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A Transformative and Ubiquitous Technology with Multifaceted Access Demands for the Near Future

Mazilescu Vasile
cray_mk@yahoo.com
Dunarea de Jos University of Galati, Romania

This paper presents the advantages, potential and risks of 5G technology which with a lower latency and a higher bandwidth than 4G, will redefine connectivity. The implications for production, in particular, are huge. The integrity, confidentiality and availability of telecommunications will be important security issues, as 5G networks will support multiple IT&C applications implemented, including at the level of critical infrastructures. 5G networks, as a transformative technology, will be designed to bring the level of performance needed for the massive IoT, will allow a massively connected and intelligent world, being ubiquitous as a whole. We believe that 5G technology together with other current technologies can and must become a real support in supporting economic processes, especially in the current context characterized by a strong similar COVID19 health, economic and climate crisis.

Keywords: Transformative technology, 5G, mobile networks, IoT, Cloud, Artificial Intelligence (AI), HPC

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1. Introduction

The adoption of new technologies is visible throughout the industry, in public institutions and in the daily lives of companies and users [22-30]. Device data helps companies operate more efficiently, have a more detailed view of business processes and make real-time decisions [3,12]. On the other hand, consumer investments are explained by the increased level of information about their properties (cars, homes), close people, but also about personal health. Even if the benefits for business differ depending on how they are implemented, a common denominator can be observed: companies have access to more data on their products and internal systems, thus having a greater ability to make changes [1]. The network becomes the platform that facilitates all applications and business processes. The applications are developed and hosted not only in data centers on premises, but also in public clouds, being built in the form of microservices, using physical, virtual or container workloads, from public or private clouds [2]. The explosion of IoT devices leads to the construction of new distributed computing models, which contribute to the exponential increase in complexity. AI is increasingly used in applications, both for business and consumers needing more computing power such as supercomputers, close to the edge [9]. Mobility is based on technologies such as WiFi 6 and 5G that will allow wireless devices to have an efficient use of radio spectrum for applications that require high bandwidth and, above all, very low latency.

In the future, many industrial functions will become virtualized and the entire factory will be able to be controlled remotely via mobile devices [4]. The next leap in the evolution of mobile and wireless communications is 5G technology, a technology that offers unprecedented speed, capacity and capabilities. In the world of 5G, networks will serve an increasing number of connected devices and each person in turn will use tens or hundreds of interconnected devices in their daily activities. Although 5G also includes new hardware, it is primarily a virtual network, turning the convergence of wireless networks and communications into reality. Using this technology comes with new threats, risks, and

vulnerabilities, because it has significantly more network endpoints that can be exposed to cyber attackers, and 5G virtualization means that the entire connection is software-based, which can be inherently attacked. . Each time the leap to the next generation of mobile networks was made, the applications and devices that followed transformed industries and increased revenue. Along with the internet itself, mobile telephony has proven to be a game-changing technology for users, companies and economies. The advent of 5G will further transform these technologies and create many commercial benefits, but will require forcing companies and telecommunications providers, with the support of governments, to adopt these technologies to take advantage of these benefits. After the incubation period, technology introduced the pinnacle of adoption, bringing about transformational changes in different industries and the whole in the economy being usually quite disruptive. 5G technology generally has some common attributes, including universal applicability to several industries, bringing continuous and long-term improvements and being able to produce new innovations. It has a profound and lasting impact on a wide range of industries, redefining economic competitiveness and changing society. As 5G technology continues to develop and support a large number of terminals, machines and processes, wireless communication is expected to enter the realm of general technology. Digital mobile technology has gradually evolved from the interconnection of people to the interconnection of people and data, on which people rely in their personal and professional lives. For example, mobile technology is generally considered to play a fundamental and important role in accessing key services for users in remote areas, such as increasing mobile banking. Accordingly, many advances in mobile technology now offer higher bandwidth and can virtually achieve ubiquitous voice and data coverage. Although some machine-to-machine and early IoT applications have emerged, these applications are usually case-specific and use older technologies. Although the media and investors pay close attention to mobile companies, mobile technology is still used mainly for consumer and business use and has not yet begun to fundamentally change the industrial or public sector of the economy.

