Body of European Regulators
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BEREC

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Guide to the BEREC 5G Radar

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Introduction

5G is one of BEREC's strategic priorities set out in the draft strategy for 2021 – 2025[1], underscoring that 5G continues to be a key area as it was already set out in the current BEREC strategy.[2] Over the past years several 5G-related activities have been going on in various working groups and committees. The challenges that need to be addressed range from work on standards, interoperability, new business models, spectrum availability and network sharing, coverage, Quality of Service (QoS), security and resilience. BEREC has identified 5G as a strategic priority with the aim to enable European-scale solutions that promote competition, to being consistent with the EU regulatory framework and which may help reap the benefits of an early and coherent implementation of 5G in terms of innovation, productivity and growth in the internal market. To this end, BEREC will – within the scope of its competence – continue to actively follow the development of 5G and, where relevant, work in cooperation with other EU bodies (in particular the RSPG) to ensure a smooth and quick implementation of 5G in the Member States.

BEREC will also need to follow innovations in other network technologies, both fixed and wireless, to find common regulatory perspectives of how these technologies influence markets and the potential responsibilities for regulators. The network technologies and developments that have the potential to directly change the way services are used and delivered, such as IoT, NFV/SDN, as well as the technologies that may play a part in enabling such changes, e.g. small cell deployment, will be of particular importance for BEREC to follow in the coming years.

Many aspects of regulation are involved in the 5G ecosystem. How these are addressed could be critical to the pace at which innovative services are brought to market – especially vertical solutions. This project seeks to help NRAs to anticipate the issues involved and to support the pace of innovation to be optimised.

This project aims to anticipate any changes to regulation that may be required to keep pace with innovation. It will build on work previously undertaken by BEREC within this area, in particular the study on the implications of 5G deployments on future business models[3] and the pathfinder mission report. BEREC has also published a number of reports and common positions related to 5G, such as reports about fixed/mobile convergence, infrastructure sharing, spectrum authorisation and award procedures, and coverage obligations. Additionally, infrastructure sharing and information to consumers on mobile coverage were further studied and published as BEREC common positions.[4]

[1] https://berec.europa.eu/eng/document_register/subject_matter/berec/annual_work_programmes/9039-draft-berec-strategy-2021-2025 (this is the draft BEREC Strategy to be adopted later in 2020).

[2] https://berec.europa.eu/eng/document_register/subject_matter/berec/annual_work_programmes/7310-berec-strategy-2018-2020

[3] Study on Implications of 5G Deployment on Future Business Models, A report by DotEcon Ltd and Axon Partners Group (BoR (18) 23). https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8008-study-on-implications-of-5g-deployment-on-future-business-models

[4] BoR(19) 110, BEREC Common Position on infrastructure sharing, and BoR(18) 237 Common position on information to consumers on mobile coverage.

Parallel work by BEREC

In a parallel project, a feasibility study was done about the expected benefits of consistent and coherent presentation of coverage information for 5G deployments for use by market sectors other than mobile network operators (e.g. by new vertical applications and use cases; automotive, industrial, environmental monitoring use cases). In summary, the feasibility study suggested that it was premature for BEREC to study a policy objective to provide harmonised information on 5G coverage and QoS aspects of networks. However, BEREC committed to continue to facilitate exploratory discussions with industry stakeholders, with the objective of keeping BEREC informed of relevant discussions around coverage information and QoS aspects of 5G networks.

