Body of European Regulators for Electronic Communications

BEREC

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BEREC Report to enable comparable national broadband coverage indicators throughout Europe

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1 Introduction

The Broadband Coverage in Europe Study[1] (hereafter, the Study) has been conducted since more than a decade in order to inform about the progress in the development of broadband networks of the EU Member States (hereafter, MS) towards the specific broadband objectives established by the European Commission (hereafter, EC) in the Digital Agenda for Europe[2] namely: universal broadband coverage with speeds of at least 30 Mbps by 2020, 50% of households having broadband subscriptions of at least 100 Mbps by 2020 and universal connectivity offering a download link of at least 100 Mbps upgradable to Gigabit speed by 2025. More recently, the EC has launched the Digital Compass in order to drive Europe fully into the digital decade[3].

Since 2012, the Study's methodology has been improved and adapted to the market developments and the informational needs, taking account of the updates in connectivity targets. The data collection exercise takes place yearly and is one of the most comprehensive at European level. The same underlying data feeds into the connectivity dimension of the Digital Economy and Society Index (DESI)[4].

The DESI was designed to monitor Europe's digital performance, helping the policy makers in identifying areas where MS are lagging behind and where there is a need for prioritised investment and immediate action. The DESI is built along 5 different dimensions, and one of them, the connectivity dimension, is relevant here as, among others[5], it builds upon the following indicators: fixed broadband coverage, 4G mobile broadband coverage and 5G mobile broadband readiness.

Despite the comprehensive data collection on broadband coverage that underlies the Study and given its widespread use for comparing countries' advancements in terms of coverage, BEREC is of the opinion that some improvements could be brought to the present state of art and, therefore, is providing a series of recommendations to be

[1] For the most recent published study, see: https://digital-strategy.ec.europa.eu/en/policies/desi-connectivity. Please note that the data collection for the Study was done for the 27 EU member states, as well as for Iceland, Switzerland, Norway and the UK, in 2020.

[2] See more at: https://www.europarl.europa.eu/factsheets/en/sheet/64/digital-agenda-for-europe

[3] The Digital Compass establishes that by 2030 all European households should be covered by a Gigabit network, with all populated areas covered by 5G. More info can be found here: https://digital-strategy.ec.europa.eu/en/policies/digital-compass

[4] https://digital-strategy.ec.europa.eu/en/policies/desi-connectivity

[5] The DESI Connectivity Dimension is calculated as the weighted average of four sub-dimensions: Fixed Broadband take-up (25%), Fixed broadband coverage (25%), Mobile broadband (35%) and Broadband price index (15%).

considered by the MS in order to provide coverage information, so that the result is more comparable coverage statistics.

Partly, these recommendations build on the extensive work that BEREC has done towards the consistent application of the provisions of Article 22 of the European Electronic Communications Code (EECC) and pursue to align the Study with the BEREC Guidelines on geographical surveys of network deployments (hereafter, BEREC Article 22 Guidelines)[6]. The recommendations also follow from the fact that Article 22 EECC requires that by December 2023 or earlier, all MS conduct a geographical survey of the reach of electronic communications networks capable of delivering broadband.

Moreover, to better understand the problems that arise during the whole process leading to the provision of the coverage indicators that feed the Study, relevant information was sought from public authorities and operators, so that BEREC was able to form a wider view of all the issues and potential improvements which could be suggested.

On the 12th of October 2021, BEREC held two workshops: one with NRAs and OCAs, and one with stakeholders, to discuss possible improvements in the methodology which is the basis for the estimation of NUTS 3 and national coverage indicators in the Study. BEREC has considered all the comments made by NRAs, OCAs, the EC and stakeholders when drafting this Report.

The stakeholders expressed that common definitions should be promoted throughout Europe so that coverage data would be more comparable across countries, but, at the same time, warned BEREC that there is a need for the stability of definitions, for efficiency reasons and also to enable the tracking of coverage across time. Moreover, the stakeholders welcomed that BEREC is providing recommendations on the treatment of overlaps and agreed that the granularity of raw data is useful to avoid errors in the aggregation of coverage information and to better inform on rural coverage.

The BEREC Article 22 Guidelines recommend that MS update such broadband mapping surveys yearly and also provide tools for the improvement and the European harmonization of the data collected at national level to characterise broadband reach and performance, to the benefit of the enhanced comparability and accuracy of broadband coverage information throughout Europe. These tools include common definitions for key concepts in broadband mapping and common templates for data

[6] https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/9990-handbook-of-berec-guidelines-on-geographical-surveys-of-network-deployments

collection, the request to enable coverage and performance data at a very granular level (address level and/or small grids) and the strong recommendation to verify the data collected. Moreover, the BEREC Article 22 Guidelines also request Authorities to maintain granular information on the availability of very high capacity networks, which are defined by BEREC's Guidelines on Very High Capacity Networks (hereafter, BEREC VHCN Guidelines). These developments should provide a better basis for the comparability of aggregate broadband indicators with respect to the past. First, the provisions of the EECC (Article 22 and related Articles 20 and 21) put forward the means for public authorities in MS to develop accurate broadband maps. Second, BEREC needs to insist on the indispensability of a granular data collection, as required in the BEREC Article 22 Guidelines: the granularity of data will allow Authorities to rely on the best information to inform their decision making and to inform the public, but also sufficiently granular data avoids the need to use untestable hypothesis to estimate coverage in areas that can be served by several operators, which is relevant to this Report. Third, also relevant to this Report is the role that public authorities need to play in assuring the quality of data, which is acknowledged in the BEREC Article 22 Guidelines and considered as intrinsic to a consistent implementation of the obligations under the said Article.

