MINISTRY OF
INDUSTRY AND TRADE

# How to approach 5G POLICIES

Visionary overview about the future of digital infrastructure and services

Five recommendations for policymakers in the Czech Republic and beyond

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# Content



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# Preface

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> **“ You do not grow if you are comfortable.”**
> **Calvin Coolidge, US President between 1923-1929**

Digital technologies are changing our lives, but also the world around us. We can no longer live without them. Let’s just think about all the digital services in communications, energy, industry and transportation, which we already taken for granted. Let’s think about all the new services and opportunities in these fields, but also about a new range of applications around Smart Cities and other areas that we cannot even imagine yet. The covid 19 crisis has made the importance of digital infrastructure and digital services yet even more visible, with a particular focus on safety and health, but also on minimizing disruption. Remote learning and particularly remote working, along with other digital tools, have not only helped us to survive the crisis, but they are also set to drive economic recovery in the business sector.

New technologies never come entirely without risks. There are valid questions, for example about cybersecurity, health or personal data privacy in relation to the rapidly expanding digital technologies. To tackle these questions and risks head on we first need to research and understand them. Subsequently, we must provide fair and appropriate explanations to the public, giving assurances about how peoples’ health, liberties and democratic rights will be protected amid sometimes fast technology-driven changes. While risks require robust responses, they should not overshadow the unparalleled benefits of the new technologies. It is our duty to always search for the best ways to support progress and innovation, particularly in areas where this directly improves peoples’ life.

On the back of these developments and the constantly growing importance of technology for all citizens, we have decided to conduct a deep analysis about the future of digital infrastructures and services. 5G, the new fifth generation of wireless networks, naturally becomes the focal point. We think that public debate about 5G has unfortunately often been quite narrow, not taking into account the wider context of what the new networks may bring to the citizens, how this may shape the telecommunication markets, what type of digital services are likely to emerge, how they will impact the real world to the benefit of all citizens as consumers and parts of various communities and economic entities, what the risks are, and how do we address them.

It would be too ambitious to expect one report to answer all these questions. However, development of digital infrastructure and support for innovation in digital services are becoming even more crucial as priorities for successful development of national economies. Therefore we certainly have an ambition to identify opportunities for deeply transformative changes, which 5G may bring or accelerate, and suggest potential policy responses to encourage the right type of action. Naturally, we have an ambition to exploit some of these opportunities in the Czech Republic, aiming to make the country an interesting, innovative and perhaps to some degree a unique 5G adoption case.

The Czech Republic has been a prosperous country with long-lasting tradition in innovation, advanced industry, well developed digital services markets, skilled labour, as well as sizeable investments into research and development (R&D). Digital transformation is one of the key pillars of the Czech Innovation Strategy for 2019-2030 (The Czech Republic: The Country for the Future). The country is investing into artificial intelligence (AI) technologies, for example through its internationally recognised research into AI deployment in natural language processing, manufacturing or safety and security. Based on the NCSI index the Czech Republic belongs to world leaders in cybersecurity. Development of human-centric AI solutions for Industry 4.0, Smart Cities, e-Health and beyond stays firmly at the heart of the Czech National AI Strategy approved in 2019.

The Czech telecommunications market may not be perfect from a competitive point of view. However, some of its players have pioneered strategic and structural solutions, which were later recognised and adopted more widely. This includes active network sharing between T-Mobile CZ and O2 CZ/Cetin adopted in 2013-14. It is an interesting case from a competition point of view and perhaps an indication of a broader industry trend, especially when we look at the new generation of networks. There is a number of reasons to think that the Czech market will remain attractive for pilot cases and innovative structural solutions in telecoms. One of them is the need of such solutions to retain competitive strengths of the local manufacturing industries. The time to think about new transformative solutions is now, also because, similarly to many other countries, the Czech Republic is in process of awarding 5G spectrum.

This report was mandated by the Czech Ministry of Industry and Trade during a period of extensive debates about how to best design the 5G spectrum auction to achieve two goals: to increase competition in the local mobile market so that mobile data essentially becomes a cheap commodity, and to incentivize 5G deployment in pursuit of the national 5G strategy. This report does not assess the Czech 5G spectrum auction specifically. Instead, it is putting 5G deployment into a broader context, attempting to establish how digital future may look like and how to best assure from a policy point of view that it we will be beneficial and safe for the citizens and the economy of the Czech Republic and beyond. This report outlines a number of generic policy recommendations, which may not fully and exactly express the Ministry's and the government's current policy positions, and they may not be consistent with the opinions of the independent national telecom regulator or the industry. That said it was prepared in close cooperation between the Ministry and the author, it reflects their belief that formation of digital policies should involve a greater variety of industries and stakeholders than before, and it reflects some of the views expressed during our debates with such stakeholders.

# 1.

# Key highlights and recommendations for 5G policies

**Innovation has been shifting economic emphasis from agricultural, natural commodity, industrial and electronic hardware assets towards software and processed data. National governments, national digital companies including telecoms, and other stakeholders in national economies may need new strategic approaches to turn this trend into an opportunity.**

**5G is a major milestone not only in national communications, but also for human life and societies, with a potential to boost their prosperity, security, health, environmental sustainability and inclusiveness.**

**Digital policies governing 5G, and related technologies such as Artificial Intelligence (AI), must be primarily human-centric. This means that they must be driven by interests and concerns of local consumers, employees, entrepreneurs and voters.**

**When competition fails to provide true choices and value to the consumers, or to convincingly assure human freedoms and safety in the fast-changing digital ecosystems, locally or globally, elected governments may need to step in with their policy interventions as proxies of the public interest.**

**Innovation as one of the key drivers of national competitiveness can be promoted by light regulation in the innovative areas, favourable conditions for disruptive innovators, support for infrastructure investments, easy access to shared infrastructures and support for research and development (R&D).**

**We recommend policymakers to consider 5G-related interventions in the following five areas:**

1. **Encouraging the opening of tech standards, platforms and networks.** We recommend selective policy interventions to encourage opening of tech standards, platforms and networks, particularly when competition is failing, and when such moves would bring benefits or reduce risks to the economies and societies.

2. **Supporting diversity in business models for private 5G networks for Industry 4.0 and beyond.** We recommend policymakers to consider allocating appropriate amount of the over 3GHz spectrum, i.e. spectrum suitable for local private 5G networks, on a flexible, localized, transparent and inclusive basis, making it directly accessible also to local entities interested in building their own private 5G networks.

3. **Exploring synergies between digital communications, energy and other strategic infrastructures.** We recommend policymakers to consider aligning regulations in telecoms and other utilities, particularly in power, to soften any potential regulatory barriers to synergic investments between these types of infrastructures and industries.

4. **Transforming telecommunications post covid 19.** We recommend policymakers to work with the telecoms and other stakeholders to formulate a vision of the future digital economy, among others around more deeply shared nationwide infrastructures as well as expanded role of telecoms as national digital service providers, trustworthy and secure providers of nationwide connectivity and guardians of private and public data.

5. **Responding to concerns about health, security and control.** We recommend policymakers to assure the public that they have a grasp on protecting its security, freedom and control over its own affairs amid a growing overlap between the virtual and real worlds, while showing their commitment to progress, readiness to take precautions against health and security risks, and support to continuous research in these fields.

# 2.

# Executive summary

**The implementation of 5G will be a major milestone not only in national communications, but also for the national economies and societies.** 5G represents a fundamental step towards bringing the virtual and real worlds closer together. It will bring unprecedented amounts of helpful data, ability to process them both on a localized as well as centralized basis, along with the ability to operate robotic devices remotely in the real world. It will fundamentally change the ways how we do business, how we work, live, interact and entertain ourselves.

**Governments will play a pivotal role in transition to 5G and digital economies by finding the right balances between economic competitiveness, security, privacy, digital inclusion and democratic rights of citizens.** A successful outcome would entail concurrent expansion of economies, improvement in human health, well-being, health of societies, quality and sustainability of our environment, management of scarce resources, our security and human freedoms. 5G may also boost inclusiveness by helping disadvantaged groups to overcome physical, geographical and other barriers. Disruptive power of 5G and digital technologies may be helpful in in addressing some of the world's most fundamental challenges, both regionally and globally. To avert adverse outcomes, it is however imperative to manage such disruptive powers rightly. Choice of digital and 5G policies is hence most crucial for the future of our economies, societies and nations.

**The purpose of this report is to provide a visionary strategic overview of options and opportunities around 5G and to give high-level policy recommendations, also relevant for the Czech Republic.** We have approached this topic as broadly as possible, putting it into the context of the latest industry trends in global technology and telecommunications. Among others we have looked into emerging new economic and technology driven opportunities for 5G wholesale networks, open RAN, a case for private 5G networks for Industry 4.0 and beyond, emerging synergies between the energy utilities and digital communications infrastructure, strategic implications of the latest trends for telecoms, as well as health and security considerations.

**We suggest policymakers to approach digital and 5G policies, including spectrum allocation, along the following principles:**

**a.** **An open mind about digital policies, 5G policies and spectrum allocation.** When designing their digital and 5G policies, policymakers should remember that the current wireless industry's business model was practically designed in the 1980-90s by their predecessors, mainly through spectrum allocation. 5G and future wireless technologies are likely to require a fundamental rethink of the wireless business model for both infrastructure and services. Given the strong role of regulation in wireless, any transformative changes in the wireless business model would likely have to involve the policymakers as well as the wireless industry, along with multiple other stakeholders. Transformative changes may entail for example building super-secure national wireless networks, national wireless wholesale networks or localized private wireless networks. Moves in this direction may lead to the emergence of new entities, resulting from transformation of the legacy telecoms, entrants from other legacy industries such as power utilities, or newcomers, who adopt differentiated business models right from the onset. Spectrum allocation policies will continue playing crucial role in driving the right type of transformation in digital connectivity to the benefit of national economies. While policies should encourage spectrum owners to make the best contribution to the national economies also through their own success, the current spectrum owners cannot not implicitly assume that methods of spectrum allocation and use will never fundamentally change, and that they, in their current form and with their current business models, will remain the best suitable candidates for acquiring of all future spectrum in a form of long-term nation-wide allocations.

**b.** **Fairness, lawfulness, and proportionality.** Digital policies should be fair. They should avoid infringing the rights of any entities or giving an unfair advantage to others. Spectrum allocation policies should not substitute broader regulations, which require different legislative and enforcement mechanisms. Policies should also not attempt to introduce rules retrospectively. Finally, policies should be proportional, i.e. avoid situations when some entities are forced to incur excessive regulatory-induced costs to secure their ability to continue their normal operations on grounds, which are not clear, fair, linked to transparent policies and supported in a law. That said spectrum has always been awarded with conditions and the nature of such conditions may evolve with changing policy priorities.

**c.** **Long-term vision, transparency and co-operation with all stakeholders.** It is important that commercial entities have grounds to endorse the new policies. Given the often strongly conflicting interests between different market players and industries, combined with aversion to risks and changes in many industries, it is essential that policymakers present sensible long-term visions in a transparent way. Such visions should be constructively discussed with commercial stakeholders from different industries, to give them an opportunity to see how to best adapt and what long-term benefits they may expect. Given the importance of digital economies and 5G, not utilizing 5G spectrum auctions for pursuing digital transformation policy visions would be a missed opportunity.

**d.** **Promotion of innovation.** Policymakers can and should promote innovation by adopting light regulation in the innovative areas, providing favorable conditions to disruptive innovators, while supporting infrastructure investments, access to shared infrastructures as well as research and development (R&D). Pro innovation policies would ideally derive from long-term digital and 5G policy visions, provide scope for experimentation and point innovators towards the areas where innovation is likely to be particularly encouraged.

**e.** **An open mind about changing societal and security requirements.** Interests of the public as consumers, employees, entrepreneurs and voters should always be crucial in formation of digital policies, also for 5G. Taking these interests into account is not always trivial, because digital technologies and ecosystems are often developed and promoted by global tech corporations. Digital connectivity, including the future 5G networks, sometimes allow innovations to spread around the world so fast that it is hard to predict all consequences. This is why control over how technologies interact with human life, work, freedom, privacy and safety is becoming increasingly important. Elected governments need to act as proxies of the public interests in this regard.

**f.** **Promotion of competition where it makes sense, consideration for shared strategic assets in other areas.** Scale economies make it hard to assure fully functioning competition across all digital market segments. Moreover, some digital assets have a strong strategic and security role. It is therefore appropriate for policymakers to assess and identify where innovation and differentiation are particularly desirable and where shared strategic resources may be a better option. Such policy choices in this area are naturally essential for shaping economies and societies. Hence they must be based on long-term visions.

**g.** **Improvement of wireless coverage and support for strategic services.** Wireless coverage is one of the strategic priorities of national governments, especially since essential services will be more and more dependent on it.

**h.** **Acceleration of economic growth post covid 19.** As part of their effort to re-build economies in an innovative manner post the covid 19 induced slowdown, policymakers may support short-term investment into the digitalization of public services. They can also support the expansion of secure and versatile digital infrastructures in order to encourage private investment into the digitalization of the adjacent industries, and that way drive theeconomic recovery.

**i.** **Flexibility in crises such as covid 19.** In exceptional circumstances, such as the covid 19 crisis, temporary allocation of some spectrum to the existing telecom industry may be warranted to deal with sudden spikes of traffic, for example. If this is the case, it is important for all sides to be transparent about the nature of such solutions, their timeframe and future expectations. As a matter of principle, long-term policies should not be driven by needs for short-term solutions at times of crises.

> **“ Spectrum allocation policies gave a rise to the wireless industry; such policies will continue playing a crucial role in reshaping digital infrastructure and service industries to the benefit of national economies ”**

**Policymakers have two principal tools for achieving their objectives: promotion of free market competition and more heavy-handed regulatory interference.** The former should be preferred. However, there are instances when the market outcomes fail to provide true choices to the consumers, including a choice to opt out of using certain products, the markets fail to function efficiently, or it can be reasonably expected that such failures will occur. There are also instances when market outcomes do not provide sufficient freedoms or protection to the public. In such instances elected governments need to fundamentally strengthen their regulatory oversight over parts of the digital ecosystems and act as proxies of public interest. Rational and open-minded debates about major issues of public interest and concern, including the impact of foreign tech companies on the rights and freedoms of citizens, or issues around safety and health, would reflect well on the credentials of any democratic governments.