BEREC acknowledged that previous network generations have been designed as general-purpose communication networks with limited differentiation capabilities across use cases. 5G is expected to create an ecosystem for technical and business innovation involving a number of different vertical markets such as energy, agriculture, city management, government, healthcare, manufacturing and public transportation. It will serve a larger portfolio of applications with requirements ranging from high reliability to ultra-low latency to high bandwidth and mobility. The 5G ecosystem is likely to become the cornerstone for digital connectivity which is a major driver of economic growth and serving societal needs. Many of the proposed 5G services and use cases and their respective providers are part of a particular vertical market (i.e. services which are specific to an industry or a group of customers), some of which have been broadly classified by the 5G Infrastructure Public Private Partnership (5G PPP) as 'verticals', but which BEREC considers are businesses with connectivity requirements. Businesses with connectivity requirements / vertical industries are expected to be the main driver of making the 5G ecosystem sustainable. Since 5G technology is designed to support a large range of use cases, the 5G ecosystem is likely to be broader than earlier generations of mobile communications systems as the needs of different users may be specific to particular sectors. In addition, different business models may arise with 5G, with new players/actors entering the market. For example, in some cases mobile network operators may have a direct customer relationship with customers in the vertical. In other use cases, one or more intermediate parties may arise that are specialised in fulfilling the specific connectivity needs of a vertical. In this new large ecosystem where multi-vendors seek to serve the communications needs of multi-use-cases, it is envisaged that NRAs may have a role to play for example in the provisioning of coverage information and Quality-of-Service (QoS) aspects of future 5G networks that cater for the needs of the verticals.

In December 2019, BEREC published a report on the impact of 5G on regulation and the role of regulation in enabling the 5G ecosystem, a first assessment based on stakeholder input. This report is the result of a “horizon scanning exercise” and poses 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. ‘New regulatory challenges’ does not mean more regulation per se, but could also mean more proportionate or less regulation, depending on the issue at hand.

Many aspects of regulation are involved in the 5G ecosystem. How these are addressed could be critical to the pace at which innovative services are brought to market – especially within vertical sectors. This project should help NRAs to anticipate the issues involved to support the pace of innovation to be optimized.

The first assessment included stakeholder views on an initial list of regulatory aspects in the context of 5G. From the initial list and the stakeholder input it can be concluded that there are many regulatory aspects that needs to be addressed. However, not all of the aspects need attention at the same time. 5G will be gradually introduced. Many Member States are now issuing the required spectrum. Aspects related to roll-out will probably need earlier attention than issues related to network slicing. In order to help NRAs prioritizing the projects to address the identified aspects, this follow-up report presents a radar plotting the 5G developments according to the anticipated time horizon.

In paragraph 1 the stepwise introduction of 5G will be explained. In paragraph 2 the stepwise introduction will be linked to use cases and regulatory challenges. Paragraph 3 describes the main observations and conclusions of the 5G-radar. Paragraph 4 explains the radar as an instrument and how it can be used.

1. The stepwise introduction of 5G

The development of 5G-services will not happen at once, but will evolve gradually. The new services are dependent on standardization work by the 3GPP and the different release phases.

In the first phase, called ”3GPP Release 15 Non-stand-alone”, the focus is primarily on specifications for radio access in order to provide the use case ”enhanced mobile broadband”, i.e. more bandwidth to handle increasing data volumes. The radio access interfaces will be the present 4G-LTE and the new 5G-NR, while the core network will consist of the present core network for 4G-LTE.

Today’s LTE-based networks have a relatively high spectral efficiency, close to the theoretical maximum. Hence, the efficiency gain when going from 4G-LTE to 5G-NR will not be as big as it was when 3G-UMTS was replaced by 4G-LTE. In order to provide higher capacity in the radio access network, it will be necessary to have new frequency bands and to install more base stations.

For the second phase, called ”3GPP Release 15 Stand-alone”, substantial investments are needed. The core network must be upgraded based on cloud services and virtualisation, and the new core will not be compatible with the old core for 4G-LTE. The standardisation for phase one and two was completed in June 2018, and 5G-modules for consumer products have become available in late 2019.

In the third phase, called ”3GPP Release 16”, new functions are included, e.g. the introduction of ”massive IoT” and other network improvements in order to realize the full potential of 5G. Standardisation for this phase has taken place in December 2019, and equipment based on these standards is not expected to be on the market before 2021.[5]

While the stepwise introduction is enabled through the 3GPP standardization process, the three phases described may not occur sequentially and not simultaneously in all the networks. It is possible that the 'phase one' and 'phase two' networks will coexist, whereas the 'phase three' services will be introduced gradually across networks.