Because of all these reasons, BEREC considers that the sourcing of data for the Study should entirely rely on the national authorities in charge of delivering the Article 22 Broadband maps or their affiliate organizations, whereas, up to now, on a few occasions, the data was provided by operators with little involvement of the public authorities. The provision of data by operators should be considered as exceptional and where properly justified.

Finally, the provision of good quality coverage data requires time, also to enable its verification, and, therefore, BEREC would recommend that the Authorities had more time to prepare the data reporting as requested by the EC consultants[7], since data is sometimes not readily available in house and implies an ad-hoc data collection process. For instance, **at least 2 months from the data request to the delivery would be considered sufficient**. Moreover, BEREC is aware that different Authorities submit data relative to different time points of the year (mainly June and December). Therefore, **it may be useful for the EC to investigate the possibility for Authorities to agree on one date/period when the data should be retrieved**.

[7] The preparation of the Study and the related data collection and verification have been commissioned by the EC to a series of consultants since the beginning of the Study. These "EC consultants" have developed, revised and applied the Study methodology under the EC supervision.

The BEREC Article 22 Guidelines and other previous BEREC work done on related topics[8] have paved the way for richer, better and more comparable broadband coverage and performance data. BEREC continues committing to this objective, as showcased by this Report and by other BEREC activities, such as the delivery in 2021 of a Workshop of NRAs' experiences with 5G and the future organization in 2022 of a Workshop to share experience on the implementation of Article 22 EECC. The reporting of appropriate and relevant indicators is subject to change, as a consequence of markets and technologies' evolution, the resulting update of the European connectivity targets, the improvement of available information tools and the harmonization efforts promoted by different institutions. Therefore, the continuation of the Study in monitoring and adapting to these developments is considered highly welcomed and most useful.

2 Definitions

2.1 BEREC Article 22 Guidelines definitions

Building on the extensive work that BEREC has already done towards the consistent application of the provisions of Article 22 of the EECC, BEREC is proposing that all data collection processes which feed into the broadband coverage indicators comprised in the Study[9] should be done using the methodology and the concepts described in the BEREC Article 22 Guidelines.

This adaptation can be implemented step-wise in order to lead to the full harmonization of data collection practices expected as of 2024, considering the deadline provided for in Article 22 by which all NRAs are expected to have implemented the geographical surveys of network deployments.

In what follows, each relevant definition promoted in the BEREC Article 22 Guidelines will be presented and its role in the conduct of broadband coverage data surveys will be highlighted and explained, making reference to the present practice in that regard.

Households/homes passed and premises passed

Currently, the broadband coverage survey prescribes a data collection based on the concept of "households and homes". The households and homes (and households and homes passed) concepts are used interchangeably and refer to a housekeeping

[8] See for example, BoR (20) 33, BEREC Feasibility study on the development of coverage information for 5G deployments and BoR (18) 273 BEREC Common Position on information to consumers on mobile coverage.
[9] Note that the Study is based on coverage indicators exclusively, and not on take-up information or information on connected households.

unit or, operationally, at a social unit having common arrangements, sharing household expenses or daily needs and living in a shared common residence. The actual household figures are computed taking into account the population data in each relevant geographical unit, as well as the average household size figures for each country. Nevertheless, should it be the case, the EC consultant invites the data respondents to update the respective figures for their countries if there is better/more accurate or up-to-date information available at national level.

In terms of the practices across Europe, the actual data collection process has shown a variety of approaches regarding the figures reported. On the one hand, there are several public authorities that update the household figures according to their own available data (in certain instances also underlying definition changes in agreement with the definitions used by the national statistics offices). On the other hand, because of the fact that some authorities cannot distinguish between residential premises and businesses, the data reported includes both, the final coverage figures being reflective of both types of buildings. Similarly, the stakeholders have also pointed out to the difficulties they find in distinguishing between residential and business premises. At the same time, there are certain NRAs who depart from the "households/homes passed" concept and use "dwellings"[10] as the relevant unit to be taken into account when reporting on coverage.

Furthermore, certain NRAs consider that the household numbers provided by the EC consultants, because of the way in which they are calculated, determine, in general, an overestimation of the actual number of households in the country and, as a consequence, coverage figures are underestimated.

All of this also renders the cross-country comparisons less reliable since some of the countries update the households' data themselves according to various definitions or sources.

Taking all the above into account, in order to promote a consistent view at European level, **BEREC recommends that instead of relying on "households and households passed", the Study considers the "premises and premises passed"[11] concepts as defined in the BEREC Article 22 Guidelines**. The premise concept is crucial to the operationalization of the mapping/characterization of broadband networks and the definition used in these Guidelines has been agreed after extensive consultation as the concept to be used by all public authorities and stakeholders and, therefore, in BEREC's view, this should be the central reference point. **BEREC recommends that this change is applied in the very short-term,**

[10] The concept of "dwellings" refers to all the buildings available in the area covered by the closest (to the end user) distribution point of the network, including but not being limited to second homes, unoccupied buildings, tourist accommodation establishments and so on.

[11] And other related definitions, also included in the BEREC Guidelines, such as building, address and address passed.

considering its importance and impact on the comparability of data provided throughout Europe.

BEREC reminds that, according to the BEREC Article 22 Guidelines, an address is passed when at least one premise at the given address is passed. Differently put, if a particular address is passed by a broadband network, then all the premises at that particular address can be considered as passed and, therefore, should be accounted for in the NUTS 3 and national coverage figures[12]. Whilst the former applies to address-based information, the situation is different where small grids are used. In this case, the BEREC Article 22 Guidelines provide for the collection of the number of premises passed per grid and this information should be the source for the NUTS 3 and national coverage figures.

