

A Review of Vision and Challenges of 6G Technology

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Abstract—With the accelerated evolution of smart terminals and rising fresh applications, wireless information traffic has sharply enhanced and underway cellular networks (even 5G) can't entirely compete the rapidly emerging technical necessities. A fresh framework of wireless communication, the sixth era (6G) framework, by floating aid of artificial intelligence is anticipated to be equipped somewhere in the range of 2027 and 2030. This paper presents critical analysis of Vision of 6G wireless communication and its network structure; also outline a number of important technical challenges, additionally some possible solutions related to 6G, as well as physical layer transmission procedures, network designs, security methods.

Keywords—Wireless communication; visions; 6G; cellular network; generations; digital technology; satellite networks; cell less architecture

I. INTRODUCTION

In spite of the fact that 5G is still in the underlying phase of commercial scale, i.e., related technical features need to be further enhanced and the business model of Internet of Things and vertical industry application situations should be additionally investigated, it is also mandatory for us to synchronously look forward to the communication needs of the future information society and start the idea and technology research for the next generation mobile communication system [1]. Here we try to analyze the necessity of the immediate start-up of the concept and technology research on the next generation mobile communication system referred to as 6G.

A 6G mobile network system requires to deliver extremely fast speed, increase capacity then non-proximity in order to support the likelihood of fresh applications, as vigorous medicine, computer disaster forecasting plus virtual reality (VR). In light of the previous pre-regulation on mobile networks, the first 6G links will be based mostly on the current 5G structure, benefiting from the advantages obtained in 5G (for example, the increase in allowed frequency bands also optimized the design of a decentralized system) and change the means we chore and play [2]. About 2030, our audiences are probable to be affected by data, allowing immediate and limitless wireless connectivity. As an outcome, 6G should promote wireless technologies we know nowadays and attain system prosecution. As an idea aimed at the upcoming, in terms of speed, 6G is likely to use an advanced frequency spectrum than preceding generations to advance the

data throughput estimated at 100 to 1000 times quicker than 5G [3]. To be precise, 6G systems will let hundreds of GBs per second to connect to the second using broadband spectrum; for instance, the combined usage of a band from 1 to 3 GHz, a millimeter wave band (mm wave) (30 to 300 GHz) and a terahertz band (0.06 to 10 THz).

In 1926, the visionary Nikola Tesla announced: "When the wireless connection is fully applied, the Earth will be full of incredible brains ..." In 2030, inspired by the basic needs on a personal and social level, and depends on is the expected progress. Information and Communication Technology (ICT), Tesla predictions can come from all over the world and 6G will perform a specific part in this progress by giving an ICT framework that will allow end users to be enclosed by a "huge artificial brain." It offers virtual storage services, unlimited storage and mass cognition capabilities [4]. This document presents a 6G vision and also analyzes the possible challenges associated with 6G.

II. 1G TO 5G

The cellular wireless Generation (G) usually mention to an alteration in the complexion of framework, speed, technology and frequency. Individually generation devours roughly standards, capacities, techniques, also novel characteristics which separate it as of the past one.

A. First generation (1G analog technology)

The first generation mobile (1980-1990): It assisted data rates beginning 1 KBps to 2.8 KBps and utilize a circuit switch. It used an output technology called Analog Phone Service. It used a bandwidth of 40 MHz and a frequency range of 800 to 900 MHz, Only the sound will support. It used Frequency Division Multiplexing. It delivered little quality calls. The energy consumption was high. It distressed from some disadvantages, as deprived sound connections, poor data capacity, lack of security and untrustworthy transfer [5].

B. Second generation (2G digital technology)

It depends on the GSM or, in other words, on the global mobile communications system. It was promoted in Finland in 1991. These were the first digital cellular networks, with some evidence of the output networks they replaced: better standard, better safety. 2G technologies have been replaced by digital technologies for digital communication by providing services for example text messaging, photo messaging and MMS. Entirely text messages are digitally encoded in 2G technology.

This digital encryption permits you to exchange your data so that the intended recipient does not understand them and does not understand them. There are 3 dissimilar kinds "FDMA, TDMA / GSM and CDMA" of 2G mobile techniques offered with diverse operational techniques, characteristics and terms [6].