After several generations of development, mobile technology has reached popularity, but 5G will become a technology platform that connects cars and cities, hospitals and homes, people and everything around them in a more meaningful way [7,19]. The improvements brought by 5G will be able to clearly meet the needs of complex and diverse use cases related to IoT. The industry specifically defines various aspects of the standard to deal with a large number of IIoT (Industrial IoT) applications and key business use cases, including autonomous vehicles, industrial automation and telemedicine [16]. These functional extensions will be implemented as part of a unified design, which means that the same 5G infrastructure will be available to support a wide range of use cases. Mobile technology extends to processes that have not yet used large-scale wireless technology, with a long-term impact for a wide range of industries. This would allow continuous monitoring of the production chain, rapid intervention in the event of a failure and greater flexibility and optimization of production. The implications for mobile operators are certainly significant. In this new era, the role of 5G will be a transformative one, with integrated telecommunications and IT like never before. 4G technology has already come close to what it can offer the most. A telecom base station can communicate on a finite number of low frequencies with customers in its coverage area, ie allocate to each one a slice of its total capacity. You can't add another base station in the same area to broadcast on the same frequencies as other phones, because it would interfere with the first one. In other cases, a time division technology is used, ie the antenna communicates in turn with each customer.

Section 2 presents the features of 5G technology, the next mobile technology, offering higher speeds and more reliable connections on smartphones and other devices. Combining state-of-the-art network technology and the latest high-spec devices, 5G should deliver faster connections than previous mobile technology, with average download speeds of around 1

Gbps which is expected to be the norm for the next generation of networks. Section 3 analyzes and highlights the impact and economic importance of 5G technology, noting that while past technological developments have primarily targeted the consumer market, 5G spending and profitability focus more on the broader space of industrial enterprises. This includes connecting not only the company's traditional workers and their mobile devices, but also connecting all electronic devices. This will involve marginal implementations that can serve, so billions of devices are expected to be connected using IoT, cloud and edge computing technologies. High Performance Computing computing architectures are and will be constantly reviewed. Section 4 presents a series of conclusions and future research directions. The fifth generation of mobile networks is ubiquitous and expects to have a greater impact on the global economy than any previous generation, contributing massively (more than $ 10 trillion) to world production by 2030. Production will be the sector that will benefit moreover, because operators are able to accelerate production and create new revenue streams as a result of the digitalisation of the industry. 5G technology with High Performance Computing (HPC) is ready to transform the largest competitive industries in the world [24,26,28]: manufacturing, energy and medical sector, agriculture, retail, financial services, entertainment, SCM tourism, marketing, security.

2. Features of 5G Technology

It is the network that must, on the one hand, facilitate the use of these new technologies and, on the other hand, ensure cyber security and segmentation of access to resources. The five main technologies that shape the new networks are [10,3]: Automation, AI, Multicloud Networking, Wireless, Security. Network automation is the process of automating the configurations, management, testing, implementation, and day-to-day operations of physical and virtual equipment within the data network. Innovations in the field of Software Defined Networking (SDN), Intent Based Networking (IBN), virtualization, programmability and open network controllers make automation a reality of today's networks. SDN is not a new term and since its inception, it proposes the separation of the control plan from the data plan, abstracting the network infrastructure of applications and services. SDN was initially introduced in the datacenter, to reduce the complexity required to migrate workloads and east-west traffic. The same principles have led to SD-Access and SD-WAN solutions, which propose optimizing applications and access to cloud services. SDN offers many advantages in the automation part, but it is only a part of the solution. Companies need continuous monitoring and optimization according to business needs. The use of AI in network operation is a necessary help for teams operating IT networks. The large number of devices that are connected has increased exponentially in recent years and a very large amount of data, telemetry and events are generated by equipment, which goes beyond the human ability to make decisions and actions based on them. AI offers the possibility for network teams to use data more efficiently, in three ways: Complex event processing, Related information that can predict with great accuracy when problems will occur (deviations from normal) and Remedy. 5G is the next generation of technology for mobile networks that will leave behind 4G from the perspective of multiplying and diversifying more and more efficient service packages. Like any previous generation, 5G aims to facilitate faster and more secure mobile communication as more and more devices are connected online. Unlike the years when mobile networks only needed to support mobile phones that only surfed the web and sent text messages, now we have all kinds of devices that require bandwidth, such as smartphones with HD streaming, watches smart with data plans, self-driving cars, internet-connected cars and other promising devices such as health sensors and uninterrupted AR and VR hardware. As billions of devices connect to the web, the entire infrastructure needs to host traffic not only to support faster connections, but also to better manage simultaneous connections and provide greater coverage for these devices. This is why 5G technology was

thought of, which replaced all older technologies [6]: 1G introduced analog voice packets, 2G introduced digital voice packets, 3G introduced mobile data packets, 4G paved the way for the widespread use of the mobile internet. The new standard is designed to provide three types of customer service:

(1) Enhanced Mobile Broadband (eMBB) actually means much higher bandwidth. 5G carries up to 20 Gbps with multi-frequency aggregation, but that's not what matters so much for a secure customer, but the fact that the antenna that serves a certain area has a much higher transfer capacity that it shares with customers in that area, so everyone has a much faster connection than 4G [8]. This is important because more and more video is being consumed, we want cities and smart devices, video cameras and autonomous cars, so everyone needs more data traffic. The enhanced mobile broadband will be the first commercial application of 5G. In the near future, 5G can help telecom operators to effectively improve their consumer business. Upgrading to 5G can allow much lower costs per gigabyte than current 4G networks. eMBB will stimulate the development of 5G and facilitate its success. The need for eMBB will encourage the rapid development of 5G technology and networks. The value of digitized information lies in the new services that can be created by connecting sources of information. Large-scale 5G connectivity will eliminate information islands, increase the prosperity of a digitized sharing economy, and promote changes in existing production methods and lifestyles. In eMBB use cases, there are three distinct issues that 5G must definitely address: higher capacity - broadband access must be available in densely populated areas, such as parks, office buildings, or public locations. , such as stadiums or conference centers; improved connectivity - broadband access must be available everywhere to provide a consistent user experience; greater mobility of users - to allow mobile broadband services in moving vehicles, trains and planes.

(2) Ultra Reliable Low Latency Communications (URLLC) means very low latency, only a few milliseconds [13]. This application has many potential uses. 5G gaming will be possible. It will be possible to handle with precision and fluency all kinds of machines, robots and others from a distance. Channel quality and lack of dedicated bandwidth can be an obstacle to meeting the desired latency requirement. Achieving the desired reliability is also a challenge. Because many mobile applications rely on different retransmission methods, data retransmission may degrade latency, unless retransmission methods are designed as required. There is a trade-off between reliability and latency, which can be based on application requirements. The physical layer plays a major role in achieving the desired latency and reliability. URLLC is the most innovative feature brought to 5G, as it will be used for mission-critical communications, such as reliable remote action with robots or coordination between vehicles. Ultra-reliable communication is a facilitator of a wide range of applications. To put this in perspective, wireless connectivity and built-in processing have significantly transformed many products by extending functionality and overcoming traditional product boundaries. Package design is one of the key issues in URLLC [13]. With an efficient packet structure, latency can be minimized in terms of packet processing time and packet transmission time. Packet processing involves purchasing a package, accessing channel information, extracting planning and control information, decoding the package, and checking for errors. According to URLLC requirements, the 5G NR system uses a square-shaped frequency-coded packet for the low-density parity control and verification (LDPC) channel for the data channel to minimize transmission latency.

(3) Massive Machine-Type Communications (mMTC or M2M) means that thousands of devices, sensors, relays and other types, can be connected to the existing 5G network, not to a wifi to be built from scratch in a factory, from example, or at the level of a city for smart city applications on each street lamp, water and gas pipe segment, traffic light [11]. The much higher bandwidth is obtained by several changes compared to 4G, the most important being the increase in the number of antennas in the base station, which allows more efficient

communications with each customer, and the use of higher frequencies. In general, higher frequency means higher bandwidth. And the higher frequency blocks you have, the higher the total bandwidth. Much lower latency is achieved by using data packaging, coding and transmission schemes that reduce delays in the entire transmission chain by up to a few milliseconds. An M2M area network is formed by the collaboration of a large number of devices (eg sensors, actuators and smart meters) and gates (data aggregation points / hubs). These devices collect sensory data from various parts of the M2M area and collaborate on smart decisions to transmit sensory and monitored data to a gateway. The gateway itself is a smart device that receives sensory data and intelligently manages the received data packets [17]. Devices deployed in the M2M field may vary depending on the type of application. Some of the most important application areas accepted for M2M are: monitoring the supply and distribution of goods, vending machines, information and automation of various resources related to housing, buildings, campuses; surveillance applications, alarms, tracking objects, man, etc .; remote patient monitoring [18], production chain monitoring and automation [14].