The BEREC Article 22 Guidelines clarify that a premise can either be a residence or a place of business, which circumvents the problem of the NRAs/OCAs who cannot distinguish between residential and business buildings and its consequences.

It is also worth noting that, when computing the coverage figures, the premises passed should be referred to the total number of premises in the country or NUTS 3 region, an information that is required in the BEREC Article 22 Guidelines. If these numbers are not available in the short term, proxies should be used based on the information available in the MS and the public authority's judgment[13].

BEREC considers that following such an approach in reporting of the coverage data would improve the comparability of broadband coverage indicators, eliminating the potential discrepancies incorporated in the data by the use of different concepts for the coverage metrics and, at the same time, being an easier to use and a good proxy for the "households" concept. Moreover, by using this transparent and widely-accepted definition, each country would be able to provide its own accurate and up-to-date statistics following the adopted recommendation by BEREC, in a harmonized manner.

Definitions for fixed and mobile technologies

The current version of the Broadband Coverage Survey in Europe provides for a series of nine technologies (both fixed and mobile) for which data are sought separately, namely:

- DSL, VDSL and VDSL 2 vectoring;
- FTTP;

[12] The number of premises passed at each address was considered as optional in the BEREC Article 22 Guidelines. In most circumstances, given the definition for premises passed in the BEREC Article 22 Guidelines, if one of the premises of a building is passed, the rest of premises of the building will also be passed.

[13] For example, some authorities find it useful to sum the number of dwellings and the number of establishments, figures that are provided by their National Statistical Offices.

- DOCSIS 3.0 and DOCSIS 3.1, to be collected separately;
- FWA;
- LTE and 5G, to be collected separately.

At the same time, the survey provides for an aggregation[14] of these data in order to provide values for the (i) overall fixed broadband coverage (all technologies included), (ii) overall NGA coverage (including VDSL and higher, FTTP and cable modem) and (iii) overall FTTP and DOCSIS 3.1. coverage.

With respect to the fixed networks, the BEREC Article 22 Guidelines provide for a slightly different technologies' classification, with data collected for DOCSIS 3.0 and 3.1 altogether, as well as DOCSIS 1.0 and 2.0 and, regarding the fixed wireless connections, BEREC recommends a split by the type of spectrum used – licenced (FWA) and unlicensed spectrum (WIFI). Considering the coexistence of legacy and fiber networks, the technologies envisaged are endorsed by BEREC as well.

Taking into account the mobile networks, the BEREC Article 22 Guidelines require the reporting of the availability of certain mobile technologies (i.e. 3G, 4G, 5G non-standalone and 5G standalone) at 100m x 100m grid level. The 3G standard includes UMTS and HSPA technologies, the 4G comprises LTE and LTE-advanced, while the 5G refers to NR non-standalone and NR standalone. It is worth to note that, according to the BEREC Article 22 Guidelines, a grid is considered covered if a broadband service (≥ 2 Mbps) is available in at least 95% of the grid, featuring a probability of successful reception of minimum 95%.

In the light of the above, BEREC considers that, in principle, the data currently requested through the Study in terms of technologies are aligned with the classification presented in the BEREC Article 22 Guidelines.

At the same time, **BEREC** is supportive of the split concerning the overall fixed broadband, the overall NGA coverage and the FTTP and DOCSIS 3.1 coverage, but **would like to address the possibility for the EC and the EC consultants to take into account the concept of very high capacity networks (VHCN)**, which is different from the current proxy used in the Study (FTTP+DOCSIS 3.1). Further details on this are provided in the subsection below.

Concerning the overall NGA coverage characterization, BEREC notes that there are certain FWA networks which are capable of delivering similar performances to the technologies already included in the said definition, being able of realistically delivering a download speed of at least 30 Mbps, for instance. Thus, for the sake of comparability and to safeguard the principle of technological neutrality, **the EC should consider as NGA the already included technologies – namely VDSL and higher, FTTP and**

[14] The aggregation formula represents an arithmetic average of the minimum possible coverage (equal to the coverage of the most widespread technology in the area and the maximum possible coverage (equal to the sum of the coverage of all the technologies being considered or to 100%, whichever is lower).

cable modem/DOCSIS 3.0., 3.1. – and as well other technologies when they enable a download speed of at least 30 Mbps.

With respect to the technologies included in the overall fixed broadband coverage, it is worth noting that **the EC might analyse the opportunity of considering other technologies capable of delivering broadband, such as FTTC/FTTN + UTP/FTP cable**[15]. In some countries, such technologies account for a relatively high percentage of the broadband connections and could be taken into account, bearing in mind the policy choices underlying the decisions based on broadband coverage data collected. Moreover, looking at the whole range of broadband technologies provided by operators individually/separately in these countries, it can be noticed that some of the operators rely mostly on this technology for the provision of services at national level.

Very High Capacity Networks (VHCN)

The BEREC VHCN Guidelines provide four criteria which fixed and wireless broadband networks must satisfy[16] to qualify as VHCNs. Following the EECC, a network is a VHCN if the underlying infrastructure has the relevant characteristics (i.e. either there is fiber at least up to the multi-dwelling unit or fiber to the base station, namely criteria 1 and 2 in the BEREC VHCN Guidelines) or if it satisfies the established QoS thresholds (criteria 3 and 4 of the BEREC VHCN Guidelines). The BEREC Article 22 Guidelines provide for this information by requiring that operators declare whether an address/grid is VHCN-served and inform on the criteria that supports the declaration. In particular, BEREC requires that any FWA network surpassing the thresholds indicated in criteria 3 of the VHCN Guidelines in one address/grid is declared as a "fixed VHCN".