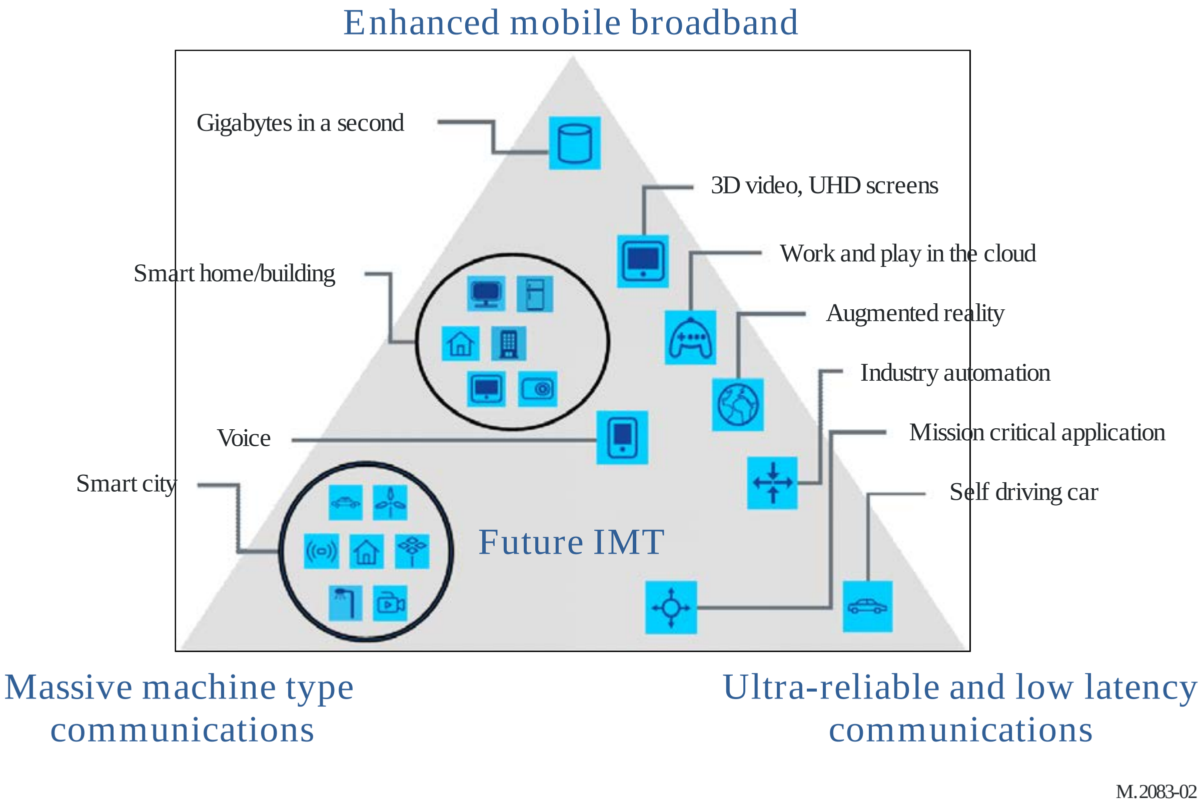
The DotEcon/Axon study on “Implications of 5G Deployment on Future Business Models”[6] commissioned by BEREC, described that existing technologies such as NB-IoT, Lora, SigFox etc. could be used to meet the connectivity demand for some M2M and IoT devices and could possibly complement the RLAN solutions such as Wi-Fi. An important insight is that it is not necessarily 5G which will enable all the customers demand. Different radio technologies, such as 5G, 4G, NB-IoT, will likely be used for the communications need in a “5G-context” for a customer. Hence, this will be an important aspect when analysing the study cases in order to identify the regulatory challenges.

2. Use cases and regulatory challenges

Generally 5G is described as it is supposed to support three main categories of usage; enhanced Mobile Broadband (eMBB), massive Machine Type Communication (mMTC) and Ultra-Reliable Low Latency Communications (URLLC)[7]. The picture below shows the future service categories made possible by 5G.

As mentioned above and as also identified by the DotEcon/Axon study, ”enhanced mobile broadband” is to be the initial driver to 5G as data consumption is expected to grow exponentially in the future. The network investments necessary to meet this demand will happen in phase one. This will include densification of the mobile network with new 5G-NR base stations on existing as well as new sites. However, in areas where 4G-LTE is sufficient to meet capacity demand, 5G may not be rolled out.

