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# 6G Technology and its Future Scope

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***Abstract:*** *6G is the sixth-generation mobile system standard currently being developed for wireless communications over cellular data networks in telecommunications. It is the successor, or the next bend in the road, after 5G and will likely be much faster. One of the goals of the 6G internet is to support one microsecond latency communications. This is 1,000 times faster -- or 1/1000th the latency -- than one millisecond throughput 6G networks are currently under research and development of 6G technology.*

***Key Words:*** *Radio Technology, Future, 4G,5G, 6G, Wireless Communication, Capacity, Latency.*

## 1. INDRODUCTION:

### 1.1 6G Technology

The 6G technology market is expected to facilitate large improvements in the areas of imaging, presence technology and location awareness. Working in conjunction with artificial intelligence (AI), the 6G computational infrastructure will be able to identify the best place for computing to occur; this includes decisions about data storage, processing and sharing. It is important to note that 6G is not yet a functioning technology. While some vendors are investing in the next-generation wireless standard, industry specifications for 6G-enabled network products remain years away. In Fig 1 represents the 6G technology. The International Telecommunication Union (ITU) standardizes wireless generations every decade.


**Figure 1: 6G Technology**

Typically, they are denoted by a gap in the “air interface,” which signifies a shift in transmissions or coding. This is implemented so that older devices cannot be updated to the newer generation since doing so would generate a limitless quantity of “noise” and “spectrum pollution.”Typically, subsequent generations (i.e., the next G) use much more sophisticated digital encoding that outdated computers cannot achieve. They depend on broader airwave bands that governments did not previously make accessible. Additionally, they have immensely complex antenna arrays that were previously impossible to construct. Today, we are in the fifth generation. The first standard for 5G New Radio (NR) was developed in 2017 and is presently being implemented globally. 6G internets use a combination of the latest in radio and fiber optics technology. We deliver through their via line of sight. Which means we don’t have to rely on the copper cable or base our speed on how to far your business is away from the exchange.

**2. ARCHITECTURE OF 6G:** A new 6G system architecture with the following distinct design criteria or goals in mind: cloud platform, simplification and sustainability, flexibility, programmability, specialization, robustness and security, and native integration of AI/ML capabilities. In Fig 2 represents the architecture of 6G technology.

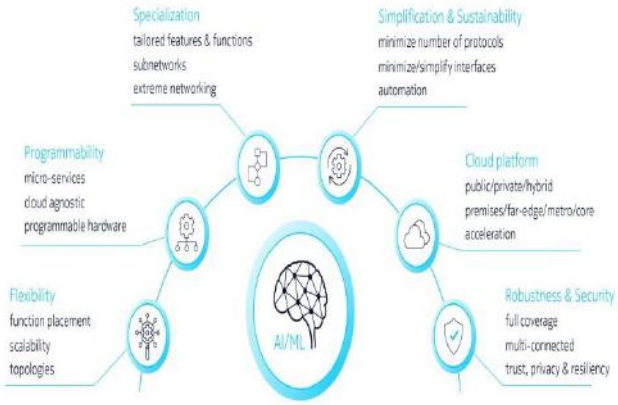


**Figure 2: Architecture of 6G Technology**

All those design criteria and goals need to be considered when the new 6G system architecture is being developed, while individual actors in the value mesh may have different priorities based on the use cases they are targeting. The 6G architecture will come with advanced domain automation functionalities providing orchestration and automation across multiple network domains, possibly spanning multiple stakeholders, multiple administrative domains and additional resources in the far edge and on premises beyond the traditional mobile network. A significant increase in compute and storage capabilities, for example, is required to store and process the massive amount of data to be collected for services like AI/ML, extended reality (XR) and the metaverse. A dedicated data and information architecture is being proposed to collect and expose the required information from the various data sources across the whole 6G system in an efficient manner. Also, it is crucial to determine the optimal placement and selection of those resources and services from an overall system performance perspective, while respecting service constraints and system KPIs/KVIs**.**

