1. **The 5G Impact**
	1. **Impact on costs and productivity**

The size and the extent in space and time of the economic impact of 5G in Romania will depend on a multitude of factors. On the one hand, the 5G offer will depend on the speed, the amplitude and the geographical configuration of the network roll-out, influenced by long-term investment cycles, by the costs of implementation and by the legislative and regulatory framework. On the other hand, concerning the demand level, the service take-up speed and integration degree are critical for obtaining economies of scale and for creating digital ecosystems: the ability of users, households and of the business environment to reap the benefits of the new technology depends in turn on settling some potential challenges related to data protection standards, on ensuring the confidentiality and security of data and devices, on concerns about the security, capacity and reliability of 5G applications, and on resistance to digital change in general.

Overall, the effect of 5G on productivity growth will be given by the evolution of production factors, inputs and outputs, as a result of the integration of 5G technology. Thus, the effects of 5G on production are expected in two directions: the increased efficiency with which existing products and services are produced and distributed (for example, mobile technologies allow better, easier access for consumers to entertainment or for the business environment to higher quality information), and the efficiency gains brought about by the new products and services that become available, compared to the products and services they replace (for example, the production and use of connected and self-driving vehicles can render the use of transport infrastructures more efficient by reducing congestion and improving navigation, transfer times, etc.).

On a global level, 5G is expected to make a significant contribution to industrial production in 2035[[1]](#footnote-1), with 5G's largest contributions expected in the information and communications technology sectors, public services, agriculture, forestry and fisheries, transport and logistics, the hospitality industry, construction, finance and insurance and, respectively, public utility services.

**5G costs**

On the other hand, regarding the necessary inputs, 5G requires additional investment and costs to build the physical infrastructure of the networks (to upgrade and install new base stations, to increase the capacity of backhaul networks, of the software and hardware platforms required, to develop systems and business models for M2M and IoT communications, as well as to acquire the rights to use radio frequencies).

The necessary investment depends, among others, on the forecasts regarding the increase of the existing capacities, on the technical capabilities used for building network coverage and capacity, on the number of users and on the concentration of the service demand[[2]](#footnote-2), or on the frequency bands used for 5G. Radio frequencies directly influence the costs of 5G implementation, in terms of spectrum costs (licence fees, usage fee, opportunity cost of not using frequencies for other purposes), but also of the investments necessary to "accommodate" services at different frequencies, taking into account the characteristics of propagation.

Despite the technological progress, it is obvious that the implementation of each new technology generation costs more than the previous one.

Considering the patterns of previous developments and subject to the rather indicative character of the figures, at European Union level[[3]](#footnote-3) a 5G investment of EUR 56-58 billion euros is estimated to be necessary in 2025, which means an average investment of **EUR 145/European user**, and **7% more than in 4G** and 20% more than in 3G (after deflation). For Romania, the same study forecasts a required investment in 5G of **EUR2.3 billion**.

It should be noted that other estimates produce significantly different results, including based on the different methodologies applied or purposes considered. Examples in this regard are the estimates of the costs of 5G development in combination with the effects of other public policies, such as achieving strict universal coverage targets or simulating market entry circumstances (greenfield investment).

The implementation of previous technology generations has shown that mobile networks deployment may advance at different paces: there are periods of rapid deployment, especially in places where costs are lowest and expected commercial benefits are greatest, but there are also deployment lags, or even white spots, in commercially less attractive geographical areas.

* 1. **5G benefits**

In the context where forecasts of global players in the field show that the number of 5G users will reach 1 billion by 2023[[4]](#footnote-4), the estimated benefits of 5G are proportionally high, being expected to materialize on multiple levels, for both consumers and manufacturers of goods and providers of public or private services.

An input-output quantitative analysis conducted to examine the interdependencies between 38 economic sectors in the European Union[[5]](#footnote-5) shows that the installation and use of 5G networks in Europe will have significant direct, indirect (multiplier) and induced (ripple) effects.

* at EU level, the multiplier effects are estimated at EUR142 billion and 2.4 million jobs; **for Romania** only, the multiplier effects are estimated at **EUR4.7 billion** and over **252,000 jobs**;
* the ripple effects estimated for four sectors (motor vehicles, transport, utilities and health) show gains of EUR62.5 billion/year, at EU level.

