Body of European Regulators for Electronic Communications

BEREC

BoR (19) 245

A first assessment based on stakeholder inputs - Report on the impact of 5G on regulation and the role of regulation in enabling the 5G ecosystem

Contents

Executive summary

The development of the 5G ecosystem already involves many aspects of regulation. How it develops as take up increases and service propositions emerge has the potential to affect regulation further. How regulatory impacts are addressed could affect the pace at which innovative services are brought to market and the full market and consumer benefits of this new technology are realised.

The BEREC Planning & Future Trends Working Group (PFT WG) was tasked with developing a report that aims to help National Regulatory Authorities (NRAs) for electronic communications anticipate where and how 5G deployment may have an impact on the regulatory environment. The work sought to build on the insights of the DotEcon/ Axon Study on the implications of 5G Deployment on Future Business Models".[1]

Essentially, the PFT WG approach was not to seek to identify specific problems today nor to come up with solutions. Instead, it sought to undertake a "horizon scanning exercise" and pose a range of questions such as how services might be rolled out, how markets might develop, and how any of these might raise new regulatory challenges for NRAs. As will be made clear later in the report, new regulatory challenges does not mean more regulation per se, but could also mean less regulation or more proportionate, depending on the issue at hand.[2]

The group sought to involve stakeholders from an early stage to enable BEREC to learn from them in which way 5G and its roll out might raise potential issues in the future. This was done through a Call for Input (CFI) which was issued in August 2019.[3] The CFI took an expansive approach to seek views on the impact of 5G on regulation and on what stakeholders might consider to be the role of regulation in enabling the 5G ecosystem.

The CFI posed a series of questions on a variety of topics ranging from privacy and security, competition and potential competition bottlenecks, and on more technical issues such as network slicing, numbering in an IoT/ M2M world and interoperability of technologies and networks. The questions were also accompanied with some suggested examples of how issues might arise in a 5G context and based on these examples stakeholders were asked for their views on work which might be taken forward in the future.

BEREC had a very good response from stakeholders to its CFI. There were more than forty responses coming from a variety of sectors, ranging from network operators, service providers, manufacturers, application providers, industry and consumer representative organisations as well as research and advisory bodies.

[1] BEREC Document BoR (18) 23
[2] Examples of such regulatory interventions could be making available more spectrum and/or number ranges.
[3] https://berec.europa.eu/eng/document_register/subject_matter/berec/public_consultations/8697-call-for-inputs-on-views-on-the-impact-of-5g-on-regulation-and-to-the-role-of-regulation-in-enabling-the-5g-ecosystem

Overall, and given the current state of play of commercial 5G deployments, BEREC is confident that NRAs and BEREC are thinking about the right things (for example, authorising rights of use to spectrum in suitable ways to satisfy various connectivity demands, or addressing perceived uncertainty in the BEREC Guidelines on Open Internet) and some of the issues raised are currently being looked at in other BEREC WGs, either included in the ongoing activities or likely to take place during 2020-21.

BEREC also received a few stakeholder comments that are not within BEREC's remit to deal with, but which are likely to be addressed by other competent authorities, at the moment or in the future. For example studies on emission levels of electromagnetic radio frequencies (EMF) or development of a toolkit for dealing with network security issues.

Furthermore, we realise that not all the received concerns and issues can be addressed at this moment because how these potential issues would develop is not yet clear. Therefore BEREC proposes to adopt a watching brief and take actions at the time when the impact of these issues becomes clear in order to enable the 5G ecosystem.

After addressing the topic of 5G technologies in relation to the application of the Open Internet Regulation in the BEREC Opinion of December 2017[4], this report is the first step for BEREC to achieve the objective of identifying and tracking relevant issues from the overall perspective of a regulator.

[4] https://berec.europa.eu/eng/document_register/subject_matter/berec/opinions/8317-berec-opinion-for-the-evaluation-of-the-application-of-regulation-eu-20152120-and-the-berec-net-neutrality-guidelines

Introduction

In line with the task to develop a report that aims to help NRAs for electronic communications anticipate where and how 5G deployment may have an impact on the regulatory environment, and where and how NRAs can enable the 5G ecosystem, the report studies the following aspects in separate chapters:

New business models and value chains – which sets out a brief summary of the potential issue of new business models, and a high level summary of respondents views on this topic.

Rollout - focuses on the different perspectives of 5G rollout, including planning and development, backhaul, coverage, small cells, infrastructure sharing, roaming, numbering and EMF.

End user – considers the possible impact 5G will have on the end user in terms of quality of service ("QoS"), information, and interoperability.

Other regulatory aspects - which sets out to identify the main issues raised in the CFI in fields that are related to the previous chapters and where BEREC works together with other competent authorities.

Conclusions and next steps – which sets out BEREC's main observations from the above, and preliminary ideas for BEREC and NRAs to consider in order to progress BEREC's overall understanding of 5G in terms of the impact of it on regulation.

1 New business models and value chains

5G technical developments and the increasing role of 5G across a range of industries have the potential to impact existing value chains and result in new business models beyond connectivity. In the CFI, stakeholders were invited to provide their views on the impact of 5G technology on a range of aspects related to these new business models and the potential impact on regulation.

1.1 New value chains and changing business models

The faster speed and greater capacity enabled by 5G will lead to increased convergence between fixed and wireless services. This process has already started with the LTE technology[5] and respective evolutions of LTE technology and will potentially create more competition at the retail level. This will potentially impact traditional value chains, as well as provide end-users with more choices in terms of providers and services.

5G Fixed Wireless Access (FWA) has emerged, in some countries, as one of the early 5G use cases offering an increasing number of alternatives for end-users seeking gigabit connectivity. Across Europe many MNOs have launched services where a wireless router acts as a mobile hotspot (e.g. MiFi[6]) and fixed wireless access services using their mobile networks, with further launches expected. Players such as FastWeb in Italy plan to use 5G FWA for the 'final hop'[7],[8] to deliver connectivity to homes. In the longer term, MVNOs and new players may offer new services using a network slice. End-users will therefore be able to choose between gigabit services delivered by a wider range of providers, including MNOs, MVNOs, Wireless Internet Service Provider (WISP), other micro operators and Fixed operators.

Regarding a more fundamental shift in digital connectivity models, as was described in the DotEcon/ Axon Study on the implications of 5G Deployment on Future Business Models, we observe that more industry sectors could utilise wireless connectivity to meet their digital transformation needs. Different industry verticals, and different businesses and organisations within those verticals, will have different requirements for connectivity. Some of these requirements are likely to be met by an MNO potentially using a network slice[9], providing additional means for MNOs to monetise their 5G investment by targeting and meeting the needs of different industry verticals. Others may instead choose to deploy a private network to meet their needs. They may choose to self-deploy or opt for a third party

[5] E.g. in the end of 2018 mobile operators in Czech Republic reported 358 000 users of fixed LTE access.
[6] A 5g mifi device uses a mobile network to deliver a mobile broadband service which has greater potential to deliver gigabit speeds.
[7] 200-400m https://www.fastweb.it/corporate/landing/5g/?lng=EN
[8] https://www.fastweb.it/corporate/media/comunicati-stampa/fastweb-rilancia-sulle-infrastrutture-e-raddoppia-la-copertura-ultra-broadband/
[9] Network slicing is a technology that allows partitioning of a network into virtually independent virtual 'slices'. The technology can be used to slice a public network to serve different organisations with independent virtual networks in a way to be able to provide a quality-of-service and a degree of control that is closer to the one achievable in a private network. With network slicing different users are sharing the same capacity, but some specific users may have specific SLAs/SLGs to ensure they have the QoS they need.

(such as a system integrator, positioned downstream from an MNO, offering to bundle and repackage connectivity) to provide a bespoke solution, therefore creating new business models for connectivity.

Input from stakeholders

Most stakeholders responded to at least one of the areas set out in the CFI related to new value chains and changing business models for connectivity.

A number of stakeholders raised network slicing and net neutrality as a potential 5G issue. Regarding net neutrality stakeholders expressed differing views on whether more work needed to be done to update BEREC Open Internet guidelines to enable slicing. One operator said that the initial NN guidelines were written before the introduction of 5G and could be a barrier to roll out new services based on edge computing and virtualized networks. It also proposed that the BEREC Guidelines should be reviewed every other year, due to the speed of change. One stakeholder suggested that the BEREC OI review was the best place to address issues on slicing. On the other hand, two operators responded that this issue was already addressed under Open Internet guidelines, and that new work was unnecessary. Another stakeholder suggested that the Open Internet guidelines allow slicing but added variety in national enforcement could create uncertainty.

On consumer choice at the retail and service level, one stakeholder highlighted that the ability to achieve gigabit speeds with 5G should be seen as an incentive for operators to invest in 5G in order to compete for end users. One stakeholder commented that end-users with triple or quad play bundles should be able to 'partially churn', stopping one or more of the services delivered in the bundle.

