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Impact of Future Wireless Networks in the Telecommunication Sector – A Review

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Abstract

A wireless network utilizes wireless data links between its nodes, eliminating the need for expensive cabling within buildings or between different equipment locations in households, telecommunications networks, and corporate installations. Different cellular networks exist, including 1G, 2G, 3G, 4G, and 5G. The transition to each new generation occurred due to specific drawbacks. Presently, 5G is considered the network of the future. This review will explain one of the most recently developed 5G networks, providing a detailed explanation of the evolution, effect, merits and demerits, and obstacles. Additionally, it provides an explanation on why and the way how 5G is being replaced by 6G.

Keywords: Wireless networks, 5G technology, networks, 6G Technology

1. Introduction

The field of wireless networks has changed dramatically during the last several decades. The development of wireless technology has transformed communication, work, and leisure activities since the introduction of brick-sized mobile devices and continues to do so with the help of effortless streaming capabilities.

1.1 The Development and Generations of Wireless Communication

The origins of wireless networks may be found in the late 1800s, when telegraphy made it possible to communicate across great distances without the need of physical cables. Mobile communication truly began with the advent of 1G wireless networks in the 1980s, In

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comparison to their descendants, these early networks were less capable and depended on analog technology. To be sure, the then-revolutionary brick-sized mobile phones were capable of making calls.

Digital voice communication was made possible with the advent of 2G networks in the beginning of the 1990s, which also resulted in lower interference and better call quality. During this period, the Short Message Service (SMS) was introduced, enabling people to send and receive text messages for the very first time. Back then, text communication was a revolutionary development—a function that seems basic now.

The advent of 3G networks brought us into the twenty-first century. It was feasible for users to make use of the internet on mobile devices for the first time since these networks gave people higher data transmission speeds. Smartphone adoption peaked during this time, as Symbian-powered phones from Nokia and products like the BlackBerry gained traction. The modern, app-centric lifestyle was made possible by the development of mobile applications and services as well as improved connection rates [7].

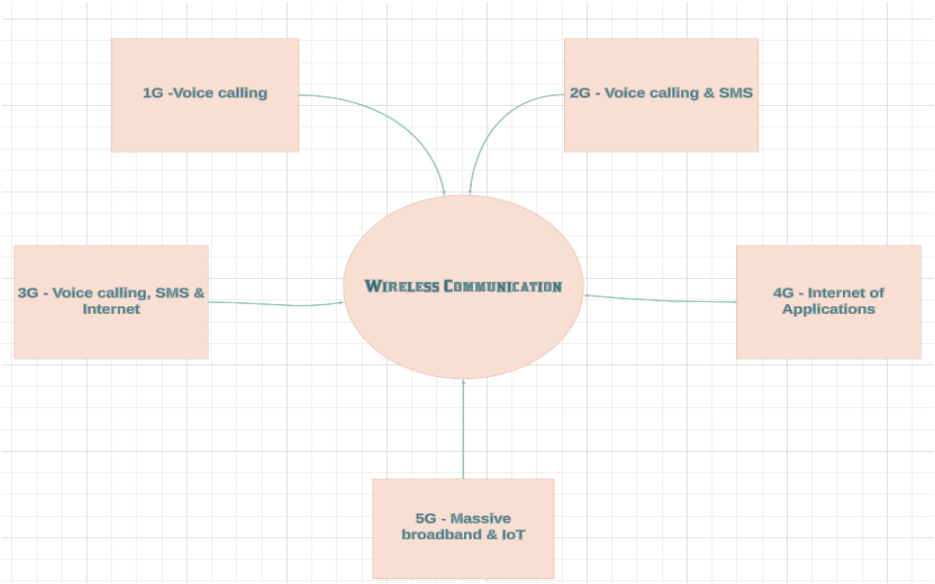

Figure 1. Different Generations and Inventions of Wireless Communication

4G networks were introduced by the cellular industry in response to the need for more rapid and effective transmission of data. Modern usage of mobile devices has been completely revolutionised by 4G networks, which offer speeds up to ten times quicker than their previous generations. For consumers all around the world, downloading big files, watching HD films, and using real-time navigation have become effortless experiences. Furthermore, 4G networks

enabled the Internet of Things (IoT), allowing different smart devices to be connected to one another and developing an ecosystem that went beyond smartphones and tablets.

The latest version of wireless networks, or 5G, is expected to dramatically transform the globe as we move into the present. 5G networks are expected to offer speeds as much as 100 times quicker than 4G, opening up new possibilities. Future sections of this study work will explore the arrival of 5G and its implications, advantages, and difficulties.