### 2.1 Six Key Technologies for 6G

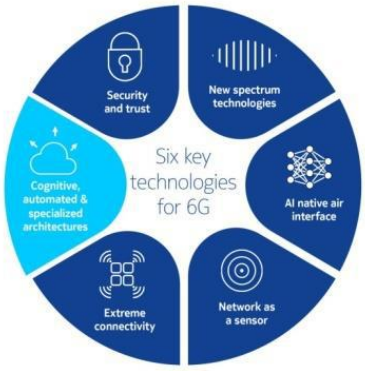


**Figure 3: 6 Key Technologies for 6G**

Researching multiple technologies that we believe will define the 6G networks of the future: new spectrum technologies, network sensing, AI/ML-defined air-interface frameworks, security and trust and extreme connectivity. The 6G system architecture will act as the glue and fabric for these technologies, giving us the foundation to make more radical changes to the way we craft networks. In Fig 3 represents the most important key technologies of 6G.

**2.2 How will 6G work?**

It's expected that 6G wireless sensing solutions will selectively use different frequencies to measure absorption and adjust frequencies accordingly. This method is possible because atoms and molecules emit and absorb electromagnetic radiation at characteristic frequencies, and the emission and absorption frequencies are the same for any given substance. 6G will have big implications for many government and industry approaches to public safety and critical asset protection, such as the following:

- threat detection;
- health monitoring;
- feature and facial recognition;
- decision-making in areas like law enforcement and social credit systems;
- air quality measurements;
- gas and toxicity sensing; and
- sensory interfaces that feel like real life.

Improvements in these areas will also benefit smartphone and other mobile network technology, as well as emerging technologies such as smart cities, autonomous vehicles, virtual reality and augmented reality.

**III 4G vs. 5G vs. 6G:**

6G means more than just faster speeds and more data transfer, although those things will exist. When we consider 4G vs. 5G, we can see how wireless technology has evolved. It becomes more nuanced when considering 5G vs. 6G – but that may just be because the technology remains a decade in the future. In Fig 4 shows that the evolution of 4G vs. 5G vs. 6G


**Figure 4: 4G vs. 5G vs. 6G**

The following table 3.1 shows that the comparison issues of 4G vs. 5G vs. 6G wireless technologies

**Table 3.1 Comparison of 4G vs. 5G vs. 6G**

| *Issue* | *4G* | *5G* | *6G* |
|---|---|---|---|
| Per Device Peak Data Rate | 1GBPS | 10 GBPS | 1 TBPS |
| End-to-End Latency | 100 ms | 10 ms | 1 ms |
| Maximum Spectral Efficiency | 15 bps/Hz | 30 bps/Hz | 100 bps/Hz |
| Mobility Support | Up to 350 KM/Hr | Up to 500 KM/Hr | Up to 1000 KM/Hr |
| Satellite Integration | No | No | Fully |
| AI | No | Partial | Fully |
| Autonomous Vehicle | No | Partial | Fully |
| HR | No | Partial | Fully |
| Haptic Communication | No | Partial | Fully |
| THz Communication | No | Very Limited | Wisely |
| Service Level | Video | VR,AR | Tactile |
| Architecture | MIMO | Massive MIMO | Intelligent Surface |
| Maximum Frequency | 6 GHz | 90 GHz | 10 THz |

## 4. 6G TECHNOLOGY CAPABILITIES:

6G technology will enhance the performance of data transmission across the globe. The following are some of the key things that 6G technology will enable:

- **Technology convergence:** 6G technology will enable the integration of previously separate technologies, such as deep learning and big data analytics.
- **Edge computing:** 6G will support the deployment of edge computing to ensure overall throughput and low latency for extremely reliable communications.
- **Internet of things (IoT):** 6G technology is tipped to support the machine-to-machine communication necessary for operating IoT.
- **High-performance computing (HPC):** There is a strong relationship between 6G technology and high-performance computing, where 6G technology supports centralized HPC resources for processing.