On access to spectrum to enable new business models, a few stakeholders highlighted that RSPG has already undertaken work to look at enabling verticals and new business models. A further stakeholder responded that available spectrum to support new business models was key, noting that leasing and trading to date has been inefficient in securing access to operators. They also highlighted that the 3.8-4.2 GHz band could be a good candidate band for micro operators because of innovative regulatory treatment.[10]

The following suggestions for further work by BEREC on these issues were:

- To monitor and report on the wholesale 5G dimension as network slicing will be important for MVNOs. Though some stakeholders said it would be premature for BEREC to undertake any work relating to the deployment of slicing.
- To focus on ensuring wholesale access for other players, such as MVNOs. A number of respondents including mobile operators and suppliers said that any analysis focused on competition at the retail level should be carried out by NRAs rather than BEREC.

[10] https://enterpriseiotinsights.com/20190528/channels/news/three-sweden-leases-public-spectrum-for-private-usage

- And a few stakeholders responded that BEREC should conduct further work on the barriers and benefits of enabling new business models. On the other hand one stakeholder said it is too early in the 5G lifecycle for BEREC to carry out further work, and that the market should enable new business models with neutral intervention by regulators.

1.2 New bottlenecks, dominance and monopolies

It is likely that with 5G, an increasing amount of data will be shared over networks and the criticality of data in terms of economic development accelerates. In that light, it is important to investigate the regulatory means to address possible competition problems regarding access to data.[11] However it should be noted that this is not a specific regulatory issue restricted to 5G networks.

Input from stakeholders

Around a dozen respondents commented on this area in their response to the CFI. Responses on this issue were mixed. A few stakeholders highlighted that this issue would go beyond BEREC's remit, including two stakeholders who both highlighted that any BEREC study should focus solely on competition in electronic communications markets. A further stakeholder added that any work done by BEREC would potentially duplicate work done by NRA's and the EC. Several stakeholders expressed that BEREC should not introduce any measures that could stifle innovation or roll-out.

On the other hand, some stakeholders expressed the view that there is a role for BEREC on this issue. One stakeholder suggested that BEREC could undertake market monitoring, a further stakeholder also suggested BEREC could monitor and support new business models, and another stakeholder representing industry suggested BEREC could work in collaboration with other authorities, e.g. NRA's on this issue. One respondent highlighted that this is not a 5G specific issue.

BEREC's observations

BEREC considers the issue of network slicing in relation to the Open Internet to be an important one for some stakeholders. This subject is already being explicitly considered in the Open Internet Guidelines update (ongoing in BEREC's work programme 2019). The final Guidelines are expected in June 2020.

In addition, network slicing may be an important enabler of new business models and models of connectivity. Regarding wholesale access to operator networks including via slicing, BEREC will continue to monitor the situation, particularly as network slicing emerges (expected from around 2022/23). BEREC's view is that the Open Internet guidelines do not prohibit network slicing.[12]

[11] See also BEREC Report on Data Economy, BoR(19) 106

[12] See page 2 of the BEREC Opinion on the application of the OI Regulation and the OI Guidelines; https://berec.europa.eu/eng/document_register/subject_matter/berec/opinions/8317-berec-opinion-for-the-evaluation-of-the-application-of-regulation-eu-20152120-and-the-berec-net-neutrality-guidelines.

In relation to views expressed by many stakeholders about the importance of access to appropriate spectrum to enable new business models, BEREC has not perceived any such barriers for users to appropriate spectrum. Many Ministries and/or NRAs (such as those with competence for spectrum management) have set out roadmaps indicating the timeframe of availability of the pioneer bands for 5G. BEREC observes that demand for access to spectrum is considered on a case by case basis by the competent authorities (which is in many instances the NRA). In addition, BEREC observes that there are spectrum leasing and/or trading regimes in place which could facilitate demand for access to spectrum by some users. BEREC also observes that several NRAs or respective Competent Authorities are considering or have made spectrum available on a more localised basis, to meet the requirements of these types of use users. The CFI did not set out to consider spectrum issues, however some views were received and these are considered in Chapter 4 later below. A number of stakeholder responses referred to the RSPG publication and Opinion on ensuring connectivity for industry verticals in October 2018,[13] which set out an analysis of the options for connectivity for verticals.

Issues of potential monopolies, dominance and bottlenecks have been highlighted as some of the digital priorities of the incoming EC and are likely to be considered further in the forthcoming Digital Services Act. In this aspect BEREC and its constituent NRAs have expertise, such as integrating technological, economic, legal, and user protection perspectives in the design and practice of regulation, as well as experience of coordinating the application of a common EU legislative approach to take account of both national and pan-European perspectives in electronic communications markets markets.

In summary, BEREC's proposal is to continue monitoring the electronic communications markets markets to ensure that no regulatory barriers to new business models for connectivity arise.

2 Roll-out

The above mentioned new business models and value chains may not become a reality if 5G networks are not rolled out efficiently and effectively. This chapter focuses on the different perspectives of 5G rollout, including planning and development, infrastructure sharing, backhaul, small cells, roaming, numbering and EMF.

2.1 Planning permission / deployment and infrastructure sharing

The introduction of 5G technology implies new deployment of network infrastructure and associated resources and planning.[14] Article 57 of the EECC seeks to remove planning constraints for small cell deployment. Also Directive 2014/61/EU on measures to reduce the cost of deploying high-speed electronic communications networks is here to reduce the

[13] https://rspg-spectrum.eu/wp-content/uploads/2013/11/RSPG18-036final-draft_opinion_on_5G.pdf

[14] In this context, the issue of planning refers to all the private and public initiatives that foster access to infrastructure deployment facilities and the associated problems that may arise with operators and / or service providers attempting to deploy equipment.

administrative burden and facilitate access to physical infrastructure[15] of other network operators to reduce the deployment costs.

A related topic is network sharing by access to passive (e.g. masts, towers, buildings, ducts, dark fibre) and active infrastructure (antennae, network equipment, backhaul links), including the possibility of sharing network resources through virtualisation (SDN/NFV) and network slicing. BEREC has already reached a common position on Mobile Infrastructure Sharing (BoR (19) 110).[16]

Input from stakeholders

One stakeholder noted that pro-innovation and light touch regulation including simplified deployment rules for small cells would be beneficial for 5G. Another response argued that additional regulation in this area would neither be necessary nor appropriate since players have a natural interest in the conclusion of contracts. One response categorized the issues mentioned as duplicate work already being done by the EC and within Member States.

Another response addressed the necessity of mandated access to passive infrastructure regardless of SMP, while another response saw a lack of considering the role of fibre in the 5G ecosystem as something which should not be overlooked. One response highlighted in particular the aspects of facilitation of network construction and public awareness of the benefits of 5G applications.

Nearly half of the stakeholder responses emphasized the importance of infrastructure sharing in the context of the emerging 5G networks. Reasons included the expected densification of the radio network, increasing planning security with regard to investment and optimising network usage while avoiding network duplication. Respondents brought forward that it should be ensured to avoid regulatory obstacles to commercially negotiated infrastructure sharing that does not harm competition.

Others mentioned the importance of fibre infrastructure for deploying 5G in timely manner and urged to acknowledge infrastructure sharing also in the context of fibre sharing.

One response highlighted the possibility of neutral host networks for assembling different verticals in a robust and cost-effective infrastructure. In order to enable that approach, standardization, technical development and business models of 5G should be coordinated to support infrastructure sharing and a neutral wholesale operator structure that can be an

[15] Art 2 of Directive 2014/61/EU - 'physical infrastructure' means any element of a network which is intended to host other elements of a network without becoming itself an active element of the network, such as pipes, masts, ducts, inspection chambers, manholes, cabinets, buildings or entries to buildings, antenna installations, towers and poles; cables, including dark fibre, as well as elements of networks used for the provision of water intended for human consumption, as defined in point 1 of Article 2 of Council Directive 98/83/EC (1) are not physical infrastructure within the meaning of this Directive;

[16] BoR (19) 110 identifies and describes factors to be considered by NRAs when assessing any infrastructure sharing agreement, where they have competence to do so. The main types of sharing considered are: passive sharing including co-location, site sharing and mast sharing, active sharing including RAN sharing, MORAN sharing, MOCN sharing, frequency (or spectrum) pooling, national/local roaming and core network sharing. Backhaul sharing can take place in both passive and active sharing.

enabler or motivator for the different verticals to invest in complementary 5G infrastructure where needed. Furthermore, the need to deal with a maximum allowed number of antennas on one site, in the context of first-come-first-served access regimes, and the importance of sharing was mentioned.

A further response mentioned the possibility of sharing between public and private radio access networks, provided that privacy and security measures are in place to ensure a necessary isolation of the networks.

The following suggestions for further work by BEREC on these issues were:

- to study Member States' practices in enabling access conditions to public or private property to deploy 5G and access to backhaul infrastructure of other utility sectors. Based on this assessment, BEREC could create guidelines for best practices for Member States.
- to support the ongoing exchange of information in relation to sharing arrangements implemented in Member States. The specific aspect of private infrastructure sharing agreements, private network sharing practices and unified networks was also brought forward.
- to study all regulatory, technical and business model aspects enabling the establishment of neutral operators and their interoperability with traditional MNOs.