**We recommend policymakers to consider 5G-related interventions in the following five areas:**

1. **Encouraging the opening of tech standards, platforms and networks**, especially when proprietary solutions pose risks to competitive efficiency, freedom and security. This is a complex issue with a global dimension, where no country or company can drive the ultimate outcomes on their own. However we see grounds for national policy visions in defence of public interests in this area. **We recommend selective policy interventions to encourage the opening of tech standards, platforms and networks, particularly when competition is failing, and when such moves would bring benefits or reduce risks to the economies and societies.** This can be done, for example, by rewarding such type of behaviour. It is also important that local companies are not subject to harsher rules than their international peers only because it is easier to enforce regulations on them.

2. **Supporting diversity in business models for private 5G networks for Industry 4.0 and beyond.** The ability to build highly secure high-capacity local private networks using licensed spectrum will become increasingly important for innovation in industry and services (Industry 4.0). The demand from industrial and service companies for the highest degree of control over such networks and data on them, which they often see as their crucial future strategic assets, appears reasonable. **We recommend policymakers to consider allocating appropriate amount of the over 3GHz spectrum, i.e. spectrum suitable for local private 5G networks, on a flexible, localized, transparent and inclusive basis, making it directly accessible also to local entities interested in building their own private 5G networks.** A qualified entity, ideally independent on entities that operate public and private networks, will need to manage dynamic and localized allocation of such spectrum to different users, including local businesses and industrial companies interested in operating their own private networks. Meanwhile, attention should be also paid to securing sufficient spectrum allocation to public networks, for example by allowing spectrum sharing and localized use of such designated spectrum by public network operators in selected areas.

3. **Exploring synergies between digital communications, energy and other strategic infrastructures.**
**We recommend policymakers to consider aligning regulations in telecoms and other utilities, particularly in power, to soften any potential regulatory barriers to synergic investments between these types of infrastructures and industries.** Countries may benefit from regulations that encourage timely and strategically sensible initiatives such as better resource sharing between today's telecommunications and utilities industries in building strategic and secure communications networks for versatile use.

4. **Transforming the telecommunicators industry post covid 19.** The changing role of digital communications infrastructures, evolving opportunities for digital innovation along with economic and societal changes triggered by covid 19 all strengthen the case for strategic transformation of the telecommunications industry. There is a number of arguments against full duplication of nation-wide 5G infrastructures including: a need for expensive fiber investments, high capacity and initial underutilization of the newly built 5G networks, public preference to limit the number of antennas, and the high cost of building full territorial coverage. The covid 19 crisis highlighted situations when states need to provide urgent support to telecom infrastructures, such as emergency spectrum or physical protection. Telecom infrastructures have therefore become strategic for national interests. This argument will only strengthen with growing dependence of individuals, families, businesses and the public sector on digital services for health, security, emergency services, finance, transportation, energy etc. This may accelerate a shift in priorities in telecom infrastructure away from full-scale competition towards regulation, safety and reliability. Meanwhile, telecom operators may find new attractive innovative opportunities in the national markets for secure digital consumer services, including in finance and health, secure personal data and national data sovereignty, personal data privacy protection and management, trustworthy media and content, trusted IoT solutions as well as helping to enable similar solutions for enterprise, including small and medium sized businesses. Since the current wireless business model was essentially created by the policymakers via spectrum allocation, fundamental reforms are not likely to be feasible without appropriate policy support. **We recommend policymakers to work with the telecoms and other stakeholders to formulate a vision of the future digital economy, among others around more deeply shared nationwide infrastructures as well as expanded role of telecoms as national digital service providers, trustworthy and secure providers of nationwide connectivity and guardians of private and public data.**

5. **Responding to concerns about security, control and health.** As digital infrastructures grow more strategic and new innovative opportunities arise in digital services, the role of regulators will grow in some areas and alter in others. **We recommend policymakers to assure the public that they have a grasp on protecting its security, freedom and control over its own affairs amid a growing overlap between the virtual and real worlds, while showing their commitment to progress, readiness to take precautions against health and security risks, and support to continuous research in these fields.** Policymakers should pursue their interest preferably by enforcing free market competition. When such approach fails, it is reasonably expected to fail, or it would have material adverse implications for freedom or security, more heavy-handed regulations may be considered in selected areas.

# 3.

# About 5G


# 3.1. What is 5G?

**At first glance 5G is just an extension of the previous trend when governments allocate nation-wide private spectrum to the telecoms (wireless) industry,** which then provides specific services to the public using such spectrum. In 2G this was mainly personal mobile voice communication and messaging, in 3G and 4G it was smartphone data and video. However, let's note that 2G, 3G and particularly 4G have unleashed dramatic changes in the economies and our lifestyle, driven by the internet and digital technologies. 5G has potential to take this to yet a fundamentally higher level.

**Fig. 1 | Key features of 1G, 2G, 3G and 4G**

| 1G in 1980s | 2G in 1990s | 3G in 2000s | 4G in 2010s |
|---|---|---|---|
| PURPOSE<br>selected consumer wireless communication | PURPOSE<br>mass market consumer wireless communication | PURPOSE<br>mass market consumer wireless data with constrains | PURPOSE<br>mass market consumer wireless data including video |
| TELCO<br>first wireless businesses, sometimes monopolies | TELCO<br>licence induced 'oligopolies' | TELCO<br>regulation moves to tackle the oligopolies, data-driven cannibalization begins, data quality is imperfect | TELCO<br>spectral efficiency induced excess capacity, larger scale cannibalization of voice/SMS, video-driven demand |
| INTERNET<br>early days | INTERNET<br>largely focused on wireline, WiFi | INTERNET<br>e-commerce and social networks on mobile | INTERNET<br>boom in consumer services including video |
| GLOBAL CAPEX<br>(US$tn)<br>0.6 | GLOBAL CAPEX<br>(US$tn)<br>1.6 | GLOBAL CAPEX<br>(US$tn)<br>2.3 | GLOBAL CAPEX<br>(US$tn)<br>3.1 |

Source: Digiteccs Associates, estimates based on OECD reports, PWC reports

## Fig. 2 | Mobile technologies and performance

| | 2015 | 2020 | 2025 |
|---|---|---|---|
| Generation | **4G** | **4.5G** | **5G** |
| Role of Macro Cells | Coverage and primary capacity layer | | Wide area coverage, smalll cell backhaul and control |
| Role of Small Cells | Selective capacity increase in dense areas | | Primary capacity layer via high frequency spectrum |
| Spectrum | Sub–6 GHz, especially around 1-3 GHz | | Wide range from -700MHz to -90 GHz |
| Peak Speeds | 300 Mbit/s | 1–3 Gbit/s | 10 Gbit/s |
| Average Speeds | 4–25 Mbit/s | 32–200 Mbit/s | 1 Gbit/s |
| Minimum Speeds | 2–5 Mbit/s | 10–20 Mbit/s | 50 Mbit/s |

Source: Source: European Commission report 'Costing the new potential connectivity needs'

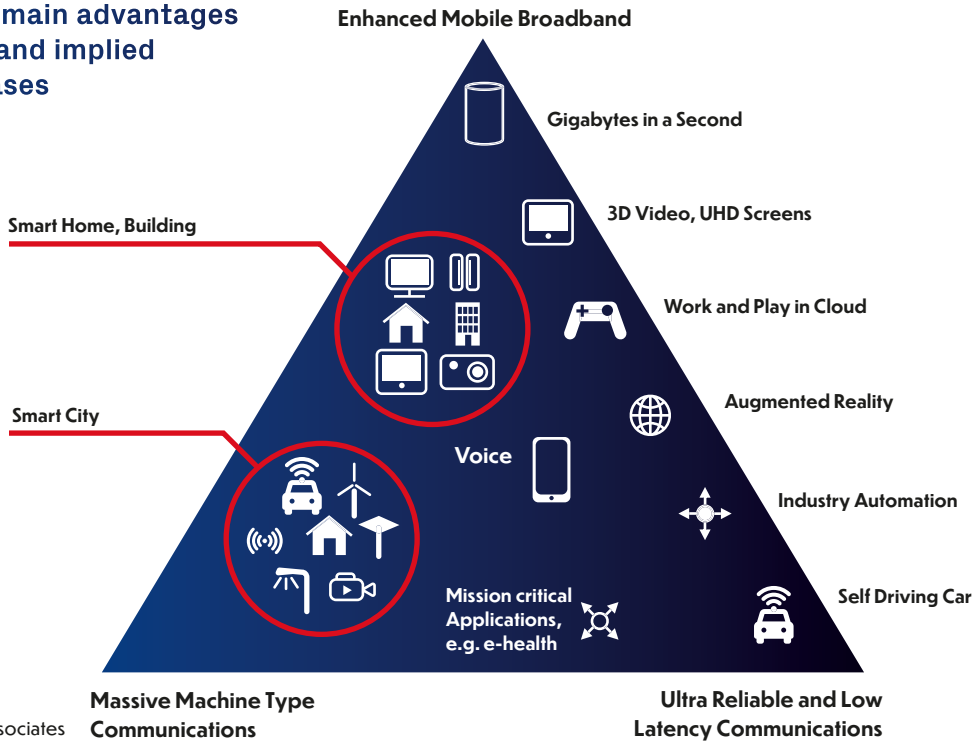
**Technologically, 5G will bring three main benefits compared to the previous wireless technologies:**

- **High capacity.** Transmission speeds in user devices in GBs per second should be achievable (see Fig. 2). Purely as a technology 5G is only marginally more spectrally efficient compared to 4G, i.e. it cannot transmit multiples of data volumes compared to 4G from one antenna using a given amount of spectrum. However, it can still offer substantially higher capacity compared to 4G, because it uses more spectrum in new spectrum bands, and higher density of antennas. The latter will be achieved for example through small cells in streets, at homes, but also by using new technologies such as MIMO, as mentioned later in this report.

- **Low latency,** i.e. response time of the network. 5G is supposed to offer 1ms latency compared to over 25ms for 4G. This is relevant for example in gaming, virtual and augmented reality and remote management of objects such as cars, machinery, robots etc. Low latency is crucial for example for making virtual reality 'feel' like it is real as well as for the safety of moving objects.

- **High number of connected devices.** 5G can handle thousands of connected devices per site, dramatically more than 4G. This, combined with advancements in battery technologies, will allow significant numbers of sensors collecting data to be installed. This can be used for example in smart cities (to manage traffic, waste collection etc), eHealth (to provide early indications of health issues), industry and transportation (to provide early indications of machinery faults), agriculture (to monitor plants and livestock), security surveillance etc

## Fig. 3 | Three main advantages of 5G and implied use cases




Source: ITU, Digiteccs Associates

## “ 5G will bring high capacity, low response time (latency) and high number of connected devices. ”

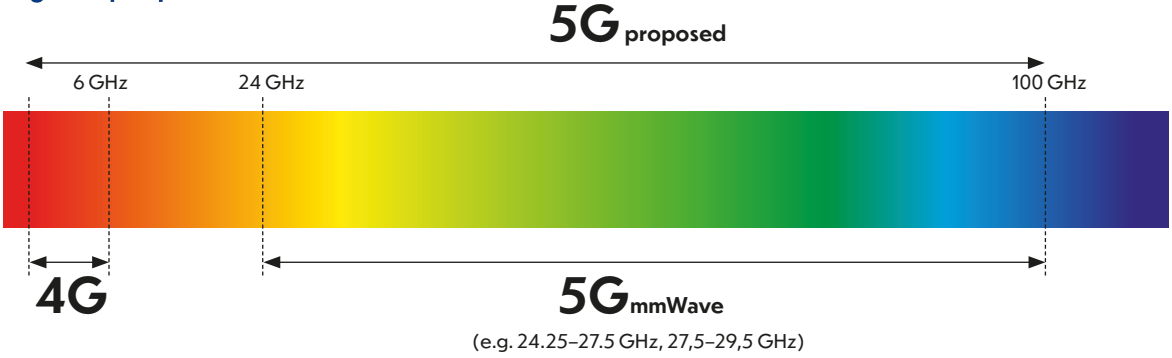
Based on international agreements, **5G will enjoy a far more generous spectrum allocation than the previous generations** (see Fig. 4). While 1G, 2G, 3G and 4G essentially operated in the sub 3GHz spectrum range, 5G will potentially enjoy frequencies up to 100GHz. While 5G can operate and it has already been tested on the already allocated frequencies for 2-4G, the following frequencies are due to be used specifically for 5G, and hence they are also most crucial for trials and commercial deployments:

1. **The 700 MHz band** is well suited for providing mobile coverage over wide areas and indoors. However, in some countries it is being used for signal transmission of Digital Terrestrial Television (DTT) and for wireless microphones in the entertainment industry. In such cases certain ‘clearance’ of this spectrum band is necessary.

2. **The 3.4-3.8 GHz band** is particularly suitable for the provision of mobile data services with high capacity requirement in densely populated areas and indoors. Some countries already use parts of this spectrum for fixed links and satellite.

3. **The 24GHz band and above, up to 100MHz**, also called millimetre waves, is suitable for very high capacity for short range transmission. This band can be used for example in automation of industrial production or as a replacement of fibre installations between homes and nearby street antennas.

### Fig. 4 | Spectrum allocated to 5G




Source: Digiteccs Associates, industry sources

**5G also offers fundamental technology innovations compared to 4G, which include:**

- **Multiple Input Multiple Output (MIMO) technology improves spectral efficiency.** Massive MIMO uses a large number of service antennas. A base station can hence communicate simultaneously with multiple pieces of user equipment on the same frequencies.