Currently, the Study is proxying the VHCN concept by considering the "FTTP+DOCSIS 3.1" category. **BEREC considers that this concept needs updating, since nowadays and in the future, other technologies/underlying infrastructures would qualify as a VHCN.** For instance, the broadband networks based on FWA, including the 5G FWA (which is expected to gain in importance in the upcoming years), may also qualify for VHCN. Moreover, according to the BEREC VHCN Guidelines criteria, DOCSIS 3.1. would only qualify as VHCN if fibre is rolled out at least up to the multi-dwelling building (with coaxial cable only within the building) or if the performance thresholds of criterion 3 of the Guidelines are met. **In the light of the above, BEREC considers that the concept of "fixed VHCN" included in the BEREC VHCN Guidelines is particularly relevant and should be considered in the Study**.

This approach would have the advantage to bring the data concerning ultrafast fixed broadband, respectively fast mobile broadband to a common standard which is aligned

[15] The operators providing broadband services through this technology are capable of realistically achieving actual download speeds of at least 30 Mbps.
[16] At least one of the criteria.

with the EECC and represents a reference point at EU level. Furthermore, most countries would have already collected statistical data about the presence of VHCN (especially in the case of fixed networks) according to the BEREC Article 22 Guidelines, and, therefore, BEREC considers that this would not pose any additional burden on the Authorities and operators. Nevertheless, the EC could still continue the data collection process concerning the FTTP, DOCSIS 3.1. proxy for a while, until the new concept would have determined a relevant time series.

Gigabit networks

Concerning Gigabit networks in the context of the EC's communication "2030 Digital Compass: the European Way for the Digital Decade"[17] and taking due account of the upcoming revision of the DESI and the indicators considered thereof, **BEREC recommends for the Study to refer to the notion of "premises/small grids passed with a broadband network capable of delivering download speeds of at least 1 Gbps", which is one of the categories included as mandatory for fixed broadband networks in the BEREC Article 22 Guidelines.** Moreover, these BEREC Guidelines also provide for very granular information on the different technologies which could currently reach the Gigabit standard.

Definitions for speeds

Regarding speeds, the data collection process in the Study comprises of several speed categories: ≥ 2 Mbps, ≥ 30 Mbps, ≥ 100 Mbps and ≥ 1 Gbps, all referenced to the download speed[18]. According to the current methodology, these speeds need to be achieved for the majority of the time, this being defined as at least 75% of the time. Of course, these speeds are to be considered with reference to the underlying technologies used, but the element of differentiation between the two is the achievement of the prescribed speed in at least 75% of the considered time.

With regards to this characterization, BEREC is wary that it might enable distortions in the reported data because the speed to which the reference is made should be qualified in clear and homogenous terms, since the idea of realistically achieving the speed needs to be linked with the conditions in the network and the QoS parameters. Nevertheless, BEREC has the understanding that this is not the peak time speed which is requested. Moreover, as the practice has shown, some countries take into account best-effort speeds when reporting, while BEREC takes that this should not be the case.

At the same time, the reference to the 75% of the time seems unclear and difficult to "measure". Because of the differences in interpreting this concept, BEREC considers

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0118&from=en

[18] Although the reference in the data collection is general, including mobile technologies as well, the EC consultants ask for the inclusion of "speed capabilities of fixed broadband access technologies".

that this methodological aspect may also be a source of divergence resulting in discrepancies across MS, which could be alleviated.

Moreover, the BEREC Article 22 Guidelines promoted the definitions of two categories of speeds, namely the 'expected peak time speed' and the 'maximum achievable speed'. Both types of speeds were included as mandatory in the geographical characterization of fixed broadband networks, and maximum achievable speed was recommended as optional in the case of the geographical characterization of mobile broadband networks. **Because of this, BEREC considers that it would be advisable for the Study to rely on these concepts, and not on a third different one, as is currently the case**. **Given that the peak time speed is a better proxy of the quality of the broadband service as experienced by end users than the maximum achievable speed, for fixed broadband, BEREC would recommend for the Study to rely on this metric.**

For mobile networks, **BEREC recommends for the Study to rely on the 'maximum achievable speed' concept**. In BEREC's view, this provides a more comparable measurement of network performance since peak time speed is very difficult to quantify in mobile networks and very dependent on external conditions which may vary in different times and places, on the conditions in the network and on the active equipment placed at the location.

Finally, it is worth mentioning that the Study defines LTE[19] by referring to the peak time speed (download). BEREC notes that such an approach implies that some sort of assessment connected to peak time conditions needs to be made. In that line, if these references are kept in the Study, the definition of peak time included in the BEREC VHCN Guidelines should be used as a reference.

2.2 Rural coverage

The EC has been monitoring broadband deployments since 2008 with the Digital Scoreboard serving as a tool for assessing progress towards these targets. Unsurprisingly, rural coverage indicators are a main feature of the Connectivity Dimension in the Digital Scoreboard and of the EC's broadband coverage reports. The rural coverage indicators help assess the progress of EU Member States[20] towards the different broadband coverage objectives[21] precisely in the areas with smaller prospects for private investment and which have, therefore, been the target of state

[19] "LTE (Long Term Evolution) is the next-generation mobile service standardised by the 3rd Generation Partnership Project and which supports peak downstream speeds of up to 100Mbps (LTE) and up to 1Gbps (LTE-Advanced)".

[20] Rural coverage figures are collected also from other European Countries, namely Iceland, Switzerland, Norway and the UK, as highlighted in the introduction.

[21] As set out in the Digital Agenda for Europe (2010) and in the Gigabit Society strategy (2016).

aid intervention. Rural areas are typically unattractive for private investment from an economic standpoint and, therefore, are of particular interest when accounting for the coverage situation.