BEREC's observations

Taking into account responses received from the CFI, and results from previous BEREC work streams, BEREC recognises that issues around planning permission are appropriately addressed, though some of the work would be contingent on the transposition and implementation of Article 57 of the EECC. BEREC considers that it should closely monitor the situation in Member States with regard to planning permissions and deployment in order to identify potential obstacles for 5G roll-out. BEREC may be the appropriate body suited to collect a benchmark on progress of planning permissions across the European Union but it is probably too early to do so. Indeed, the 26 GHz band, which, given its propagation characteristics, may be a key band relying on planning permissions, has not yet been widely assigned in Europe (e.g. UK has an indoor local licensing regime in place, Germany intends to adopt a local licence regime whereas Italy issued a national licence according to the "club use" model[17]) and until now there are no fully fledged 5G services using this band also due to the timelines for commercial availability of network equipment and devices for this band. Furthermore, also on the demand-side for services in this band there are still no clear indications from the market. Therefore monitoring and information tools may play an important role to provide stakeholders with improved access to information about public

[17] According to this model, each licensee can dynamically use all the awarded spectrum (up to 1 GHz) in areas where frequencies are not used by other licensees. To this aim, licensees can stipulate commercial reasonable and non-discriminatory agreements, proportionally sharing the costs. Each license holder has the pre-emptive right in favour of its assigned block of 200 MHz. Moreover, licensees can assign to a trusted third party the task of managing the uses to avoid harmful interference as well as the access scheduling.

infrastructure facilities, planned civil works and available infrastructure and permission requirements.

BEREC proposes that its experts continue to gather information on the first 5G use cases, pilot experiences and standardisation activities, especially regarding SDN/NFV and network slicing, on an informal basis so that when the time is correct more formal projects in this area could be commenced.

In relation to infrastructure sharing and 5G, BEREC intends to conduct a workshop in 2020 and is currently seeking views on this proposal in its Work Programme 2020 consultation.

2.2 Backhaul, fronthaul and any-haul

In the CFI BEREC asked for views on backhaul. Backhaul, in the context of this document, is the high-speed connection between base stations to the core network. In the context of 5G it is likely that backhaul will be mainly realized using fibre, with legacy backhaul and 5G radio backhauling as an option.

Input from stakeholders

More than a dozen stakeholders provided input regarding this topic. All of them consider backhaul to be very important for 5G rollout. They welcome BEREC studies on the topic. Several stakeholders mention that backhaul is not just fibre but will also need to include wireless technologies for example using the 26 GHz and 100 GHz frequencies. Stakeholders also mentioned that BEREC should include ‘any haul’ when further elaborating this issue as they expect an increasing need for fronthaul and midhaul as well. Additionally fixed-mobile convergence, which encompasses the usage of core and backhaul network infrastructure to provide both fixed and mobile services, was mentioned as an important backhaul option. Although this combined approach has already been widely applied (for instance by the incumbents) in many markets for the existing technologies, there seems to be a general belief among the stakeholders that this approach can have a more important role in 5G, especially when a network operator has access to a well-established fibre network.

The only topic on which stakeholders’ views differ is regulation. Some express concerns that any additional regulation of fibre would slow down independent or joint fibre roll-out and therefore also would delay the 5G roll-out. Others believe that NRAs should ensure, either through regulation or competitive markets, that backhaul is available on commercially viable and non-discriminatory terms and at reasonable cost.

BEREC's observations

BEREC welcomes the feedback from the stakeholders on this topic and recognizes that various types of haul may need to be considered in light of 5G, for example the demand of fronthaul may increase.[18] Academic studies and industry researches show that C-RAN (Cloud Radio Access Network) can be regarded as one of the ways to evolve the mobile

[18] Intel whitepaper: Exploring 5G Fronthaul Network Architecture Intelligence Splits and Connectivity.

networks and architecture. The main idea of C-RAN is baseband units from multiple Base Stations (BSs) being pooled into centralized BBU (Base Band Unit) pool so that they can be shared between BSs of several cell sites.[19] Figure 1 shows such fronthaul and backhaul network architecture in LTE.

A separately defined market for mobile backhaul is not included in the list of relevant markets of the EC's Market Recommendation (Recommendation 2014/710/EU)[20]. However, with fixed access and mobile backhaul infrastructures partly overlapping, fixed access regulation might influence mobile backhaul issues. The increasing use of fixed infrastructures for mobile purposes means that it could be relevant for NRAs to continue monitoring the needs of mobile backhaul transmission and evaluate, when necessary, the current approach to regulating the fixed network accordingly.

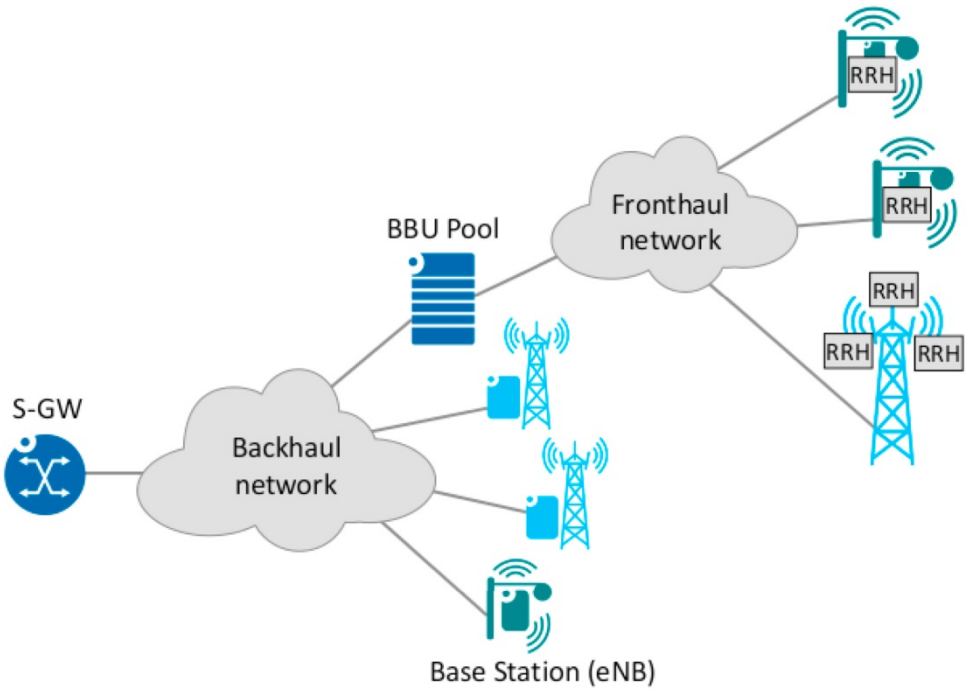

Figure 1: Mobile backhaul and fronthaul network architecture in LTE[21]

At this moment BEREC does not have the impression that this architecture has been widely adopted in the market. BEREC would be interested in the views of stakeholders in relation to

[19] Elsevier Optical Switching and Networking Volume 30, Mobile fronthaul transport options in C-RAN and emerging research directions: a comprehensive study.
[20] In the Explanatory Note to the Commission Recommendation in relation to the market 4 (Wholesale high-quality access provided at a fixed location), the Commission leaves NRAs the option to identify specific competitive problems which require a separate national market for passive access to backhaul infrastructure.
[21] idem footnote 19.

the implications of the above architecture. BEREC is also interested to hear whether any regulatory issues need to be considered to enable the sustainable mix of different hauling options for the market.

2.3 Small cells

Article 57 EECC addresses small cell deployment as it aims to significantly reduce the administrative barriers for deploying small-area wireless access points (SAWAP), i.e. small cells that comply with a certain set of characteristics. Smalls cells should be exempted from any individual town planning permit or other prior individual permits, except for environmental or historical reasons or public safety. In order to achieve these physical and technical characteristics, such as the maximum size, weight and, where appropriate, emission power, per frequency band, of those SAWAPs must be defined. In early 2019, the EC published a consultation document[22] dealing with that issue.

Input from stakeholders

Several responses stressed the importance of a harmonised approach to deploying small cells in order to increase the development and the spread of small cells. Some stakeholders claim that to achieve this, obtaining the permits usually required should be made easier, also in consideration of the low impact of small cells in terms of power emissions. This would also facilitate the deployment of common infrastructure and backhauling networks in a larger number of sites and in shorter time. The creation of a uniform background and the adoption of common rules in all EU Member States could ultimately boost the rollout of 5G and the enjoyment of all the related benefits.

One response focused on the energy consumption as energy for small radio sites may create significant overhead cost and might need metering independently of power supply to the building or the infrastructure the station is attached to.

With regard to further BEREC work in the area of small cells some responses mentioned that the EC is expected to bring forward a EC implementing act regarding small cells by June 2020 which should be followed by a BEREC study to find out how Member States are progressing with the respective regulations.