[5] Due to the current circumstances, the earmarked date will be postponed to a later date. There is a halt in the 3GPP development, incl. stage 3 of Rel-16, process. Most plannings are shifted by 3 months. Source: https://www.3gpp.org/release-16.
[6] Study on Implications of 5G Deployment on Future Business Models, A report by DotEcon Ltd and Axon Partners Group (BoR (18) 23).
[7] Study on Implications of 5G Deployment on Future Business Models, A report by DotEcon Ltd and Axon Partners Group (BoR (18) 23), p.20.



The initial roll-out of 5G for eMBB will depend on the availability of frequencies in the 3.4-3.8 GHz band, the availability of 5G equipment for operators, as well as demand from end-users.

MNOs will most likely want to make as much use as possible of existing sites and assets. However, 5G for eMBB will probably be rolled out in areas where 4G capacity is deemed insufficient to meet future demand. 5G for eMBB will be rolled out in those areas where there is a need and demand. It is likely that deployment in dense areas will be based on the 3.6 GHz band, whereas in rural areas operators will rather use harmonized bands below 1 GHz (e.g. the 700 MHz band which the RSPG also identified as a pioneer band for 5G).

The increased network capacity at each site may also lead to a demand for fibre backhaul or high capacity microwave links on existing sites.

At a later stage, 5G will be rolled out with small cells in the 24.25–27.5 GHz-band. The start of roll-out will depend on when the licensing process takes place. These cells will have smaller radius (e.g. of 50 – 200 metres), and will provide increased capacity locally, outdoors as well as indoors. Gaining access to outdoor and indoor sites and having to deploy fibre backhaul and provide power to base stations may pose challenges of availability.

This will require careful planning and agreements with municipalities and property owners. The large number of new sites may also make it necessary for operators to share infrastructure. Property owners on the other hand may have objections to housing multiple base stations from several MNOs in the same building.

In phase three, the services in the triangles lower corners are made possible and should be introduced to the market. Licensing of new spectrum in higher frequency bands may be necessary in order to enable local networks. In this phase specialised services are expected to be introduced. Regulators may have to assess, amongst others criteria, whether QoS differentiation of a specific mobile specialised service will be compliant with the Open Internet regulation.

Further, in order to enable an end-to-end service between multiple networks, the NRAs need to make a regulatory judgment of the need of obligations for national roaming and interconnection.

An important obstacle of the rollout of national based services, for example connected cars, to take into consideration is of course the geographical dimension of less dense networks in rural areas. This raises the question of the need of state aid in order to roll out networks in areas where it is not economically profitable. The new services developed for usage in the third phase may result in new end-user concerns, like privacy and transparency. Tailor-made services using a special slice of a network may be confronted with challenges concerning switching or interoperability.

3. Main observations and conclusions

Each phase of the gradual introduction of 5G will have its own aspects that may need regulatory attention. In the paragraph above we have not mentioned all the possible aspects, but some examples. From the report on the horizon scanning mission, published at the end of 2019, the 24 most important aspects have been derived based on stakeholder input and plotted on the radar. The radar shows what are the most important aspects for BEREC and NRAs, and when regulators should be prepared for those developments. The interactive radar is published in a separate file. The 2D radar image is included in this document as Annex 2. The BEREC 5G radar is developed as a tool to identify developments in the 5G ecosystem that may need regulatory attention, and prioritize them in time.

Many regulatory challenges can be identified in which BEREC and NRAs have an important role. Another observation is that the different phases of introduction and deployment of 5G can also be recognized in the radar. The time between those phases should be used by BEREC and NRAs to be able to address all the regulatory challenges.

4. Interpretation and use of the radar

The marine radar is an instrument that is used on the ship's bridge in carrying out a safe navigational watch. A radar is used in identifying, tracking and positioning of vessels (including one's own vessel) among other things in order to safely navigate a ship from one point to another. The identified objects may also move in certain directions, and with a certain speed.