2. Evolution of 5G

One of the most cutting-edge technologies, 5G would revolutionise how people, machines, and sensors communicate with one another in order to create a connected, intelligent, and safer society. Our lives have been completely changed by the quick development of technology, which has made it possible for us to engage and communicate instantly, obtain information with ease, and live better lives overall. Through the implementation of the SBA (services-based architecture), Artificial Intelligence (AI)/ Machine Learning (ML) and software-defined networks, the shift to 5G redefines services and opens up new opportunities for economic growth through use cases like telemedicine, virtual and augmented reality, machine communications, smart manufacturing, smart services, and smart cities. It is anticipated that 5G in particular would accelerate the transition away from unimportant phone and data services and towards sophisticated, mission-critical, and time-sensitive services like gaming, AR/VR, robots, IIoT, and V2X. In order to allow AI native & futuristic use-cases which will grow in the present decade, this creates the perfect foundation for 6G networks and beyond [8].

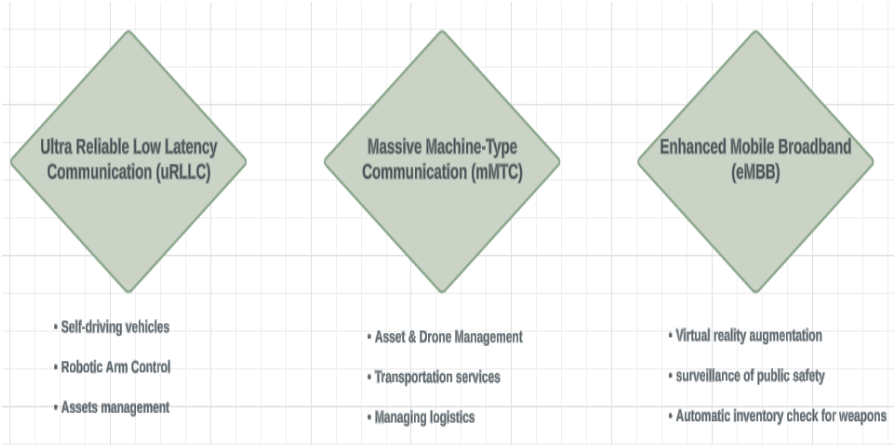

Figure 2. 5G Use Cases in Telecommunication Sector

An ecosystem for 5G is being developed that will link almost anything, including devices, machines, and things. By offering high-speed connection together with increased capacity, low latency, and dependability, 5G overcomes the digital divide. The main benefits of a digital network are the speed, latency, dependability, capacity and coverage. Compared to 4G networks, 5G networks offer significant gains over these metrics.

3. Impact of 5G in Different Fields

The most recent generation of wireless communication networks, or 5G technology, is anticipated to outperform its predecessors in terms of speed, latency, and dependability. 5G technology is important because it may provide speedier communication, enhance user experience, and open up new business prospects.

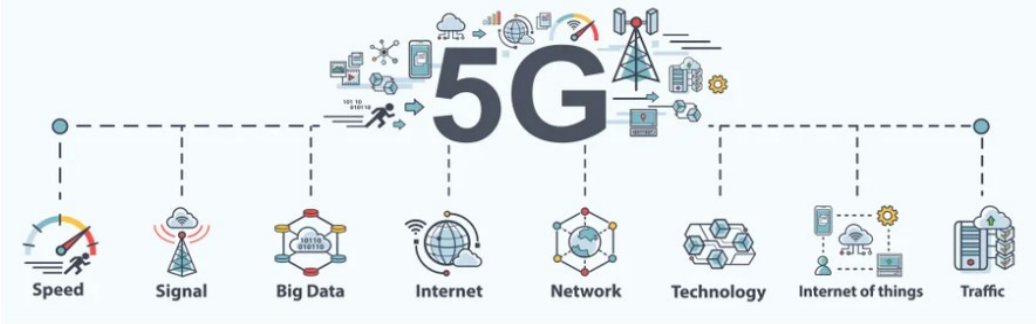

Figure 3. Features of 5G Network [9]

If the telecom industry hopes to stay competitive, it has to adopt 5G. It'll not only offer them a benefit over their competitors, however it will also allow them to provide customers with the newest technology available. 5G is important because it offers a number of advantages over previous wireless technology that existed. To begin with, its speeds are significantly quicker, enabling customers to accomplish more with their gadgets. Because to its lower latency, utilising 5G-capable devices will cause less lag. Telecom companies can lower their energy expenditures since 5G consumes less energy than previous generations. All things considered, 5G represents a major breakthrough for the telecom industry. It offers quicker speeds, lower latency, and more dependability which are all required for the development of new apps and services in a short period of time.