BEREC's observations

Taking into account responses received from the CFI and results from previous BEREC work, small cell deployment may become necessary for 5G roll-out. BEREC may therefore be required to address this in its future work.

[22] https://ec.europa.eu/digital-single-market/en/news/public-consultation-light-deployment-regime-small-area-wireless-access-points

Backhaul and in the broad concept xHaul is an important topic for mobile network. A good understanding around the 'haul' roll out and its accessibility has high priority. In the coming years BEREC will continue its dialogue with the stakeholders and the NRAs in order to understand the potential concerns. BEREC will also gather information and analyze how to address those potential issues. For example, and in light of the earlier views on hauling BEREC proposes that it could carry out a study to analyze the 'xHaul' and the implications on regulation. In this way BEREC would continue to follow market developments and technology advancement closely.

2.4 Numbering

One of the main benefits of 5G may be its ability to connect millions of devices to enable massive machine type communication. For certain use cases the number of devices is crucial to fulfilling a certain QoS being referred to as connection density by the ITU in its report of 2017.[23] The connection density is one of many technical capabilities that differentiate 5G applications from 4G and older versions of the mobile technologies.

The massive increase in the demand for devices could also lead to an increasing and potentially massive demand in E.164 numbers and other types of numbering resources (e.g. E.212). E.164 numbers include fixed and mobile numbers and could be assigned to both fixed and mobile network operators. It is recognised that other forms of naming and addressing (IP addressing in particular) are also relevant, and therefore it is difficult to predict the approximate demand for E.164 numbers.

This will also be the case for E.212 numbers, which are part of the ITU's international identification plan for public networks as subscriptions may increase under 5G. It can be expected that verticals and intermediary operators may want to provide their own SIM cards to their customers, which may increase the demand for MNCs. For Member States opting for allowing the assignment of numbering resources, and in particular MNC, to undertakings other than providers of electronic communications networks or services in accordance with Article 93.2 of the EECC, the increase of demand for MNCs may be relevant. In this regard, BEREC is in the process of developing guidelines on common criteria for the assessment of the ability to manage numbering resources by undertakings other than providers of electronic communications networks or services. BEREC consulted[24] on a set of draft Guidelines earlier in 2019 and is scheduled to complete its work in March 2020. Further, as devices are also expected to be used abroad, it may make sense to allow extraterritorial use of the assigned geographic MNC and/or encourage use of global mobile country codes (MCC).

Input from stakeholders

[23] Report ITU-R M.2410-0 (11/2017) Minimum requirements related to technical performance for IMT-2020 radio interface(s)

[24] https://berec.europa.eu/eng/news_consultations/Closed_Public_Consultations/2019/5752-public-consultation-on-the-draft-berec-guidelines-on-common-criteria-for-the-assessment-of-the-ability-to-manage-numbering-resources-by-undertakings-other-than-providers-of-electronic-communications-networks-or-services-and-of-the-risk-of-exhaustion

Few stakeholders provided comments or suggestions as to whether BEREC should elaborate on the implications of massive machine type communication on numbering. Most stakeholders did not provide any comments about whether BEREC should further examine national roaming agreements with regard to 5G, either.

On the other hand many stakeholders voiced their ideas about numbering resources for 5G applications, which for instance include issues about interoperability, call/ data termination and roaming. Some stakeholders believe that the numbering resources should be expanded, especially the E.212 numbers, to accommodate possible future roaming scenarios and to ensure cross-border services. Stakeholders also suggested developing separate numbering plans for private networks. Some voiced the need for pan-European numbering to allow interoperability.

Some stakeholders consider the use of eSIM (and Over-The-Air (OTA) provisioning) more important for verticals than assigning MNCs and are of the opinion that the numbering issues identified are not specific to 5G, but rather to IoT, eSIM and multi SIM devices. Scarcity and fragmentation of the numbering resource was mentioned as a reason for favouring eSIM. Stakeholders also believe that providing eSIM is more efficient and likely to have lower implementation costs as it facilitates switching between providers. A cautious approach should be taken towards assigning numbers to verticals due to the impact on efficient public networks. Stakeholders stressed that assigning numbers to verticals should comply with the international interoperability standards defined by ITU, ETSI and GSMA.

Another issue to be explored could be identifiers for non-handset usage. Stakeholders also suggested that BEREC could coordinate with ENISA to undertake further assessment.

BEREC's observations

BEREC recognises the importance of having a sufficient supply of numbering resources available to meet the demand. With respect to managing the limited resource, it is noted that BEREC has a task conferred by the EECC to produce guidelines on common criteria for the assessment of the ability to manage numbering resources by undertakings other than providers of electronic communications networks/services and of the risk of exhaustion of numbering resources if numbers are assigned to such undertakings. This task is in progress in the Regulatory Framework EWG. The Electronic Communications Committee (ECC) Working Group Numbering and Networks (WG NaN) being best-placed to provide expertise in numbering and network issues, is also involved.

BEREC is also working on a database of numbering resources with a right to extraterritorial use within the European Union. The EECC made a step towards harmonisation, but many details remain in national competence. In this respect, NRAs or other CAs will monitor the provisioning of such numbering resources and for that purpose BEREC must establish a database.

2.5 National and international roaming agreements

Roaming agreements allow providing and consuming seamless services across different networks. Seamless connection across different networks could be crucial for 5G

applications, because the services will require a high level of coverage – it is expected that some 5G services can be offered in the 700 Mhz band, that has good propagation characteristics and a high level of coverage. Network coverage in a 5G setting using higher spectrum bands may entail deploying a higher number of base stations as the cell radius is much smaller in such a case. In addition to rolling-out infrastructure, negotiating roaming agreements is one way to reach sufficient network coverage. This is most likely to be assured by not only having one operator deploying the network.

The roaming agreements can either be limited within a national territory (national roaming) or across different countries (international roaming).

National Roaming agreements were considered as competition measures to facilitate market entry and included as an obligation in the spectrum award procedures in some EU EEA countries. On the other hand, other countries do not place obligations for national roaming agreements on their operators.

The case is different for international roaming. The Roaming Regulation includes provisions for access to wholesale roaming services. Access seekers can be mobile network operators (direct wholesale roaming) as well as mobile virtual network operators or resellers (indirect wholesale roaming).

There could be specific requirements for 5G applications where roaming agreements are negotiated between network operators and verticals. Roaming agreements may also be required for users of a specific network slice.

Input from stakeholders

Some stakeholders stressed the importance of having in place a regime for roaming agreements so as to ensure access and ensure network expansion. Concerns revolve around delaying interconnection and unreasonable wholesale prices. Roaming agreements are considered beneficial due to their cooperative nature. In addition, roaming agreements are perceived to incentivize the roll-out of the 5G network and foster innovation. Some stakeholders would like to have roaming agreements mandated in the spectrum award procedure.

Other stakeholders favour investment in networks and therefore support a rather balanced approach between national roaming and individual licensing. This could mean national roaming to be limited in duration and scope. Stakeholders stressed the importance of regulation to be technologically neutral, i.e. not painting 5G specific roaming scenarios, as well as relying on market dynamics, particular when it comes to industrial applications.

Stakeholders raised some issues that should be further examined such as network slicing and the relation between roaming agreements and network slicing, interconnection of private and public networks and infrastructure sharing (RAN and spectrum).

Stakeholders pointed out various issues that are to be considered such as permanent/ temporary slice rental, various types neutral-host wholesale arrangements (for instance should there be specific rules for incumbent operators or not) and shared RAN and

spectrum. Furthermore, roaming between private networks operated by verticals and publicly operated networks could be investigated to find out how local interconnection or local roaming work. BEREC is encouraged to examine network slicing as a means to facilitate virtual network sharing and to substitute roaming agreements. Another stakeholder would favour a study about the impact of legacy M2M and the opportunity to terminate those services.

BEREC observations

The CFI identified some issues that could be further examined such as the role of eSIM, which was already one of the potential topics identified by BEREC. Suggestions concerning international roaming scenarios are unclear, because the Roaming Regulation refers to travelling within the Union according to Article 1 Roaming Regulation (using a SIM card in a visited network for periodic travel). This may make the permanent use of SIM cards abroad difficult as providers could for instance charge excessive prices. There are some issues which may arise concerning international roaming and numbering, which may need to be further elaborated.

Stakeholders raised some issues that should be further examined such as network slicing and the relation between roaming agreements and network slicing, interconnection of private and public networks and infrastructure sharing (RAN and spectrum).

2.6 Electro Magnetic Fields

Policy on exposure to EMFs (Electro-Magnetic Fields) is generally a matter of public health and is dealt with by appropriate bodies within Member States. Scientific research over many decades has enabled national and international health authorities to establish safety limits for exposure to electromagnetic fields.

At the EU level, the limitation of exposure to electromagnetic fields has been subject to a Council Recommendation (1999/519[25]) which recommends exposure limits which apply to all frequency bands between 0 Hz to 300 GHz, including those envisaged for 5G.