To provide for rural coverage indicators, the EC relies on Point Topic's[22] European Kilometer Grid. Using the Corine land cover database[23], the Point Topic database provides information on the population of every square kilometre in Europe. This allows identifying the square kilometres for which population density is smaller than 100 inhabitants per km^2, which are those qualifying as "rural". By adding up the number of households in the rural cells of each NUTS 3 region, an estimate of the rural households per NUTS 3 area is delivered. Then, public authorities are requested to provide the number of rural households passed in each NUTS 3 area so that the percentual rural coverage indicator is calculated.

This approach was chosen in 2012, to render the national indicators comparable and because most European countries had no public data which allowed identifying the number of rural households at NUTS 3 level. Also, because by relying on very granular data, very small areas contiguous to or within more densely populated areas could be considered as rural. Since then, the keeping of the approach has also made possible the comparison of rural coverage information at different points in time and the tracking of the evolution of the corresponding indicators.

Indeed, the delivery of rural coverage indicators is complex for many reasons. First, as explained, it is necessary that the identification of rural areas takes place on a very granular basis, and this identification is not always equally available or even available for all MS. Second, different definitions of "rural" coexist, partly as a consequence of the differences in demographic characteristics and the geographical configuration of European countries[24]. Whilst population density is a key characteristic of a rural area, other indicators related to the number of inhabitants of an area or its degree of isolation can also be relevant and useful. Third, ideally, since data is collected by many NRAs/OCAs at the address level, in order to estimate rural coverage and to avoid misinterpretations followed by pseudo updates, it would be necessary to know the exact location of rural areas and then the number of premises in each area, as well as

[22] Point Topic was the first consultant that developed, together with the EC, the data collection methodology for the Study.
[23] Available at https://land.copernicus.eu/pan-european/corine-land-cover.
[24] For example, some National Statistical Offices use definitions where the population density thresholds do not match the one proposed in the Study.

those that are covered by a broadband network. Summarising, the production of rural coverage data relies on many granular pieces of information.

Therefore, to provide for comparable rural coverage indicators across Europe, BEREC holds that a common definition of rural, which can be mapped in small grids, should be available. Unfortunately, such set of resources do not always exist, and therefore rural coverage information can only be proxied. The approach of the EC consultants is a good attempt of dealing with the shortages of information.

However, comparability problems emerge in practice as public authorities are cautious to compare the "rural household passed" sourced from the Authority/operators with the "rural households" obtained from the Point Topic database[25]. Then, in several cases, public authorities update the rural households figures so as to make use of the existing national official statistics and/or to ensure a better comparison of this figure to "rural households passed" figure. In some cases, public authorities use the 100 inhabitants per km^2 definition and the data in the National Statistical Office information to update the rural households figure. In other cases, public authorities resort to other definitions of "rural" since public data at sufficiently granular level is provided only for these alternative definitions. All of these hinder the comparability across countries, although it does not impede the tracking of the evolution of rural coverage figures at national level across time.

Because of this, **in order to have more comparable data, it would be advisable to investigate the possibility to use a common database which tags "rural" areas at a sufficiently granular level, under a common definition and which could be shared with the National Authorities, so that they are able then to locate rural areas in their own coverage maps, usually with data at the address level.** The implications of such choice would need to be considered by the EC and the relevant public authorities: mainly its impact on financial and human resources, but also on the technical possibilities to integrate such information in the existing national mapping tools.

For example, in 2021, Eurostat has used such type of database to classify NUTS 3 regions as predominantly urban, predominantly rural or intermediate[26]. According to the Eurostat webpage, the first step in the Eurostat classification methodology is to identify rural populations at the level of the 1 km² grid cells. In this setting, Eurostat defines rural areas as all areas outside urban clusters, where an urban cluster is a

[25] Note that public authorities cannot trace the specific zones in specific country that are deemed as rural since Point Topic provides only NUTS 3 rural households.
[26] See https://ec.europa.eu/eurostat/web/rural-development/methodology

cluster of contiguous (neighbouring) grid cells of 1 km² with a density of at least 300 inhabitants per km² and a minimum population of 5,000 inhabitants.

When comparing the Eurostat definition and the definition adopted by Point Topic with respect to rural areas, the advantage of the former is that it incorporates the idea of contiguity and, therefore, may prevent very speckled maps and the declaration of rural zones when those are contiguous or even in the middle of urban areas. As said, BEREC considers that the delineation of rural zones should be based on very granular information and on a common definition. Yet, at the same time, these highly granular or cell information should be used to delineate rural areas so that the outcome is not an excessively speckled map which can be difficult to manage for public authorities.

Finally, **it also needs to be noted that if a new tool and definition of "rural" could be considered, there would be no need to discontinue the statistical series of the existing information, which then would best be tagged as "coverage in sparsely populated areas"**.

3 Aggregation

The EC methodology used in the Study focuses on the absolute number of households passed by broadband networks for each of the NUTS 3 regions, and is applied to the following key metrics of the research regarding fixed networks:

- For each of the technologies (DSL, VDSL, VDSL2 Vectoring, FTTP, cable DOCSIS 3.0, DOCSIS 3.1 and FWA) NRAs should supply the number of households passed by each individual technology in the country by NUTS 3[27].
- Rural coverage – the same information is required for households passed in rural areas of each NUTS 3 region, as well as for the total number of rural households passed country-wide.
- Speed coverage - the numbers of households passed by networks able to achieve download speeds of at least 2 Mbps, 30 Mbps, 100 Mbps and 1 Gbps.

Regarding the mobile networks, data on coverage is sought for LTE and 5G mobile technologies, at both NUTS 3 and national levels, including for rural areas. Also, data on the individual mobile operators' population coverage for LTE is to be reported.

