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Current Scenario and Future Direction of 6G Communication Technology

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ABSTRACT

Many elegant applications are being included now that 5G wireless communications technology is accessible. On the other side, 5G criteria are far from combining the needs for the development of new technologies.

These include put off, resource sharing, energy per bit, capacity, and data rate. To fulfill these strict objectives, analyzers are focused on 6G wireless communications, which provides a broad variety of technologies and an array of new applications. A number of executives at some of the world's major telecommunications and technology companies, 6G, the next generation of mobile internet following 5G, is expected to arrive around 2030. In this study, we analyze the network dimensions current scenario and future direction of 6G communication in depth.

KEYWORDS:

6G, Machine learning, Artificial intelligence, IoT.

1. Introduction:

A new communication system is produced roughly every 10 years, increasing new features and technologies. Despite the fact that 5G has not yet been made public, present research is focused on 6G communication technology.

6G will need a shift in the design of communication networks. Multiple important needs must be reconciled. It enables sustainable expansion in a trustworthy manner.

Since the roll-out of 5G systems is well under way, research has switched to 6G mobile cellular technology. This initiative seeks to give a future vision of communication in order to stimulate future study. We strive to present a complete overview of the technology and communication demands in the 6G future.

Some of these characteristics may already be addressed by the 5G architecture. In principle, we believe that any enhancements to the 5G framework that can be implemented to suit new performance objectives while retaining backward compatibility and at a reasonable cost will be included in 5G development.

Although the fact that there is still a lot of innovation in 5G with the publication of new 5G-Advanced standards, Nokia Bell Labs has already begun the process. When thinking about such a future, the following important new topics also stand out together with the new communication requirements.

2. Related work:

Muhammad Waseem Akhtar et al. have looked at the use of deep learning for network anomaly, network setup, and optimization [1].

Data may be sent via 6G with the greatest degree of security available.

AI technology opens up the prospect of autonomous 6G wireless systems. Intelligent agents have the ability to actively and automatically detect issues with networks and resolve them. AI-based network management keeps networks healthy by continuously checking their state.

In addition, AI techniques may give edge computers and devices intelligence, allowing them to understand how to handle security challenges on their own. According to Zhengquan Zhang et al., autonomous applications are also in the works for 6G [5].

Several technologies have previously been highlighted as possibly critical for 6G by studies. Our research examines the various technology's advantages and loopholes and gives suggestions for future study into 6G applications. Amin Shahrak and co. [6].

Almost every 6G vision now under consideration is examined in our study, which provides a thorough analysis of both physical and network layer technology.

Blockchains are used to manage and distribute the spectrum resources since they are unchangeable, unmodified decentralized databases, potentially eliminating the need for a central authority. CIC Senior Member Guangbin Xu and others [8].

For existing wireless communication networks to satisfy the needs of 6G, a number of potential technologies have been put up. According to Hutesh Baviskar et al. [9].

3. Application:

Every communication system offers space for new functions and applications. The emergence of AI, automation, and smart cities came with 5G. These innovations were, however, only partly implemented.

With 6G, more technologies and applications are available that enable faster data speeds, better dependability, lower latency, and secure, efficient transmission.

Fig. 1 depicts the importance of 6G communication.6G offered new uses, trends, and technologies. Some of these 6G technologies and applications are explored in this section.