It is anticipated that 5G wireless communication technology would completely transform the telecom sector. The following are some possible impacts of 5G technology [9]:

3.1 Increased Speeds: 5G technology is expected to provide internet speeds that are up to 100 times faster compared to those of the present 4G networks.

3.2 Better Connections: 5G technology will boost network capacity and coverage while enabling multiple devices to be connected to the internet at once. As a result, there will be more linked devices and sensors, expanding the reach of the Internet of Things (IoT).

3.3 Reduced Delay: 5G technology will minimise network latency, which is the amount of time required for data to transit between a device & the network. It will allow more applications that are real-time, such as augmented reality, virtual reality, and autonomous automobiles.

Enhanced Network Slicing: With 5G technology, network operators may develop virtual networks specialised to certain application and service, which includes smart cities as well as industrial automation.

Enhanced Income Opportunities: The enhanced speed, connection, and capacity of 5G wireless networks will open up new revenue streams for telecom service providers, such as delivering premium services to companies or charging for usage of fast networks.

Overall, 5G technology is likely to have a huge influence on the telecom sector, with the potential to alter how people live, work, and communicate.

4. Literature Survey

Smart hospitals are subject to some operational restrictions as a result of their regularization. Through the integration of cutting-edge technologies such as the Internet of Things and artificial intelligence, smart hospitals maximize resource usage and improve patient care in this article. [1]. Nevertheless, security, interoperability, and data privacy are all hampered by the regularisation process. There are difficulties in striking a balance between the necessity of data security and the effective exchange and review of medical data. These limitations must be overcome by smart hospitals in order to guarantee patient safety and regulatory compliance. Fifth-generation (5G) wireless technology is a recent advancement in mobile technology that aims to significantly increase the speed and response of wireless networks. 2019 witnessed the global launch of 5G technology by mobile phone providers, which will eventually replace the 4G networks which currently link a large number of

smartphones. Fifth-generation technology, resembling another cellular network, makes it possible for many more contemporary devices to function on same radio frequencies that are already in use by satellite communications, Wi-Fi networks, and smartphones. As of September 2019, users in Germany may now connect to the 5G network. Few nations are currently utilising 5G networks. The first nations to use the 5G network are China, South Korea, the United States, and Canada. Before a widespread distribution, issues with regulation and authentication must also be resolved.

The newest wireless communication technology on the market is called 5G. It makes information sharing between devices like cell phones and Bluetooth-enabled devices possible. The type of energy that 5G operates on is electromagnetic radiation. Because it uses higher frequencies than conventional wireless connections, it is faster and more effective. When electromagnetic frequencies, like those produced by 5G, are introduced to an area, electromagnetic fields (EMFs) are produced. Some people believe that EMFs are hazardous. As a result, people are concerned about how 5G will affect their health. Nevertheless, there are currently no significant health risks associated with 5G. Although there have been many theories on the connection between COVID'19 and 5G, none of them have been supported by data. It seemed logical to assume they were all frauds because there were no practical similarities. We have attempted to examine the numerous instances that support these assertions in this article [2].

The introduction of cutting-edge IoT solutions along with the improved features and increased coverage of 5G cellular networks is changing how people engage with machines. Within these Internet of Things applications, electroencephalography (EEG) is a crucial biometric that is valued for its uniqueness, affordability, and sensitivity. Nowadays, EEG is being used in a greater range of industries, including neuromarketing and neuroscience research. This article's [3] main goal is to provide a thorough analysis of the issues and potential paths in EEG data collection, processing, and classification. It also highlights the growing importance of data-driven approaches in the field of 5G wireless network-supported EEG-enabled Internet of Things solutions. The paper also includes an example study on EEG-based emotions identification, which highlights the use of EEG as a biometrics tool in the Internet of Things (IoT) driven by 5G technology.

In academia [4], research, and the telecommunications industry, low-profile Multiple-Input Multiple-Output (MIMO) antenna design is a hot issue for a variety of 5G applications.