On the BEREC 5G radar, there are 24 identified 5G related developments[8] that will be relevant to BEREC and NRAs in the coming years. The radar does not identify solutions, but developments that should be looked closer into in order to facilitate a smooth implementation of 5G and new services. The radar indicates the relevance for BEREC and NRAs and when BEREC and NRAs should be prepared for that development. This means preparations and work in many cases have to start well ahead of the timing that is indicated in the radar. The closer the circles are to the centre, the more relevant they are. Closer to the baseline means that they become relevant very soon. Like on the marine radar, the objects identified by the BEREC 5G radar may move, as their relevance changes, or their speed changes, and thereby the year that BEREC and NRAs should be prepared. Careful study of the radar will enable BEREC and NRAs to timely plan the projects that address the regulatory challenges.

Annex 1 describes per cluster the relevance and timing of the developments. In the annex will be the short form of the radar. An interactive radar will be published separately in pdf-format.

All the plotted aspects are relevant developments for BEREC and NRAs. Relevance is described as relative to relevance of other topics, and relevance for BEREC and NRAs. Certain aspects can be very important, with BEREC only having a minor role in addressing the issue. Those aspects are indicated as relatively less relevant.

[8] Some developments already take place in the 4G ecosystem, often BEREC and NRAs are already involved in addressing those developments. These developments are not plotted on the radar. This does not imply less relevance of the topic for the work of BEREC and/or NRAs.

Annex 1. Relevance and timing of the developments

In July 2019 BEREC had approached stakeholders with a call for input (CFI) containing an initial list of regulatory aspects. In the report on the impact of 5G on regulation and the role of regulation in enabling the 5G ecosystem the responses from almost 50 stakeholders across the industry are summarized, and related to projects already in the pipeline. From this report 22 of the most relevant take-aways are chosen. The 22 topics are clustered according to the themes of that report. Sustainability, as a new strategic priority of BEREC, is a new addition after the 2019 report. Satellite Communication (SatCom) is added as a result of the public consultation, and is placed with the theme Interoperability.

	Theme		One-liner (with reference to the paragraph in the Report on the impact of 5G on regulation and the role of regulation in enabling the 5G ecosystem	Trend	Relevance and timing
1	Privacy	Private information as cost	End-users may not understand the impact of sharing their private information in terms of the data economy in 5G. (4.2)	Gigabit speeds and other enhanced capabilities may increase user's ability to generate or disseminate private information and to generate more private information on the web.	Data will be generated only when the new services have been launched, which will take some years. **Timing: 2024.** Despite this may become a bigger issue, BEREC's role might be limited. **Relevance: Low.**
2	Privacy	Sharing of end-user data between different actors	Increased data exchange between parties in the 5G ecosystem. (4.2)	Smart city use cases increase (harvesting data from different uses). Data processing actors in the 5G value chain develop but may not have a direct relationship with end users and therefore unable to request data processing consent directly.	Data will be generated only when the new services have been launched, which will take some years. **Timing: 2024.** Despite this may become a bigger issue, BEREC's role is not yet clear. **Relevance: Low.**
3	Security	Network and application security	Cybersecurity: higher sensitivity and dependency on 5G networks (4.1)	Any vulnerability in 5G networks or applications running over 5G networks could be exploited, potentially causing serious damage to critical infrastructures and services (e.g. smart city, industry automation, e-health, logistics) and affecting the economies and societies of the EU.	From early in the process, when vendors and suppliers are selected, network security is a relevant topic. Studies building on the work of Recommendation 2335, and the EU Toolbox of risk mitigating measures are relevant. **Timing: 2021.**