The benefits of capitalizing on 5G performance are derived from several sources:

* **direct** benefits for 5G **users**, derived from their access to better products and services (improved in respect of costs, quality, experience, safety etc.);
* **strategic** benefits for vertical **industries**, derived from the better quality of information on production chains, internal operations, market characteristics, segmentation, consumption habits, etc., enabled by the use of 5G advantages;
* **operational** benefits and increased productivity for vertical industries, generally following the real-time use of information on internal operations;
* the advanced techniques of real-time data processing enabled by 5G have benefits for **adjacent sectors or third parties** as to the sector where the data are collected - for example, improving the provision of public services or of the security, based on the traffic management data collected;
* launch of new business models, enabled by the use of 5G specific capabilities;
* increasing productivity and creating new jobs[[6]](#footnote-6).

In another prospective analysis approach, the transformation enabled by investments in IoT and industrial digitization **in Romania** will bring significant increases in the turnover of smart industries, from $ 3.7 billion in 2020 to $ 9 billion in 2026 (CAGR + 15% 2016 - 2026). The 5G contribution to achieving these values ​​is estimated to reach 40% in the year 2026[[7]](#footnote-7).

*Distribution of benefits by Romania’s economic sectors*

In the impact study on 5G implementation in Europe, the business environment is expected to achieve 55% of the 5G benefits by 2025. However, in terms of distribution of benefits across sectors, the 5G impact is likely to be felt different from one country to another and from one sector to another, depending on the intensity of use of advanced technologies and communications services in the intermediate or final production.

Thus, according to the Romanian Industrial Policy Document[[8]](#footnote-8), despite the progress made in the last decade, the technological intensity of the production processes in the Romanian processing industry continues to be modest (8% - in industries with advanced technologies), the gross value added at factor cost, achieved by the industries with advanced technologies, reaches barely 6% of the total.

Deeply intertwined with European value chains, the supply of industrial products made in Romania is, however, dominated by intermediate goods (61% in 2016) mainly manufactured in economic sectors with low and medium-low technological intensity, and the length of value chains is in inverse proportion to value added, despite their already modest length (1,9). Moreover, it is noted "*a downward trend in Romania’s position on global value chains, which become shorter, "securing" its downstream position, as an exporter of intermediary products*", including in the context of Romania’s ranking last in EU’s European Innovation Scoreboard in 2016.

This situation calls for "supporting enterprises’ digitization, in the context of *Industry 4.0*, given the overwhelming importance of the EU", as well as "the adoption of digital technologies and the development of clusters in services for the modernization of the Romanian industry and the development of new emerging industries".

In this context, 5G can make a substantial contribution to supporting industrial policies, thus responding to real needs in Romania.

* 1. **Preferred uses**

While many of the initial expectations regarding 5G have focused on consumer uses (improved internet) similarly to the case of previous technology generations, more and more technology providers and public authorities anticipate industrial use cases with significant impact, likely to generate demand on an industrial scale for the services introduced by the new technology generation.

If - in the long run - 5G networks are to provide the necessary connectivity to cities, businesses and homes of the future, there are virtually no economic or community sectors in which 5G and IoT lack the ability to deliver innovation, productivity benefits or competitive advantages. On the other hand, it should be noted that at present, even in the most advanced economies of the world, the use scenarios are still to be carried out, and their success will be achieved progressively, step by step, as the digital ecosystems develop. It is also very likely that the roll-out of 5G will be accompanied by further uses that could not be anticipated. There may occur also situations where connectivity providers are not communications operators (current providers of public electronic communications networks). That is, 5G connectivity does not necessarily imply the presence of a mobile communications operator in the value chain.

Concerning a series of key sectors, Table no. 3 below summarizes the issues on which many 5G debates have focused so far, as well as the potential contribution of 5G to meeting specific needs and challenges.