- **Beamforming** is a technique that focuses a wireless signal towards a specific receiving device, rather than having the signal spread in all directions from a broadcast antenna as it normally would. The resulting more direct connection is faster and more reliable than it would otherwise be. Beamforming also helps to reduce interference.

- **Network slicing** is a concept that derives from the virtualization of network functions. The same network hardware can be used to meet different network needs.

- **Edge computing** is not directly linked to 5G, but its spread is likely to coincide with the 5G rollout. It is about collecting data for example via consumer devices and sensors, processing and using them near the location where the data was collected. This reduces the need to send data over long distances, which improves latency and optimizes bandwidth consumption.

# 3.2. 5G use cases and the technology's impact on our world

**The main innovation in 5G is that it is expected to enable a large number of connected devices such as data-collecting sensors, combined with its ability to navigate robotic devices from remote locations.** This means that large numbers of data can be collected in the field, processed remotely (in nearby locations via the so called 'edge computing' or in faraway locations via the so called 'cloud computing'), and then used extensively to impact the real world. This, in combination with advances in Artificial Intelligence (AI), can unleash a true technological revolution. It is sometimes also called Industry 4.0, but its reach will go far beyond the industry.

> "5G will enable a large number of connected data-collecting devices, along with robots empowered by such data processed by AI in the edge and cloud"

**Technically, we can split 5G use cases into the following categories:**

- **Fixed-Wireless Access (FWA).** This is the so far economically most solid use case. Local 5G networks with multiple fibre-connected sites in each street would allow households, particularly in suburbs, to enjoy fibre-like speeds without costs and inconveniences of installing fibre into each property. FWA was the leading use case for the early 5G installations in the US.

- **Consumer smartphones and other devices.** Higher speed can bring more power and convenience to the consumer smartphones. It may allow, for example, very fast downloads of movies before boarding a plane. In the absence of variety of other devices, the mobile industry is likely to focus on 5G smartphones initially. Later on, 5G should empower new types of consumer devices such as virtual and augmented reality glasses. This could create fundamentally new products and experiences, although some of these technologies may still have to overcome certain challenges (picture quality, battery life, radiation safety etc).

- **Wearables.** These are mostly sensors attached to humans or animals, ranging from watches, wrist bands, other health monitoring devices up to implanted chips. They can be used for example for the health and safety of humans and pets, or in agricultural production. However, wearable devices have their limitations linked to battery power, which restricts their ability to process and transmit large amounts of data and makes regular charging necessary. Wireless charging technologies may help with this in the future. That said wearables and wireless charging are likely to bring wireless radiation health issues into the spotlight.

- **Property-attached sensors.** Sensors attached to non-living objects are mainly aimed to collect data, which can subsequently improve security and management of such properties (smart home, smart office), machinery (early fault indication), cities (smart city), farms (smart agriculture) etc. Again, battery life in the absence of wireless charging may initially limit the versatility of use of such devices. Sensors including cameras connected and powered by wires may fulfil a similar function without a need for 5G connectivity. Again, the installation of large numbers of connected devices into inhabited areas may fuel the radiation health debate.

- **Robotic devices.** Automated production lines, automated cars and other kinds of robotic devices represent the ultimate use case for 5G and probably the only one, which can fully utilize the technology's true potential. Given their larger size and autonomous operation, batteries and radio pollution are less of an issue compared to the sensors. Apart from 5G networks the main bottleneck is in the advancement of AI, robotic and automation technologies. However, breakthroughs in these areas are likely in the next few years.

## Fig. 5 | 5G use cases


Source: Digiteccs Associates

**As discussed, the game-changing innovative impact of 5G will only come in combination with robotics, automation and AI technologies. This can play out across different industries in the following ways:**

- **Industry 4.0** - automation in manufacturing (flexible setup of production lines, better predictability of potential problems and oversight of the production process, use of robots in factories and warehouses, possibility of humans working in the production facilities remotely, reduction of risks for human workers, better scope for product customization etc)

- **Transport** – automated cars, drones, smart airports, smart train stations, smart trains (better matching of personal needs with infrastructure capacity, safer transportation, urgent deliveries, deliveries into remote areas, better management of transportation disruptions, better predictability of technical faults, more convenience for travelers through physical help, information, entertainment etc)

- **Cities** - smart cities (better matching of personal needs with infrastructure capacity, improved security, optimization of environmental impact of the city infrastructures and services, better management of waste including collection and recycling, better coordination and efficiency of emergency services, more efficient use of healthcare capacity also by heavier use of personal health devices and data etc)

- **Security** – smart security (possibility to extensively monitor properties and cities, early identification of potential risks etc)

- **Electricity** –smart grid (allowing higher share of renewable local power sources, smart power management of appliances, smart management of energy uses that can be delayed such as battery charging etc)

- **Media** – smart media (personalized and interactive experience, multi-screen and multi-dimensional viewing, augmented and virtual reality, convergence between classical and social media etc)

- **Entertainment** – games and super-real video content (virtual and augmented reality, new levels of interactivity etc)

- **Healthcare** – smart health and eHealth (remote consultations, remote surgery, use of data from health monitoring devices, higher efficiency and frequency of health advice, more choices to the patients, robot-powered care for the elderly and disabled etc)

- **Construction** – smart building site (more efficient and safer management of building sites, remote navigation of construction machinery, robotic construction, better ability to detect problems in buildings and machines via data etc)

- **Mining** – smart mines (safer and more efficient management of mines, remote navigation of mining equipment, robotic mining, better ability to detect problems in buildings and machines via data etc)

- **Education** – smart learning (flexibility in terms of location of the students, access to extensive eLearning content, interactive learning via remote teamwork, combination of learning and entertainment, use of smartphone cameras to instantly obtain information about objects and landscapes etc)

- **Travel** – smart travel (virtual tours, use of augmented reality in historical sites, smart hotels, smart museums, personalized assistance during travel etc)

- **Agriculture** – smart farms (health monitoring of livestock and plants, early indications of problems, use of predictive models, use of remotely operated and robotic devices etc)

- **Retailing** – smart shopping (virtual and augmented reality product trials, enhanced consumer experience in smart shopping moles, customized shopping using consumer data)

- **Real estate and building management** – smart buildings (better in building security, more efficient air supply and energy management, virtual viewing of real estate etc)

More broadly, the 5G-powered new digital economy will **change the way we live and work by introducing fundamental novelties**. Key changes in our world resulting from the adoption of 5G, robotics, automation and AI will be as follows:

- **Feeling the physical presence of people and objects.** Today's communications networks still pose limitations compared to person-to-person communication in terms of quality of the contact experience (voice quality, picture etc). We can still easily distinguish and feel the physical presence of people and objects compared to their digital alternatives. 5G and related technologies can help to remove this barrier, making virtual interpersonal communication or experience of objects and surroundings very real, using AR/VR, 360 degrees cameras and 3D projection technologies such as holograms. This can bring our world much closer together and even redefine relationships between people, for example by bringing real and virtual friendships closer together. It can also boost inclusiveness.

- **Providing unprecedented access to information in forms useful to the humans.** 5G and related technologies will allow humans to search for information in smart ways where and when they need it. Many devices will be able to speak to people. Handheld devices may allow us to see not only distant objects, but also how things appear from inside, how they appeared in the past and how they would appear if we saw them in their entirety. AI should help us to use such enhanced information to make predictions helpful in our life and business.

- **Different approach to cities, living space and resource use.** 5G and related technologies may be better able to manage scarce resources, including street space and living space. This can be done in two ways. Firstly, AI may show us smart ways how to achieve our objectives with less need for scarce resources. For example, it can dynamically plan our day schedules, putting travel to times when traffic on the required routes is lighter. Secondly, digital technologies may reduce risks and the inconvenience of sharing resources, e.g. by assuring safety, punctuality, reliability and other standards of services such as shared automated vehicles.

- **Living with robots.** Personal robots will be able to perform household tasks, transport us (automated cars), take care of individuals with special needs (elderly, sick) or provide companionship and personal assistance in our homes or outside.

- **Working with robots.** Businesses and public bodies may use robots to help their customers in ways, which human workers would struggle to accomplish. Robots will also help humans with their work in a number of ways. They can perform repetitive tasks, high precision tasks, or tasks that involve risks or unhealthy environments. Moreover, they will allow humans to work from environments that are more suitable and convenient for them, including their homes.

- **Enhancing human creativity.** Freed from repetitive tasks, humans will have more time for creativity. 5G and related technologies should boost human creative potential by enabling people to experience things virtually, processing and filtering large amounts of real-world data to provide inspiration, but also by helping with repetitive (trial and error) tasks as part of their creative work.

- **Introducing digital asset classes.** As the virtual world continues growing in its importance and creativity becomes increasingly important for humans, issues around Intellectual Property (IP) become even more important than before. This can lead to the creation of numerous intangible digital asset classes with different economies compared to the real-world assets. Examples include experiences, arts, commercially useful information up to digital currencies.

- **Facilitating body/silicon convergence.** This is a somewhat controversial topic. Silicon technologies may theoretically directly interact with our bodies and brains, enhancing our capabilities as humans. Examples may include bio bots (robotic replacement of a missing body part), chip implants as well as more sophisticated technologies capable of directly connecting with our brain. 5G would then facilitate connection between us and the AI processing power in the cloud.

> **“ 5G will let us feel the presence of remote people and objects, access information and see objects in previously unthinkable ways, take human creativity to another level, expand our economy, better use scarce resources and benefit from robotic technologies”**

# 3.3. 5G and the telecom industry

**The telecom industry has been going through a challenging period over the past two decades.** After a very successful 2G (GSM) cycle, which made telecoms the star performing industry in the stock markets in the 1990s, but which ended with a major crash in the year 2000, telecoms have never really recovered, financially or strategically. The reasons for the initial success include the facts that 2G wireless operators benefited from nominally priced spectrum, light regulation, low number of competitors (usually 2-3 per country), pre-set technology with limited disruptive threat, and full control over their consumer platforms and products, which were mainly voice and messaging. Some of this can be seen simply as luck, the rest, for example spectrum allocations, as privilege. In 1995, the wireless operators founded their international industry body, GSMA, which subsequently became one of the most influential industrial associations globally.

Unfortunately, such concerted global effort to keep spectrum and other privileges within one specific industry ultimately failed to work. Governments started extracting value of the spectrum privileges from telecoms back to the state budgets via spectrum auctions (the UK's 3G auction alone generated £23bn in the year 2000, while inconsistencies in how different governments approached spectrum auctions, often without underlying visionary policies, made telecoms less predictable and appealing for global investors). Governments also often used ad hoc mechanisms and awards of privileges to new entrants into local wireless markets. **Such ongoing focus on awarding and subsequently attacking privileges, combined with the disruption of telecoms services by the global internet companies, which practically replaced telecom product platforms by their own, have very often practically spoiled opportunities for the telecoms to generate satisfactory returns and growth from their 3G and 4G investments.** This in some cases led to in-market consolidation (merging between operators). Such mergers were however often accompanied with remedies, i.e. awards of privileges to smaller players, which partially diluted their purpose.

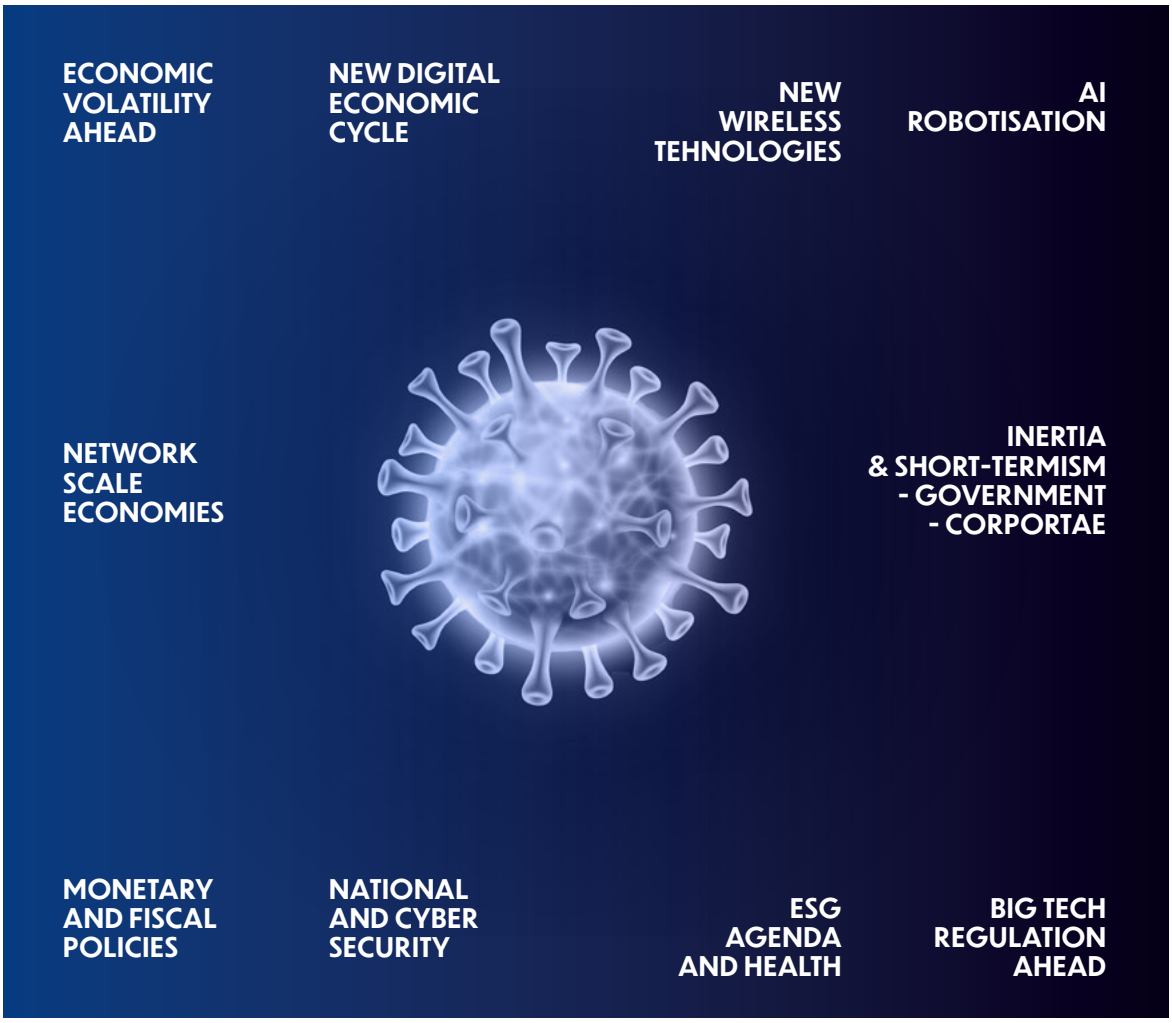
**Today, ahead of the 5G investment cycle, telecoms still face significant number of challenges, as also shown in Fig. 6. These are linked to the following:**

- Based on the currently known or reasonably predictable commercial service revenues from new 5G services, there are understandable **doubts about profitability of significant frontloaded investments required for nationwide 5G rollouts.**

- Most telecom operators have not been very clear about whether **their main purpose** is building and running national digital communications infrastructures, provision of digital consumer services or facilitation of digital services to the business segment.
- Many telecom operators have been showing **strong inclination towards opportunism,** aiming to secure privileges and protect their legacy business models rather than searching for the best business models from a long-term perspective.
- Finally, as shown in Fig. 7, **fading competitiveness in the internet services (big data), but also in the telecom equipment market, creates new pressures on telecoms.** Any delays in dealing with the big tech dominance, compounded with potential exclusion of certain network technology vendors, and hence limited equipment choices, would obviously complicate the situation further.