				In the IoT environment, the growing number of connected devices enabled by 5G will increase the entry points for possible network security attacks.	This topic is high on the political agenda, and one of BEREC's strategic priorities. **Relevance: High.**
4	New business models and value chains	New business opportunities	5G has the potential to impact existing value chains. (1.1)	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. They may influence both wholesale buyer and retail end-user choices in terms of providers (MNO, MVNO, WISP, other micro operators e.g. using a network slice) and / or fixed network operators.	New technical developments and new business opportunities resulting in changing in value chains starting to emerge. **Timing: 2022-2023.** **Relevance: High.**
5	New business models and value chains	New bottlenecks, dominance and monopolies	5G use cases may increase dependency on data for market access. (1.2)	5G is a potential driver for IoT applications with more data produced, stored and analysed, which can lead to network effects creating or strengthening dominant players (such as digital platforms) who may have incentives to frustrate access / sharing of their proprietary data.	'New bottlenecks' is a topic BEREC has already identified in the DotEcon/Axon study in 2018. These topics are likely to intensify during the first phase of the 5G uptake. **Timing: 2022-2023.** **Relevance: Medium/high.**
6	New business models and value chains	Creation of new wholesale markets	5G could allow for new players to enter the market. (1.2)	Industry automation use cases potentially increase the need for tailor-made 5G services by new micro-operators (plant wide operators, campus operators), thus creating new business models such as e.g. intermediaries that could provide wholesale access, bundle or repackage solutions for the specific industry or specific local sites with the necessary network operator.	Timing: **2022-2023.** Relevance: **Medium/high.**
7	New business models and value chains	Private/local networks	Introduction of private/local networks. (1.2)	Many see an increase in revenue streams for operators to arise from the business-to-business segment where private/local networks will play an important role for certain verticals/sectors. Enhanced 5G features such as URLLC and network slicing could be applied to Private/Local networks.	**Timing: 2022-2023.** **Relevance: Medium/high.**
8	New business models	Network slicing and 5G wholesale markets	Higher QoS-requirements might be implemented using 5G network slices (1.1, page 6)	Industry automation and other use cases (e-health, gaming…) with specific URLLC and bandwidth needs may increase the need to be able to differentiate services with different classes of quality of services which might be supported by the use of	Even though the standards are still to be finalised, operators are already preparing for it. Slicing is likely to play a larger role in the near future. **Timing: 2022.**

				network slicing beyond other technical solutions. These use cases will have to follow Net Neutrality regulation.	**Relevance: Medium.**
9	Quality of Service	QoS-requirements of Pan-European services	How might 5G impact the operation of potential transnational / pan-EU operators. (3.1)	Pan-European services (e.g. connected mobility) will require continuous QoS and seamless handover, both within a country and between different countries. This could imply a need for increased QoS provisioning for interconnection and roaming.	The special services are still several years away. **Timing: 2024.** Interconnection with proper handover based on QoS is crucial. **Relevance: High.**
10	End-user	Transparency of information	Stronger need for information on coverage and QoS of 5G networks to enable informed choices.	The introduction of 5G enables operators to differentiate products and services in much more complex ways. Information on coverage and QoS potentially becomes more important, not only for M(V)NOs, CAPs, for IoT SPs, for verticals, but also for end users. Especially with services tailor-made for specific user groups (network slicing) it becomes crucial where and when a service is available (e.g. geographically or in a roaming situation).	The special services are still several years away. **Timing: 2024.** QoS is strongly related to slicing. It is also important for BEREC's monitoring work to see what operators are offering, and knowledge building. **Relevance: High.**
11	Numbering	M2M numbers and mobile numbers	Increased demand for M2M and mobile numbers. (2.4)	Massive Machine Type Communications increase. As a result demand for numbers for M2M/IoT/MTC communication increases (given the expected increase of number of connected devices). The rising demand for devices could also lead to an increasing and potentially massive demand in other E.164 numbers (e.g. mobile numbers) and other types of numbering resources/identifiers (e.g. IPv6).	The timing and relevance may be different per Member State, depending on the market dynamics and their impact on the availability of numbering resources. This is relevant to NRAs and BEREC because of involvement of NRAs in assignment of numbers inside blocks. **Timing: 2022** **Relevance: Medium**
12	Numbering	Mobile Network Codes	Increased demand for MNCs, especially due to local/private networks (campus networks). (2.4)	The importance of having a sufficient supply of numbering resources available to meet the demand, especially of campus networks. Verticals and intermediary operators may want to provide own SIMs, potentially leading to increased demand for MNCs. When E.212 MNCs are used for cross-border IoT/M2M applications, global MNCs under MCC 90x could be used. MCC 999 could be applied for standalone non-public networks (SNPN) where interconnectivity and roaming are not supported.	The timing and relevance may be different per Member State, depending on the evolving business models. **Timing: 2022** **Relevance: Medium**