*Table no. 3 – anticipated contribution of 5G*

*to addressing challenges and meeting needs in various sectors*

| **Sector** | **Challenges** | **Needs** | **Contribution of 5G** |
| --- | --- | --- | --- |
| Automotive | * stricter CO2 emission targets
* strong competition
* pressure on innovation
* globalization
* *commodification*
 | * self-driving and connected cars
* innovative *infotainment* solution
 | * dynamic configuration of network resources, for meeting ever more heterogeneous needs
* completing V2V communications
 |
| Mass-media, entertainment | * constant improvement of the quality of users’ experience
* new devices and services
* exponential growth of mobile data usage
 | * networks enabling innovative services (VR, AR, tactile internet) for immersive experiences
* interactive content, generated by users
 | * facilitate massive growth of connection speed and data processing capacities
* guarantee high service quality
 |
| Smart communities (e.g. cities) | * sustainable development
* quality standards in public services (sanitation, lighting, safety)
* congestion & peak load
* diseconomies of scale (home heating, selective garbage collecting)
* pressure on costs
 | * higher capabilities
* revamping technology
* shorter response time in emergency
* better information for city managers
 | * real time monitoring facilitates forecasts for disaster management, and for congestion response
* higher granularity in the data processed, more advanced data analysis capacities
 |
| Smart homes | * increased efficiency in energy and water consumption, in heating etc.
* environment responsibility
 | * reduced consumption and pollution
* adjustment to the environment factors
* time economy (housekeeping efficiency)
 | * scalable solutions based on IoT sensors and cloud applications
 |
| Energy and utilities | * decentralised electrical power supply
* pressure on consumption
* more renewable energy
* addressing blackout situations
 | * dynamic smart networks, that can be remotely monitored and controlled
 | * real-time control of transport and distribution networks
 |
| Public transport | * emphasis on safety and security
* higher numbers of passengers
* shorter waiting time
 | * real time information
* passenger entertainment
* higher infrastructure maintenance and operational efficiency
 | * provides coverage and bandwidth required for infotainment and for higher efficiency
 |
| Agriculture  | * growth in global population
* pressure towards cutting down on pesticide use
* deficit of labour force in agriculture
* subsistence farming with reduced efficiency
* climate change
* food waste
* globalization and price volatility
 | * solutions for sustainable agriculture
* precision agriculture for increased productivity and efficiency
 | * remote connecting and control of agriculture equipment
* provides the required bandwidth for advanced imaging and drone use
 |
| Banks & insurance | * accuracy in risk estimates
* (re)insurance premiums
* electronic, mobile banking services
* alternative money transfer methods
* cryptocoins, fintech
 | * fraud detection
* consumer segmentation
* enhanced experience
* fast transactions
 | * advanced data processing and analysis techniques
* safe solutions
 |
| Health | * population ageing
* higher numbers of chronic disease cases
* number of nights in hospital
* expectations regarding personalized medical care
* cost of medical care
* fragmentation of medical services
 | * access to medical care solutions
* wearable devices for monitoring and even treatment
* remote care and monitoring
* patient’s medical file
 | * enables guaranteed and secure mobile connections for remote monitoring and care solutions
* better imaging and diagnosis using advanced data processing techniques
 |
| Industries 4.0 | * ageing of labour force
* competence deficit
* globalization, pressure on cost reduction
* environment protection
 | * enterprise robotics and automation
* solution for lower production costs
* inventory reduction
* freight tracking
 | * provides and ultra-reliable communications platform in the enterprise
* customised IoT solutions
* advanced data processing techniques
 |
| Education | * low participation of rural population in education and training
* early school dropout
* adjust labour offer to the market demand
* quality of education processes
* cost level compared to financing
 | * sharing resources with a higher number of students/pupils
* high quality remote education
* accessible continuing education programmes
* adjustment to special needs
 | * tactile internet, virtual reality, no physical barriers to accessing experiments and enables real-time interaction
* cloud robotics for special needs
 |
| Security, emergency services | * increased recurrence and complexity of security alerts
* terrorist threats
* focus on cybersecurity
 | * more monitoring and screening in public spaces
* instant access to better information
 | * enables higher monitoring and detection capacities, including by dedicated applications
 |
| Extractive industry | * high production costs
* globalization of the raw material market
* impact on environment
 | * environmental rehabilitation
* competitiveness
 | * extractive processes automation for significant efficiency growth
 |

*source: GLI-5G, based on publicly available information*

In the long run, 5G will have a universal and probably greater impact than is usually anticipated in the studies currently conducted. Moreover, a major challenge is to identify the various 5G usage scenarios and to create the services and pricing arrangements that are appropriate for these uses.