Then comes a concept called slicing, which involves dividing the entire physical 5G network into slices, into virtual networks, each adapted to the necessary work scenarios [15]. They must be thought of as a kind of VPN or even as 5G networks completely separated from each other. Autonomous cars need high upload and low latency. We connect them all on a network sequence in which the equipment will be configured to provide high upload and low latency. A factory needs machine-to-machine connectivity between robots and its sensors. Instead of investing in its own wifi network, the telecom operator assigns it a 5G network card that the factory administrator manages as its own VPN, to which only its devices are connected. Theoretically, this virtualization option is also designed to allow virtual telecom operators (MVNOs), that companies specialized in certain types of services and offers may appear, and telecom operators cut off part of the network and let them use it. With 5G, higher transmission rates and shorter response times are possible, but the number of devices connected to the network and the energy efficiency per transmitted data unit are also increasing. In addition to these quantitative requirements, 5G allows for new qualitative aspects that were not previously possible or were only possible to a limited extent. Compared to previous generations of cellular communications, 5G presents the prospect of further developments and new applications. 5G enables better management and use of infrastructure (traffic management, energy control) in the smart city and smart home sectors. Enhancements for IoT and high availability networks should be enabled. To this end, the cellular network will become more flexible. Edge Computing allows computing and storage services close to the client. This improves performance and meets the requirements for data security, which is absolutely necessary for critical infrastructures or industrial companies [20]. Companies can streamline their production and logistics processes by using mobile networks directly in their value creation process. To be ready for the widespread use of IoT, 5G will be able to operate about 100 times more devices per cell radio than it is today. Several virtual subnets can be created on physical networks in order to meet the specific requirements of customers. This makes it possible, for example, to provide high availability subnets based on the public cellular network for different types of services, railways or other companies and organizations. This is called network truncation. It should be possible for nearby cellular devices to communicate directly with each other. This device-to-device (D2D) communication is not yet integrated into the current 5G standardization version, but will be included later [3]. Direct communication between vehicles should also be possible. They will not only communicate with each other, but also with the infrastructure, the network or the Internet. With a response time of a few milliseconds, remote control and monitoring of devices, machines or systems is possible without delay and in real time - for example, for autonomous transport systems (vehicles and drones), production machines or industrial robots . 5G makes AR or VR representations faster, more realistic and possible in real time.

The key components in 5G technology are ultra-fast connections and minimal delays. While this is certainly important for anyone streaming video from their phone, it is much more important in scenarios where minimizing delays is imperative, such as the future of interconnected devices. The same goes for any other fast-acting devices, such as autonomous cars that need to avoid sudden collisions and understand the directions they need to travel, remotely controlled hardware, and robotic systems that learn or respect remote controllers. However, 5G will continue to pave the way for easier connectivity for our everyday devices, such as gaming, making video calls, streaming movies, downloading files, sharing HD and 4K content, receiving updates for real-time traffic, etc. 5G is so fast that it will not only be available for mobile devices. It has the potential to replace even fixed cable access as well as wireless connections. 5G standards are not yet fully established, and service providers will not necessarily use the same technology to implement 5G, so it is difficult to say exactly how it will work for each company in each country. For example, in some cases, 5G will provide data in a completely different frequency range than existing networks. This wider range of waves will be called the millimeter wave range, and will operate in the 30 GHz to 300 GHz range (given that current networks use bands below 6 GHZ). What makes this significant is that instead of a multitude of devices sharing a small space in that spectrum, they will be able to spread along that line and use more bandwidth, which means higher speeds and fewer connections lost. However, while these higher frequency waves may carry more data, they cannot broadcast to the lower ones, which is why some providers, especially T-Mobile, will provide 5G on the 600 MHz spectrum for starters, then they will switch to the other frequencies. Providers that use higher frequencies may need to position small wireless stations between 5G towers to repeat data to provide 5G speeds and at the same time cover longer distances. Instead of transmitting signals everywhere to reach nearby devices, these stations will likely use what is called beamforming to direct signals to specific targets. This type of configuration should allow faster transmissions not only because there will be more stations to help transmit data at full speed, but also because the signals will no longer have to physically move to cover other devices. This communication between devices is what will allow low latency. Once 5G becomes widely available, it may be the last major breakthrough in mobile networks. The availability of 5G service depends not only on the area, but also on the service providers that are available. 5G is trying to improve several areas of mobile communications, from how fast you can download and upload data, to the number of devices that can connect to the internet at the same time.

The data rate, like the minimum requirement for 5G, is the minimum download and upload speed that every 5G cell must support, although it can fluctuate under certain conditions: Download 20 Gb / s (2.5 GB / s) s), Upload 10 Gb / s (1.25 GB / s). The above values are what each mobile station must support, but this does not mean that any device will benefit from these speeds. The speed is shared between all users connected to the same base station, which makes these rates more realistic for each user: Download 100 Mb / s (12.5 MB / s), Upload 50 Mb / s (6.25 MB / s) s). 5G will support at least 1 million devices for every square kilometer. This means that in that amount of space, 5G will be able to connect 1 million or more devices to the Internet simultaneously. However, 5G does not only need to support one or two devices per person, but also everyone's smartwatch, all vehicles in the area that could be connected to the internet, smart door buttons in nearby houses and any other current devices. or to be launched and connected to the network. Latency refers to the time interval between the time the cell tower sends data and until the destination device receives that data. 5G requires a minimum latency of only 4 ms, assuming the ideal conditions are met, but could decrease to 1 ms for certain forms of communication, especially for ultra-reliable and low latency (URLLC) communications. For comparison, the latency on a 4G network could be about 50-100 ms, which is actually twice as fast as the 3G network. Mobility refers to the maximum speed at which a user can travel and still benefit from 5G services. The 5G