13	Numbering	eSIM	Using eSIM to support application implementation and switching. (2.4)	Using eSIM may help in initial device provisioning and in switching between providers due to lower implementation costs when over-the-air switching is applied. The availability of eSIM is also relevant in IoT use cases with device miniaturization and deployment in high-risk and/or restricted accessibility environments.	The timing and relevance may be different per Member State. 5G may accelerate the adoption of eSIMs in more devices. **Timing: 2022.** **Relevance: Medium**
14	Interoperability	Interoperability	Possibilities of interoperability of networks, including cross-border. (3.3)	There will be an increased number of service providers and localised networks. It will be vital that different networks are interoperable, wherever this is demanded, especially in a context where 5G involves important virtualization of the network and increased reliance on software, notably through SDN and NFV technologies. It might require a deeper standardization process or the implementation of APIs. Lack of interoperability could raise many issues. Notably, it could hinder end-to-end connectivity. Furthermore, if verticals want to switch to a new service provider whether WISPs, MNOs, MVNOs, micro-operators or fixed providers, vendor lock in could become a more prevalent issue due to the opportunity to highly customise networks in 5G.	First the new services need to be developed before the interoperability of the networks becomes relevant. The last standards still need to be developed. **Timing: 2024.** BEREC may not be involved with the standardization process, but interoperability is important for network effects, avoidance of dominance of new platforms, end-user choice, operator-lock-in etc. **Relevance: High.**
15	Roaming	New requirements for national roaming	Requirements for coverage will increase the need (or demand) for national roaming and infrastructure sharing (2.5)	New services will become available requiring a high level of coverage and/or QoS which in many cases will not be possible to be provided by a single network or operator alone. Operators may therefore require national roaming or infrastructure sharing agreements for the new services to meet QoS requirements or coverage obligations set out in the spectrum authorization regime. This would allow an efficient use of spectrum. Operators may also wish to share the costs of deploying network elements and engage in co-investment projects.	BEREC could further explore the national provisions with regard to the use of national roaming and infrastructure sharing agreements as well as co-investments. Timing of those topics should probably be aligned. **Timing: 2023.** **Relevance: High.**
16	Roaming	New requirements for international roaming	5G will contribute to the addition of new services to the current international roaming	In the next few years, other international roaming services than voice, SMS and data, such as IoT/ M2M are likely to play an increased role. It makes sense for the current revision of the Roaming	International roaming is crucial for the functioning of the telecom markets across the EU/EEA and BEREC has a crucial role in providing its expertise to the

			services portfolio, such as M2M. (2.5)	Regulation to consider those services and investigate whether there is a need to adapt the provisions to meeting both the market and technological developments.	Commission and Co-legislators when discussing amendments for the Roaming Regulation. The work has already commenced. **Timing: 2022.** **Relevance: High.**
17	Roll-out	Backhaul, fronthaul and anyhaul	Further fiber roll-out in networks. (2.2)	Because of the increasing demand for bandwidth, connections between the RAN and the CN are mainly expected to be realised using fibre, and other fast (wire)less technologies. Stakeholders emphasize that NRAs should ensure the existing backhaul is available on reasonable terms while fibre is rolled out quickly.	Backhaul is a very relevant topic in the roll-out of 5G networks. Initially operators will roll-out backhauls to existing base stations, which may still be linked with radio waves or copper. Therefore this topic will be relevant soon. **Timing: 2021/2022.** **Relevance: High.**
18	Roll-out	Small cells	Gigabit coverage requires small cell deployment. (2.3)	Small cell deployment will be necessary in order to achieve gigabit coverage. A harmonised approach for network planning and permits will facilitate roll-out. Deployment is costly and initiatives seeking to allow deployment in a cost effective manner such as infrastructure sharing or other co-investments initiatives will likely occur.	Deployment of small cells will be intensified with the availability of suitable spectrum. For many MS availability of 26GHz is not a priority until after other pioneer bands are awarded. The timeframe is more likely 2023. The topic of small cells may have many aspects; note that the timing may differ per MS. **Timing: 2023.** **Relevance: High.**
19	State aid	Coverage	State-aid to meet coverage targets.	Extension of broadband coverage to rural areas is one of the main objectives of national state aid rules and spectrum licensing conditions. The requirements associated to 5G use cases could potentially affect existing state aid plans for broadband extension. In order to increase coverage in rural areas and to reduce a digital divide, state-aid for FWA or fibre based backhaul solutions, state-owned infrastructure or spectrum coverage obligations could for example be relevant to apply.	Coverage is an important issue, because it involves the roll-out plans of new fibre. This happens in the beginning of the process. It is important to have clarity on state aid, because it concerns high levels of investments. **Timing: 2022.** This is relevant for operators, and also for BEREC and NRAs. But BEREC's role in state aid may be limited. **Relevance: Low/medium.**
20	Convergence	Media distribution convergence	Issue of convergence of broadcast and broadband requirements in 5G.	In the context of 5G, convergence could become an issue with advances in 3GPP Release 14 principally allowing improved support for national TV services	Based on stakeholder input BEREC concludes that this technical development becomes relevant later in time. For