* + 1. **Industry 4.0**

Increasing productivity by digitizing the manufacturing industry, also known as the fourth industrial revolution (or Industry 4.0) is fuelled by the development of cyber-physical systems (CPS) [[9]](#footnote-9)[[10]](#footnote-10) and by the Internet of Things (IoT). Increasing the significance of CPS necessarily and objectively implies a substantial improvement of connectivity, but also communication and rapid exchange of information between many different devices, situations that clearly enhance the role of 5G in value-added generating chains.

The most popular uses of connectivity in Industry 4.0[[11]](#footnote-11) are based on machine-type communications and target both the industrial processes within an enterprise (closed circuit) and their integration between different companies:

* the devices installed on a production line communicate automatically with the control units, to ensure the significant flexibility and efficiency of production cycles;
* autonomous vehicles transport goods safely and efficiently within the factory;
* process automation, achieved through a large number of sensors and actuators that communicate and receive instructions from the control units contribute to increasing efficiency and reducing inventories;
* permanent tracking allows the optimization of goods flows, in different processing stages, from raw material to finished product and delivery to the customer;
* remote assistance and control of robots to perform a variety of tasks, such as measurements, digging under difficult conditions, etc.;
* augmented reality improves the physical environment necessary for maintenance operations or for personnel training.

Some of the connectivity scenarios required for Industry 4.0, especially the closed-circuit ones, within the enterprise, can be carried out using existing technologies, such as NB-IoT, LoRa, SigFox, etc. and Wi-Fi networks or their evolutions, such as WiGig[[12]](#footnote-12).

However, the massive increase in the density of connected objects, latency, bandwidth, or even energy efficiency requirements may require 5G deployment. Also, the use of 5G will have major comparative advantages, given by the simple network planning and management, but also by the security of the services and the advanced data processing techniques facilitated by edge computing.

The great diversity of connectivity use cases in Industry 4.0 is both an opportunity and a challenge: on the one hand, understanding the specific requirements of the sectors creates the need for information sharing, and on the other hand, productivity pressure fuel the industrial environment’s interest in 5G development, materialized through active partnerships with communication network providers.

In the context of the strategic planning in Romania and the implementation of the National Competitiveness Strategy[[13]](#footnote-13) and the Research, Development and Innovation Strategy 2014-2020[[14]](#footnote-14), the technological refurbishment of the companies due to 5G can become an area of ​​priority intervention defined as an integrated area of ​​development, justifying as well the intervention of public funds to support investments in technological refurbishment.

For example, implementing 5G smart systems in Romania can give rise to uses in the following areas/directions:

* **remote industrial maintenance** for industrial equipment with ultra-fast intervention and adjustment/configuration;
* **industrial cybernetization**, offering the possibility of simultaneous coordination (management) of multiple high-tech mechatronic and cyber-mechatronic units of equipment, with variegated orders and in optimum time;
* **connectivity and integration at regional level** (or multi-regional level) of digital production facilities from different SMEs (associated in clusters/competitiveness poles) that generate high added value through digitized partnerships, in keeping with smart manufacturing, which is much more flexible and adapted to global requirements;
* **programmable robotics** with ultra-fast connection and integration, which will make all robotic processes exponentially more efficient, faster and which can generate a particularly high technological breakthrough.

By analogy or induction, the term 4.0 is used to characterize technological progress related to digitization and in other sectors of economic life.

* + 1. **Connected and self-driving cars**

The automotive industry is marked by the early adoption of a variety of connectivity solutions, aimed at improving the driving experience and road safety, at collecting information on the performance, on pollution or on the maintenance of the vehicle, while being considered one of the predilect industrial sectors for the capitalization of 5G performance.

Here are several of the numerous car connectivity use cases to be developed in the future:

* enhanced infotainment – on-demand entertainment, travel guidance services and roadside assistance, traffic management, local weather or road condition information services, etc;
* innovative services, such as insurance according to usage, due to the large volume of telemetry data that can be generated;
* boost towards autonomous vehicles, by means of collision avoidance solutions, emergency braking, platooning and extending V2V communications beyond the field of vision, based on improved location etc.;
* remote monitoring of the car's condition and predictive maintenance.