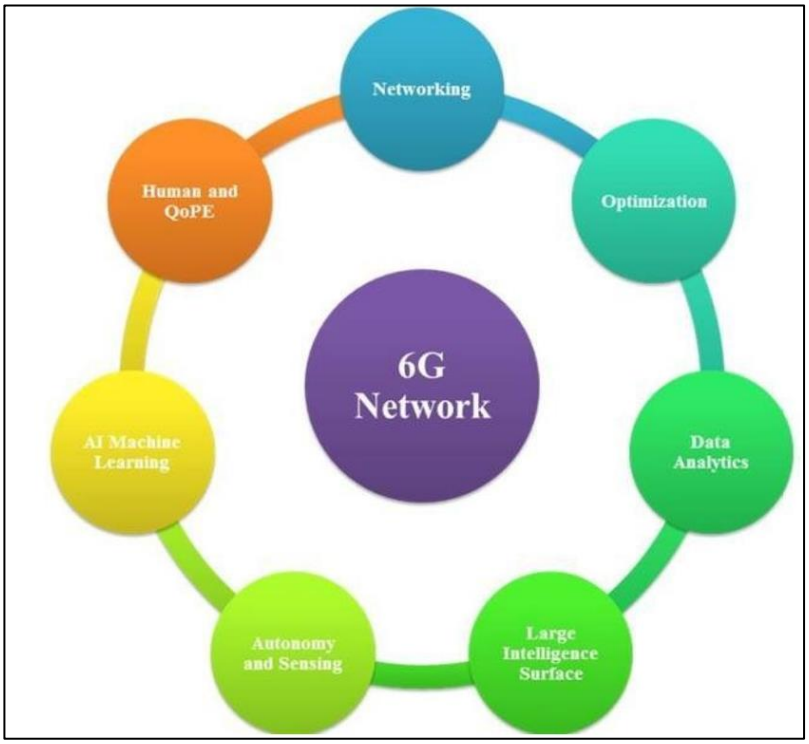

Fig 1: The most important 6G uses, trends, and technologies

I. Tera Hertz Communication

Because the demand for wireless communications technology is increasing at an exponential rate, the RF band is virtually completely saturated and can no longer keep up. The THz range, which runs from 0.1 THz to 10 THz, will be important to enable better bandwidth, and capacity. It aids in the creation of nanoscale cells with diameters ranging from nanometers to micrometers, as well as the Internet of Nano-Things by enabling exceptionally high-speed communications over distances of 10 m.

II. Artificial Intelligence

There was no application of artificial intelligence (AI) in 4G, 3G, 2G or 1G. 5G is altering the telecommunications business and opening the way for fresh exceptional usage like. However, 6G will entirely ease automation utilizing AI. The most significant 6G technologies are artificial intelligence (AI) and machine learning (ML) [2].

III. Extended Reality

A headpiece that creates sounds and sights to create an artificial world is used in virtual reality (VR). AR augments the actual world using a specialized technology, like a mobile phone. The mix of audio, video, and GPS may be integrated to create an interactive environment. Due to its stable connection, rapid data throughput, excellent resolution, and low latency, 6G will be very beneficial for this role [4].

IV. Blockchain Technology

The distributed blocks that make up the data in the blockchain technology are linked together and cryptographically safeguarded. Blockchain will be applied for massive data management, 6G connection management, and big data organization. It will also be employed for spectrum sharing, offer safe, inexpensive, intelligent, and efficient spectrum utilization. The network will become more flexible and the QoS will be enhanced by allowing constructing an advanced caching system, and using deep reinforcement learning and blockchain integration [1,20].

V. Automation

Researchers are working on robotics, automation, and self-driving cars. 6G will help these knowledges by allowing direct connections amid robots and servers. The 6G network will enable total automation, which includes complete systems, devices, and control procedures. 6G will enable unmanned aerial vehicles (UAVs) to be used in wireless communications [2,21].

VI. Wireless Brain-Computer Interface

A rising variety of applications for brain-computer interface (BCI) are being made use of lately employing wearable technology. Smart headgear, smart embedded technology, and smart body implants are all examples of BCI applications.

The brain will be able to effortlessly interface with outside separate devices utilizing BCI technology, which will be in charge of decoding and analyzing brain signals. Affective computing technologies, which modify how a device acts based on the user's mood, will also be employed in BCI [5].