spectrum has defined four classes that it will support, anywhere from a stationary person not moving to someone who is in a high-speed vehicle such as a train, traveling up to 500 km / h. Different areas may require a different mobile base station to adapt to different speeds. For example, a small city, which has only users who travel by car and on foot, may not have the same base station that is included in a larger city with a high-speed public transportation system. Energy efficiency is another component passed in the 5G specifications. Interfaces will be built to quickly adjust power consumption according to the current load. When a radio station is not in use, it will go down in a lower power state in less than 10 ms and then return to normal consumption just as quickly when more power is needed. 5G is designed to change the frequencies used according to the customer's current needs. There are two terms commonly used in discussions about 5G [1,2]: i) Sub6: frequencies lower than 6 GHz, ie usually those already used for telephony and so far by telecom operators. 5G defines a way to transmit information, but you can use this mode on any frequency, including the already existing 700, 800, 1800, 2600, 3600, 4400 MHz and so on. These frequencies will provide large area coverage for 5G and speeds of a few Gbps; ii) mmWave: frequencies around 26 GHz, where speeds of the order of Gbps are possible. The name comes from the fact that the frequency of 26 GHz is at the beginning of the band millimeter waves. Sub6 frequencies are sometimes divided into two: low frequencies (700 MHz) and medium (2,600-3,600 MHz). More frequencies are needed for the following reason: low frequencies provide the highest coverage but low speeds, and high frequencies provide very high speeds, but signals propagate over short distances. Therefore, for 5G, operators will eventually use practically two or three frequencies, switching customers' phones from one to another depending on the current need: i) 700 MHz for the best coverage, especially outside the cities, where base stations are fewer; ii) 3,600 MHz for a balanced ratio between coverage and speed (for example Vodafone and Orange operate 5G networks in the 3,600 MHz band with speeds up to 1,200 Mbps and could increase after acquiring more spectrum at this frequency); iii) 24 GHz for the moments when you want serious download or upload. The problem with this frequency is that the coverage is very small and very easy to attenuate, ie it will only be available in crowded areas around cities, where a large capacity is needed for all connected.

However, in order to achieve the 5G objectives, changes in radio technology are also needed [19]. For example, adjustments to the structure of the radio signal, the so-called air interface (NR), are required. This is a further development of the overhead interface of LTE (4G) predecessor technology. In order to be able to use higher bandwidths (up to 800 MHz) and the various frequency bands 22, the signal structure had to be weaker and more flexible. In this regard, 5G will send considerably less control signals than 4G. These adjustments to the signal structure will not only lead to less interference in the radio cells and thus increase the transmission quality, but will also reduce the average exposure in the unused radio cell. In a 5G network, the bandwidths used can be set more flexibly compared to 4G to operate 5G in both the lower and higher frequency bands. The coexistence of 4G and 5G in the same frequency band should also be possible. 5G should make it possible to use additional capabilities through WLAN functions. The advantage is that all applications are available globally through a single technology, which stimulates innovation and reduces costs. On the end side of the device, the bandwidth is also flexible. A mobile radio device does not necessarily have to use the full bandwidth proposed by the base station, but only works with part of it. This allows the device to save electricity, which explains the long battery life of the sensors.

Campus networks are examples of the study and implementation of the 5G concept and are in a massive transition to meet unprecedented challenges as businesses move to certain IoT-ready campuses [21]. Network architects face a new mandate to better align with the transformed business needs and ubiquitous workloads of users, using open-source cloud-oriented principles for a seamless enterprise-wide operational experience. The term 5G