Treatment of overlap when several operators cover one area

[27] According to the EC methodology, where the coverage data is delivered on a more detailed geographical level than the requested NUTS 3 areas, the EC consultant aggregates the provided data to match the NUTS 3 regions.

An important challenge in the delivery of aggregated coverage indicators arises in correctly identifying the households passed by each individual technology, dealing with overlaps when several operators are in the same area and ensuring that the data is accurate and comparable across the countries. An overlap can be identified when more than one operator provides access to broadband for a single spatial unit (e.g. a grid cell), as well as when one operator provides access to broadband for a single spatial unit through more than one technology.

Finding the absolute number of households passed by broadband networks for each of the NUTS 3 regions requires the use of aggregation methodologies that consider a household passed by a technology only once.

The granularity level with regards to the data that is collected by the NRAs/OCAs differs for mobile and fixed broadband networks. The majority of the NRAs/OCAs collect coverage data for fixed broadband on address level. This makes aggregation of the data to NUTS 3 level and the treatment of overlaps in technology straightforward. Other resolution types, when it comes to fixed broadband, introduce inescapable errors in the aggregation of the data, especially when treating overlaps of different operators.

For the mobile coverage, a grid-type resolution (100mx100m or lower) gains majority use between the NRAs. Using a grid (and address-level resolution) gives an advantage when it comes to aggregation and treating the overlap of different networks over other resolutions[28].

Depending on how the results are presented at locality level (for both fixed and mobile broadband), issues can arise when it comes to aggregating the data: if the data is presented as either fully covered or not covered, then aggregating continues to be an easy task if the granularity is adequate (address level or small grids), but when coverage at locality level is presented in percentages and the granularity of raw data is poor, the final accuracy of the results decreases after treating the overlap. This is because when two or more networks are present in the same locality, the coverage of that locality is somewhere between the coverage of the network with the largest presence and the sum of the coverages of all present networks (or 100% if the total coverage (i.e. sum of operators' coverages) exceeds 100%).

[28] In the case of mobile networks, it is worth noting that the Study provides no information regarding aggregation of the raw mobile coverage data.

Clearly, lower resolution levels than NUTS 3 (national level, for example) should be avoided because consistent data at NUTS 3 level cannot be achieved in this manner.

Considering the treatment of overlap in cases where public authorities collect data at locality level (this is: town, city, municipality, parish), only a few use the formula suggested by the EC consultant[29]. Alternatively, several authorities have their own aggregation methodology, and other consider the minimum coverage in the selected area, this is, they take the coverage of the operator with highest coverage in the selected area (this is known as the "full overlap hypothesis").

Country specific methodologies adopted to calculate overall coverage are based on the specific knowledge that NRAs/OCAs have of the networks in the country. For example, one country treats overlap at parish level and, if several operators are covering the same parish, the most widespread operator in the area is considered. Then, assuming that retail and wholesale networks are complementary (not overlapping), the premises passed of wholesale only providers in the respective area are added. These kinds of assumptions can only be made by the NRA/OCA because the EC consultants do not know how complementary different networks are in an area or a country.
During the aggregation process at NUTS 3 level, besides the treatment of the overlapping at address/grid level (or other levels such as municipality level) some countries "cap" the number of premises passed in an area (municipality, for example). That is, if the number of premises passed at the level of individual municipalities (for each technology separately) is higher than the number of households in the municipality, the "cap" (the number of premises passed) is set at the level of the overall number of households in the municipality[30]. This process ensures that coverage data (expressed as a percentage per reference to the number of households) is not higher than 100%.

The delivery of coverage indicators by technology combinations

[29] This is to take the average of the minimum coverage (full overlap hypothesis) and of the maximum possible coverage (this is, the sum of the coverage of all operators in the area, or 100% if the sum is larger than 100%, namely the no overlap hypothesis).

[30] In one country, the "cap" includes not only the number of households in the municipality, but also the number of business establishments (as the number of cabled households also include non-residential buildings).

A second challenge relates to the estimation of coverage for different technology combinations at NUTS 3 level (NGA, overall fixed broadband, overall FTTP and DOCSIS 3.1).

The EC methodology states that: “after reaching the broadband coverage figures by individual technologies in each country and NUTS 3 regions, the research team calculated estimates for the (...) three technology combinations, taking into account overlaps of different technologies.”

Unless the information provided by NRAs/OCAs or telecoms groups suggests otherwise, the standardised default formula takes the average of:

1. The minimum possible coverage; equal to the coverage of the most widespread technology in the area; and

2. The maximum possible coverage; equal to the sum of the coverage of all the technologies being considered, or if the sum is higher than 100%, coverage is capped at 100%.

Additionally, a varied formula is used in cases where technologies’ coverage is more complementary than overlapping. In these cases, the minimum coverage is taken as equal to the sum of the complementary technologies, if this was greater than the most-widely available single technology (no overlap hypothesis).

Moreover, the aggregation, when several technologies are involved at the NUTS 3 level, as is performed by the EC consultant in the questionnaire underlying the Study, tends to dismiss the coverage increase by other technologies except the main one (e.g. the deployments effort at rural level, where specific wireless solutions are shadowed when the aggregation is performed at NUTS 3 level with the massive FTTH deployments in urban areas).

With more granular information (e.g. address level), NRAs/OCAs can treat technologies overlap on address basis and do not need to rely on formulas (i.e. one address that is connected to multiple technologies is considered only once). Then, authorities can input the NGA coverage figures at NUTS 3 level. By collecting the data on address basis, overlapping problems with regards to different technologies and/or operators can be easily solved. It also has the benefit of eliminating the errors that otherwise are introduced by aggregating data with a lower resolution.