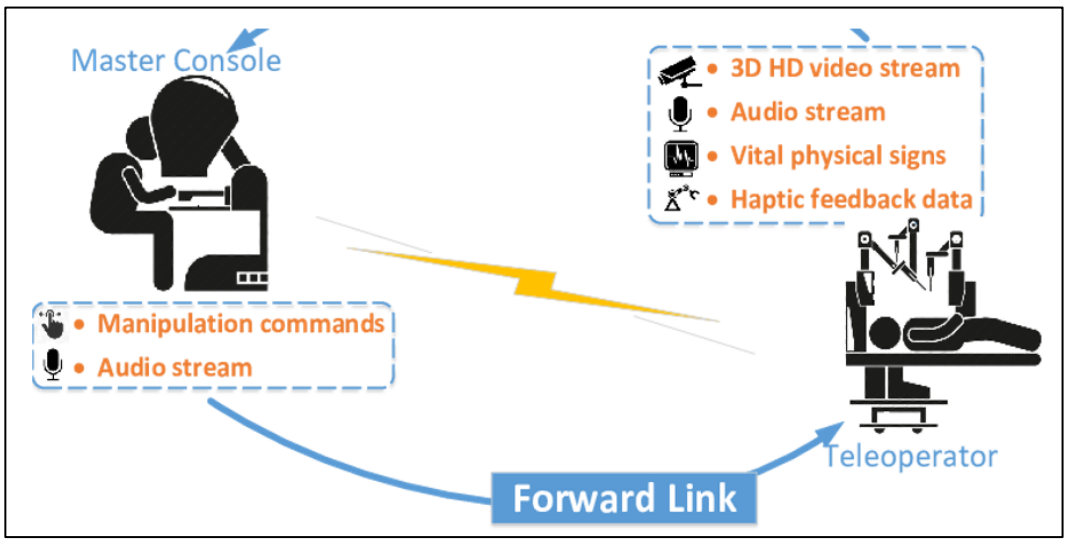

Fig 2: Communication between the master console and tele-operator

VII. Healthcare

Prior wireless communication systems lacked electronic healthcare due to low data rates and timing issues. As demonstrated in Fig. 2, 6G will enable the existence of remote surgeries by offering secure connections, ultra-low latency, enormous data speeds, and high dependability via AI. Furthermore, the short wavelength of the THz band facilitates communication and the creation of nano-sensors, allowing the development of autonomous nanosized devices that may work within the human body [4].

