA/OCA	Boolean

(1) Polygon resolution or grid size

Annex 5 – 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.[54]

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.[55]

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.[56]

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

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

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

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

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 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.[57]

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.[58]

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.

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

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

Annex 6 – 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) Collect selected vector spatial data (city, county, streets, addresses, building, cadastre etc.) and import into database

d) Choose a geographic coordinate system

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

Presentation of gathered data and results analyses by open network protocols such as WMS or WFS enabling download using open formats