### 4.1. Features of 6G:

6G networks may coexist with 5G for a while and will be a significant improvement over previous generations in several ways. This is because 6G will offer the following differentiated features:

1. The use of new spectrum bands
2. Very high data transfer speeds
3. Ultra-low latency network functions
4. Greater support for machine-to-machine (M2M) connections
5. A focus on energy efficiency
6. Greater network reliability
7. The rise of new architectures
8. The use of AI and ML for optimal connectivity

### 4.2 Advantages of 6G Networks

6G networks are anticipated to offer the following benefits:

- **Enforces security**

Cyber attacks are increasingly focusing on networks of various types. The sheer unpredictability of these attacks necessitates the implementation of robust security solutions. 6G networks will have safeguards against threats like jamming. Privacy concerns must be addressed when creating new mixed-reality environments that include digital representations of actual and virtual objects.

- **Supports personalization**

OpenRAN is a fresh and evolving technology that 5G utilizes. However, OpenRAN will be a mature technology for 6G. The AI-powered RAN will allow operators of mobile networks to provide users with a bespoke network experience based on real-time user data gathered from multiple sources. The operators may further exploit real-time user data to provide superior services by personalizing quality of experience (QoE) and quality of service (QoS). The operators may customize several services using AI.

- **Extends the capabilities of 5G apps**

This degree of bandwidth and responsiveness will enhance 5G application performance. It will also broaden the spectrum of capabilities to enable new and innovative wireless networking, cognition, monitoring, and imaging applications. Using orthogonal frequency-division multiple access (OFDMA), 6G access points will be able to serve several customers at the same time.

- **Drives the development of wireless sensing technologies**

The sampling rate refers to the number of samples obtained from a continuous signal per second (or as per an equivalent time unit) to form a digital signal. 6G's frequencies will allow for much faster sample rates than 5G. Additionally, they will provide dramatically increased throughput and data rates. Moreover, the utilization of sub-mm waves (wavelengths lower than 1 millimeter) and frequency selectivity is expected to accelerate the advancement of wireless sensing technologies. The network will become a repository of situational data by collecting signals reflected from objects and detecting their type, shape, relative position, velocity, and possibly material qualities. Such a sensing method may facilitate the creation of a "mirror" or digital counterpart of the actual environment. When combined with AI/ML, this information will provide fresh insights into the physical world, thereby rendering the network more intelligent.

- **Inspiring new technology innovations**

6G will benefit society as a whole since new technological innovations will emerge to support it. This includes:

**More advanced data centers**: 6G networks will generate significantly more data when compared to 5G networks, and computation will evolve to ultimately encompass edge and core platform coordination. As a result of these changes, data centers will need to develop.

**Nano-cores that replace traditional processor cores**: Nano-cores are anticipated to develop as a single computing core that combines HPC and AI. It is not necessary for the nano-core to be a tangible network node. Instead, it might consist of a conceptual aggregation of computing resources shared by several networks and systems.

- **Saves costs through reduced software dependency**

Software-defined operations are already being used by contemporary networks. Additional 6G components, like the media access control (MAC) and physical (PHY) layers, will be virtualized. Currently, PHY and MAC solutions require the deployment of specialized network hardware. Virtualization provided by 6G will lower the cost of networking equipment. Therefore, an immensely dense 6G rollout will become economically feasible.

- **mproves cellular network penetration**

Among the many advantages of 6G networks is their vast coverage area. This implies that lesser towers are necessary to cover a given amount of space. This is useful if you want to construct towers where it showers regularly or where trees and vegetation abound. Additionally, 6G is intended to support additional mobile connections beyond 5G. This implies that there will be reduced interference between devices, resulting in improved service.

- **Optimizes indoor network usage**

The majority of cellular traffic today is produced indoors, yet cellular networks were never built to properly target indoor coverage. 6G overcomes these obstacles using femtocells (small cell sites) and Distributed Antenna Systems (DASs).

**4.3 Disadvantages of 6G:**

As with any new technology, there are also some potential disadvantages to 6G networks. For example, the increased speeds and reliability of 6G networks will require more energy, which could lead to higher energy costs for users. Additionally, the costs associated with building and maintaining 6G networks could be prohibitively expensive for some countries and regions.Finally, there is the potential for 6G networks to be used for surveillance and other nefarious purposes. This could lead to an increase in digital privacy issues and potential abuses of power.