campus network means a geographically limited local cellular network that is adapted to special requirements, such as industrial communication. Thanks to 5G technology and the use of dedicated frequencies, it can meet the requirements of the highest quality of services in terms of latency, reliability and availability of communications networks. This makes 5G campus networks attractive for applications in various industries. Therefore, they are considered to be important pioneers for the factory of the future and are currently the subject of numerous media reports. The factory of the future (Smart Factory) depends on a technologically significant communications infrastructure, with solution models to reliably connect machines, processes, robots, products, tools and people. Unlike wired networks, mobile radio solutions allow for more flexible and dynamic production. Mobile radio communication is thus preparing new ways to achieve higher productivity through increased flexibility. With the emergence of new business models, the old ways of providing goods and services have been drastically changed or completely abandoned, and 5G technology will bring greater complexity in the formulation and supervision of economic policies. Preparing for the opening of the 5G world will require the modernization of policies and regulations in many areas, including public safety, network security, privacy, spectrum allocation, public infrastructure, healthcare, spectrum authorization and approval, and education, training and development. The challenge for 5G policy makers is that they must be prepared to cope with the spread of 5G technology in everyday life and avoid setting up systems that hinder continuous innovation. The risk hypotheses discussed for mobile communications in general include a wide range of changes in genetics, cell biology and physiology, well-being, sleep quality, neurodegeneration. Specific risk assumptions for 5G focus mainly on the new significantly higher mobile radio frequencies near the millimeter wave range [18]. Based on the considerations of frequency-specific absorption patterns and interaction mechanisms, they refer to possible damage to the eyes and skin. For established mobile radio frequencies, there is inadequate and limited evidence of possible risks, as a large number of studies, some of which are very demanding, cannot provide clear evidence or provide everything clear. However, for the new mobile radio frequencies close to the 5G millimeter wave range, there are considerable gaps in knowledge, as studies on relevant risk assumptions, frequency ranges and field strengths are almost unavailable. There is agreement that the real situation of population exposure is made up of the growing ubiquity of electronic devices (from monitors to mobile phones, smart meters, cars with automatic control and IoT) with a wide variety of radiation emissions and a multitude of complicated sources (at least in terms of ubiquity and duration).

3. The impact of adopting 5G technology from an economic perspective

Companies can use the data to streamline systems and supply chains, with reliable information about how they work [5,12]. Considered at the level of an entire supply chain and within a particular industry, the impact can be huge, observable in the exact delivery of materials and in the efficient management of production throughout it. In addition, IoT can create new sources of revenue for companies. New technologies come with the promise of making our environment (homes, cars, etc.) smarter, easier to measure and manage, and security systems contribute to our safety, allowing real-time monitoring of property. On the other hand, different sensors can provide accurate information on the degree of environmental pollution, and autonomous cars bring major changes in everyday life. Various devices facilitate interpersonal communication and increase accessibility to various services. Concerns about the security of these systems are currently an important topic of debate. Any object connected to the internet is prone to attacks, and IoT products are no exception to this rule. Organizations and consumers accept and embrace the changes brought about by the IoT. Consequently, it will be incorporated into every aspect of our daily lives.Innovation is key to the success of the 5G economy. Companies that take risks to invest and continue to pursue

innovation, especially those that regulate the protection of intellectual property rights, are the best operators for using and developing the full value of the 5G economy.

By 2035, the impact of 5G popularization will exceed the capabilities of existing technologies, platforms and industries and promote their development. But while the 5G economy is booming, the development of 3G and 4G mobile technologies can provide an important benchmark. Private sector-led 5G investment is expected to reach a very high level and to build on previous infrastructure and R&D spending for 3G and 4G. These investments stem from the vitality of technology and spectrum licensing, stimulating and investing in the economic prospects of growing wireless dependence. Policies and incentives that encourage investment and the availability of venture capital, as well as strong intellectual property protection, will share a friendly environment that supports the prosperity of the 5G economy. This will improve the ability of people and machines to interact with each other to share information faster, to achieve greater returns in time and capital in pursuing personal goals and results in the workplace. The economic impact of new investment, new research and development and new technological innovations shows that 5G will have a profound and lasting impact on global growth. 5G will be widely popularized in the global economy over the next two decades and will become one of the major contributors to global economic expansion. Organizations such as the police, medical services, fire and rescue services depend on stable and secure communication networks. For example, joint communication must be ensured at mass events and access to strategically important data, such as real-time video streams, photos, construction plans or maps, must be facilitated. Information is crucial for on-site operations centers and for team coordination. Search missions and rescue teams can be supported in hard-to-reach areas with HD images from drones. 5G technology will significantly increase the availability and security of these important critical communications networks. With the so-called network truncation, priority networks can be made available to emergency services as standard.

With increasing traffic, road and rail infrastructure is reaching its limits, and the population is increasingly resistant to the volume of traffic - especially in city centers and residential areas [19]. In the mobility sector, 5G technology opens up a wide range of opportunities for better use and protection of existing resources. For example, real-time transmission between sensors, devices and infrastructure can be used to optimize traffic flow by continuously detecting capacity blockages and avoiding congestion. In addition to smart assistants, dynamic traffic signs could also be used. Thanks to smart and networked parking guidance systems, search traffic could be greatly reduced - which alleviates the burden on inland neighborhoods and cities and protects the environment. Other options include real-time information on the use of individual buses, trams or train compartments. Increasing security is another key area in the mobile technology sector. Due to real-time data transmission, networked artificial assistants could immediately warn of the dangers caused by environmental influences (e.g., road conditions, wind gusts, road objects) or other road users (e.g., accident sites). , sudden traffic jams, drivers in the wrong direction). Real-time warnings and long-term automatic and autonomous feedback from driving systems could save lives, especially during hectic rush hours and high-speed routes. In the health sector, 5G offers new opportunities, especially due to real-time data transmission and increased availability. Through live video streaming, for example, paramedics could connect an intensive care physician to the on-site emergency service or ambulance, doctors could support crisis relief organizations with medical treatment, and international experts could accompany extremely complex remote operations. Real-time transmission could be used to monitor vital data outside the hospital. With remote real-time health monitoring, patient safety could be increased, reaction time shortened and care made easier. The independence and individual mobility of people with disabilities can be improved. For the visually impaired, for example, the real-time transmission of camera images in audio information provides better guidance. By using new 5G-based