			(4.3)	to both mobile devices and stationary TV sets over eMBMS (enhanced multimedia broadcast and multicast system over LTE) and unicast.[9]	example, BEREC notes that the use of the band 470 – 694 MHz will be reviewed c. 2025, with some MS issuing licences for broadcasting services in this band up to c. 2030/32. It should be noted that WRC23 is going to consider the future use of the 470-694 MHz band. **Timing: 2024-2026.** Stakeholder input did not give much indication of relevance on the BEREC agenda. **Relevance: Low.**
21	Convergence	Fixed-Wireless Access	FWA potentially emerging as pioneer 5G use case. (1.1)	5G Fixed Wireless Access (FWA) has emerged as one of the early 5G use cases offering gigabit connectivity. With increased capacity in the networks, operators are likely to have more opportunities to offer competitive FWA services. The technological developments will enable mobile networks to match the expectations that consumers already have with regard to fixed broadband services.	Fixed Wireless Access is one of the early developed business cases. **Timing: 2022-2023.** **Relevance: Medium.**
22	EMF	Electromagnetic fields	Increased attention for EMF. (2.6)	At the EU level, the limitation of exposure to EMF is based on the Guidelines from ICNIRP (endorsed by WHO and ITU). This is updated in March 2020[10] to include 5G technologies and may impact the EU-level framework in 2021-2022. Consistency at EU and national/local level with ICNIRP EMF exposure limits is a matter of concern for stakeholders, to avoid adverse effects on rollout and reassure public opinion using evidence-based scientific recommendations.	With significant attention for EMF roll-out of new base stations or upgrading of existing base stations may be impacted if scientific information on health effects is miss-communicated. Locations for roll-out will soon be selected. Recent incidents have shown that this needs our immediate attention. **Timing: 2021**. BEREC is very much interested in this topic, including misinformation and fake news. Otherwise the topic as such is not

[9] From https://www.3gpp.org/news-events/1905-embms_r14, 15.04.2019.
[10] https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf and https://www.icnirp.org/en/applications/5g/index.html

					in BEREC's immediate remit and competences. **Relevance: medium**.
23	Environ ment	Sustainability	5G as an enabler of sustainability in the face of increased network energy consumption	5G systems have been designed to ensure higher level of energy efficiency: the energy required to process a data unit has been decreased compared to previous technologies. Nevertheless, the new services made possible by 5G systems may impact data consumption, which in the end may offset what a better energy efficiency can provide in terms of overall energy consumption: the so called rebound effect.	BEREC recently started working on sustainability and its possible role in improving it. **Timing: 2021-2022.** Sustainability is high on the political agenda and relevant for all NRAs. **Relevance: High.**
24	Interoper ability	Satellite communication (Satcom)	Satcom could have a complementary role in relation to 5G. (new addition)	The expansion of the broadband coverage may be realised not only via terrestrial network. Satcom can be a crucial component in 5G deployment to reach previously inaccessible areas.	3GPP Release 16 covers satellite communication for 5G. The seamless integration of Terrestrial Networks and Non-Terrestrial-Networks using 5G NR has been included in the list of features for 3GPP Release 17, expected to reach 'Functional Freeze' and 'End Date' milestones by September 2021 and December 2021, respectively. **Timing: 2022.** BEREC intends to keep this under review. **Relevance: Low.**

Annex 2. The 5G radar 2020 – 2026.