This element involves the design and analysis of a small and low-profile 5G MIMO antenna for use in a variety of 5G applications, particularly in the regional multipoint distribution band (27.5–28.35 GHz) and 24 GHz bands (24.25–24.45 GHz and 25.05–25.25 GHz) of the 5G spectrum. The dimensions of the suggested antenna construction are 20 × 20 × 1 mm3. Two spade-shaped radiators made of annealed copper material are positioned perpendicularly to each other in order to preserve signal variety and enhance isolation. Rogers RT 5880 is utilised as the substrate material. The antenna's broad bandwidth of 21.5–28.5 GHz is demonstrated. A T-shaped parasitic strip has been inserted between the radiating components, allowing the mutual isolation |S21| to be maintained at ≤29 dB. In comparison to comparable antenna categories, there has been an observation of higher performance and novelty in design.

Beyond cellular internet, 6G will be necessary to provide ubiquitous artificial intelligence (AI) services from the network's core to its endpoints. AI will be essential for creating and enhancing 6G designs, protocols, & operations in the meantime. In next-generation communication networks, especially in 6G, URLLC is essential for applications that demand dependability and extremely low latency. Advanced technologies such as robotic surgery that are performed remotely, smart factories, autonomous cars, and augmented reality apps are supported by these services. 6G communication infrastructures can support time-sensitive as well as safety-critical services since URLLCs provide reliable connectivity and prompt response. This article [5] explains the significance of URLLCs in 6G, how they interact with deep learning algorithms, the security issues they raise, and possible fixes.

This report offers a thorough analysis of the deployment of collaborative learning on 6G wireless networks. Our research [6] is especially focused on the Split Federated Learning (SFL), a method that just surfaced and shows promise for improved performance over current collaborative learning techniques. First, we give a summary of 6G networks, their primary goal, and a history of significant advances. We then cover three new collaborative learning paradigms: split learning, federated learning, & split federated learning. Next, we emphasise that split federated learning is essential for the future 6G networks in all respects, including 6G technology and 6G use cases. In addition, we examine frameworks and datasets that are currently available for use in building SFL for the 6G networks. Finally, we pinpoint the major technological obstacles, unresolved problems, and future possibilities for SFL that are enabled.

5. Challenges, Pros & Cons of 5G Technology

The latest generation (5G) of wireless communication has enormous promise. Even so, there may be hazards to think about. Here are some of the problems, advantages, and disadvantages of 5G in the communication firm,

5.1 Challenges

Infrastructure: Significant infrastructure investment is required to enable 5G technology, involving the construction of brand-new antennas and small cells, as well as the upgrade of existing network gear. This is a costly technique that requires a significant amount of time and money.

Spectrum Availability: A significant amount of spectrum is required to enable 5G, and it may not always be available. This entails reallocating current spectra and assigning new spectrum bands, that may be a lengthy and difficult process.

Security: Because of the expanding number of connected devices and the implementation of new technologies such as software-defined networking (SDN) and network function virtualization, 5G networks are vulnerable to security threats such as cyberattacks and hacking. (NFV). New security processes and procedures are required to safeguard the security of 5G networks.

5.2 Pros

Improvement in Speed and Capacity: When compared to previous wireless technology generations, 5G offers much quicker speeds and capacity. Telecommunication companies will become capable to serve more customers and provide more reliable service as a consequence.

Reduced Latency: Latency refers to the time it takes between when an end user makes a request and when they receive a response, and 5G has the ability to significantly lower it. This might allow real-time applications such as virtual reality & gaming.

More Efficient Spectrum Use: Because to 5G's better spectrum utilisation, numerous users can be serviced on the same network.

5.3 Cons

Major Health Risks: Some research suggests that radiofrequency radiation from devices such as cell phones might cause cancer and other health problems. More study is needed to properly understand the concerns, as 5G technology is likely to increase exposure.

Interaction with Other Devices: It has been proved that 5G transmissions impact weather radars and other sensitive equipment. This might cause major problems in industries that rely on this technology, such as air transportation and emergency services.

Privacy Concerns: In compared to previous generations, networks using 5G are expected to be substantially more complex, making them more vulnerable to assaults.

6. Possible Ways to Transition of 5G to 6G

The next generation of wireless communication offers advantages worth exploiting in IoT installations or for other uses. Practically, 6G is a successor to 5G, each development of wireless communication has resulted in enhancements and new capabilities, enabling previously unimaginable use cases. The key technological distinction between 6G and 5G connection is that 6G will operate at greater frequencies compared to its predecessors. By combining higher frequency bands, over 100 gigahertz (GHz) and maybe even higher than 1 terahertz (THz), 6G will ultimately provide particular enhancements to the entire wireless experience, resulting in a number of benefits and making 6G suitable for various kinds of next-generation applications [10].