Some of the automotive connectivity scenarios, especially those that do not have real-time provision requirements, such as remote monitoring or predictive maintenance, do not necessarily require the use of 5G. Also, primary vehicle-to-vehicle (V2V) communication solutions - such as DSRC (dedicated short-range communications) or standardized[[15]](#footnote-15) ITS (Intelligent Transport Systems) systems allow direct communication between origin and destination without using a communications network. However, in the gradual evolution towards the self-driving, connected vehicles of the future, such solutions may prove insufficient, especially insofar as, in order to ensure security, the connectivity requirements extend beyond the simple connection between vehicles (V2V), involving connecting vehicles to infrastructure (V2I - vehicle-to-infrastructure) or to pedestrians (V2P - vehicle-to-pedestrian).

Thus, it is anticipated that the role of 5G in the automotive industry will show in several domains: improve the infotainment services on board cars, facilitate the collection and processing of more data needed to provide innovative services, etc. Furthermore, 5G performance is considered critical for completing the current short-distance communication requirements through ultra-reliable V2X (vehicle-to-everything) communications, which are needed to improve the autonomy of cars.

Moreover, a study by Deloitte for the association of mobile communications providers in the United States of America (CTIA) estimates that self-driving vehicles could reduce pollution by up to 90%[[16]](#footnote-16), and - in Romania - the *National Strategy on climate change 2013-2020* sets among the strategic objectives[[17]](#footnote-17) cutting down emissions related to road transport and promoting intelligent transport systems, as those enabled by 5G technology.

* + 1. **Transport & logistics**

The potential of 5G-based applications is also huge in terms of logistics, freight and passenger transport and of postal services, in the context of globalization and increasing pressures related to environmental protection. The increasing demand for passenger mobility and for transport, storage and delivery of goods, due to the upsurge of international trade and - in the recent years - of electronic commerce, has had a significant impact on the market for postal and transport services and has already generated a wave of innovation and re-technologization. However, the phenomenon continues and grows - the higher the speed, the greater the carbon footprint.

Similarly, to the internal logistics of a production company, in the logistics related to domestic or international trade involving operations of handling, storing, transporting and delivering goods, there are multiple flow optimization opportunities, which new applications based on the new technologies can materialize. Sensors connected to 5G networks, as well as the automation of processes in warehouses and on sorting and loading lines will increase the efficiency, accuracy and speed of deliveries and will significantly reduce the pollution generated by logistics. Delays inherent in intermodal transport, due to the multiple platforms (road, rail, air, river or maritime) used, can be minimized by means of 5G.

Intelligent public transport solutions in cities or on the roads are best approached in the smart city context.

* + 1. **Energy**

First, 5G technology will be more energy efficient than previous technology generations, allowing the installation of off-grid network elements that are independent of the electricity grid and reducing both operational costs and environmental impact.

Moreover, due to its specific features - the capacity to connect a huge number of objects (mMTC), low latency and ultra-reliability (URLLC), the 5G technology seems to meet the constructive and functional requirements of smart-grids - smart networks for energy transport and distribution, able to control real-time consumption, with instantaneous capacity optimization and two-way communication with consumers.

To benefit from the opportunities offered by the global energy transition process, *The Romanian Energy Strategy 2016-2030, with an outlook to 2050*[[18]](#footnote-18), sets new strategic directions for action, including the development of smart networks of energy transport and distribution networks, and shows that smart grids will facilitate the transition of the consumer to the role of prosumer, who injects his/her own electricity production into the grid.

The strategy identifies the delays in the action plan for the development of smart grids and lays down provisions for the financing of investments in transport and distribution networks to increase their efficiency and carry through the transition to smart grids.

Another strategic direction is promoting smart buildings in respect of their construction, architecture, operation, transformation and energy storage, with due regard to the prosumer target, as well as transforming Romania into a production centre for energy-transition machines, components and materials for. The strategy provides that the new technologies will be adopted gradually, at an ever-lower cost, considering the protection of privacy and a high degree of security to cyber-attacks.

* + 1. **Public utility services**

Beside the direct benefits from investments and the enhanced connectivity offered to local citizens and businesses, the new generation of communications is of interest to local authorities because it comes with solutions to many of the requirements of smart city applications - the "smart city" - developed in recent years. In fact, many 5G use cases address the need to optimize public utilities, transport and safety in densely populated urban areas. Due to the superior technical features of 5G, applications that now operate on LTE networks will materialize their full potential, processing data from hundreds of thousands of fixed and mobile sensors, transmitting information from moving vehicles or from sewers, monitoring the use of certain road segments or the status of bridges, for years.