At international level, the World Health Organization (WHO) and ITU have endorsed the International Commission on Non-Ionizing Radiation Protection (ICNIRP) to develop the international EMF exposure guidelines. The limits in the EU Recommendation are based on the Guidelines from the ICNIRP.[26] It should be noted that a revision to these Guidelines has been subject to a public consultation in 2018 and publication of the revised Guidelines is pending.

In this context, many countries adopt the EMF limits set by the ICNIRP; other (sometimes local) authorities impose different limits.

[25] COUNCIL RECOMMENDATION of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz).
[26] https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf

From the roll-out perspective, 5G networks will necessarily involve the installation of more radio equipment. In a scenario where many sources of EMF already exist, including overlapping 2G/3G/4G base stations, there are concerns about how the EMF limits may impact 5G planning. This can influence the rollout procedures, installation costs and network designs.

Input from stakeholders

Most stakeholders support the provision of consistent information aimed at end users regarding the health effects resulted from exposure to EMFs. In their opinion, NRA's and BEREC, should encourage consistent science and evidence-based communication on 5G and EMF at EU and national/local level, in line with the internationally accepted recommendations of the WHO and ICNIRP.

In addition, several stakeholders are concerned that the rollout may be delayed in some Member States due to the existence of EMF exposure limits that differ from those recommended by ICNIRP. They believe BEREC can perform an important role in promoting consistency amongst Member States with ICNIRP EMF exposure limits.

BEREC observations

BEREC is in favour of access for all citizens to the best level of science-based information on this matter. BEREC takes note that this issue may have an effect on rollout procedures and network design.

To this regard, the ICNIRP is currently concluding a review of EMF exposure limits, which will be taken into account by the EC. The EC also relies on the findings of the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER). This Committee[27] has a standing mandate to provide an independent review of the latest scientific evidence available, including the assessment of health risks that may be associated with exposure. And the Committee is committed to the constant update of scientific knowledge, which must also be taken into account in the development of 5G. To date the SCHEER Committee has produced 5 opinions, the latest 2015, which have not provided any scientific justification to revise limits set by Council Recommendation 1999/519/EC. Taking into account the activities ongoing about EMF limits, BEREC intends to see what if any updated information on EMF is available to address concerns about 5G deployment and EMF.

3 End-user

In addition to the considerations about business models and rollout, it will be important to ensure that end-users of 5G services, including both consumers and industry verticals have access to connectivity where and when they need it, and have sufficient access to information about the service they should be receiving. In the CFI, stakeholders were invited to provide their views on the impact of 5G technology on end users.

[27] The Committee has already produced five relevant opinions, the latest at 2015, which have not provided any scientific justification to revise the limits set by Council Recommendation 1999/519/EC.

3.1 QoS - consumer and verticals

BEREC has been tasked to issue guidelines on the implementation of the EU regulatory framework for electronic communications[28], the EECC[29], on relevant quality of Services (QoS) parameters which NRAs should take utmost account of. BERECs task is described in the BEREC Guidelines on Quality of Service Parameters[30]. Annex 1 to the Guidelines sets out the wording of Article 104 and Annex X of the EECC as well as the related EECC recitals.

QoS is defined by ITU as "Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service"[31].

Further, according to ITU, the end-to-end QoS depends on the contributions of the different parts in the chain as illustrated in Figure 2.[32]

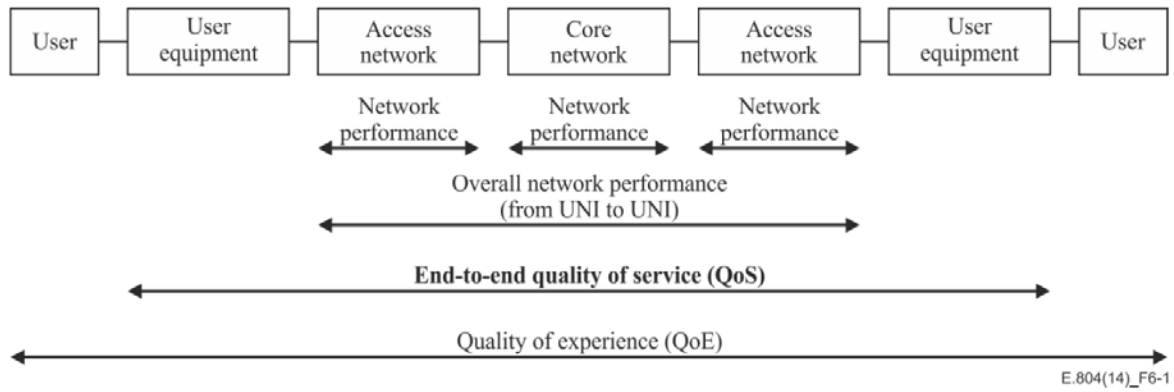

Figure 2: End-to-End QoS

QoS of Internet Access Services is also closely related to the application of the Open Internet Regulation. In 2012 BEREC issued Guidelines for Quality of Service in the scope of net neutrality.[33] Currently BEREC is developing an open source tool to assist NRAs in providing a measurement tool for end-users.

In the CFI, BEREC asked stakeholders for input regarding two perspectives of QoS, the enhanced Mobile Broadband end-user perspective and the verticals concerning Massive Machine Type Communications and Ultra-reliable & low latency communications perspective.

[28] Directive (EU) 2018/1972
[29] European Electronic Communications Code
[30] BEREC Guidelines detailing Quality of Service Parameters, BoR (19) 189
[31] ITU-T Rec. E.800.
[32] Rec. ITU-T E.804 (02/2014), p.16
[33] BEREC Guidelines for quality of service in the scope of net neutrality, BoR (12) 131

3.1.1 Enhanced Mobile Broadband (eMBB) – QoS issues from an end-user perspective

In 5G, gigabit speeds may enable the introduction of new retail services, e.g. UHD video streams or 3D video systems, therefore QoS information may need to be clear and available to end users.

In the CFI, BEREC asked stakeholders to provide views on whether they consider that BEREC should examine how to improve information on coverage and QoS of 5G networks so that end-users can make informed choices.

Input from stakeholders

Nearly half of stakeholders submitted comments regarding eMBB issues from the end user perspective though a few stakeholders do not think that there is a task for BEREC *per se*. For example, they consider that in so far as QoS is concerned it is already addressed in the EECC, and that the Open Internet working group of BEREC is involved in updating the open internet guidelines and there exists sector specific consumer rights regulation for telecoms. Some stakeholders point out that the operators need to be transparent and that the new EECC (Art. 102-104) sets out strong transparency and information requirements related to QoS. These stakeholders consider that BEREC should in turn wait for the final outcome of the Open Internet guidelines update and the other relevant aspects in the implementation of the EECC before any gap analysis regarding QoS for 5G is performed by BEREC.

Some stakeholders believe that some kind of regulation is needed, calling for different actions and resolutions but without providing any specific details at this stage. Stakeholders set out that BEREC should study the need of regulation focused on social benefits, or to investigate how different QoS levels can be provided without discrimination of the internet access.

Stakeholders also emphasise that QoS is important for a consistent 5G deployment and should be transparent for end-users in order to prevent the promotion of fake 5G services. BEREC could study whether the current set of QoS parameters (i.e. bandwidth without throughput and latency) are adequate for reaching the Digital Single Market and the satisfaction of the end-users, and whether today's in-door and out-door coverage maps are sufficient for 5G services.

3.1.2 Massive Machine Type Communications and Ultra-reliable & low latency communications – Verticals

An important feature in 5G is the enabling of massive machine type communications and Ultra-reliable & low latency communications services. A use case that often is described which relies on Ultra-reliable & low latency communication is the connected car (or new forms of track and trace services) and their need to develop and require coherent and consistent application of regulation across borders.

BEREC therefore asked the stakeholders whether BEREC should analyse application of relevant regulations for pan-EU operators (e.g. operating services flowing across borders) and cross-border interoperability.

Input from stakeholders

Over ten stakeholders have submitted comments regarding the issue of pan-EU operators. Several stakeholders think that BEREC should investigate whether there is a need to regulate QoS in order to stimulate continuous 5G QoS and seamless handover across borders, e.g. through a pan-European QoS, but they also point out that there could be similar problems within a country, for example between private and Mobile/Fixed Communications Networks.

Other stakeholders point out that QoS issues are not 5G specific and that QoS obligations are already expressed in the EECC. The QoS framework is well specified at standard level and will be guaranteed in cross border scenarios by industry market, operators agreements, to guarantee the necessary SLA according to the different classes of services. It has also been suggested that any BEREC study should coincide with work undertaken by ENISA.

Stakeholders are also concerned about the relation between industrial networks and MFCN (Mobile/Fixed Communications Networks) due to the different QoS requirements between industrial networks and MFCN.

BEREC's observations

BEREC considers that the level of responses on QoS issues in both the end user and verticals perspectives shows that this is an important topic for stakeholders.