4. The primary requirements of 6G networks:

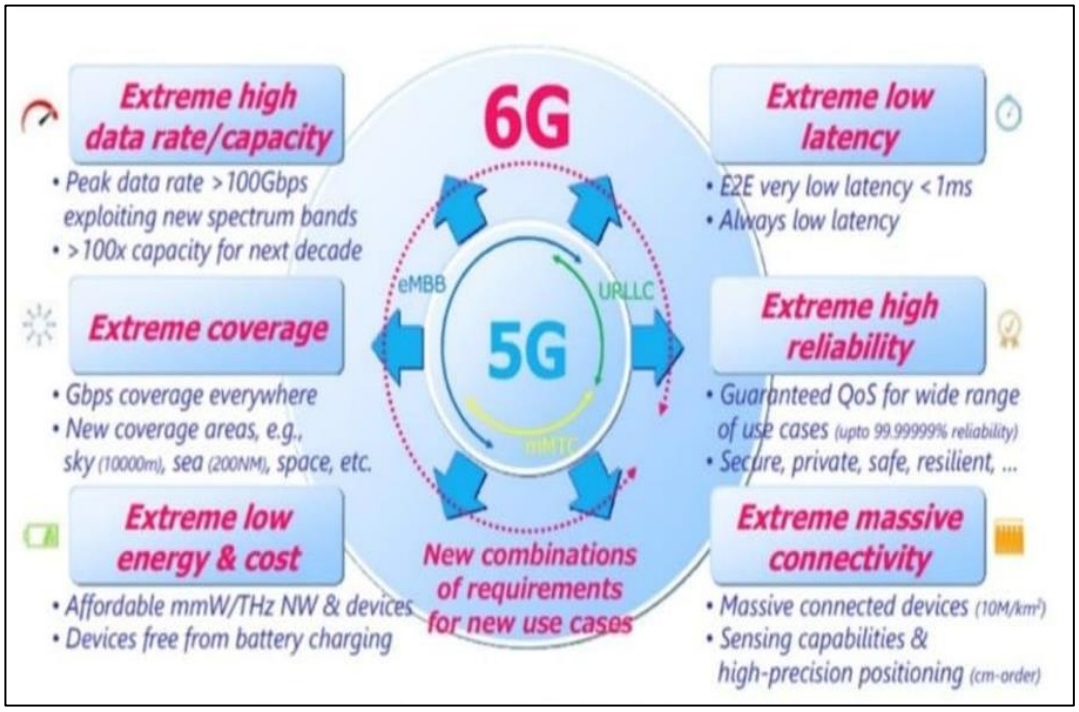

Fig 3: The Requirements of 6G networks

Architecture of 6G System:

The purpose of 6G mobile networks is to offer high-speed wireless connectivity, ubiquitous intelligence, and processing capability in the air, space, and seas. Satellite and underwater communication networks will be combined in order to enable network coverage all around the planet [5,13].

In 6G mobile networks, a super-fast service with data rates up to 1000 Mbps is needed [11,14]. 6G needs include holographic communication, dependability, low latency, and so on [5,15]. The essential conditions for 6G networks are given in Fig. 3 [16]. Using smaller cells and higher frequency bands are potential choices. Larger power consumption and higher operational costs will come from smaller cell sizes, and route loss may be suffered by high frequency bands. As a consequence, we must establish a limit on how far we may

lower cell size and widen frequency bands [20,21]. In a completely decoupled RAN, multi-point coordination and centralized resource management may be used to provide elastic resource cooperation [14]. To allow smart applications, 6G will make extensive use of sensor, networking, and computing technology.

5. Evolution of network

The transition of 1G to 4G

The main role of the 1G network in the 1980s was to deliver solely voice communications. It transfers data using analog modulation methods rather than a specific wireless protocol. To provide voice and text messaging capabilities. A lot of individuals currently utilize GSM mobile communication.

1G was the first generation of wireless cellular technology, enabling communication between compatible devices but limited to voice calls due to interference and lack of roaming functionality.

2G technology improves phone conversations, data services such as SMS and MMS, and roaming, allowing users to answer calls and send/receive text and multimedia material while on the road.

While 3G pioneered mobile television, online radio services, and phone emails, it was video calling and mobile phone applications that truly characterized the 3G era.

3G laid the groundwork for 4G, the current mobile network generation, enabling high-definition voice and video calls, improved data rate, and advanced multimedia services, and perfecting the LTE system.

The ongoing development of 5G

5G is expected to cater to both smartphone users and enterprises due to its improved data speeds, low latency, and high throughput. Because of advances in technology and a high-security architecture, data speeds may increase as 5G network rollout nearby.

The upcoming of 6G

India plans to launch 6G services in early 2024, using indigenous infrastructure, to optimize and reduce costs for 5G use cases, such as the metaverse, which is expected to disrupt traditional and digital spaces. 6G communications is a more efficient technology compared to 5G.

It offers high data throughput, ultra-low latency, and network availability over 99.99%. 6G can accommodate devices per km and deliver services like enhanced Mobile Broadband, ultra-massive Machine Type Communication, and more. Emerging technologies like Federated Learning, Intelligent Edge computing, and Quantum Communications will enable next-generation communication networks.

Issue	4G	5G	6G
Per device peak data rate	1 Gbps	10 Gbps	1 Tbps
End-to-end (E2E) 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
XR	No	Partial	Fully
Haptic Communication	No	Partial	Fully
THz communication	No	Very limited	Widely
Service level	Video	VR, AR	Tactile
Architecture	MIMO	Massive MIMO	Intelligent surface
Maximum frequency	6 GHz	90 GHz	10 THz

Fig 4: 6G Communication System vs. 4G and 5G Communication Systems.