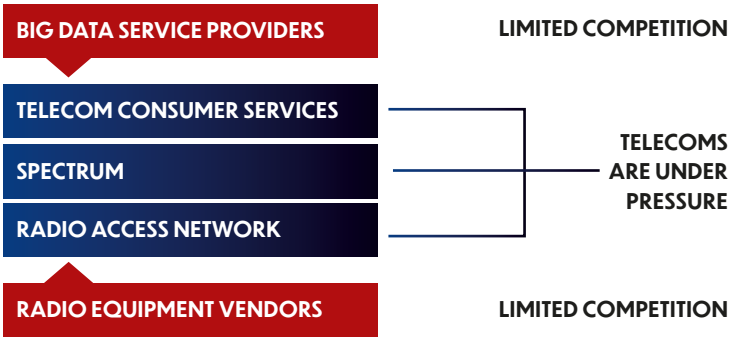
> **" The commercial business case for 5G infrastructure under the current telecom business models is often weak, if there is any "**

**Fig. 6 | Various challenges and new trends facing the telecoms industry**




Source: Digiteccs Associates

**Fig. 7 |**
**Telecoms are under pressure as adjacent industries are not enough competitive**




Source: Digiteccs Associates

In the light of the discussed challenges, the telecom industry may ultimately find its current **business model of operating parallel competing nationwide networks as not entirely suitable for 5G.** Deeper sharing of some infrastructures may become a must, not just an opportunity. The question therefore arises whether 5G may in fact invoke ideas of a re-birth of telecom monopoly, also due to the following reasons:

- 5G will largely **rely on underlying fibre infrastructures,** which would be very costly, if not impossible, to replicate.
- Scale economies and initial **capacity abundance in some of the newly built 5G networks** may be such that it would be practically difficult for smaller competitors to succeed.
- 5G network services may become **strategic for national interests,** for example due to their role in operating of emergency services, utility and transportation networks, and other key functions of the state.
- Some states may want to build 5G networks, and deep 5G coverage, as their **long-term infrastructure investments without waiting until such projects become commercially viable.**
- **Health concerns around mobile radiation may lead to pressures to minimize the number of 5G antennas.**

Given the unclear business objectives (purpose) of the telecom operators, the telecom industry has been struggling lately to make bold strategic moves. However, **5G and the covid19 situation are now increasing pressure on telecoms to think more strategically.** Some of the trends that we have already seen, or are beginning to see in telecoms, include the following:

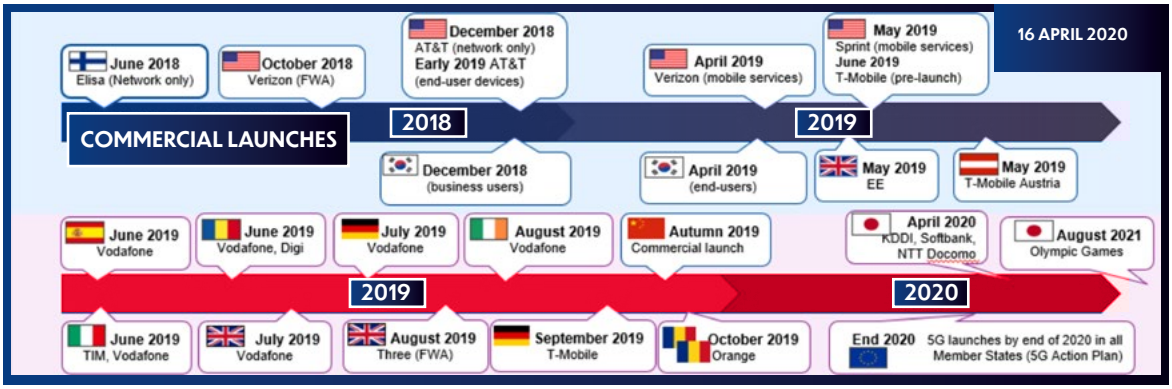
- **Passive network sharing.** This phenomenon has been in place for many years. It is not productive to duplicate expensive network resources, especially the passive ones, such as tower and fibre access networks. Sharing and separating towers has already become a world-wide phenomenon, while sharing of fibre networks is likely to rise further with further expansion of residential fibre and densification of the mobile networks.
- **Active wireless network sharing.** We have also seen some instances when the industry has moved towards active Radio Access Network (RAN) sharing, i.e. sharing of radio equipment and potentially also spectrum. Regulators have had mixed views about this so far. In some cases, they raised anti-monopoly concerns about it (e.g. in Europe), in other cases they encouraged it (e.g. the UK rural sharing).
- **Open RAN.** This is an example of the so-called network virtualization, i.e. separation between network hardware and software. Such a move makes the network more flexible to offer different applications and services, similarly to a smartphone that acts as a camera, personal assistant, TV, phone and various other things. In open RAN networks the operators would use vendor-neutral generic hardware, but they can also open their networks to a higher number of possibly smaller innovators. Similar to a smartphone, this could make the networks more versatile and hence valuable in the 5G environment. The open RAN concept is particularly appealing given the fading competition in the proprietary network equipment market, especially in countries, which are choosing to exclude vendors such as Huawei. The open RAN concept is supported by the US and some other governments. The first open RAN network was recently launched in Japan by Rakuten. A number of wireless operators including Vodafone are supporting the concept. That said open RAN technologies cannot yet provide network performance, which is comparable to the leading proprietary technologies. So far open RAN solutions lack scale, and the technology is yet to be standardized. Hence deployments initially focus on less competitive and less densely populated areas. Although buying non-proprietary wireless technology is obviously materially cheaper for the operators, unless we talk about newcomers such as Rakuten, the operators will also have to deal with their existing networks and equipment vendors, who may be reluctant to support the open RAN concept and transition to it.

**“ It is hard not to see a tendency towards the re-birth of telecom infrastructure monopoly in some areas. After all, what’s the logic of duplicating all towers, fibre networks, radio antennas and high capacity networks in factories and airports? ”**

# 3.4. 5G in the European and global context

5G is a relatively new technology. Countries usually first establish their 5G strategies, then allocate 5G spectrum, engage in trials, which are followed by commercial launches and eventually larger-scale deployments. **Fig. 8 shows that countries such as Finland, the US and Korea as early adopters,** which launched some form of 5G networks already in 2018. This was followed by **China and a number of European countries in 2019.** The European Union intends to have functioning 5G networks in all its member states this year.

## Fig. 8 | 5G development milestones




Source: The EU 5G Observatory by the European Commission, Directorate-General of Communications Networks, Content & Technology, using data from IDATE Digiworld, Note: data for March 2020

**Europe has already performed nearly 200 5G trials** involving its leading telecoms, equipment vendors and other tech companies. Over 3Gbps speeds were achieved, 5G was tested with Virtual Reality (VR), Augmented Reality (AR), 360° live video and 4K video streams. A majority of these trials used frequencies in range of 3.5GHz. In terms of verticals, media & entertainment was most popular, followed by transport and automotive.

**There are also plans to build cross border corridors in Europe** to pursue innovative and automatic solutions in transportation (see Fig. 12).

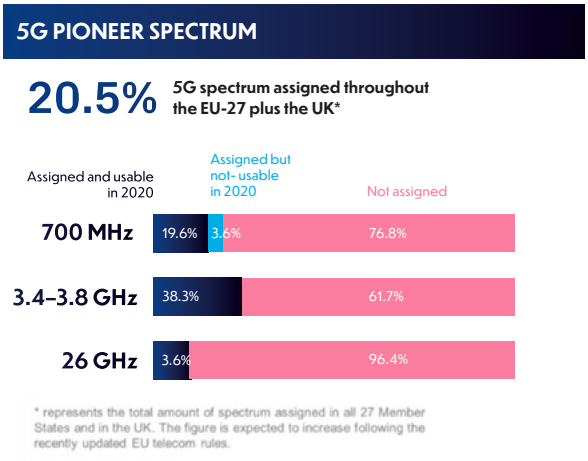
By the end of March 2020 an estimated **25 countries commercially launched 5G.** Apart from the mentioned early launches 5G is now also available for example in Japan, a number of Middle Eastern countries, but also in selected locations across all other inhabited continents.

**Ten European countries have already launched commercial 5G services in some areas.** Several of the leading European countries such as Germany, Spain, Italy and the UK, alongside with Finland and other countries, have been particularly keen on advancing 5G licensing and deployment.

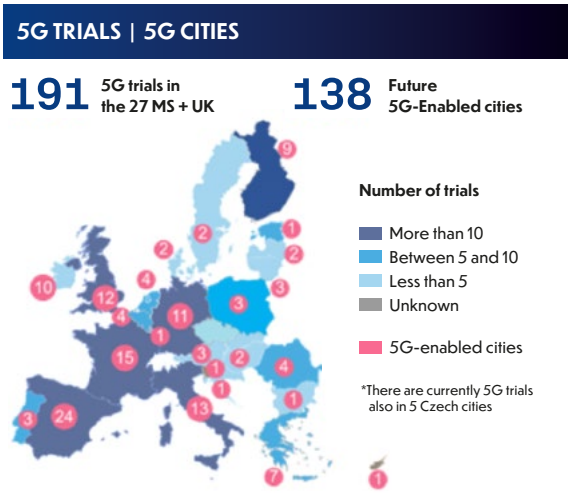
That said most 5G commercial launches have so far been in relatively modest scale and coverage. **Large-scale 5G deployments in range of with over 10,000 sites have started occurring only recently, led by China and Korea.**

In the absence of industrial use cases the early launches focused either on fixed-wireless access (FWA), especially in the US, or high speed (usually up to 1GBbps) data packages for mobile phones. In Europe such packages have been priced around Euro30-50/month. **There are no widespread consumer applications yet, which would encourage consumers to pay a material premium for the 5G connection quality in mobile phones.**

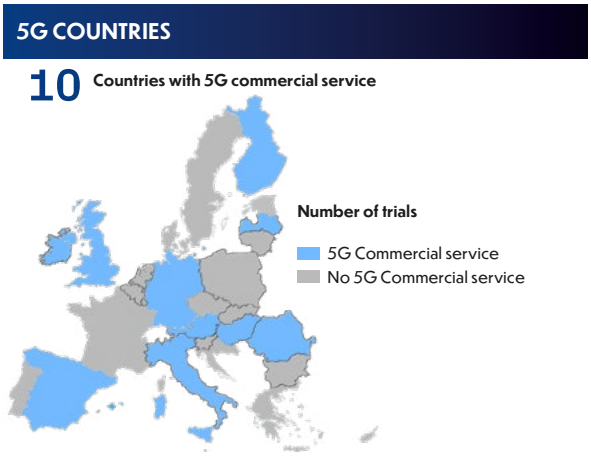
## Fig. 9 | 5G spectrum assigned in Europe




## Fig. 10 | 5G trials in Europe*

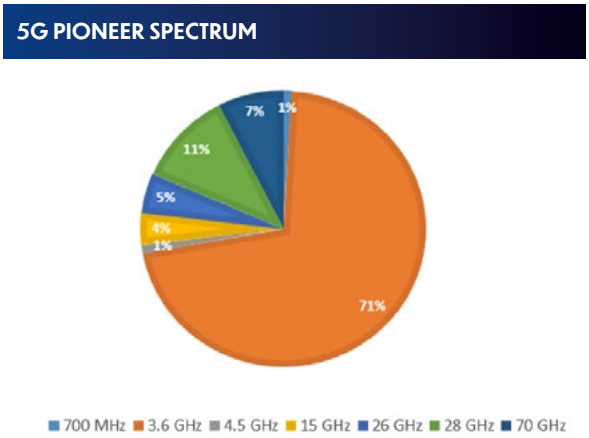



## Fig. 11 | 5G Commercial launches in Europe

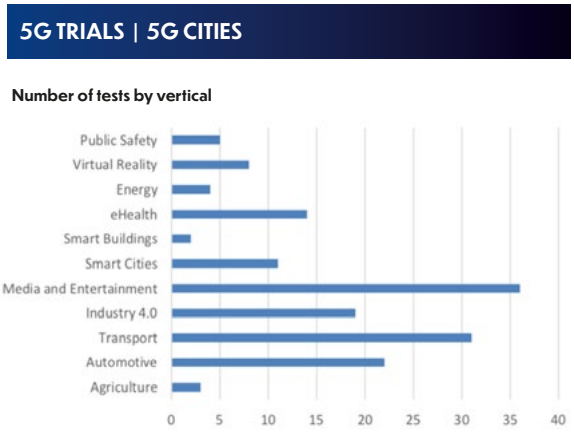



## Fig. 12 | 5G planned cross-border corridors in Europe

## Fig. 13 | European 5G tests by frequency




## Fig. 14 | European 5G tests by vertical




Source: The EU 5G Observatory by the European Commission, Directorate-General of Communications Networks, Content & Technology, using data from IDATE Digiworld, Note: data for March 2020

Also, the vast majority of commercially available 5G devices have so far been smartphones, devices for fixed wireless internet and industrial modules. **The consumer ecosystems around 5G will flourish not only once coverage is built, but mainly after a sufficient number of 5G enabled consumer devices hits the market.** This is more complex in 5G than for 4G, because 5G will require more diversity in types of devices.