In terms of the end user perspective, BEREC agrees that there is work being undertaken in this area (such as the current updating of the Open Internet guidelines). BEREC recognises the importance of the availability of information which is transparent and can empower end users to understand new services, and which can assist users, including vulnerable users, to avoid potentially fraudulent / fake services (see also consumer information aspects discussed in more detail in the next section). So while no particular areas of concern seem to be highlighted by stakeholders under this perspective at this time, BEREC considers it should follow a watching brief on relevant eMBB issues as the pace 5G innovation may alter the end-user environment rapidly.

As regards stakeholders' views on issues from the perspective of verticals (massive machine type & ultra low latency communications), BEREC notes that there is no consensus yet about how 5G might impact the operation of potential transnational / pan EU operators. BEREC has considered respondents' views that QoS issues are not only 5G specific and believes that there may be examples or use cases where 5G specific QoS may need to apply across borders to particular use cases / business cases (see also Chapter 4 in DotEcon/Axon report). BEREC would require further details on these types of services and their potential requirements in order to make informed views on the types of issues which NRAs or BEREC should anticipate studying in the future.

Perhaps service requirements in 5G could be met through service level agreements negotiated between willing parties, as suggested by some respondents, but it seems to BEREC to be too early to conclude this. As a result, further views which could help define

the problem might assist BEREC to advance its thinking on relevant QoS issues / metrics for verticals.

In relation to the stakeholder comment on industrial networks and MFCN, and in so far as BEREC understands the comment, some stakeholders may prefer to build their own industrial connectivity networks to protect commercially sensitive QoS information (e.g. they consider privacy and security issues would be better addressed on networks other than MFCN) or to retain flexibility to control/guarantee specific QoS levels themselves (e.g. information on the metrics needed to solve particular connectivity problems in their respective industries requires flexibility which that they do not believe MFCNs achieve). Considering security, privacy and flexibility as possible aspects, BEREC does not find any reason to believe that they would represent barriers to 5G. For example, none of the aspects are new issues in the discussions on 5G (and the CFI sought views on privacy and security). BEREC considers that it would be best to continue to track developments around 5G connectivity models, observing that it would welcome further discussions between all stakeholders so that concerns may be fully understood by the parties themselves. For example, various concerns may be addressed when more information on how network slices would be deployed in practice comes to light (noting that the first commercial deployments of slices may be a year or two away).

Similar to other issues addressed in the report BEREC intends to keep a watching brief on all of the above.

3.2 Consumer information

The 5G technology with its ability to provide enhanced mobile broadband with gigabit speeds will likely enable the introduction of new retail mobile services, e.g. UHD video streams, 3D video systems or services specially designed for gamers. 5G will also enable operators to differentiate products and services in much more complex ways. In order to make informed choices or switch between operators, end-users will need more detailed information on the characteristics of the services on offer. Hence, information on QoS, e.g. speed and latency, needs to be clear and available to end-users. Also, the speed and quality required for these services may not be available in all locations and at all times in a network. Information regarding the 5G network coverage and capacity is therefore essential for the end-users.

Input from stakeholders

Regarding whether BEREC should further examine the need for more specific information on characteristics of 5G services, more than ten stakeholders made comments. Operators, industry organisations and manufacturers were of the opinion that this is not a 5G specific issue.

A consumer organisation commented that, in addition to examining the need for more specific information, BEREC could also consider how regulation and enforcement, and sanction practices have the potential to protect consumers.

The issue of coverage maps for 5G was raised by several respondents as follows:

- Eleven stakeholders commented on whether BEREC should examine information on 5G network coverage. Operators, industry organizations and manufacturers were of the opinion that it is hard to see why this is particularly relevant to 5G, as 4G/3G networks will persist for some time. Moreover, the EU-funded project for mapping of broadband services in Europe is already addressing coverage maps for EU. There are no specific issues related to 5G networks that justifies a new obligation on coverage maps, hence there is no need for additional BEREC activities, recommendations or analysis.
- a consultant commented that it may be worth thinking about volumetric / 3D coverage maps, rather than 2D, especially where large buildings or aerial objects (eg drones) need coverage.
- a consultant commented that BEREC could consider how speeds and latencies etc. will be represented in a heterogeneous world of 4G, 5G, indoor, outdoor and with coverage variations

BEREC's observations

In 5G, many different services may coexist in the same network but require different QoS. In an end-to-end perspective, it will be critical that these services will function with seamless handover, both within a country and between different countries, which could imply a need for interconnection or roaming.

There are however already several initiatives regarding QoS. In June 2020, for example, BEREC and OECD will arrange a joint workshop regarding the customer experience and QoS will be an important aspect of this. The recently adopted EECC as well as the Open Internet Access Regulation include detailed information requirements on QoS which are also applicable to services based on 5G. BEREC is in the process of reviewing its Net Neutrality Guidelines, and that process provides an appropriate and timely forum for addressing these issues. As it is reflected in the document published by BEREC for public consultation[34], BEREC remains of the view that the Regulation seems to be leaving considerable room for the implementation of 5G technologies, such as network slicing, 5QI and Mobile Edge Computing. In particular, BEREC has clarified in its draft updated guidelines that both tariffs with different QoS (as long as the tariff as such is application-agnostic) as well as specialised services are possible, which would be relevant for 5G use cases such as in the IoT/M2M context. To date, BEREC is not aware of any concrete example given by stakeholders where the implementation of 5G technology as such would be impeded by the Regulation.

[34] https://berec.europa.eu/eng/news_consultations/ongoing_public_consultations/5947-public-consultation-on-the-document-on-berec-guidelines-on-the-implementation-of-the-open-internet-regulation

BEREC would agree with the general comment in relation to regulation and enforcement, and sanction practices having the potential to protect consumers.

In relation to the issue of coverage maps for 5G, BEREC makes the following points:

- Some stakeholders' seem to associate the development of coverage maps with a "new obligation", without first considering whether there are benefits with the availability of 5G coverage information for use by verticals or other business users with connectivity requirements. Amongst the high-level benefits which BEREC would welcome views on include: whether 5G coverage information would assist optimising verticals' select their connectivity solutions and/or would it provide them with a useful input for negotiation purposes with connectivity providers etc. BEREC would welcome any preliminary views on these high level aspects rather than on the viewpoint how to achieve the maps;
- BEREC is aware of the EUs mapping project for broadband services in Europe and would note that its present enquiry into 5G coverage maps would be complimentary to this project. For example, BEREC would welcome views on the types of metrics to be mapped rather than on the mapping exercise as a whole. In this aspect, the BEREC Wireless Network Evolution working group is conducting a feasibility study on the development of coverage information for 5G deployment.[35] Some of the preliminary findings from that study also suggest that it is too early to define the QoS requirements of verticals / business users with connectivity requirements. BEREC intends to identify any relevant insights from that study in its report on 5G;
- In relation to the concept of volumetric mapping of 5G coverage, BEREC would observe that the respondent does not set out what types of metrics might be mapped. Again, the metrics aspect is important to BEREC at this time, as BEREC is considering what the potential benefits of mapping particular metrics would be from the perspective of verticals, etc. The volumetric mapping concept also raises more questions for BEREC such as to what extent would this mapping concept be served via an EU harmonized approach (if any) and, if the mapping would be localized (such as to serve where drones need coverage near buildings etc) how scalable would the mapping technique be to wide areas, having regard to the wider benefits achieved by BEREC's Common Position on information to consumers on mobile coverage[36].
- In relation to the comment that BEREC should consider how speeds and latencies might be represented given heterogeneous networks, BEREC would reflect on two relevant workstreams that show BEREC is aware of this issue – e.g. BEREC's proposed net neutrality and the specifications it has adopted for a reference

[35] BEREC Document, BoR(19) 191 https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8848-berec-feasibility-study-on-development-of-coverage-information-for-5g-deployments

[36] BEREC Document BoR(18) 237 on common position on information to consumers on mobile coverage 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

measurement tool for the monitoring of the Internet Access Services[37] and the Common Position on information on mobile coverage to consumers.

In summary, BEREC does not consider there to be a priority consumer issue arising out of this aspect but will keep the issues under review.

3.3 Interoperability

In this new 5G ecosystem of increased numbers of service providers and localised networks, it will be vital that different networks are interoperable, wherever this is demanded. This will ensure that different networks can connect and share data where there is a business need.

There will also be a cross-border interoperability aspect for verticals (e.g. asset tracking).

In addition to networks being interoperable in order to deliver a seamless experience, there is also a societal angle to consider. Some 5G use cases will deliver wider societal benefits to end users and will need to be able to connect to other similar devices, even when using different technologies or provided by different operators. For example, connected vehicles from different manufactures and utilise different technologies (i.e. 5G and WiFi) need to communicate with each other for reasons of traffic safety. As smart home/building use cases increase, data will need to be harvested and shared in order to improve energy efficiency.