technologies, the value of the annual output of the various economies will increase. Smart job offers will be possible for all companies - including SMEs and businesses. The use of the latest technologies serves the research and education sector. Thanks to holographic and virtual meetings, collaboration between researchers is improved, location-independent work is possible and air travel is reduced. With 3D, AR and VR projections, new experiences and new means of learning are possible. 5G technology offers huge potential for any industrial campus. Innovative companies can expect many new applications to increase productivity, improve resource planning or more flexible changes in production processes for individualized products. Safety at work can be increased and work processes can be improved by including sensors and real-time image monitoring. Hazardous work situations could be recognized more quickly and specifically defused. The technology also helps to automate work processes in physically dangerous or very demanding activities. In the field of AR or VR, destinations and hotels could invite their future guests to take a virtual tour of the hotel or holiday resort before booking. Historic museums or old towns could use AR to virtually revive buildings that have collapsed on the spot or tell historical events not only with an audio guide, but also visually. Numerous new, innovative advertising and marketing tools are also designed.

In the ski areas or amusement parks, visitors could be informed in real time about the use of lifts, waiting times, as well as the slope conditions and weather via live mobile information. In addition, tourists appreciate a good cellular network for individual communication. More and more people want to share their impressions on the site directly with relatives and friends at home or through social networks. In agriculture, the reduction of environmentally harmful chemicals and the more efficient use of resources are currently a major problem; especially in relation to drinking water quality and water consumption. Based on 5G technology, farmers should be able to more easily and quickly determine and evaluate data on soil, plant condition, weather and any future pest infestation, using smart sensors or drones. This provides farmers with valuable decision-making bases so that they can use pesticides or water in a more targeted and better-dosed manner. Tractors and machines equipped with GPS, 5G and intelligent agricultural technologies could carry out certain works autonomously.

Reviewing how cybersecurity is addressed to keep 5G networks safe will be key to paving the way for all potential benefits for consumers, businesses and society, as well as for the safety of end users. However, this need should not distract organizations, governments, cities and industries planning the 5G revolution from the significant opportunities it offers. In fact, by understanding and combating the specific risks of 5G, companies can build greater resilience and use 5G as a source of revenue and profit for both themselves and society. This has become all the more important today, as the new coronavirus pandemic has changed the way people work and interact. For example, with staff working from home, companies' IT infrastructure systems are in high demand, creating a heightened vulnerability to cyber security attacks. Also, in the use of telemedicine, as patients connect with doctors via tablets, laptops or mobile phones, sensitive information will need to remain secure. An essential first step towards protecting any network against cyber threats (including 5G) is to understand where vulnerabilities can occur. They are primarily found at interconnection points, where there is a risk of switching from one element of the network to another. It is important to note that many of the security vulnerabilities that are usually found in 5G are not actually specific to the technology itself. If devices, encryption algorithms, or AI engines connected to 5G networks are penetrated or compromised, then serious problems arise for 5G operators and users. Effective security in a 5G world requires each participant in the value chain to fulfill their role. Company leaders will need to focus on three key pillars of security [10]: trust (to take cyber security measures), resilience (to prevent, exit and return from disruptive attacks), activation (to quickly overcome threats) new and existing). These pillars underpin a sound cyber strategy and will ensure that organizations can deploy 5G quickly and safely, enabling individuals,

businesses and society as a whole to enjoy the potential of this new tool with confidence and security [15].