The 700 MHz band has already been allocated for 5G networks in seven European countries including Denmark, France, Finland, Germany, Hungary, Italy and Sweden. The 3.4-3.8GHz band has been allocated in nine countries, including Austria, the Czech Republic (partially), Finland, Germany, Hungary, Ireland, Italy, Latvia, Spain and the United Kingdom. The 26GHz band has so far been allocated only in Italy. Fig. 9 shows that the majority of the 5G spectrum in the European countries has not been allocated yet. **Europe somewhat lags behind the US and the advanced Asian countries in spectrum allocation.** Four EU countries, Austria, France, Spain and Portugal have postponed 5G spectrum auctions due to the covid 19 epidemic. The Czech Republic has also postponed its 5G auction, but for different reasons.

Apart from the 3.7GHz spectrum allocation for localized industrial use in Germany and contemplation of similar moves in several other European countries (see chapter 5.2), **the European 5G spectrum auctions have so far not shown many strong innovative or disruptive elements aimed at reforming the local digital infrastructure and service markets.** Details about the status of the European 5G auctions can be found for example in:

**5G Observatory Quarterly Report 7**

Moreover, several countries including Italy and the Czech Republic have **selected specific cities for early development of 5G-driven innovative ecosystems, bringing together telecom operators, technology companies, municipalities and the academic sphere.** The aim is to find and test innovative use cases for 5G and to establish the best practice. One way to incentivize these early investments is to significantly decrease price for usage of 5G spectrum for such testing.

The GSMA expects the **mobile industry to invest US$1.14tn globally by 2025, with around US$0.9tn into 5G**.

It also expects that by 2025 **there will be 1.8bn 5G connections in the world** excluding IoT, approximately 20% of total connections by that time.

> **“ The GSMA expects 1.8bn 5G connections ex-IoT world-wide and over US$1tn wireless investments by 2025 ”**

# 4.

# 5G as an opportunity to reform digital infrastructure and service markets

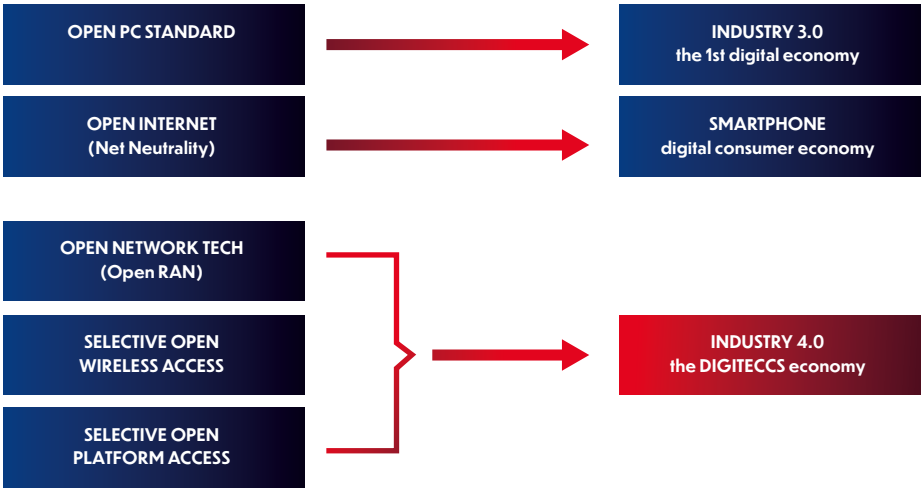
# 4.1. Utilizing the power of opening of tech standards, platforms and networks

**The technology, media, internet and to somewhat lesser degree the telecom industry have one thing in common.** They innovate, aiming to create a unique product proposition to the customer, such as the best smartphone, the most liked news portal, the best search engine or the best mobile network. **Scale economies usually significantly limit the number of winners or even survivors in such markets.** For products with easy cross-border sales, ranging from smartphones, software up to social networks, markets eventually become dominated by global leaders such as Microsoft, Google, Apple or Samsung, unless these companies face regulatory hurdles and local alternatives are proactively promoted (for instance in the internet markets in China and to some extent in Russia).

This winner-takes-it-all phenomenon poses significant challenges to free market economies, especially as the technology industries keep expanding their influence in the overall economies. Outcomes when the winning companies create significant user dependence on proprietary products and services, which may not be compatible with each other, do not seem ideal. **That said dominant tech, internet and telecom companies are usually opening their hardware, platforms and networks to smaller companies, at least to some degree.** This creates so called 'ecosystems' in which multiple innovators, service providers and other businesses use technologies, platforms or networks of the leading providers to conduct their own business (e.g. app designers using the Apple store, businesses using Google data to target their customers, or content providers using networks of the established wireless operators).

**The phenomenon of technology standard, platform and network opening is very powerful.** As shown in Fig. 15 the opening of the PC technology to multiple producers led to a massive boom in personal computing, which transformed the world's industry and office work (Industry 3.0). Open internet networks at the IP layer, also called net neutrality, was a key prerequisite for global spread of online consumer services including social networks. The open nature of the Android system and the app stores played a key role in advancing the wireless service industry.

## Fig. 15 | How the opening of tech standards, platforms and networks leads to progress




Source: Digiteccs Associates

**The phenomenon of tech standards, platforms and networks opening is not simple. Let's note the following.**

- **Complexity.** Technologies are often complex, involving multiple layers, which may be interlinked. It is therefore not easy to define what open access into tech standards, platforms or networks exactly means.

- **Tech companies, infrastructure and service providers face tradeoffs.** Tech companies, infrastructure and service providers face tradeoffs in relation to opening of their tech standards, platforms and networks, i.e. providing their technology, consumer interfaces and networks to other players. On one hand, opening can make their assets and ecosystems more attractive to bigger customer segments, i.e. boost the scale of their business. On the other hand, they may partially lose control over products delivered through their own assets. Ultimately, they may become dependent on other parties, they may have to deal with such parties and even risk losing competitive advantages to them.

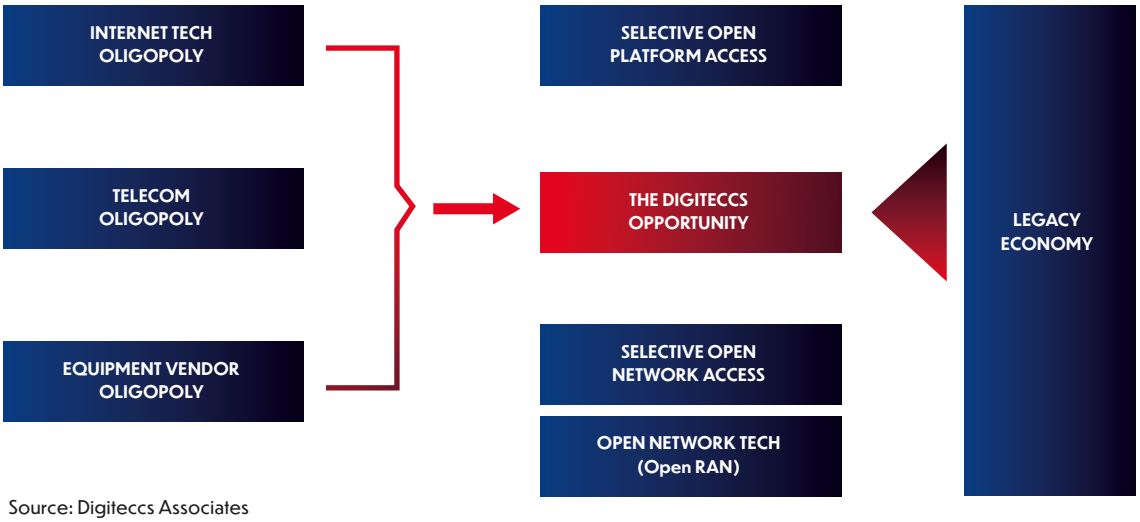
- **The choice to open certain assets are best made by the private companies themselves, however this can be impacted by visionary policies.** Successful cases of opening are usually 'voluntary', i.e. the technology, infrastructure and service providers make such choice based on their commercial interests. However, these choices can still be significantly influenced by visionary policies, which may either encourage the established private entities to make transformational moves, or attract new private entities with different business models into the market (e.g. open access infrastructure companies).

- **Despite their advantages, it is impossible to universally claim that open solutions are always superior to proprietary ones.** It is impossible to say that open tech standards, platforms and networks are always better than proprietary options. While open solutions attract more competition and innovation through small companies, proprietary solutions allow creation of large and powerful corporates, which may be in a stronger position, for example, to fund R&D, or take responsibility for the security of entire ecosystems.

From a practical standpoint, big technology, media, internet and telecoms corporations tend to initially resist solutions, which would utilize full potential of opening of their technology standards, platforms and networks. This phenomenon has so far led to the formation of 'legacy industries', as opposed to their disruption through vertical integration. As a result, we can now see three distinct legacy industries: **the big tech internet companies, telecoms and the telecom equipment vendors (see Fig. 16). It is possible to see clear dividing lines between those industries, but also scale economies which often tend to produce oligopolies in each of them.**

The dividing lines between different industries in the digital technology chain can also be also observed in Fig. 17. **Market concentration in the globally concentrated big tech internet and in network technology vendor markets is naturally putting pressure on telecoms,** which are often subject to regulations that vary region by region; in some regions they tend to be more pro-competitive than in others. However, we expect 5G to bring some changes to the established paradigm of internet tech, telecoms and the network tech vendor model, because:

## Fig. 16 | How diluting TMT oligopolies may bring the DIGITECCS opportunity and progress




Source: Digiteccs Associates

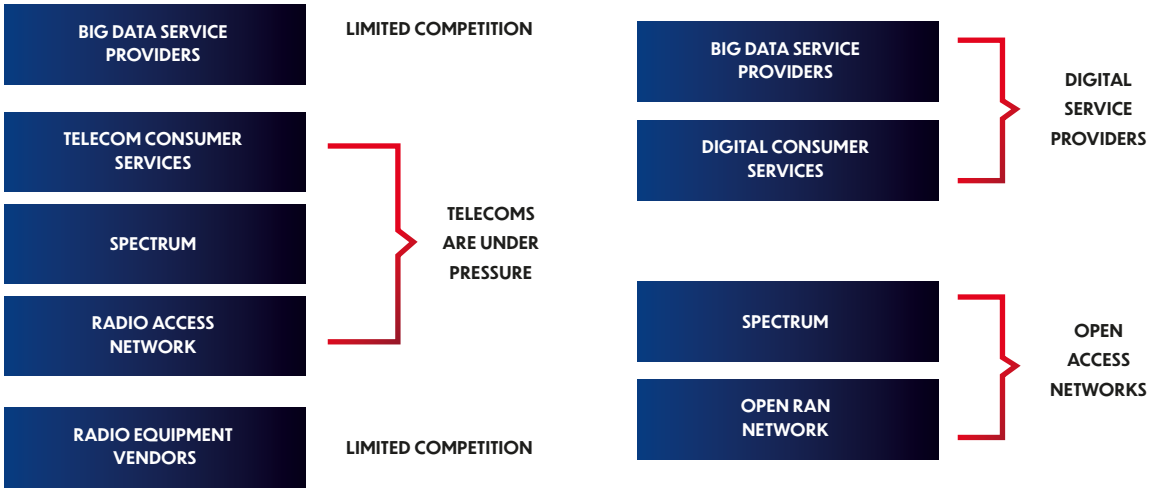
- the market **power of the internet big tech industries** and its distortive implications are increasingly obvious
- the telecom equipment **vendor market is also quite concentrated globally**; this problem is further amplified in countries, which are excluding vendors on security grounds
- the telecom industry is starting to respond to the network equipment vendor market concentration through its **Open RAN** initiative
- **5G makes duplication of some telecom infrastructures impractical,** it makes some nationwide wireless open access more desirable (e.g. in IoT) and it also boosts relevance of private local networks
- **telecom infrastructure is also becoming strategically more important for nations**

**We recommend policymakers to consider the following approaches to the opening of tech standards, platforms and networks:**

1. **to encourage opening of tech standards, platforms and networks,** especially where proprietary solutions lead to market inefficiencies that adversely affect security and functioning of economies and societies; and when the positive impact of such opening on innovation and the economy outweighs potential adverse impact of scaling down innovative proprietary solutions
2. any regulatory interference in the area of **opening should be ideally based on long-term policy visions**
3. **private entities should ideally not be forced into opening their assets,** but the already established ones may be encouraged to act in such way voluntarily; policies may also encourage creation of new entities established on the open principles
4. **to address issues surrounding global companies as rigorously as the local ones;** if certain regulatory tools are practically not available or not enforceable in dealing with global companies, alternative approaches may need to be considered, including giving compliant local companies certain regulatory benefits

> “ Policymakers should consider encouraging open tech standards, platforms and networks, especially when shortcomings of the proprietary model become a burden.”