In some of these use cases, the transmission aspect of 5G will be embedded into an end-to-end managed service. Individual 5G use cases such as connected vehicles might well share characteristics of online platforms: a tendency toward concentrated markets that can 'tip' in favour of one or a few providers due to the underlying importance of the use of data and algorithms to the service being provided. Collected data can be used to derive insights about user behaviours which can in turn inform algorithms that can 'improve' the service by personalising and targeting services in novel ways. The advantage of dominant providers can be further exacerbated when providers of these types of services extend their scope into offering a wide range of services for customers. The resulting 'ecosystems' of services can have an anti-competitive effect if the ecosystems are closed to new entrants because the underlying economies of scale and scope can provide incumbents with a competitive advantage, which can be difficult for potential entrants to overcome. In particular, the relative lack of data can hinder the ability for potential entrants to compete with incumbents in terms of service quality. In such a scenario, interoperability, if it is to be an effective remedy that can facilitate a competitive outcome, might need to be wider in scope than the interoperability of the transmission element of a service; it would need to encompass a full service interoperability including access to the underlying data as has been suggested in a number of studies into potential regulation of online platforms including one commissioned by the EC on 'Competition Policy for the Digital Era'[38]. In fact, in a subsequent high level working paper regarding the content of a future Digital Services Act, the Commission has stated that:

[37] BEREC Document BoR (17) 179 on net neutrality measurement tool specification https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7296-net-neutrality-measurement-tool-specification

[38] https://ec.europa.eu/competition/publications/reports/kd0419345enn.pdf

"where equivalent services exist, the framework should take account of the emerging application of existing data portability rules and explore further options for facilitating data transfers and improve service interoperability - where such interoperability makes sense, is technically feasible, and can increase consumer choice".

Input from stakeholders

A number of stakeholders highlighted the importance of interoperability between different networks. One stakeholder added that interoperability should be defined by need and not by default, so isolated networks can still be created where needed.

Regarding whether there is any action required by BEREC, responses were mixed. One stakeholder suggested that BEREC should focus on interoperability as a mechanism to achieve greater competition and public interest objectives. Another suggested that BEREC should study interoperability issues. On the other hand, a few stakeholders commented that interoperability was not an area for BEREC to study. One stakeholder commented that they see interoperability as an issue being covered by 3GPP and ETSI and a few other respondents commented that this issue should be left to the market to decide. A further stakeholder said that interoperability is not a 5G specific issue and questioned BEREC's mandate.

One stakeholder highlighted that it will be important to keep the information model around Network Slice Selection Assistance Information (NSSAI) internationally coordinated for public 5G networks, and that this will have an impact on the ability for users, for example of a network slice, to switch providers. Another stakeholder noted that transparency around QoS is required in order to ensure that MVNOs/Service providers and fixed operators are able to compete with MNOs.

BEREC's observations

BEREC is of the view that interoperability for verticals will be important, however at this time our view is that this is something the market will cater for. We will keep a watching brief in the event that this becomes a barrier to connectivity. In 2020, BEREC will also publish a report on Market & Economic issues of digital platforms.

As verticals increasingly rely on connectivity, it will be important to ensure that they are not locked into vendors or providers, and are free to switch, including from MNOs to micro operators to fixed operators, etc. However, parties will enter into commercial negotiations to agree the most appropriate terms for the provision of connectivity, for example, if the network provider owns the infrastructure, a change of provider means that the infrastructure within the factory also needs to change ownership. Although vendor lock in/switching is not specifically a 5G issue, an increase in more localised networks, highly customised and slices and an increase in number of players providing connectivity, means that this issue could become more prevalent.

For consumers, it will be important to ensure end-users can switch between different 5G operators and are not locked into a specific provider, particularly as the greater number of services may lead to an increasing variety of bundling options.

4 Other regulatory aspects

The CFI also focused on identifying the potential regulatory issues and responsibilities that may be addressed by other competent authorities. In particular, this chapter deals with other topics / regulatory aspects which are not under BEREC's remit, but stakeholders' consider are relevant to 5G. For example, security and privacy aspects are included in this category, as well as is spectrum.

4.1 Security

5G technology has been designed with advanced performance features that will provide virtually ubiquitous, ultra-high bandwidth and low latency connectivity to different users but also to a high number of connected devices. These characteristics will enable 5G networks to support a wide range of services, sectors and applications. The 5G ecosystem is expected to involve many different actors and users in different domains (e.g. smart city, industry automation, health, logistics), carrying sensitive information and requiring specific security requirements. Any vulnerability in 5G networks could be exploited, potentially causing serious damage to crucial infrastructures and services and affecting the economies and societies of the EU.

On 26 March 2019 the EC adopted the EC Recommendation on Cybersecurity of 5G networks.[39] The Recommendation identifies the actions at national level, and coordinated at Union level, which should be taken to assess the cybersecurity risks affecting 5G networks, in order to develop a common toolbox of best risk management measures. BEREC's role includes acting as a conduit for information and experience sharing on electronic communications market matters amongst its Members and participants and other relevant bodies and to assist the toolbox development process as mandated in Preamble 24 of the Recommendation.

The CFI sought stakeholders' view about how these security issues could impact end-users and the 5G value chain.

Input from stakeholders

Several consumer associations highlighted that security should be prioritised over other topics, requiring a coordinated framework to facilitate vendor diversity. Liability rules for operators and providers, assisted by security certification of software and devices, like the proposed by the EU Cybersecurity Recommendation, are suggested ways security issues could be managed/monitored by competent authorities. One contribution identifies a lack of coordination between the EU, more focused on end-user, and the Member States security regulation, focused on geopolitical competition and national security, that potentially could damage citizen's trust and network equipment vendors. It was specifically mentioned that some authorities would block vendors from introducing security enhancements.

IoT environment is emphasized as being insecure by several stakeholders. The associations which represent the interests of telecom operators, mention that the growing number of

[39] (EU) 209/534 of 26 March 2019 - https://eur-lex.europa.eu/legal-ontent/EN/TXT/?uri=CELEX%3A32019H0534

connected devices enabled by 5G will increase the entry points to network security attacks. On the other hand, 5G also includes specific privacy and integrity characteristics and features like network slicing for a better security and protection of users.

On the other hand, some stakeholders (operators, equipment providers and industry associations) do not immediately consider security a major concern in 5G networks deployment, yet they would consider this topic to be important. Security in private dedicated networks has been highlighted as an issue and security optimization standards for mMTC and URLCC are expected. Further the need to standardize security requirements is mentioned and these requirements should be verifiable for all vendors and operators. One stakeholder noted that legal remedies for any breach should be harmonized and appropriately balanced in Europe.

Regarding any future enquiry area by BEREC into security issues, stakeholders seem to consider that BEREC's role should be a supportive one; supporting the EC, rather than taking a leading role. The consensus was that BEREC should avoid duplicating activities that are already underway (e.g. workstreams arising from the Cybersecurity Recommendation, ePrivacy and NIS Directive etc.). In this way, stakeholders support BEREC to collaborate with the EU Agency for Cybersecurity (ENISA) on the evaluation of the measures taken by Member States to ensure 5G security following the EC Recommendation, in order to ensure a consistent approach in the EU.

Stakeholders also support BEREC to assess, jointly with ENISA, if the scope of obligations of the NIS Directive[40] (security by design, duties of reporting to authorities and users) is sufficient in the realm of 5G networks or should be extended to also cover hardware and software manufacturers.

In terms of potential study areas, one stakeholder adds that a potential study to address regulation of countermeasures against information warfare and disinformation campaigns should be conducted. Another proposal was that BEREC should study the provision of guidance on the security requirements of verticals, including defining stakeholder responsibilities.

BEREC's observations

On 9 October 2019 the NIS Cooperation Group[41] (composed of Member States, the EC and ENISA) published a report on the EU coordinated risk assessment of the cybersecurity of 5G networks.[42] This report is based on the results of the national cybersecurity risk assessments by all EU Member States. It identifies a number of important security issues, which are likely to appear or become more prominent in 5G networks. Regarding security, BEREC's role is supportive to NRAs and the EC. As stated in Preamble 24 of the

[40] Directive on security of Network and Information Systems, adopted by the European Parliament on 6th July 2016 (DIRECTIVE (EU) 2016/1148).
[41] The NIS Cooperation Group has been established by the NIS Directive to ensure strategic cooperation and the exchange of information among EU Member States in cybersecurity.
[42] https://ec.europa.eu/digital-single-market/en/news/eu-wide-coordinated-risk-assessment-5g-networks-security

Cybersecurity Recommendation, BEREC is intended to assist the NIS Cooperation Group in the toolbox development process.

Thus, BEREC provided as input to the Commission, the NIS Cooperation Group and ENISA an internal survey on the state of play of security requirements for 3G, 4G and 5G electronic communication networks.[43]

Taking this assessment into account, the NIS Cooperation Group is expected to establish a common toolbox identifying types of cybersecurity risks and best mitigation measures that can be applied at national and European level. The mitigation measures could for instance be derived from an established set of common security requirements since the stakeholders mentioned a need to standardize security requirements, which also should be verifiable for all vendors and operators.

4.2 Privacy

Gigabit speeds and other enhanced capabilities in 5G networks may increase users ability to generate or disseminate private information and to generate more private information on the web. On the other hand, different use cases will harvest data from different uses, enabling the development of data processing actors in the 5G value chain, who may not have a direct relationship with end users and therefore cannot request data processing consents directly.