Current technological trends are the result of a combination of 5 technological changes [9]: cloud, artificial intelligence (AI), IoT, AR / VR and 5G. Cloud, AI, IoT, VR / AR are growing exponentially today. 5G will allow the connection of these technologies to feed each other. The widespread adoption of 5G in a wide range of industries can support the optimization of core processes and establish new business models, thus achieving potential sales of products and services [11,12]. The 5G value chain will continue to deepen the basic 5G technology foundation. The mobile technology promoted by 5G has the potential to stimulate global GDP to achieve long-term sustainable growth, which is the final measure of healthy economic development. This era full of transformative technological innovations has brought countless changes in daily activities. With the emergence of new business models, the old ways of providing goods and services are drastically changed or completely abandoned, and the 5G economy will bring greater complexity to the formulation and supervision of economic policies. In this context, 5G will provide a new path and stronger technical support for the digital transformation of enterprises and will affect the labor market through direct and indirect means. The biggest impact on the labor market comes from new employment opportunities through how 5G will enable new applications, services and ways of doing business, along with overall business growth. The additional workforce needed to build the network to implement 5G will create the most immediate demand for new jobs. The positive economic impact described above results from the fact that businesses and consumers will benefit from the 5G network that responds to their demands for new goods and services. IoT requires 5G to reach its full potential and will be a major source of productivity improvements and competitive advantage for businesses. The 5G ecosystem will also create a significant amount of value for consumers, who can look forward to mobile broadband transmission speeds of about 10 to 20 times faster than 4G LTE, as well as much lower latency. The real promise of 5G and IoT for consumers is to do completely new things using wireless and fixed wireless devices and IoT technologies, such as healthcare devices, autonomous vehicles and traffic management systems, the smart grid to revolutionize energy management, smart home smart technology, etc.

5G will mark a digital transformation that will profoundly revolutionize the business world. This technology will involve the use of a higher frequency band of the spectrum, which allows the transfer of considerable volumes of data much faster than with the dedicated lower frequency band 4G / LTE. For example, the total volume of video and audio media, entertainment and other data will increase from 33 zettabytes recorded in 2018 to 175 zettabytes by 2025, implying an aggressive launch of 5G by this year. In addition to its commitments to speed, power, reliability and intelligence, the ubiquitous connectivity of 5G devices could have the biggest impact. For example, current 4G / LTE technology limits connectivity to about 100,000 devices per square kilometer. 5G will increase this density tenfold by connecting 1 million devices in the same space at a speed of 200 times. By this year, when the 5G era begins, 50 billion connected devices will produce 4.4 zetabytes of data, according to estimates. In adopting 5G, senior management and internal audit should take into account that a significant increase in the volume of data collected may expose the organization to new financial and extra-financial risks related to the data.

4.Conclusions

The fifth generation of 5G telecommunications technologies is fundamental to achieving a zettabit society by 2025. The goal of covering all urban areas, railways and major roads with wireless communications can only be achieved by creating a very dense network of antennas and transmitters. [7]. The number of higher frequency base stations and other devices will increase significantly. This raises the question of whether there is a negative

impact on human health and the environment due to higher frequencies and billions of additional connections, which, according to research, will mean constant exposure for the entire population. An international comparison shows that these possibilities have already been recognized worldwide and that the preparatory work for a successful implementation has already begun in many countries. A fast 5G launch can create optimal conditions for the development of modern services as early as possible. Research and innovation often form the basis for the development of successful digital products and services. Research and development activities based on the use of big data and AI methods, as well as the development of innovative applications in the field, need to be increasingly supported. This is to the benefit of vertical economic sectors (mobility, production, agriculture, services, energy, healthcare, education, media and logistics), in which the next wave of digitalisation is imminent and which have enormous growth potential. In the field of infrastructure, fixed and mobile radio technologies are considered strongly complementary. Therefore, the expansion of fiber optic networks, which is already underway as part of the broadband initiative, provides a basis for the future launch of 5G technology. They are extremely important in terms of modeling, analysis and characterization of urban mobility, data analysis for smart mobility services, mobile cloud and 5G / B5G edge computer for mobile applications. Architectures, techniques and applications of the 5G / B5G compatible mobile edge smart cloud, algorithms and machine learning (ML) algorithms for edge computing, architectures, protocols and algorithms for efficient interconnection of smart mobile objects will also be developed, resource management with mobility in 5G networks.

Future research focuses on AI-based modeling and analysis for 5G mobile communications, 5G multimedia-based smart mobility applications, and collective mobility management for smart cities. Before implementing AI in networks it is good to analyze: the formulation of good operational practices (AI will not solve all network problems and it is very important to be aware of the limitations as well as the areas that would benefit most from this type of intelligence), defining clear functions and objectives (no ML algorithm can produce results without first specifying the objectives), the interaction between man and AI (how far can AI go in making decisions), human knowledge vs. AI (a dependence on what Increasing AI has the potential to create gaps in subject knowledge, as a result the expertise of network engineers must be maintained to verify the decisions made by the AI engine), the need for data collection (ML algorithm needs data from several sources, and the correctness of the decisions depends on the amount of data received), the areas of AI applicability. Although there are some processing capabilities today AI on premises, it generally takes the cloud to run AI algorithms, for HPC power and storage.

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