## Fig. 17 | Network open access as a potential solution to the telecom challenge




Source: Digiteccs Associates

From a practical standpoint, opening of tech standards, platforms and networks is also complicated by **diverging interests of different industries**, see Fig. 18. This makes strong policy visions, which encourage more long-term behaviours from certain industries to achieve win-win solutions, particularly important.

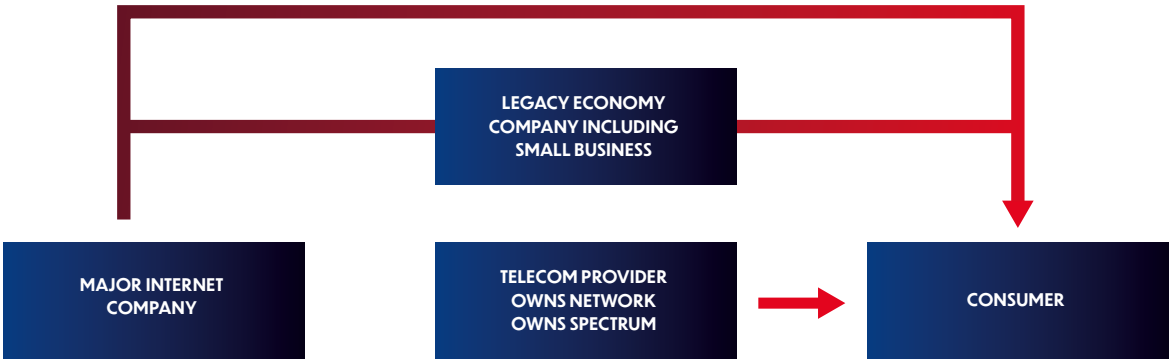
## Fig. 18 | Interests of different industries in regard to opening tend to vary

| | | |
|---|---|---|
| PROPRIETARY NETWORK | PROPRIETARY BIG DATA NOW | PROPRIETARY BIG DATA old telecom wish |
| | OPEN BIG DATA RAN vendor wish | OPEN BIG DATA new telecom wish |
| OPEN ACCESS NETWORK | PROPRIETARY BIG DATA | PROPRIETARY BIG DATA internet tech wish |
| | OPEN BIG DATA | OPEN BIG DATA IDEAL |
| | PROPRIETARY RAN TECH | OPEN RAN TECH |

Source: Digiteccs Associates

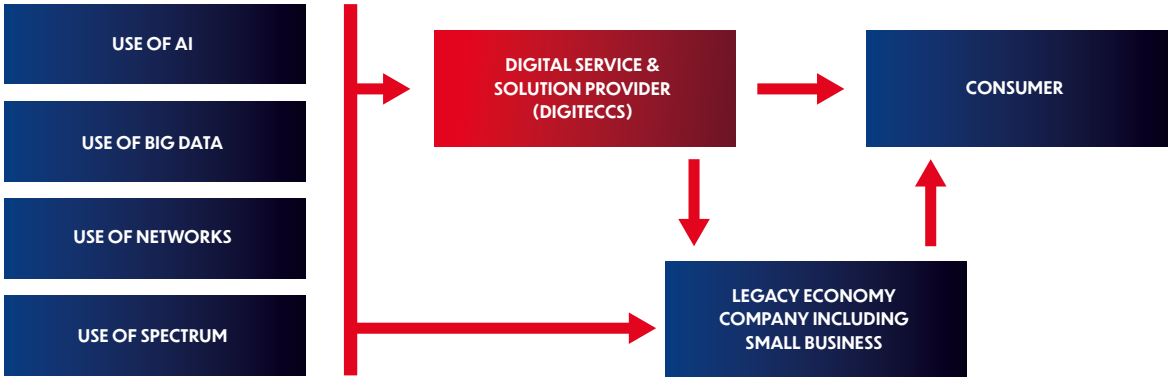
***5G* will put pressure on telecoms to enter the business for software, data and more differentiated consumer and enterprise services.** Subsequently, telecoms may find their involvement in parts of heavily capital intensive infrastructure businesses less efficient than before and start turning towards the so-called asset light model. The exact shape of telecom transformation however needs to be assessed market by market and over time as conditions in different markets evolve.

Fig. 19 | Legacy digital service model with a major internet company and telecoms




Source: Digiteccs Associates

Fig. 20 | New digital service model with open access to some networks, technologies and spectrum




Source: Digiteccs Associates

# 4.2. Enabling private networks for Industry 4.0 and beyond

**There have been three types of spectrum so far:**

- **National strategic licensed spectrum** has been used for example by the army, emergency services or in TV broadcasting. It is allocated and used nation-wide.
- **Non-licensed spectrum** has been used for example for WiFi, TV remote control or personal drones, but also in many other use cases. In most instances it is used locally, but rarely it can be used nation-wide, for example to create WiFi hot spots on trains.
- **Commercial licensed spectrum** has so far been used mainly by the wireless industry. It is allocated and used nation-wide.

Technically, spectrum can also be divided into four categories, based on localization of its use and the licensing approach, see Fig. 21.

## Fig. 21 | Different ways of using spectrum

| | | |
|---|---|---|
| **COUNTRY-WIDE** | rare examples such as train companies using WiFi | army, emergency services, TV broadcasting, mobile networks |
| **LOCAL** | WiFi, TV remote control, personal drone | NEW PRIVATE NETWORKS OPPORTUNITY |
| | **UNLICENSED** | **LICENSED** |

Source: Digiteccs Associates

Since the 1990s the wireless industry, which runs a specific business model of duplicated competing networks and nationwide coverage, has generally enjoyed the privilege of acquiring most of the newly allocated commercially licensed spectrum. 2G spectrum was allocated practically exclusively to the wireless operators, for example. Following the success of 2G, there has been a strong appetite to replicate similar approach towards spectrum allocation with 3G, 4G and even 5G spectrum allocation. That said from 3G onwards the telecom industry often had to pay material amounts for its spectrum privileges in the form of auction fees. **The wireless industry has hence preserved its business model primarily not because this has been the best model for its own prosperity or for utilising spectrum, but because such a model has essentially been imposed on it through the spectrum allocation processes.**

> **" The wireless industry has preserved its not so efficient business model partially because the established spectrum allocation mechanisms did not provide sufficient incentive for change"**

Perhaps this is the time to realize that **spectrum privilege does not mean an automatic win for wireless telecoms. Instead, it could mean obligations, regulations, costs, unclear future commitments, along with a reduced ability to compete and change.** To boost their business agility and maximize their own profits in a long-term wireless operators may need to be more open minded about pursuing the best strategic model for themselves at each time rather than aiming for the best protection of their existing model.

> **" To maximize their own profits wireless operators may need to be more open minded about pursuing the best strategic model at each time rather than aiming for the best protection of the existing model."**

**The established ways of spectrum allocation could have, in some occasions, led to competitive failures,** for example by providing some companies with unmatchable competitive advantages, encouraging the so called spectrum hoarding (acquisition of spectrum mainly to assure that it cannot be used by rival competitors or disruptors), allowing them to build excess capacity that could distort markets, or allowing them to distort competition by utilizing synergies with their existing assets, products and services.

With the raise of 5G a fundamentally new opportunity to use spectrum has emerged. This is because 5G also uses higher frequencies than the previous Gs, for which the respective sites have a smaller coverage range. It is deemed that nationwide coverage is practically impossible for frequencies above 3GHz (5G uses for example 3.5GHz and 26GHz). **A different and more location-driven business model may appear more suitable.** The 3.4-3.8GHz spectrum is deemed as highly valuable for example for high capacity networks inside factories, shopping malls, airports, but also for relatively short-range communication within streets, which could, in some instances, substitute the more expensive fibre-to-the-home connections, and even in-home or commercial in-building WiFi networks.

The 3.4-3.8GHz and the 26GHz spectrum will be particularly attractive for businesses, both in production and service industries. They may find 5G superior for their local installations compared to WiFi due to security, but also equipment availability, performance and standardzation. Local 5G networks are likely to become highly strategic for such businesses, enabling automation, but also addressing security and privacy sensitivities around data. For this reason, **some businesses, business parks, infrastructure or other companies may wish to build and operate their independent proprietary 5G networks, using their own spectrum and trusted technology partners, rather than being strictly limited to work with nation-wide telecom operators.**

The idea of private 5G networks is naturally seen as disruptive by the telecoms industry. **Hence, there is a debate about the pros and cons of allowing spectrum allocation to local entities vs. allocating the 5G spectrum entirely and exclusively to the nationwide telecom operators.**

**Large parts of the telecom industry oppose the idea of direct localized spectrum allocation to users of local private networks, especially when talking about spectrum around 3.5GHz, raising the following concerns:**

- **Interference.** Building multiple local network installations near each other, or local networks covering moving objects such as trains or boats, may lead to issues with interference, causing technical challenges. Wireless operators argue that the best way to prevent this is by awarding all spectrum to them on a nationwide basis and allowing them to manage such situations. It is true that such situations need to be professionally managed. However, other entities including for example some tech companies may be able to help with this. In theory, different entities may own the spectrum, manage its flexible allocation among multiple users and operate local networks using it.

- **Handover.** Local private networks have naturally limited coverage. If such networks were built by the nation-wide wireless operators, seamless handover to nationwide networks can be provided, which means that devices leaving territories covered by the local networks stay connected without disruptions. This will be relevant for some, but not all local network use cases. For operating connected in-factory machinery as part of industrial automation, for example, local coverage may suffice. It is also possible that a well-functioning national wholesale wireless market may provide such solutions.

- **Utilization of the spectrum.** The telecom industry sometimes claims that the allocation of valuable spectrum for use by local entities would lead to underutilization of such spectrum in most of the national territory, where no local entities would apply for such spectrum use. However this does not need to be the case. Regional spectrum allocation schemes may allow spectrum unused by local business and landowners in some areas to be used by other parties, including the telecom companies. Moreover, high frequency spectrum is unlikely to be used for full nationwide coverage anyway.

- **Size of the spectrum block**. The telecoms industry and other experts claim that larger blocks of spectrum in the 3.5GHz range can be fundamentally better utilized for innovative techniques such as spectrum slicing. Telecom operators often propose to use 80-100MHz block size as desirable. The discussions about the block size do indeed have substance. However, this does not automatically imply that the best utilization is achieved when all such blocks are exclusively in hands of the legacy wireless operators.

- **Price of the spectrum.** The wireless industry sometimes suggests that if a large spectrum block was allocated outside its scope, the limited amount of the remaining spectrum would lead to excessive spectrum prices. This is a valid concern, also based on the German 5G spectrum auction experience. However, this issue can be addressed for example by allowing operators with smaller spectrum allocations to share spectrum. If some operators wanted exclusivity, they may have to economically assess what price they are ready to pay for it vs. a perfectly plausible scenario of spectrum sharing, or even using regionally allocated spectrum in some geographies.

- **Skills of network building.** The wireless industry may argue that it is ideally skilled to build and operate private wireless networks. The wireless operators certainly have skills in network building, but tech ansd other companies may learn such skills. Moreover, nothing stops the wireless operators from selling such skills to businesses, which secure local access to the spectrum for themselves (we have already seen this for example in Germany).

- **Harm to telecom value, which would adversely affect telecom innovation**. It is fair to admit that private 5G networks may lead to some disruption to telecoms future business opportunities. It is equally true, however, that the so called 'spectrum hoarding', i.e. allocation of all precious spectrum towards one particular business model to effectively suppress this type of disruption, would likely boost the telecoms' incentive to seek rent from the spectrum as opposed to innovating aggressively. Telecoms showed this lack of innovation in the previous business cycles. Arguably, telecoms need to win innovation-driven competitive battles by providing superior service to their customers, not by securing full spectrum-related entry barriers. A reasonable and fair disruptive pressure on the telecoms industry may therefore encourage its own innovation.

> **" Telecoms need to win innovation-driven competitive battles by providing superior service to their customers, not by securing full spectrum-related entry barriers"**

According to a recent report from BearingPoint//Beyond **only 21% of early enterprise 5G related contracts have been awarded to telecom carrier service providers**. In additional 40% of early 5G enterprise contracts, telecom carrier service providers were secondary vendors. This shows a desire of material parts of the business community to buy such private networks solutions from vendors outside the telecom industry. It also means an opportunity for telecoms to improve their standing with enterprise customers. The creation of some disruptive tension via regional allocation of spectrum may encourage telecoms to focus harder on the customer and competitiveness of their own service, and hence fundamentally strengthen their business.

> **" The creation of some disruptive tension via regional allocation of some spectrum may encourage telecoms to focus harder on the customer and competitiveness of their own service, and hence fundamentally strengthen their own business"**

**A number of countries have already allocated, or they are contemplating a model of allocating 5G spectrum in the valuable band around 3.5GHz, but also in other 5G-suitable spectrum bands, for local private networks.** This method follows ideas sometimes also called Dynamic Spectrum Access (DSA), promoted by the Dynamic Spectrum Alliance. Examples of localized spectrum allocation initiatives for private 5G networks include:

- **The Citizens Broadband Radio Service (CBRS) project in the US.** This is so far the most sophisticated DSA spectrum allocation scheme for 150MHz in the band between 3,550-3,700MHz. It is a three-tier system when incumbent users such as the US navy get absolute priority for using this spectrum in local areas where they need it (this can change over time, as the navy ships move, for example, but generally the territory where such spectrum is required is limited). Other users can choose to be either tier two, Priority Access License (PAL) holders, or tier three, also called General Authorized Access (GAA). The system uses technologies to manage spectrum interference based on the above-mentioned tiered system and the location of users, which may change in time. In practice, it can give direct access to the same spectrum band to government institutions, telecom operators, tech companies, industrial companies as well as other users, including small and medium sized business. It aims at tech-driven higher and more versatile utilization of the spectrum than under the legacy telecom model.