Moreover, several authorities use different methods to those proposed by the EC consultant to estimate coverage for different technology combinations: while some only provide data per technology and the overall technology class coverage is calculated automatically by the EC consultant using the above-mentioned formula, many use their own methodologies which are based on national specificities.

For example, one country uses a statistical method at the municipality level to produce data, considering that the multi-technology coverage of a municipality is the average between perfect overlapping and zero overlapping of the technologies. Other countries consider a full overlap between technologies. Another country collects data from operators not only by technology, but also regarding the total coverage of each technology class. In another country, if the same parish (i.e. the relevant geographic unit of choice) is covered by more than one technology by the same operator, it is assumed that they are covering different premises and, therefore, for the purpose of overall NGA coverage, the sum of all premises passed by the different technologies by the operator is considered.

Additionally, as per the aggregation at NUTS 3 by technology, besides the treatment for overlapping at address level (or locality level), some countries “cap” the number of premises passed in an area (such as a municipality).

Although these customized methods to perform aggregation (and treat overlaps) can result in more reliable information, the results may not be entirely comparable across countries. However, having in mind the objective of the Study, which is to provide reliable data on the broadband coverage in each country, the best, most reliable results should be accepted, regardless of the methodology used, as long as they are validated and accepted by the EC consultants, and the details of the methodologies are made available in a transparent, comprehensive manner within the Study.

Regarding the mobile broadband, most NRAs/OCAs use a separate coverage map for each technology and do not aggregate them. However, having separate coverage maps by technology, in case several technologies are available in a given grid (100m x 100m, for example), the most advanced mobile technology is shown as the technology covering this grid.

Conclusions and recommendations

The primary concerns in relation to aggregation include challenges in ensuring the completeness and accuracy of coverage data, considering network overlapping, alongside with ensuring comparability of results across countries. Potential steps that could alleviate the issues identified and improve the results are presented in what follows.

For fixed broadband, firstly, NRAs/OCAs should collect data at the most granular level which is realistically achievable. This should preferably be at the address level. Then, they should proceed with data collection of premises passed at address level, by technology and operator, including georeferenced data and performance parameters (download speeds). More generally, public authorities should follow the BEREC Article 22 Guidelines as regards data specification, as explained in the previous section as well.

As stated in the BEREC Article 22 Guidelines, data collected as exact points and lines allow NRAs/OCAs to calculate the most accurate representation of reality. Aggregation is rather straightforward and requires few, if any, GIS skills. Thus, when NRAs/OCAs collect data at address level, they can accurately calculate the aggregated coverage rates for various resolution levels, without any approximation, and it is possible to identify perfect overlaps between operators and between technologies.

Currently, most NRAs/OCAs use address level resolution for collecting the raw information from the providers per technology. These countries do not report aggregation problems, as they can clearly identify if the premise is passed by one or more operators and with which technologies and can easily treat the overlaps.

In case the NRAs/OCAs use small grids (100m x 100m or similar) for fixed broadband, the estimate aggregated coverage at grid level should be 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**.

For those countries that do not collect data at address or small grid level but at a locality level (municipality, parish, settlement), the aggregation and treatment of overlapping should be done at the smallest granularity possible.

BEREC recommends that any formula used to deal with overlaps, when used, should be used at the most granular level possible (lower than NUTS 3). In principle, the formula suggested in the Study should be used, but, if Authorities possess more in-depth information regarding network coverage, they should use their specific method to treat overlaps, reflecting the situation more accurately. These customized methods, however, need to be communicated to the EC consultant for the sake of transparency and to enhance the better understanding of the specific national circumstances.

Secondly, besides the strong recommendation of treating overlapping at address level, in the absence of this level of granularity, **Authorities should "cap" the number of premises passed per area at the best granularity level possible, before aggregating to NUTS 3**. This process ensures that the NUTS 3 coverage indicators are not overestimated, by avoiding the consideration of the total number of premises passed in subareas with an underlying coverage exceeding 100%.

Thirdly, **to aggregate data at national level, all authorities should use the same aggregation methodology, resulting from the sum of all premises passed per NUTS 3**.

A small grid level resolution (100m x100m or lower), by technology, would be the ideal solution to properly provide mobile broadband coverage and to enable the retrieval of aggregate coverage indicators. BEREC recommends that, for such grids to be considered as covered, authorities should ensure that a broadband service is available at least in 95% of the grid area.

In case of mobile broadband, when small grid information is not available to the NRAs/OCAs and there is more than one operator or technology in an area, BEREC recommends that the coverage of the most widespread technology or operator in the area is considered.

Regarding the current practice, almost all NRAs/OCAs hand over aggregated coverage data. It is important that the authorities aggregate the data to NUTS 3 level before sending the data to the EC consultant, as an intermediary step towards reaching the final national values to be reported. It is important that NRAs/OCAs do these aggregations themselves as otherwise it is difficult for them to verify the final outcome in the Broadband Coverage in Europe Report.

Finally,, **for transparency and comparability reasons, the public authorities should provide information to the EC consultants on the methodology used to calculate broadband coverage (including aggregation methods) and the assumptions considered.** The methodologies and assumptions should be accepted by the EC consultants and should be available in the published Report based on the Study.

4 5G indicators

This section is more of an exploratory nature, focusing on the specific challenges linked to 5G rollout monitoring and listing the possible options for the way forward identified by BEREC. At the same time, it presents the different stages of 5G rollout in Europe.

5G is rolling out at different paces in Europe, with countries where auction of spectrum is still pending, as well as countries with already commercially available 5G services. As a result, the work on 5G monitoring is also heterogeneous between various European authorities: some have established a framework for monitoring 5G coverage while others have not or are currently planning to do so in the near future. There is also a difference in the perception of the changes brought by 5G, as about a third of authorities have identified “5G-specific” challenges when it comes to coverage, a third have not, and the last third indicates that it is too early to tell.