C. Third generation (3G)

The third generation of mobile transmission systems offers 144kbps great speeds and more for high speed data. It conforms to improvements in older wireless technologies, such as "high speed transmission, high multimedia access and global roaming". 3G is commonly utilized for mobile phones and headphones as a way to link the telephone to the Internet or other IP networks to provide voice and video calls, download and data, plus surf the web. 3G will help multimedia applications such as complete video movement, videoconferencing as well as Internet access. Data is directed via technology named packet switch. Telephone calls decrypted by circuit switch. It is a very modern process of communication that has evolved over the past era [7].

D. Fourth generation (4G)

4G mobile communication framework was presented in the late 2000s and was an IP organize framework. The primary objective of 4G innovations is to give great quality, great capacity, and minimal effort security administrations for voice and information, sound and Internet services through IP administrations. The aim of modifying all IP addresses is to have a shared platform for all the innovations advanced to date. It has a capacity of 100 Mbps and 1 Gbps. To utilize the 4G mobile network, multimodal user terminals must be clever to select the wireless destination system. To deliver wireless service anytime, anyplace, terminal portability is an important influence in 4G. Terminal mobility suggests automatic roaming among dissimilar wireless networks. 4G technology coordinates a number of present and future wireless techniques such as "OFDM, MC-CDMA, LAS-CDMA and Network-LMDS" to deliver liberty of drive and continuous roaming from one technology to a different. LTE "long-term evolution" and Wi-MAX "wireless interoperability for microwave access" are pondered 4G technologies. The initial triumphant fourth generation field test was coordinated in Japan in 2005 [8].

E. Fifth generation (5G)

In 5G, research focuses on the progress of a "World Wide wireless Web (WWW), dynamic ad-hoc wireless networks (DAWN) and real wireless communication". The utmost significant techniques for 5G technologies are "802.11 wireless networks in local areas (WLAN) and wireless networks in an urban area (WMAN), an ad hoc wireless personal area network (WPAN) and networks wireless for digital communications". 5G feature provides AI capabilities to portable devices [9].

III. 6G VISIONS

Since 5G has not yet been launched economically and there are still no excellent applications, it seems very convincing to discuss the 6G prerequisites [10]. The necessities for 6G will track the next technological models, as

"smart cars and smart assembly". On transportation as well as manufacturing, a large network of smart means of transportation and robots will need a mobile broadband network as well as an "ultra-high rate wireless with excellent reliability and ultralow latency, giving new kinds of mobile-as-a-service and mobile-as-manufacturing applications".

There are some visions described in this paper according to different prospective and requirements of 6G wireless technology.

A. A framework of 6G founded on the space resource use, frequency, time

Fig. 1 describes 6G will use an advanced frequency spectrum than preceding generations to advance speed of data in the frequency dimension. On one needle, great frequency bands, as "mm wave band, terahertz band and visible light frequency band" will be utilized for a transmission of 100 GB / s + in 6G. On the next needle, in the forthcoming, "mobile networks with satellite systems and the Internet may be integrated to build integrated networks", which will gain the frequency, sorts on behalf of services from a point of view of individual mobile communication. In the spatial dimension, to benefit more from multi-channel, the number of antenna devices prepared in equally the transmitter then the receiver will be amplified. MIMO residue techniques (PM-MIMO), as the ultra-huge MIMO (UM-MIMO) for terahertz communication, can help hundreds or thousands of antennas to transmit / receive. In the time dimension, 6G will provide promising change to weak and structural. In addition, the 6G time slot unit can be coherently trodden to further proficiently utilize the higher frequency bands and respond to subtle services. As particle time improves, the flexibility also versatility of the systems will be better also thus ease their compatibility with 2G to 5G [11].

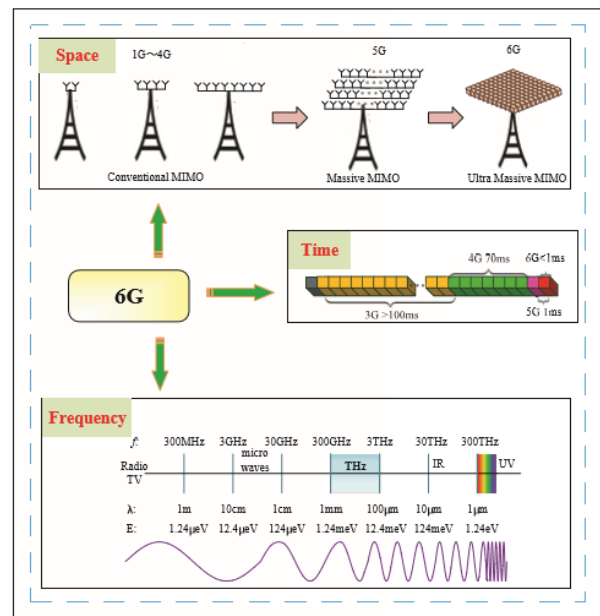


Fig. 1. A framework of 6G founded on the space resource use, frequency, time [11]