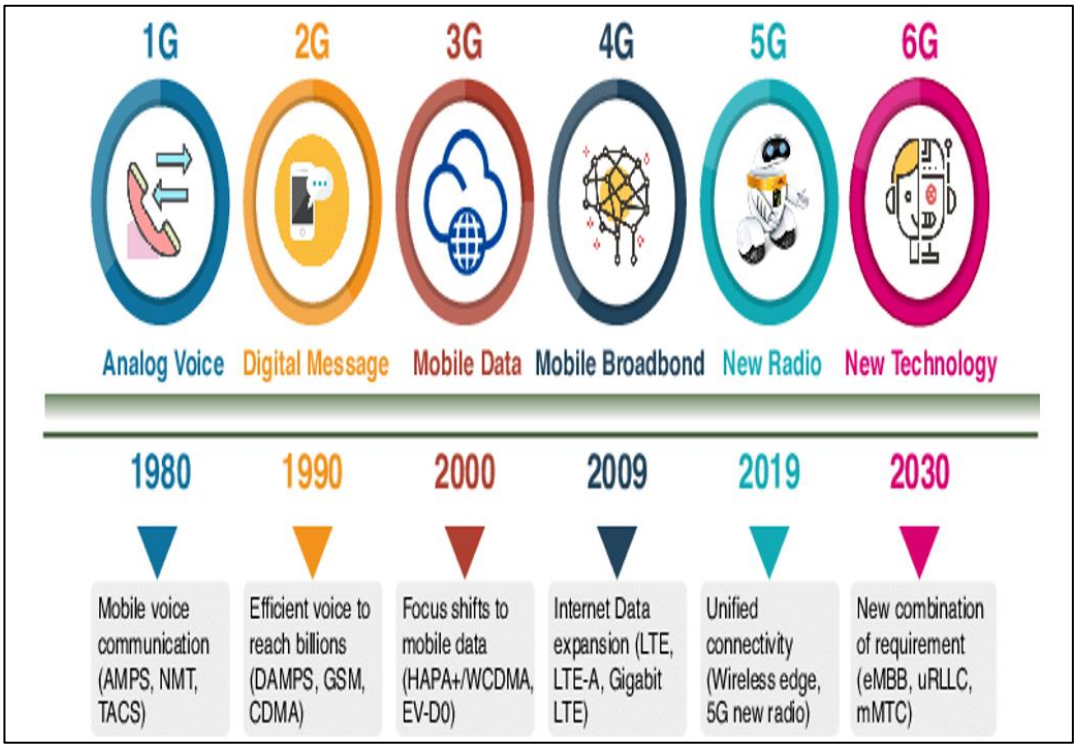

Fig 5: The evolution of 6G Technology

6. Future Perspective:

With the upcoming of 6G AI and humans will be connected in factory. In addition, some sectors, certain conditions will not need human aid. Nowadays, the majority of factories must be speedy, and secure. These facilities contribute in the improvement of the industrial process. They can balance demand and market supply intelligently [1]. They can predict when 'machines' will require maintenance. Large international corporations may remotely monitor their plants using global control centers.

Future wireless communication is projected to allow various advanced applications, one of them being the factory of the future. To operate businesses remotely, new XR tools and human senses detecting technologies are essential. Digital twins will be deployed to supply equipment, gadgets, robotics, and network. A vast volume of data will be sent between devices and collected by humans in the control center [12]. Self-healing factories are an absolute necessity. These challenges need the development of specialized wireless networks. To tackle latency and capacity concerns, D2D will be made accessible in 6G. For high-accuracy positing (1 cm), better localization and procedures powered by the 6G network will be essential.

7. Conclusion:

Technology has a great influence on human lifestyle. Mankind is constantly striving to provide many solutions to various problems and new paths to growth.

Because of this human urge, wireless communication has progressed from 1G to 5G. However, the evolution is not over. Many elegant applications are being included now that 5G wireless communications technology is accessible.

Researchers and Scientist throughout the globe are working hard to introduce 6G network communication by 2030.

On the other side, 5G criteria are far from combining the needs for the development of new technologies. We examined major issues of 6G wireless networks from different viewpoints in this article. Finally, the prospects and research difficulties for next-generation communication networks are addressed on the way to commercialization.

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