- **Spectrum for Industry 4.0 in Germany.** The country has designated a 100MHz block between 3,700-3,800MHz specifically for industrial users on a local basis. This spectrum is currently used by over 30 industrial companies, including Bosch, BMW, BASF, Lufthansa, Siemens and Volkswagen. We have already seen a telecom operator offering its service to an enterprise customer, which chose to build its own network, using its own locally allocated spectrum. Critics of the scheme however point out that spectrum allocated this way is only used on a small part of the national territory, and it is practically wasted outside the industrial complexes.

In addition the Netherlands, Sweden and the Czech Republic are planning to allocate some spectrum around the 3.5GHz band for local private networks. Other countries such as the UK, France, Japan, Australia and Hong Kong are also contemplating the concept of regional spectrum allocation for private 5G networks, although potentially in different frequency bands.

For more information:
https://5gobservatory.eu/5g-private-licences-spectrum-in-europe/

The Czech Republic is one of Europe's most industrialized countries. Therefore, industry use of 5G is the country's top priority, as outlined in its new 5G Strategy approved in January 2020. This strategy among others proposes support for industrial 5G research and Smart Industrial Zones (also see chapter 5.2.).

**Policymakers should consider boosting the diversity of 5G private network business models through designating a bloc of spectrum in the 3.4-3.8GHz range, and other 5G-suitable spectrum blocks in bands higher than 3GHz, for more flexible and location-driven allocation regime under the following conditions:**

1. **Such designated blocks of spectrum will need to have appropriate size to allow optimal spectrum utilization.**

2. **There will be clearly established and transparent rules about how allocation and use of such designated spectrum is managed in real time and across different local territories.**

3. **Management of flexible allocation of such designated spectrum across different locations and over time would be ideally overseen by a qualified and independent entity.**

4. **Private and local entities, ranging from small businesses, business parks, providers of transport and other infrastructures, up to large industrial conglomerates, should be able to use such designated spectrum for operating their own local private 5G networks on their land, around their infrastructures or in their indoor areas,** under preestablished conditions aimed at preventing interference, and overseen by the above-mentioned qualified entity.

5. **Access to such designated spectrum should not be strictly limited to local entities.** Especially in areas where such spectrum is not used by local entities, access to it can be made available on a localized and dynamically managed basis also to the telecom, tech, utilities and other industries, or other entities.

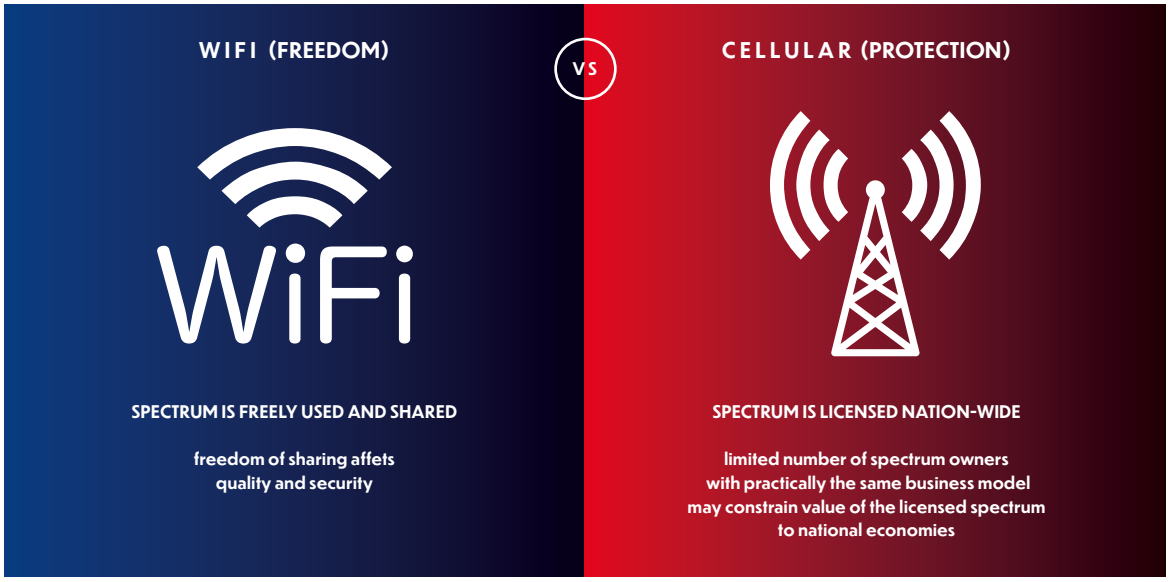
6. **If such designated spectrum was to be used in some locations by public entities, this must not lead to distortion of any competitive markets.** As a result, ability of public entities to use such spectrum to provide localized public services may need to be restricted.

7. **To further ease spectrum availability related pressures from public networks, utilisation of all spectrum can be further boosted by allowing private spectrum owners to engage in certain types of spectrum sharing.** This should help addressing the telecom industry's concern about spectrum shortage due to designation of part of the spectrum for local use.

8. **While initial clarity and transparency around the local spectrum designation scheme is vital, as with any pro-innovation policy, it will be appropriate to review the outcomes after a period of time and consider results of such review in setting future policies.**

> " Reserving a block of spectrum in the 3.4-3.8GHz band for a more dynamic and regionally driven use could help to boost efficiency and innovation across industries including telecoms "

## Fig. 22 | WiFi vs. cellular spectrum




Source: Digiteccs Associates

## Fig. 23 | Use of dynamic spectrum access


Source: Digiteccs Associates

# 4.3. Exploring synergies between digital communications, energy and other infrastructures

Telecommunications, energy utilities and other utilities and infrastructures have historically operated as separate industries. This is despite the fact that investors have largely seen telecoms as utilities, and despite **obvious network synergies between telecoms and other network infrastructures, in both construction and maintenance. Telecoms companies usually do not want to be seen as utilities for two main reasons.**

- **Telecoms usually want light touch regulation,** which is only possible when they can credibly claim **that they operate in competitive markets** and, unlike utilities, offer differentiated products.
- **Telecoms usually want to be able to use exclusive spectrum** to keep potential competitors and disruptors out of their markets. Again, this is only feasible if the industry can claim to have competitive and differentiated products.

Telecoms have pursued their non-utility status with the aim to maximize return on their investments through light touch regulation, spectrum privilege and service differentiation. **Meanwhile, utilities such as energy companies have so far been cautious not to act as major telecom disruptors, because** different regulations and entry barriers in telecoms such as spectrum.

**However, energy utilities are now beginning to look at expanding into telecom infrastructure for the following reasons:**

1. **Energy utilities need telecom-powered smart grid solutions.** The sustainability agenda is likely to influence the electricity market in a major way, particularly through pressures on energy efficiency (saving) and investments into renewable energy sources. This will lead to a requirement to remotely control and manage power consumption directly at the end-user appliances, i.e. remotely managing power supply for example for factory machinery, battery-charging stations or household appliances. In addition, there will be a need to manage large numbers of small local power sources (e.g. solar, wind) in relation to the national power grid. All this needs digital connectivity, in some cases wireless. Given the risk of failures causing power blackouts, any communications infrastructure used in the smart grid has to be highly reliable, and by default as strategically important as the power grid itself. This is why some utility companies are now building their own communications networks, with both fibre and wireless components, to get greater control. Excess capacity of these networks may be sold on a wholesale market or even used in the utility companies' own consumer telecom businesses.

2. **Energy companies sometimes see the process of changing telecom vendors as inconvenient.** Some European power companies also quote the sheer complexity and inconvenience of changing telecom vendors, in other words competitive inefficiency of the telecoms market, as a reason for considering their own telecom infrastructure investments.

3. **There are synergies in strategically protecting telecom and energy infrastructures together.** As telecom networks will be used to run energy utilities, emergency services, but also a variety of commercial services where communications failures have major adverse consequences, policymakers are increasingly realizing a need to strategically protect the telecom infrastructure in the same way as the energy utilities infrastructure. This situation has become even clearer as a result of the covid 19 developments, see chapter 4.4. There are naturally synergies in protecting such infrastructures in a coordinated way.

4. **There are also synergies between strategic telecom infrastructure built by the energy utilities and other mission critical government services**, such as the PPDR (blue light) emergency services, communications needs of which will also grow substantially.

5. **Energy utilities may exploit the currently opportunistic timing of the strategic changes in digital infrastructure to move into the space.** The telecom industry faces disruptive pressures on several fronts, including from the new digital infrastructure industries. Energy utilities may use this somewhat unsettled transitionary period to seek opportunity to either disrupt or partner with the established telecom players, or with new telecom infrastructure players.

6. **Energy utilities may also explore synergies in digital services.** The market for consumer digital services and solutions will grow and become more complex. Following a period when digital consumer service markets were practically dominated by the global big tech companies, it is feasible to assume that new opportunities for local vendors will emerge now, also due to the growing technological and regulatory complexities. For example, energy utilities may see synergic opportunities between smart power management in homes and other smart home services.

**European energy utilities are gradually waking up to telecom opportunities,** although the scale of their telecom investments has so far been relatively modest, mainly concentrated on fibre backbones and Mobile Virtual Network Operators (MVNOs). That said plans for targeted wireless investments in the utilities industry are also emerging, including **possible intentions of some leading Czech power companies to take part in the 5G spectrum auction.** In Europe there is a number of organizations focused on communication needs in utilities such as Alliance 450, RSPG and EUCT. The power utility companies are looking not only at building their own infrastructures to replicate the current telecoms networks, but also **other models such as purchasing guaranteed capacity from the established telecom infrastructure vendors.** 5G will offer new models in this regard, with possible opportunities in wholesale and network slicing.

**We recommend policymakers to consider the following:**

1. Recognise the growing **synergies between public telecoms, PPDR emergency communications, transport, power and other utilities** in respect to building, operating and securing strategic national infrastructures.

2. **Consider aligning regulations particularly in telecoms and utilities such as power,** to soften any potential regulatory barriers to synergic investments and resource sharing between different types of infrastructures.

3. **Recognize the potential benefit of the emerging willingness of energy utilities to be strategically active in digital communications infrastructure,** and steer such activities to be as synergetic with the existing communications infrastructures as possible.

> “ European energy utilities are waking up to timely and strategically sensible opportunities in communications infrastructure; countries may benefit from supporting such initiatives especially when they exploit synergies between different types of infrastructure. ”


# 4.4. Transforming telecommunications post covid 19

The world-wide spread of covid 19 and the subsequent actions taken by governments to contain it resulted in **the greatest shock to global economies and societies in decades.** This has had the following implications:

- **The overall economy has substantially weakened and hence pro-growth policies are needed more than ever.** Consumer spending power will decline substantially in short-term. Hence policies to boost investment will become crucial. Understanding of the opportunities brought by digital technologies and the right policy moves will be essential to trigger investments in the public sector in a way that would spread to the public sector as well.
- **Both consumers and businesses have become more dependent on digital services** including social networks, video calls and online commerce.
- **Both voice and internet traffic has increased substantially, causing in some cases capacity constraints** and in some countries even temporary network disruptions.
- **Telecom infrastructure has become more strategic** for the nations due to the lockdowns, which have severely curtailed opportunities for people to communicate in other ways.
- **Regulation and re-distribution in the economies has risen,** which makes investors in any new businesses naturally careful.
- **Policymakers' attention has been diverted towards dealing with the covid 19 crisis,** which is often delaying decisions in other areas, for example about spectrum licensing or competitive issues. Sometimes less rigorous fast solutions are being adopted as a response.

**So far we could observe a range of distinct responses by the telecoms industry to the situations around covid 19. They include:**

- **Offering consumers extra free services within their price plans** to ease the pressure of the covid 19 lockdowns and to boost their safety. This has sometimes involved extra data allowances or even unlimited data use. Zero rated content offers, for example for health, safety and education, have been particularly popular in emerging markets.
- **Traffic management.** The lockdown-induced spike in consumer internet traffic, especially video, at some stages resulted in network disruptions in a number of countries including Switzerland and the UK. Hence some operators not only issued pleas and guidance towards the consumers how to use the internet 'responsibly', but in some cases they adopted certain traffic management mechanisms.
- **Co-operation with governments on tracking the infected individuals.** The leading European telcos for example offered to share some personal data with governments and the EU authorities already in the early stages of the covid 19 crisis. This issue is naturally sensitive due to privacy.
- **Requesting emergency spectrum.** The FCC has provided emergency spectrum to the US telecom industry, Vodafone called for similar steps, some other countries including South Africa have followed. New Zealand even scrapped its spectrum auction entirely and awarded the spectrum directly to the chosen operators.

- **Crisis management including national and international coordination.** Telecoms need to assure both smooth functioning of their networks as well as safety of their own employees in this special unique situation. Collaboration between telecoms may be temporarily more important than competition. Some challenges and bottlenecks also need to be addressed by cross-border cooperation.

**There is a number of arguments against full duplication of nation-wide 5G infrastructures,** which include: a need for extensive fiber investments, high capacity and initial underutilization of the newly built 5G networks, public preference to limit the number of built antennas, and the high cost of building full territorial coverage. The covid 19 crisis also highlighted situations when states need to provide urgent support to telecom infrastructures, such as emergency spectrum allocation or physical protection. A need for a highly protected and regulated digital communications infrastructure will also continue to grow due to the growing dependence of individuals, families, businesses and the public sector on digital services for health, security, emergency services, finance, transportation, utilities etc.

**The current wireless business model was designed by the policymakers 30-40 years ago. 5G and the covid 19 crisis are exposing the need to transform it. Such transformation would appear most likely to succeed when led by long-term visions and implemented in co-operation with multiple stakeholders.** We recommend policymakers to play a constructive role in helping to establish such visions as well as helping to implement the following transformational processes:

1. **Transformational changes in telecom infrastructure.** The covid 19 crisis has made digital connectivity infrastructure more strategic for national interests than previously thought. This effect, which is unlikely to reverse, may accelerate a shift in priorities in some digital communications infrastructures away from competition towards regulation, safety and reliability. Policymakers should adjust their approach accordingly, also in the area of enforcing competition vs. specific quality requirements in infrastructure.