As a consequence, there is, at this stage, little common understanding or perception of complex issues regarding 5G coverage, such as:

- interlinkage between 4G and 5G in NSA configuration (should LTE anchor band be accounted for or not?),
- how to account for Dynamic Spectrum Sharing (DSS) when reporting 5G coverage;
- the introduction of different classes between 5G or not, and if yes, according to which parameters (theoretical or real speeds, latency, capacity, NSA/SA configuration etc.);
- the speed class(es) to associate with 5G, and whether 5G and 4G should be considered separately or together[31].

When reporting 5G coverage (or planning to do so), most NRAs consider that it is important to aim for information that is meaningful in terms of service availability and quality for end users, with as limited complexity as possible.

For these reasons, reporting of 5G coverage is, today, a challenge for each NRA individually, and therefore, even more, when it comes to doing so at the European level. However, the reporting of coverage data regarding 5G remains necessary in order to back European digital policies with facts and data and motivate policy decisions.

The identification of common methodologies or principles may be possible for simple metrics such as the number of base stations, but it is not realistic today to illustrate the 5G coverage. However, there are already initiatives that the EU can build upon. In any event, with respect to 5G particularly, it is important for the EC and Authorities to reflect on the need to have relatively simple and comparable indicators, such as, for example, the number of base stations, and at the same time enable the collection of richer and more relevant metrics to reflect 5G coverage, but which may be subject to national specificities. However, it should be noted that the “number of base stations” does not really provide information on the coverage of a mobile network *per se* and is only a coarse proxy to enable the comparison among MS in a simple manner.

Moreover, most NRAs are working on the issue of 5G coverage mapping or planning to do so and are or will soon be able to provide coverage information – according to their own methodologies - for the purpose of reporting at European level. Even though such data may not be fully comparable across Europe as of today, it is still the most

[31] When comparing, for instance, 5G in 3,6 GHz and in 700 MHz, the speed classes associated to 5G are completely different. It is difficult to establish a minimum threshold defining the minimum expected speed for the 5G technology. In addition, this might be worse than 4G speeds based on carrier aggregation.

accurate and objective data available, that should be strongly prioritised before coverage information coming from other sources such as operators' commercial publications or announcements of areas that they planned to serve with 5G services. One key point for transparency when using 5G coverage data from NRAs should be to explicit the way in which 5G coverage is defined and/or verified. This may not ensure comparability but could at least make it easier to understand differences in reporting from one country to another and put the figures in the right setting.

At the same time, BEREC notes that there is currently a workflow tackling the issues of 5G mapping carried out within BEREC, with the purpose to achieve a common understanding of the relevant aspects with "representing" 5G and the pros and cons of the different available options to map 5G. These developments will take time and may not necessarily deliver a specific set of methodologies that could be directly applied to the reporting of 5G coverage at European level but should at least provide valuable input to the EC and Authorities on the challenges that come with it and the possible options to be considered.

5 Conclusions

BEREC has prepared this report in order to explore possibilities of improvement in the comparability of the coverage indicators in the Broadband Coverage in Europe Study and the DESI coverage indicators. Considering the different practices among some Authorities' reporting, it makes some recommendations for the public authorities and the EC that can be undertaken on the short term (i.e. with respect to the use of 'premises passed' concept or concerning the recommendations to be adopted regarding aggregation), recommendations to be taken into account step-wise as MS incorporate in their data collection processes the BEREC Article 22 Guidelines and, finally, provides food for thought on some aspects, for which change should be considered and assessed in the future, such as the definition of rural coverage.

BEREC is also mindful that in the future there will be a need to deliver indicators regarding Gigabit connectivity. The BEREC Article 22 Guidelines provide for information on premises/small grids passed with a broadband network capable of delivering download speeds of at least 1 Gbps, which is relevant to this effect. Moreover, the BEREC Article 22 Guidelines also promote the collection of upload speeds (mandatory for fixed broadband and optional for mobile broadband), which in the future may be another indicator of interest for policy makers, end users and operators.

A main conclusion of the report is that BEREC considers of outmost importance that the data is collected and treated in terms of aggregation at the highest granularity

available, since such practice results in the most accurate description of the reality in the respective countries.

In this respect, BEREC is aware that the public authorities and operators in certain MS have important difficulties in sourcing address or geocoordinate information, and that these kinds of databases are not always public or available for free, or in appropriate quality. However, these resources are the cornerstone of the improvement of broadband coverage information in the different MS and in Europe, and BEREC considers that the development of such public resources, where needed, should be highly encouraged.

In providing this Report, BEREC has found that, in many cases, NRAs/OCAs use their own methodologies to deliver the coverage indicators at NUTS 3 level. Quite generally, the reason for this is that these public authorities hold information that allows them to make varying hypothesis concerning overlap, or the shaping of the indicators. Whilst this may be fully justified, transparency should be sought at different levels. On the one hand, in case of deviations from the EC consultants' methodology, definition or formulas, the public authorities should provide the underlying explanations and assumptions, so that the data is accounted for and understood in a clear and comprehensive manner. On the other hand, the relevant cut-off date for the data and all the relevant pieces of methodological information should be published (either as footnotes or potentially as a separate Annex) in the Broadband Coverage in Europe reports, to enhance their transparency and to allow their readers to have information relevant to interpret the coverage figures provided within by all interested parties. Indeed, one of the conclusions of the workshop held on the 12th of October 2021 is that stakeholders would appreciate a better knowledge on how the coverage and performance data is being processed and used within the Study and, more generally, put to serve the different functions it is meant for.