Studies on the 5G’s potential to improve the lives of communities indicate that this technology will make possible integrated traffic optimization applications that combine road use monitoring with traffic lights control and intelligent parking systems, will enable reducing interruptions in water and energy supply, as well as reducing energy consumption on public lighting or improving the efficiency of selective waste collection. For providing these benefits to their communities, local administrations are directly interested in speeding up the issuance of building permits, allowing access to public property and adapting their charging systems[[19]](#footnote-19).

In Alba Iulia, designated a flagship smart city by the Government of Romania, 29 private companies - application developers and communications providers - are already testing, in collaboration with the local authorities, over 60 specific smart city solutions, among which traffic monitoring, air quality and illegal parking detecting systems. The buses of the local public transport system are equipped with GPS, so the citizens can find out their real arrival time. The pilot applications tested in Alba Iulia have been installed at the expense of private companies, the local authorities providing the information they control and the necessary approvals.

Based on the results of these tests and drills, as well as on various success stories in the country and abroad, an inter-institutional working group led by the Ministry of Communications and Information Society is currently preparing the national strategy for regulating, implementing and optimizing smart-city digital technologies in Romania.

* + 1. **Agriculture**

For Romania, with about 30% of the population employed in agriculture and a low labour productivity in this sector[[20]](#footnote-20), increasing agricultural productivity is a strategic priority, correlated with the sustainable management of natural resources, the balanced territorial development and with environmental constraints.

Precision agriculture focused on improving yields and minimizing economic risks, aims to ensure high control in the management of agricultural production. Agricultural companies are turning to computer systems for real-time monitoring of crops, which facilitates informed decision-making regarding fertilization, sowing, treatment and harvesting.

5G can provide the infrastructure needed to develop precision agriculture due to the bandwidth that 5G networks will ensure and that will become important when sensor-based monitoring systems are combined with advanced imaging received from unmanned aircraft systems (drones) or from special cameras located on-site and with cloud analysis, allowing automatic adjustments in precision agriculture. Agricultural machinery and equipment will be increasingly connected and become autonomous, low latency and network security being crucial requirements.

Scalability of a large number of connected devices will optimize agriculture by improving productivity and crop selection, in pursuit of integrated crop management within smart farms.

Here are a few of the possible applications enabled by 5G in the future, in the field of agriculture:

* **connected agricultural equipment**: vehicles (tractors, combine harvesters and trucks) remotely controlled by an operator, or automatic agricultural equipment (smart milking equipment);
* **smart irrigation**: the use of devices and controllers that reduce the waste of water based on information transmitted in real time about the conditions in the field;
* **crop monitoring**: real-time crop monitoring, which allows the tracking the positive or negative dynamics of crop development;
* **soil sensors**: real-time monitoring of soil or air quality parameters (degree of fertilization, pH, nitrogen, phosphorus, potassium, humidity, temperature) and identification of diseases or insects;
* **directing and monitoring livestock**: real-time monitoring and management of livestock;
* **unmanned aircraft systems (drones) in agriculture**: monitoring of agricultural areas, livestock or self-driving vehicles.
	+ 1. **Health**

Some of the applications that 5G will enable in healthcare, such as least invasive VR-based surgery - including tele-surgery -, indicate that implementing connectivity- and new technology-based medicine solutions and can significantly reduce the burden on the medical system and healthcare costs[[21]](#footnote-21). The availability of healthcare services will improve, access to high quality services will no longer be limited to large cities, permanent monitoring systems will increase the survival rate in heart attack and, most importantly, will prevent the installation or aggravation of various diseases, significantly increasing the quality and duration of people’s life, and providing the medical and research community with the information needed to identify new healing solutions and rehabilitation or prevention methods.

Specifically, these new possibilities for collecting and processing large volumes of data on the impact of lifestyle, reactions to different treatments and on patient evolution give researchers hope due to their potential for discoveries and innovations with a significant impact on health, while studies reveal that patients are willing to use connectivity-based monitoring systems, to let their data be processed in cloud, and even adjust their lifestyle using connected objects (smart watches and fitness bracelets).