## 5. CHALLENGES OF 6G TECHNOLOGIES:

With the high-speed development of telecommunication technology, all the industrial partners in telecom make an effort to promote **the digital transformation**. It can be seen that the 6G era is coming in the future. In Fig 5 represents the most important challenges of 6G. In the future, the intelligent network with end-to-end AI and perceptive capability will be able to help operators achieve the goal of energy saving.


**Figure 5: Challenges of 6G Technology**

Compared to the 5G technology, what are the challenges and changes of 6G?
From the possibility to the certainty
2. Openness and customization
3. Artificial intelligence network
4. 100% Coverage
5. Terahertz communication
6. Perception and location
7. Make the best use of spectrum
8. Network security

9. Flexibility, redundancy and self-healing capability
10. Low-carbon transformation

## 6. FUTURE SCOPE OF 6G NETWORKS:

Several researches and discussions are going on across the world among technologists, researchers, academicians, vendors, operators, and governments about the innovations, implementation, viability, and security concerns of 5G. About 10 years ago, the phrase "Beyond 4G" (B4G) was coined to refer to the need to advance the evolution of 4G beyond the LTE standard. It was not clear what 5G might entail, and only pre-standards R&D-level prototypes were in the works at the time. The term *B4G* lasted for a while. It referred to what could be possible beyond 4G. Ironically, the LTE standard is still evolving, and 5G will use some aspects of it.


**Figure 6: Future Scope of 6G Technology**

Similar to B4G, Beyond 5G is seen as a path to 6G technologies that will replace fifth-generation capabilities and applications. 5G's many private wireless communications implementations involving LTE, 5G and edge computing for enterprise and industrial customers have helped lay the groundwork for 6G. In Fig 6 represents the future scope of 6G Next-generation 6G wireless networks will take this one step further. They will create a web of communications providers -- many of them self-providers -- much in the way that photovoltaic solar power has brought about cogeneration within the smart grid. 6G could advance mesh networks from concept to deployment, helping to extend coverage beyond the range of older cell towers. Data centers are already faced with big 5G-driven changes. These include virtualization, programmable networks, edge computing and issues surrounding simultaneous support of public and private networks.

For example, some business customers may want to combine on-premises RAN with hybrid on-premises and hosted computing -- for edge and core computing, respectively -- and data center-hosted core network elements for private business networks or alternative service providers. 6G radio networks will provide the communication and data gathering necessary to accumulate information. A systems approach is required for the 6G technology market that makes use of data analytics, AI and next-generation computation capabilities using HPC and quantum computing. In addition to profound changes within RAN technology, 6G will bring changes to the core communications network fabric as many new technologies converge. Notably, AI will take center stage with 6G.

Other changes 6G is likely to bring include the following:

- **Nano-core.** A so-called nano-core is expected to emerge as a common computing core that encompasses elements of HPC and AI. The nano-core does not need to be a physical network element. Instead, it could encompass a logical collection of computational resources, shared by many networks and systems.
- **Edge and core coordination.** 6G networks will create substantially more data than 5G networks, and computing will evolve to include coordination between edge and core platforms. In response to those changes, data centers will have to evolve.
- **Data management.** 6G capabilities in sensing, imaging and location determination will generate vast amounts of data that must be managed on behalf of the network owners, service providers and data owners.

## 7. CONCLUSION:

6G is the next step in the evolution of wireless technology and is set to revolutionize the current 5G networks. After a successful comparison of 5G and 6G networks, businesses have begun imagining cutting-edge wireless use cases enabled by 6G technology, even though 6G networks do not yet exist and are still in development. In the future, the

primary objective is to transition into the new age of wireless technology and introduce new inventions that will alter the globe. As soon as the next generation of wireless networks, i.e., 6G mobile network, reaches a broader area in the telecommunications industry, it is predicted that fascinating possibilities about speed and dependability will become a reality. This new technology will undoubtedly add new dimensions to how we live and do business electronically.

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