2. **Transformational changes of telecoms towards national digital service providers, trustworthy and secure providers of nationwide connectivity and guardians of private and public data.** Progressive telecom operators, which are willing to transform themselves to national digital service players, should find new opportunities in the national markets for secure digital consumer services, including in finance and health, secure personal data and national data sovereignty, personal data privacy protection and management, trustworthy media and content, trusted IoT solutions as well as helping to enable similar solutions for enterprise, including small and medium sized businesses. Policymakers should consider encouraging this type of visionary transformation of telecoms towards innovative providers of data-driven national digital services, importance of which for national economies will grow.

**Furthermore, in respect to the covid 19 crisis and potential future similar crises we recommend policymakers to play a role in the following responses:**

3. **Re-building economies digitally.** As part of their effort to re-build economies in an innovative manner post the covid 19 induced slowdown, policymakers may support short-term investment into the digitalization of public services. They can also support the expansion of secure and easily accessible digital infrastructures in order to encourage private investment into the digitalization across all sectors in the economy in order to drive economic recovery.

4. **Crisis solutions** such as fast decisions to lend spectrum, collaboration between competitors or provision of special services to vulnerable groups, are warranted at times of crisis. Such decisions should be preferably made by consensus between the policymakers and the commercial entities involved. It should be clear to all sides that any crisis solutions are temporary, and they should not prejudice or adversely impact any long-term policy formation.

5. **Use of personal data in crisis**. If crises require moves that may compromise privacy of personal data, such decisions should be made by the policymakers, who take the ultimate political responsibility for handling the crisis, and not by private companies. The EU's initiatives in terms of balancing privacy in the covid 19 tracing initiatives are worth noting.

> **" The covid 19 crisis may accelerate a shift in priorities away from competition towards regulation, safety and reliability in some digital communications infrastructures, while encouraging innovative competition and expansion in services. "**

# 4.5. Responding to concerns about security, control and health

**Concerns about risks of 5G for human freedom, security and health are not new.** However, publicity around such concerns, particularly about health, has been escalating over the past twelve months in relation to commercial 5G launches. Anti-5G campaigns have already forced partial suspension of network deployments, for example in Switzerland and Belgium. Unfortunately, they also led to vandalism against telecom infrastructure in the UK and in other countries.

The situation has polarized public views also because the anti **5G campaigns have often been led by forces, which benefit from fuelling panic by spreading alarmist information.** This includes unproven conspiracy theories and so called 'fake news', popularity of which tends to be amplified by social networks. There are currently several groups around the world campaigning for full suspension of 5G rollouts, suspension until more research into health effects is conducted, or tightening of the existing radiation safety limits.

This creates challenging situations for policymakers, because **attempts to censor public debate about health impact of mobile radiation may risk further polarization in views and undermining potential independent research into this important subject. Meanwhile, letting potential misinformation to spread may adversely affect infrastructures, economies and even health and well-being of people.**

**The main grievances against 5G include:**

- Interference of 5G electromagnetic field with living tissues with potential adverse **impact on human health and health of natural ecosystems.** Critics of the technology also claim that the use of higher frequencies and techniques such as beamforming could make the ways in which 5G mobile radiation interferes with human tissues different compared to the previous mobile technologies.

- Concerns that deeper overlaps between the virtual and real worlds will **reduce individuals' control over their life and make them more vulnerable to cybersecurity risks.** Such risks may not only be related to malicious intentions, but also to human error, natural forces or failures of IT systems.

- Concerns that public debate about **mobile radiation health may be intentionally suppressed**, and scientific research trying to prove links between mobile radiation and human health has not been sufficiently supported.

**Since 5G has some new elements as a technology, it is naturally surrounded by uncertainties about potential risks and side effects.** Many of the concerns discussed on social media are baseless or exaggerated. That said the **security/control risks are relevant, as shown for example in the debate about technology vendors. However, this is addressable by establishing prudent policies** and working with trustworthy technology companies. In terms of the radiation health concerns, the frequencies initially used in 5G will not fundamentally differ from what is already being used in mobile networks and WiFi. That said the overall amounts of mobile radiation may increase when 5G is added to the existing networks and there are some other nuances, for example linked to **beamforming, which may be theoretically seen as bringing some unknowns and risks.**

**Despite such unknowns, it is fair to say that beamforming is able to transmit data while generating much lower overall levels of radio pollution compered to the previous technologies, hence reducing certain types of risks, because it directs the radio signal in a narrow space just towards the active devices. Moreover, MIMO and beamforming have already been selectively used in 4G, bringing material performance enhancements. Finally, the amount of radiation falls rapidly with distance from the antennas. Based on the so called 'inverse square law', physics suggests that the radio intensity is inversely proportional to the square of such distance. However, risks are not unusual for any major innovations.** What is different for 5G, is that its direct benefits for consumers, employees, small and medium sized businesses are yet to be well understood by the general public. This compounds with the population already being very concerned about health due to covid 19. Unfortunately, **this is helping those, who intend to spread potentially misleading information with the intention to slow down the 5G rollout.**

Looking at the past cycles, **the main beneficiaries from fast advancement of wireless technologies were the global tech companies, the losers would have been mainly legacy industries disrupted by digitalisation. With 5G, we also expect fast rollouts to boost competitiveness of nations. In science, the health debate is focused on the overall impact of electromagnetic radiation emitted by the mobile networks, not only 5G, on humans and the ecosystems.** The current mainstream scientific view is that such radiation, also called non-ionising radiation, has proven to have only thermal effects, i.e. it warms living tissues. Radiation safety limits are set in a way seen as safe from this point of view, also see:

**Statement on RF EMFS (Mobile Radiation) by International Commission on Non-Ionizing Radiation Protection (ICNRIP)**
**There have been attempts by parts of the scientific community to challenge this mainstream view and claim that non-ionising radiation from mobile networks interferes with living tissues in other than thermal ways as well, potentially causing harm.** Examples of initiatives pursuing such views, and demanding more research or other action in these areas, include:

- **International EMF Scientist Appeal** - group of scientists calling on the United Nations to tighten the radiation health limits
- ***5G* Appeal** - a group of scientists calling on the EU to suspend *5G* rollouts until there is more evidence about health effects
- ***5G* Crisis Summit** – initiative involving scientists wishing to debate *5G* health risks and potential solutions
  "Parts of the scientific community are challenging the mainstream view that non-ionising radiation has no proven health effects other than thermal ones."

**We recommend policymakers the following:**

1. To demonstrate to the public that **they have a grasp on the underlying issues around security, freedom and health** and they are ready to defend the public interests amid various pressures from different sides, global as well as local.
2. **To carefully assess security risks linked to any tech or other companies involved in building and provision of critical infrastructure and services, and if necessary, adopt appropriate regulations.**
3. **To encourage a cultivated public debate about benefits and risks of technologies**. When relevant, promote public appetite to adopt technologies and help to fairly understand the risks, also by debunking misinformation and explaining the rational basis for the used security and health regulations.
4. **To continue supporting truly independent scientific studies in areas of the main risks, both security and health, and on relevant issues of public interest.**
5. **To strictly enforce the law,** both in protecting the existing infrastructures, as well as building new ones.
6. When **technologies lead to excessive market power**, and subsequent risk to freedoms, competition, security or democratic rights, policymakers should adopt credible plans to address this via **boosting competition or stricter regulations.**
7. **To reassess the telecommunications infrastructure model so that it does not encourage building excessive numbers of antennas** due to economically and technologically unnecessary duplication of wireless networks.

**" We recommend policymakers to assure the public that they have a grasp on protecting freedom, health and security while remaining committed to progress "**

# 5.

# The Czech context


# 5.1. The European 5G strategy

The development of 5G networks belongs to strategic priorities of the European Union. **The European 5G Action Plan** was approved in the year 2016, with the key focus on:

- **timely 5G rollout in the cities and around the main roads**
- **support for cross-European 5G testing**
- **support for innovation via investment**
- **support for technology standardization**

In the subsequent **Electronic Communications Act from 2018** the European legislators put further emphasis on preparedness of national infrastructures for 5G as well as coverage requirements.

Furthermore, in 2019 **the European Commission issued its recommendations regarding cyber security of the 5G networks,** seeing 5G as a key national infrastructure.

**The European Commission estimated 5G to bring Euro113bn to the European economy by 2025.**

> **“ The development of 5G belongs to the strategic priorities of the European Union. ”**

# 5.2. The Czech government 5G strategy

The Czech government is following its '**Digital Czechia**' program from 2018, which focuses on digital interaction with the European Union, public services up to the industry and consumer economies. There are also other documents including an Action plan 2.0 aimed at removing obstacles to building 5G networks; as well as an Action plan linked to the Memorandum about the future of the Czech automotive industry, which also touches on issues such as autonomous driving.

In January 2020 the Czech government set two key priorities for the upcoming 5G auction:

(1) support competition in the telecommunications market with positive impact on pricing in the mobile market
(2) support development of 5G networks in context of the 5G strategy

**The Czech national 5G strategy has been outlined in the document 'Implementation and development of 5G in the Czech Republic',** which highlights the following:

- it is impossible to build digital economy in the Czech Republic without high speed 5G networks

- the process of building high-speed 5G networks should be made easier by the government

- 5G will enable the so called convergence between fixed-line and mobile networks

- 5G will also increase the need for significant extension of the fibre optic coverage of the country

- the 5G initiative can only be successful if cooperation among the following entities occurs: the government institutions, businesses, municipalities, academic institutions up to consumers

- 5G infrastructure buildout is expected to cost the Czech government up to Kc1bn, but private investments are estimated in tens of billions Kc

- synergies with building other infrastructures, including the so-called smart grid in energy, should be explored

- the key 5G services to be considered in the Czech Republic include Industry 4.0, smart cities, smart transport and mobility, eHealth, eEducation, smart agriculture, smart culture, emergency communication and consumer services

- two key risks, which will have to be addressed in the Czech 5G deployment, are: a risk of unreliable equipment or software vendors and a risk of targeted external cyber-attacks; some trust to the vendors will be needed

The ministry of Industry and Trade of the Czech Republic also intends to create a 5G Alliance, which would bring together various stakeholders not only from telecommunications, but also from the technology industry, the academic sphere, local governments etc. This Alliance will include for example cybersecurity or 'fake-news' subgroups. One of its key aims will be to create an innovative ecosystem for digital solutions to help the Czech economy and society.

**Although the Czech Republic does not belong to the European early movers in terms of full spectrum allocation and commercial rollouts of 5G, the technology is nonetheless an important priority for the Czech government.** The Czech strategy does not view 5G as just another mobile technology, which should be handled in ways as the previous generations were, but as an opportunity to fundamentally boost innovation and digitalisation of the national economy. This is deemed as essential, because the Czech economy is highly industrialized and hence its future competitiveness is highly dependent on digital transformation of the industry. Therefore, the Czech 5G strategy does not deal only with spectrum issues, but it also focuses on R&D and innovation support, support for trials and experimentation, use cases and applications. As part of this effort 5G trials are currently in progress in five Czech cities.

> **" The Czech economy is highly industrialized, hence innovative approach to 5G can make a big difference for its success. "**

# 6.

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Note The Czech Telecom Office, CTU, is an independent regulator responsible for telecommunications regulation in the Czech Republic. While this report contains general policy advice, it does not contain any feedback, opinions, recommendations or predictions directly linked to CTU's proposals and other activities.

For over 25 years, **Dalibor Vavruška** has helped investors, companies and policymakers to understand the communications and technology industries. Work of his teams was consistently top-rated in prestigious international investor surveys, with investors highlighting the quality of predictions and unbiased approach. Dalibor's research on digital transformation of telecoms and communications infrastructure monopoly in recent years set the agenda for the global telecoms industry. He was also involved in some of the world's most innovative, successful and trend-setting telecom transformation stories, such as the digital transformation of Turkcell, structural separation of O2 Czech Republic or the formation of the EU's Electronic Communications Act. Following long stints at Citibank and, before that, at ING and other leading banks, he founded Digiteccs Associates Ltd to help various stakeholders to achieve their objectives while building broad-based digital prosperity. Dalibor, a graduated mathematician and MBA, is a frequent speaker at international TMT events. He has also helped to introduce various TMT companies in Europe, Asia and Africa to the stock market.

**Petr Očko, PhD,** currently serving as the Deputy Minister of Industry and Trade responsible for digitalization and innovation, is a senior Czech public official and a leading expert in information economics, European integration and adjacent areas. Peter started his career in a successful Czech start-up, Globe Telecom, and has been active in both the private and public sectors. He has been extensively involved in various EU-related projects, for example as the Czech National Coordinator for the introduction of the euro; EU funds advisor at the Finance Ministry; EU project coordinator for Telefónica O2; Chief Executive Officer for Budget and EU Funds at the Ministry of Transport; and Section Director for the EU Funds and R&D at the Ministry of Industry and Trade. He was also involved with the Czech National Innovation Fund; the Czech-Moravian Guarantee and Development Bank; he acted as CEO of CzechInvest, the business and investment support agency; and the Chairman of the Czech Technology Agency. Petr, who passionately believes in innovation and Czech Republic's potential to belong to research-driven global leaders in Industry 4.0 and human-centric digital innovative solutions, is now deeply involved in preparation and implementation of the recent Czech initiatives such as the National Innovation Strategy, National AI Strategy and National 5G Strategy.


Digiteccs Associates Ltd (www.digiteccs.world) was founded this year by former analyst and global TMT strategist, Dalibor Vavruška, based on his vision of digital technology- and connectivity- powered services driving future growth of national economies. Such transition to the Digiteccs Economies brings opportunities and challenges to individuals, corporates, investors and policymakers. Policies should enable free markets to distribute benefits of digital innovation as widely as possible across geographies, population and market segments. Digiteccs Associates advises its clients on how to best position themselves for the digital tech trends while helping to build broad-based digital prosperity alongside the following principles: (1) human-centricity, (2) personal and economic freedom, (3) technology-driven progress; and (4) sustainability.

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