B. 6G with Satellite Network

The 6G mobile system for global coverage will be coordinated 5G mobile wireless system plus the satellite network. Such satellite networks include a "satellite communications network, an Earth image satellite network and navigation satellite network". The telecommunications satellite is utilized to transmit voice, data, the Internet and video; the data from the earth imaging satellite network is used to collect climate and environmental data and the satellite navigation network to the global positioning system (GPS). The four republics that built such satellite systems are GPS by the USA. The Compass framework built by China, the "Galileo system" by EU plus the Russian Glonass system [12]. The core objective of 6G is to deliver mobile phone users with a variety of services as a network identifier in a variety of locations, multimedia applications and accessibility to the Internet association for mobile users with a speed of high data without interrupting the network. Below Fig. 2 shows the satellite network with 6G.

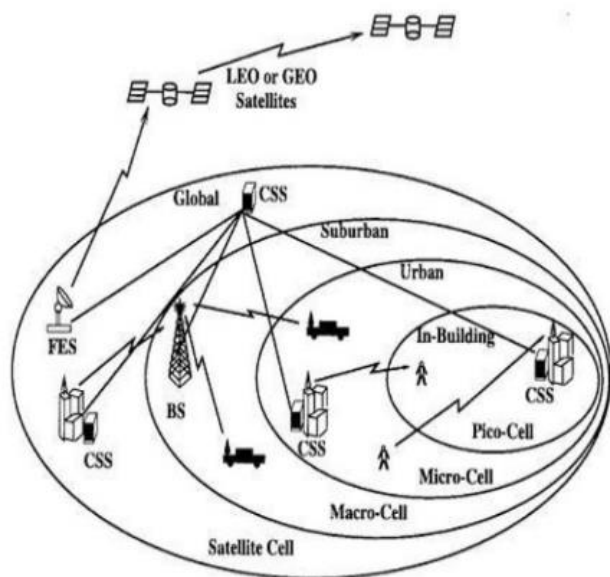


Fig. 2. 6G with Satellite Network [13]

It will provide extremely fast access to Internet services with fantastic data rates of up to 10-11 Gbps. It offers a complete wireless network without borders. Inadequate connectivity between network clients to provide incredible transmission speeds in the Terabit range. Maximize data and IOPS (input and output per second operation) [13].

C. 6G connectivity vision

According to Fig. 3 6G vision can be summarized into four main words "Intelligent Connectivity", "Deep Connectivity", "Holographic Connectivity" also "Ubiquitous Connectivity". These four main words organized establish the 6G general vision of "Wherever you think, everything follows your heart".

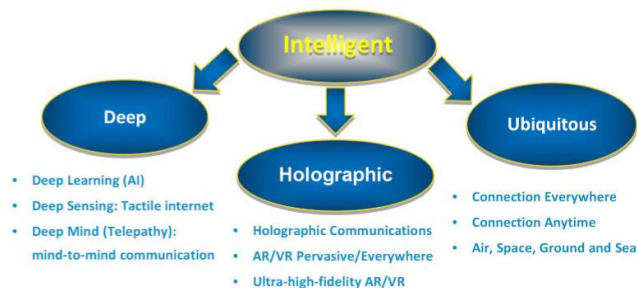


Fig. 3. 6G vision [15]