Taking account of GDPR legislation, BEREC's CFI sought stakeholders' opinion about the end-users understanding of the impact of sharing their private information in terms of the data economy in 5G, and about privacy regulation for data exchange between parties in the 5G vertical's value chain.

Input from stakeholders

Regarding the privacy topic from the end-user perspective, most stakeholders agree on considering privacy issues already covered by the relevant authorities, not particularly related to 5G, and consider BEREC input is not required, as the EC has already carried out Eurobarometer surveys on end-user privacy, in addition to national surveys. Instead, some stakeholders recommend BEREC to collaborate with the European Data Protection Board (EDPB) and Data Protection Authorities (DPA).

Concerning data portability, some stakeholders would welcome cooperation between NRAs and DPAs, because of the concerns raised in the interpretation of guidelines on the rights to data portability, and the implications for telecom operators. Other stakeholders consider data portability is covered by GPDR regulations.

In relation to the EU proposal for e-privacy regulation, some stakeholders suggest a further analysis[44] regarding the compatibility with GDPR.

[43] BoR(19)218.
[44] Specifically concerning proposed article 6 and 8.

Regarding verticals value chain impact, some stakeholders consider it should be undertaken by the relevant authorities dealing with privacy, whereas other stakeholders support BEREC analysis of the issue, as the proposed e-privacy regulation is causing uncertainty and impossibility for business-to-business (B2B) and business-to-business-to-customer (B2B2C) players in the value chain in obtaining end-user consent.

Another contribution points out that mobile edge computing may make personal location easier to identify, although this would be covered under GDPR and future e-privacy regulation. And concerning dedicated 5G/LTE networks, a stakeholder mentions that support of GDPR required privacy by private networks is essential.

BEREC's observations

As highlighted by most stakeholders, privacy regulation is often covered by other authorities (EDPB and DPAs). Currently BEREC holds the view that 5G does not trigger a need for additional guidance on this aspect. BEREC would only be required to collaborate with the EDPB and DPAs authorities, if needed.

4.3 Convergence with broadcasting services

The CFI set out one question concerning the broadcasting services because 3GPP Release 14 in principle allows improved support for national TV services to both mobile devices and stationary TV over eMBMS (enhanced multimedia broadcast and multicast system over LTE).[45] Some broadcasters consider that access to 5G to deliver broadcast signals may require *must carry rule*s to be updated (in this context, must carry rules would refer to license obligations mandating the carriage of certain public content on broadcasting networks). As 5G could become the mobile multi-purpose technology of the next ten years it is of interest to attract as many users as possible to 5G. On the other hand, obligations like must carry rules have a strong impact on the market and need strict examination prior to any regulatory action.

Input from stakeholders

Around 20% of the stakeholders gave feedback on this aspect. The majority considers that this subject is still in premature phase and it is too early to analyze the impact of must carry rules on 5G. In general stakeholders set out that this subject is a low priority one. In addition, stakeholders consider that national regulators with responsibility for content would be the most appropriate bodies to evaluate the impact of 5G on must carry obligations on the basis of the national market circumstances. Some stakeholders consider that the subject needs analysis by network manufacturers, broadcasters and operators.

BEREC's observations

In the context of convergence between operators and broadcasting services, BEREC is of the opinion that it is at this moment too early to evaluate the impact of 5G on must carry

[45] From https://www.3gpp.org/news-events/1905-embms_r14, 15.04.2019.

rules. BEREC and other media regulators or agencies with responsibility for broadcasting content will, in the coming years, continue following the development on the market.

4.4 Spectrum

The availability of spectrum is important for the roll-out of wireless 5G networks. While some of the spectrum currently in use for 2G/3G/4G can be already re-used for 5G with technology-neutral licensing, it is important to ensure sufficient spectrum is available to accommodate the rising demand for enhanced mobile broadband and new services. Given spectrum in the 700 MHz band, the 3.6 GHz band and the 26 GHz band the RSPG identified the so-called pioneer bands that have to be made available by Member States for 5G usage in timely manner. The current implementation status within the EU member states is published on the RSPG website.[46]

5G has the potential to allow new players to enter the market and to bring changes to traditional value chains. Large corporations from various industries ("verticals") are evaluating the possible build-or-buy options with regard to (probably mostly local or regional) 5G networks. Furthermore, sharing options are discussed in the light of a larger number of players potentially competing for scarce spectrum resources.

Input from stakeholders

Although spectrum issues have not been explicitly addressed by BEREC in the CFI, stakeholders brought forward comments regarding spectrum.

A few responses mentioned the importance of the availability of both licensed and license-exempt spectrum. It was also mentioned that regional licensing plays an important role. A further response highlighted that the number of WiFi connections in 2022 will be much higher than the number of 5G connections, and thus WiFi should be integrated into 5G. One response urged for spectrum leasing prices to be restricted by regulation, when spectrum is allocated nationally via auction. With regard to spectrum issues it was suggested that BEREC should address the cost of spectrum as too high costs could go against the EU's agenda to provide widespread 5G coverage.

BEREC's observations

Taking into account BEREC's role in the market related aspects of spectrum assignment, BEREC finds no reason that the prices of spectrum leases is an issue that requires an action by BEREC to regulate. BEREC considers that spectrum leases mostly are, and would likely continue to be, negotiated on commercial terms and that the remit of contract law and relevant provisions therein would apply. In addition, in relation to claims that the cost of spectrum is too high, and could go against the EU's agenda to provide widespread 5G coverage, BEREC observes that prices for rights of use to spectrum reflect the need to ensure the optimal and efficient use of radio spectrum, which is a shared objective of Member States. In addition, BEREC considers that licensing is a national issue, observing that information sharing and exchange of assignment practices between relevant bodies is

[46] http://5gobservatory.eu/

enshrined in the EECC under Article 35 on the peer review process, which provides for cooperation between BEREC and RSPG. In this regard, BEREC Document (19) 100 sets out the working arrangements between BEREC and RSPG[47] facilitating expert exchanges which assures that spectrum issues can receive the attention they need.

[47] https://berec.europa.eu/eng/document_register/subject_matter/berec/others/8602-working-arrangement-between-berec-and-rspg

5. Overall conclusions and next steps

5G introduction is at a very early and experimental phase. During the drafting of this report we have learned that this makes it difficult to exactly pinpoint and analyse regulatory aspects of 5G at this moment. Nevertheless BEREC highly appreciates the strong resonance this project has already found among stakeholders.

In this report BEREC has identified regulatory aspects that may need BEREC's attention, in some way, and at some point of time. And over time it will become easier to identify and define concrete projects, and prioritize them.

The regulatory aspects that BEREC had provisionally listed for comments from stakeholders in its CFI were widely recognised by stakeholders. Some additional or related concerns were raised as well. For many of the regulatory aspects BEREC and NRAs have competences to address them directly, or can signal issues with other competent authorities.

With respect to numbering and net neutrality BEREC has already started making and respectively updating guidelines, and thereby preparing for the introduction of new 5G services. BEREC is also working on a database of numbering resources with a right to extraterritorial use within the EU. BEREC will keep working on this project, as it has to be kept up to date. NRAs or other CAs will monitor the provisioning of numbering resources.

BEREC will also continue to support the Commission recommendation implementation on 5G Cybersecurity during 2020 by scheduling an external workshop with stakeholders to discuss the expected toolbox that will have been issued by then.

The CFI identified some issues that could be further examined such as the role of eSIM, Other issues may also arise concerning international roaming and numbering, which may need to be further elaborated in the coming years.

Monitoring and information tools play an important role in BEREC's work, and it can also be used to provide stakeholders with improved access to information about public infrastructure facilities, planned civil works and available infrastructure and permission requirements, also in relation to small cell deployment.

Stakeholders raised some issues that should be further examined such as network slicing and the relation between roaming agreements and network slicing, interconnection of private and public networks and infrastructure sharing. Also interoperability may be an issue to be addressed in the coming years.

In relation to infrastructure sharing and 5G, BEREC intends to conduct a workshop in the first quarter of 2020 and is currently seeking views on this proposal in its Work Programme 2020 consultation. BEREC also proposes that its experts continue to gather information on the first 5G use cases, pilot experiences and standardisation activities, especially regarding SDN/NFV and network slicing. 5G use cases will be studied from a regulatory perspective in the upcoming workshop.

In the coming years BEREC will continue its dialogue with the stakeholders and the NRAs in order to understand the potential concerns of ‘hauling’. BEREC will also gather information and analyze to mitigate those potential issues. For example, BEREC could carry out a study to analyze the ‘xHaul’ and the implications on regulation.

Based on the input from stakeholders and BEREC’s remit, BEREC is of the impression that the continuous cooperation between BEREC and the relevant competent authorities would sufficiently ensure that security, privacy and spectrum aspects that have been highlighted in the CFI are covered.

BEREC will keep on working on 5G related regulatory aspects. Besides 5G specific projects, this could also be embedded in other projects. Because of the strategic importance of 5G most of the BEREC projects will have a 5G component.