In Romania, fragmentation of health services is one of the major current problems, with a negative impact both on the people’s access to services adapted to their needs and on the costs for the health system, often the services reimbursed from public money being unnecessarily doubled (e.g. - investigations for a patient’s diagnosis are repeated at very short intervals)[[22]](#footnote-22). Interconnection of the different recording and reimbursement systems and the possibility of accessing updated data in real time could contribute to the achievement of the strategic objective of developing an integrated health system.

The Ministry of Health, through the National Health Strategy[[23]](#footnote-23), is committed to the development of the telemedicine system and to fostering its use at the pre-hospital and inter-hospital level, setting a strategic action direction in this regard.

Increasing the public health system's capacity of response in the event of pandemics or emergencies is also a strategic national defense objective[[24]](#footnote-24), and solutions based on new technologies can contribute to actions of national importance such as reviewing the mechanisms for monitoring the activity in the emergency sector.

* 1. **New business models in communications**

Beyond the new business models enabled by the digitization of economic sectors, through its features, the 5G development may be associated with changes in the traditional models of providing services and communications networks and with the emergence of new positions in the value chain. Elements featuring the highest potential are mentioned below:

* *service differentiation*

The ability to differentiate between services due to virtualization and informatization (given the increasing importance of software), network segmentation, etc., may lead to growing demand for mobile connectivity (for example, niche applications with limited coverage, such as augmented reality in a factory), and to increased complexity of the pricing models (for example, for capturing the particular characteristics of the services offered).

* *growing connectivity demand*

Increasing the number of connected objects due to the uptake of IoT, in combination with their ability to be connected to alternative networks (e.g. to 5G private networks, or to Wi-Fi) requires the development of new pricing models, which are not currently available.

In particular, the success of the new tariff models depends on giving the right economic signals, in accordance with the respective connectivity scenario, beyond solving the "who pays for connectivity" problem. As well, the position on the value chain can evolve: for example, the communications operator can expand its portfolio by selling devices connected to its own network, the device provider or an intermediary can negotiate connectivity agreements with the network providers to provide a "complete" solution.

* *new downstream intermediaries*

To the extent that 5G enables products and services with built-in connectivity, these will be launched on the international market. As a result, 5G opens opportunities for intermediating the provision of services, such as connectivity aggregators for specific products, industries or transnational geographies. Typical use cases are currently deployed in the automotive sector, the communication operators’ downstream intermediaries.

* *network densification and upstream intermediaries*

Massive site densification, especially in the case of using millimetre waves to meet the requirements of indoor coverage or in semi-public spaces (shopping centres, airports, stadiums, etc.) raises significant problems (contractual, logistical, technical, environmental, etc.). Furthermore, the multiplication of challenges in one place, given the need for multi-network coverage, is potentially inhibiting for the owner/manager of the space, as well as for operators.

Such a situation can give rise to new opportunities for intermediation, upstream from the providers of traditional communications networks: specialized in the acquisition, installation or operation of sites in well-defined areas - high-density hot-spots or parks/industrial halls - this type of enterprise provides wholesale connectivity services to providers of mobile networks with national coverage. A typical case in this regard is illustrated by the use of part of the 3.6 GHz band in Ireland.

* *mobile convergence* *- PPDR*

As the performance of mobile internet is drawing near the experience offered to users by the fixed internet, or is improving in special geo-demographic situations (e.g. low population density in remote areas), mobile internet services may evolve progressively from complementing the fixed internet to substituting it. Moreover, with cell densification and function virtualization the boundaries between fixed and mobile networks will become irrelevant.

Furthermore, the competition dynamics in Romania have shown high potential for exploiting the fixed-mobile convergence through organic development, and recently, through the effects of an acquisition on the European market.

Moreover, public protection and disaster relief (PPDR) services, currently provided by an independent network infrastructure, may be ensured by the software evolution and virtualization facilities offered by the networks of commercial operators. These facilities enable creating separate virtual networks on the same physical infrastructure, each with its own specific requirements.

Although it is unlikely that commercial networks will be able to provide a complete PPDR solution from all points of view, they can benefit from the operational and investment efficiencies due to reducing the duplication of physical infrastructures by exploiting synergies with PPDR services.