We believe that building 6G network based on AI technology will be an inevitable choice, and "Intelligent" will be the inherent feature of 6G network, namely the so-called "Intelligent connectivity". 6G networks will face many challenges: more complex and huge networks, more types of terminals and network devices, and more complex and diverse business types. "Intelligent Connectivity" will meet two requirements at the same time: on the one hand, all the related connected devices in the network itself are intelligent, and the related services have been intelligent; on the other hand, the complex and huge network itself needs intelligent management. "Intelligent Connectivity" will be the basic characteristics supporting the other three major features of 6G network: Deep Connectivity, Holographic Connectivity and Ubiquitous Connectivity. We expect that in the next 10 years (2030 ~) of 6G systems, access requirements will evolve from deep coverage to "Deep connectivity". Its characteristics can be summarized as follows: Deep Sensing: Tactile Internet, Deep Learning/AI: Deep Data Mining, DeepMind: Telepathy, Mind-to-Mind Communication. It can be expected that in ten years (2030 ~), the media communication will be mostly planar multimedia, higher fidelity AR/VR interaction, even holographic information interaction, also wireless holographic communication will become a genuineness. High fidelity AR/VR will be ubiquitous, as well as holographic communication and display can also be carried out at anytime and anywhere, so that people can enjoy fully immersed holographic interactive experience at any time and place, that is, to realize the communication vision of so-called "holographic connectivity" [14]. "Anytime, anywhere" connection requirement ten years later (2030 ~), that is, to achieve real "Ubiquitous connectivity", a vast" world will become more and more accessible. Future 6G visions, "Intelligent Connectivity" is the brain then nerve of the 6G network, while the other three characteristics of "Deep Connectivity", "Holographic Connectivity" and "Ubiquitous Connectivity" establish the trunk of the 6Gnetwork. These four characteristics together make the future 6G network a complete organic whole with "soul". In the future, the communication system will be further developed and enhanced on the basis of the existing 5G. The information will break through the curb of time and space, the network will close the distance between all things, the seamless integration of human and all things will be realized [15].

wireless communication will support random communication. **Smart healthcare:** 6G systems will ease a consistent remote monitoring system in the healthcare system. Even remote surgery will be possible thanks to 6G communication. Lager data speed, less failure, and a very consistent 6G network will aid transport large amounts of medical data quickly and reliably, which can advance access to upkeep and eminence of care. **Automation and industrial:** The term automation references to "automatic control of processes, devices and systems ". 6G automated systems will offer "highly reliable, scalable, and secure communications using high-speed, low-intelligence networks ".

Information transfer in the five senses: This technique applies from the neurological procedure to sensory integration. It regains the feelings of the human physique as well as the environment and utilizes the body efficiently in the surroundings and in native conditions. BCI technique will efficiently improve this application. **Internet of everything:** The 6G system will support the complete IoE system. It is essentially an Internet of Things (IoT), then it is a general word that assimilates four characteristics, as "data, people, processes also physical devices", into a framework [19].

IV. COMPARISON BETWEEN 5G AND 6G

A valued comparison of 5G and 6G communications is shortened in Fig. 6 [21]. We first assume that the electrical competence of 5G was previously close to the border with progress in a huge MIMO, network compaction and millimeter wave transmission, for example, similarly a series of legacy multiplex methods acquired from 4G. As the limits of Shannon are limited, it is unlikely that the spectral efficiency in 6G will improve on a large scale. On the contrary, 6G communications should significantly improve security, privacy and confidentiality with novel techniques. In 5G networks, customary encryption algorithms founded on the main "Rivest-Shamir-Adleman (RSA)" public crypto-sms are still used to ensure the security and confidentiality of transmissions. RSA crypto-spores are uncertain about the pressure of Dig Data and artificial intelligence technologies, much less than the privacy mechanisms that weren't developed in the 5G era.

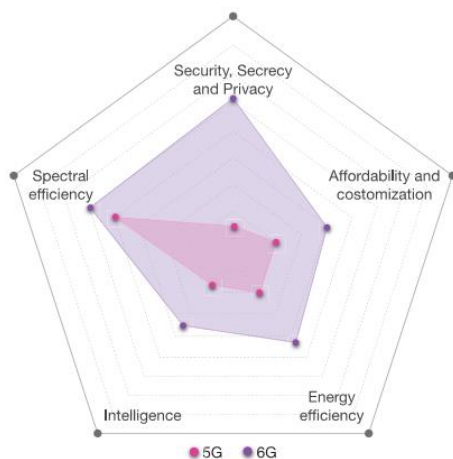


Fig. 6. Comparison among 5G and 6G communications [21]

TABLE I. A COMPARISONS OF 5G AND 6G KPIS [22]

KPI	5G	6G
Traffic size	10 Mb/s/m ²	~ 1-10 Gb/s/m ³
Downlink data rate	20 Gb/s	1 Tb/s
Uplink data rate	10 Gb/s	1 Tb/s
Uniform user experience	50 Mb/s, 2D everywhere	10 Gb/s, 3D everywhere
Latency (radio interface)	1 ms	0.1 ms
Jitter	NS	1 μs
Reliability (frame error rate)	1-10 ⁻⁵	1-10 ⁻⁹
Energy/bit	NS	1 pJ/b
Localization accuracy	10 cm in 2D	1 cm in 3D
NS: not specified		

The KPIS summarized in Table I [22], which highlights essential improvements through admiration to 5G KPIS. More or less KPIS, as delay jitter and energy per bit, are not definite in 5G, as they do not truly signify an emphasis of 5G, whereas they are important KPIS for 6G.