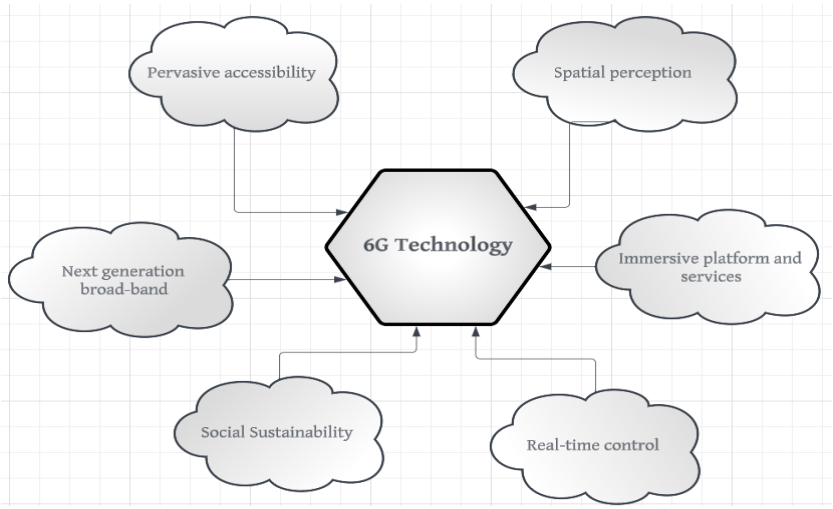

Figure 4. Different Techniques of 6G Technology

One of the advantages of shifting to a new technology—or preparing for the upcoming of the next generation—is obtaining benefits that prior versions did not provide. They are enhanced capacity by incorporating sub-THz spectrum and operational range of 30 - 300 GHz. The extended spectrum improves coverage and dependability by as much as 99.99999% (7 9's). Increased peak speeds at 1 terabit per second. Reduced latency to enable microsecond latency. Improved spectrum efficiency as high as 100 bps/Hz and increased mobility support to 1000 km/h (600 mph).

7. Conclusion

5G technology is expected to have a dramatic influence on the telecom sector. In this article, we covered the 5G wireless network in the telecommunications industry. Here, the evolution and impacts of 5G are thoroughly discussed, as well as its significance in the modern world. Overall, the influence of 5G technology on the telecom sector and beyond is still in its beginning stage, but the opportunities for growth and development are enormous. As previously noted, 5G has both advantages and problems that influence worldwide. This article also compares 5G to 6G, a forthcoming technology.

References

[1] Gautam, Arun, Rashid Amin, and Kengne Jacques. "Constraints Due to Regularization of Smart Hospitals: To Study the Impact of 5G Technology on the Financial Sector." In 5G-Based Smart Hospitals and Healthcare Systems, pp. 63-75. CRC Press, 2024.

[2] Bale, Ajay Sudhir, Sabhyata Uppal Soni, Dheeraj Singh Rajput, R. Hamsalekha, S. Saranya, Salna Joy, and Mamta B. Savadatti. "5G Wireless Communication and Its Adverse Effects on the Human Body: Distinguishing Falsehoods from Reality." International Journal of Intelligent Systems and Applications in Engineering 12, no. 5s (2024): 101-112.

[3] Beyrouthy, Taha, Nour Mostafa, Ahmed Roshdy, Abdullah S. Karar, and Samer Alkork. "Review of EEG-Based Biometrics in 5G-IoT: Current Trends and Future Prospects." Applied Sciences 14, no. 2 (2024): 534.

[4] Bhattacharya, Ankan. "Design, fabrication, and measurement of a miniaturized MIMO antenna applicable for 5G communication." International Journal of Microwave and Wireless Technologies (2024): 1-12.

[5] Kamath, Srikanth, Somilya Anand, Suyash Buchke, and Kaushikee Agnihotri. "A Review of Recent Developments in 6G Communications Systems." Engineering Proceedings 59, no. 1 (2024): 167.

[6] Hafi, Houda, Bouziane Brik, Pantelis A. Frangoudis, Adlen Ksentini, and Miloud Bagaa. "Split Federated Learning for 6G Enabled-Networks: Requirements, Challenges and Future Directions." IEEE Access (2024).

[7] https://utilitiesone.com/the-evolution-of-wireless-networks-a-brief-history

[8] https://stl.tech/blog/the-evolution-of-5g-and-its-use-cases/

[9] https://www.logic-fruit.com/blog/wireless-communication/5g-impact-on-telecom/

[10] https://www.digi.com/blog/post/when-is-6g-coming-what-does-it-mean-for-5g-4g