*- sharing infrastructure, costs and benefits*

The actual implementation of certain connectivity use cases is more attractive by sharing infrastructures, being facilitated by the evolution towards software and virtualization. With 5G and the industrialization of IoT/M2M, the sharing of infrastructures, usually achieved between the communications providers, may be extended by the emergence of infrastructure operators or by attracting "verticals". That is, any disparity in investment incentives between "verticals" and communications network providers can be balanced by partnerships or joint ventures.

* 1. **Key SWOT elements**

The scrutiny of these emerging trends in Romania and around the world - of the global race for 5G, of the European 5G pioneering and of and their impact on public policies, of the benefits, costs and use cases enabled by 5G - generates the main elements of a SWOT analysis on the implementation of 5G in Romania.

|  |  |
| --- | --- |
| **Strengths*** the dimensions of Romania’s internal market
* belonging to the European Economic Area
* superior performance
* availability of new spectrum resources for 5G
* healthy and dynamic competitive environment
* the multinational experience of communications network providers
* user/consumer equipment becoming more intuitive, easy to use
* massive miniaturization
* evolution towards software and virtualization of network functions
 | **Weaknesses*** limited incremental revenues from the sale of the mobile internet as a spearhead for the 5G transition
* limited integration in the medium term of 5G technologies in other sectors (short value chains)
* limited commercial attractiveness of some use cases
* import of connectivity solutions customized for other markets
* poor development of R&D activities
 |
| **Opportunities*** digitizing the economy and society

 • massive increase in demand for internet & data, mobility• the advancement of the Internet of Things (IoT)• the advancement of knowledge mining from data (data mining) and advanced data processing techniques (data analytics)• size and performance of existing networks and currently used frequency portfolios• the advancement of the ICT & software industry• long investment cycles• the stock of existing physical infrastructures and their usage degree • emerging business and social organization models (e.g. sharing economy) | **Threats*** the authorization regime for construction works
* connecting cells by optical fibre
* legislation (primary, secondary, etc.), procedures, not adapted to the digitalization of the economy and society
* competing alternative solutions (e.g. NB-IoT, Wi-Gig, etc.)
* market structures, inefficient tariff models
* risks (including risk perceptions) of security, data protection, electromagnetic radiation, etc.
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One could carry out a more detailed SWOT analysis, but we consider that it would bring marginal utility to the strategic planning approach for 5G in Romania, especially due to the limitations of such analyses in the case of such disruptive technologies as 5G, and to the complex dynamics on various world markets, with pronounced cross-border cascade effects.

1. <https://cdn.ihs.com/www/pdf/IHS-Technology-5G-Economic-Impact-Study.pdf> [↑](#footnote-ref-1)
2. for example, 85% of the 5G investment budget in Great Britain is estimated to be used for covering sparsely populated areas [↑](#footnote-ref-2)
3. Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe, <https://publications.europa.eu/en/publication-detail/-/publication/ee832bba-ed02-11e6-ad7c-01aa75ed71a1/language-en> [↑](#footnote-ref-3)
4. Ericsson Mobility Report 2017, <https://www.ericsson.com/en/mobility-report/reports/november-2017> [↑](#footnote-ref-4)
5. idem footnote 43 [↑](#footnote-ref-5)
6. for example, extrapolating the results of a study on 5G for smart cities for Romania, approximately 50,000 jobs could be created in a city of the size of Bucharest, 10,000 în in cities such as Cluj or Iasi, and approximately 400 jobs at Lugoj. [https://www.accenture.com/t20170222T202102Z\_\_w\_\_/us-en/\_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf%23zoom=50](https://www.accenture.com/t20170222T202102Z__w__/us-en/_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf%23zoom%3D50) [↑](#footnote-ref-6)
7. cf. Ericsson – presentation for GLI-5G, 21 August 2018 [↑](#footnote-ref-7)
8. version June 2018, <http://www.economie.gov.ro/images/politici-industriale/SIPOCA7/Draft%20Document%20de%20Politica%20Industriala%2025%20iunie_final.pdf> [↑](#footnote-ref-8)
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10. more info on CPS is available at - for example - <https://rria.ici.ro/wp-content/uploads/2013/12/art.5-dumitrache.pdf> [↑](#footnote-ref-10)
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