V. 6G ISSUES AND SOLUTIONS

A. Limits on Flexible Radio Access

Cell size plus carrier frequency may limit the OFDM numerology option [23]. On one arrow, utilize of numerology with the extensive subcarrier spacing is usually further appropriate for minor cell sizes owing to its smaller delay extensions than large cell increases. On the other hand, large quantities of digital cells can be used with a larger space subcarrier, but at a lower performance cost. It is similarly significant to remember that the size of cells with high frequency carriers is restricted because of problems of route propagation and Doppler propagation in case of high mobility [24].

B. Network security issue

Security is a serious concern for 6G wireless networks, specifically when using the Terrestrial Space Integrated Network (STIN) technique. In 6G, in addition to traditional physical series safety, other forms of privacy, as cohesive network security, must be measured together. A novel approach to security, which depends on little difficulty and a high level of security, must therefore be intensified. To this conclusion, certain physical layer security techniques intended for 5G can be protracted to 6G systems, for example, a secure MIMO mass based on low density parity control (LDPC); Mm-Wave Safe techniques can also be used for "UM-MIMO and THz band applications". When it comes to integrated network security, it is very important that there is an appropriate management purpose for diverse function means for diverse security domains. A central distribution management mechanism is a promising mechanism for STIN which takes into account the management of multicultural and certificate less communication keys. With the efficient administration and application, these physical and network layer security methods can combine this integrated security solution, which effectively protects confidential information and confidentiality on 6G networks [11].

C. Resource as a Service (RaaS)

The advent of software networking (SDN) and network functionality verification (NFV) eases the evolution towards an integrated resource-oriented resource allocation called RaaS. The result is a perception of network splitting to generate virtual networks across the physical infrastructure. It permits mobile operators or service suppliers to assign virtual network resources to encounter precise service needs. Programmable metro conditions and software specificities will probably be part of the network's resources. Therefore, only NFV development trends during the 6G cycle will contain the network screening with programmable software and surfaces defined by the metro, from a machine-activated cloud access network (C-RAN) to free [25].

D. Heterogeneous High Frequency Bands

The use of mm-Wave and THz in 6G presents a number of new open problems. For mm-Wave, support for high movements at mm-Wave frequencies will be an open central problem. In the case of THz, new models of architecture and propagation are necessary [26]. The great power, great sensitivity and low noise of the transmitter required to overcome the THz loss on the high path are key features. Once these elements of the physical series are well understood, network layer protocols and new connections must be developed to enhance the utilization of cross-frequency resources, captivating into account the extremely variable also inexact nature of mm-wave and THz environments. Alternative significant way is the learning of the coexistence of THz cells, millimeter waves and microwaves in each series [27].

E. Tactile Communications

Next using holographic communication to translate virtual views near to the reality of people, actions, environments, etc. It is advantageous to remotely exchange a physical communication via a real-time Internet connection [28]. The expected services include telecommunications, the automated collaborative reader and interpersonal communication, which should allow the application of random control across communication networks. The efficient design of the communication system between the rows must be carried out to meet these strict requirements. For instance, new physical layer diagrams (PHY) must be established, for the design of signaling systems, the congestion of waveforms, etc. to improve transfer and motivated protocol. Wireless communication systems cannot meet these requirements and wireless fiber communication systems are required [29].

VI. CONCLUSION

In this document, we have discussed current then upcoming generations of wireless communications. We present a general description of the technologies that will characterize 6G networks. 6G networks will embrace new spectrum bands, combining advances across the network, from the circuit and antenna design to network architecture, protocols and artificial intelligence. Finally, we highlight a number of issues in 6G communication systems, which we hope will inform future development. We noticed that 6G networks considered by their flexibility also versatility and

that the sketch of 6G networks is a very ordered scientific arena.

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