TEST Engineering & Management

January - February 2020
ISSN: 0193-4120 Page No. 16695 - 16700

A Review on 6G Wireless Communications

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Article Info
Volume 82
Page Number: 16695 - 16700
Publication Issue:
January - February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 29 February 2020*

Abstract

The fast development of smart as well as emerging real-time applications increases the wireless data traffic. The current fourth generation (4G) cannot completely match the rapid increase of technical requirements of future cellular networks. Although, the fifth generation (5G) will be deployed commercially soon but there is even greater requirement for high data rate (Tbps), less latency and large expansion of internet of things (IoTs). This motivates for sixth generation (6G) wireless communication which is under way in different organizations and countries. Thus, to meet the future challenges and satisfy the next future intelligent applications, the 6G cellular network will be the able to cast the high technical standard, new spectrum and energy efficient techniques. This paper presents the developments features, architecture and requirement implementation of 6G wireless communication network. The paper also describes the comparisons of all mobile generations. key issues for 6G wireless communication. Moreover, the key issues, applications of 6G wireless communication in various fields have been described.

Keywords; *fifth generation (5G), sixth generation (6G), internet of things (IoTs)*

I. INTRODUCTION

To allow the huge traffic, in early years, the various industrial and academic researchers are developing technologies and creating new telecommunication standards for fifth-generation (5G) cellular mobile communication. The 5G can be used to provide high data rate (1Gbps with enhanced mobile broadband), connection of about 1 million per kilometre square machine type devices in internet of things (IoTs) with massive machine type communication and reliability as well as latency of around 99.999% using ultra-reliable low latency communication for real world applications. But the concept of ten-year horizon motivates towards six-generation (6G) wireless communication on the end of 5G deployment. The extensive research of 6G is on the way as new network for 2030 and beyond has been established by international telecommunication union (ITU) to guide the information and communication technology [1],[2]. The need of 6G over 5G wireless communications is due to the attractive features of 6G. Some of key features of 6G are as follows: [3], [4].

• High data rate up to 1Tbps.

• High energy efficiency to support battery free IoTs free connected devices.

• Low latency approximately less than 1ms

• Broad frequency band i.e. 73 GHz-140GHz and 1THz-3THz.

• Global ICT facilities

• Intelligent and machine learning capability.

• Space and underwater communication capabilities

Various researchers and scientists are now more focus on 6G developments. In [5], the vision for 6G wireless communication to cater the rapid demand for internet of everything (IoE) in viewpoint of time space and frequency has been presented. The major challenges in 6G such as hardware design, power supply and network security are discussed to guide

Published by: The Mattingley Publishing Co., Inc.

January - February 2020
ISSN: 0193-4120 Page No. 16695 - 16700

for future developments. Some major features such as flexibility, versatility and design of 6G wireless network are helpful in medical, chemistry, biotechnology and semiconductors research areas.

Theodore S. Rappaport et. al. provided the fundamental approaches, opportunities and challenges to create the 6G era above 100GHz in 2025-2035 time span. For this, directional steerable antennas will be the suitable choice for THz frequency. Further, imaging and sensing will enable for THz band for 6G in urban and rural areas in non-line of sight environment with cost effectiveness, energy efficient devices etc. [6].

In [7], new services and technologies have been highlighted for 6G wireless communications. The visible light communication and THz methods at physical level can make the 6G as powerful enablers. For this multi-radio access technologies (RAT) and multilink methods are needed to handle the issues for propagation in THz band for high reliability.

Thus to understand the way for 6G wireless communication and beyond, the vision of 6G has been discussed in this paper. In this paper, section 2 describes the 6G system architecture, requirements and comparison from 1G to 6G. Section 3 and 4 presents the potential applications and key issues in 6G development respectively. In section 5, conclusion is discussed.

II. 6G NETWORK ARCHITECTURE:

The 6G communication network architecture has numerous terminal users within small geographical areas that provide the ultra-dense base stations (BSs) and access points (APs). Fig. 1 shows that 6G network architecture which is cell-less architecture. The figure shows that various devices will be employed simultaneously by multiple BPs/APs with effective handoff and frequency allocation management. This will be a distributed multiple input multiple output (MIMO) massive system. APs are considered as remote radio heads (RRHs) which are served by each device. This architecture consists of very fast central processing units to assign resources to APs. Here, high frequency bands (mmWave or beyond) will solve the problem of spectrum ability [8], [9].

2.1 Requirements for 6G

The basic 6G requirements are as follows: [10],[11].

• High data rate (1Tbps) i.e. 100 times of 5G: It is expected to provide the spectral structures need the THz wireless front haul and backhaul data rate upto 10Tbps.

• User-experienced data rate (1Gbps) i.e. 10 times of 5G: Again, for indoor hotspots, it is expected to provide the 1Gbps user-experienced data rate.

• Need low latency (10-100microsec) and high mobility (>1000km/h):

This will provide acceptable quality of services for airlines systems.

• High connectivity density i.e. 10 times of 5G: For hotspots structures, the traffic capacity will increase up to 1Gb/s/m2.

• High energy efficiency means 10-100 times of 5G is needed.

• High spectral efficiency means 5-10 times of 5G is needed.

To fulfil all these requirements for 2030 intelligent wireless communication network 6G will provides excellent network capabilities [10], [12].

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January - February 2020
ISSN: 0193-4120 Page No. 16695 - 16700

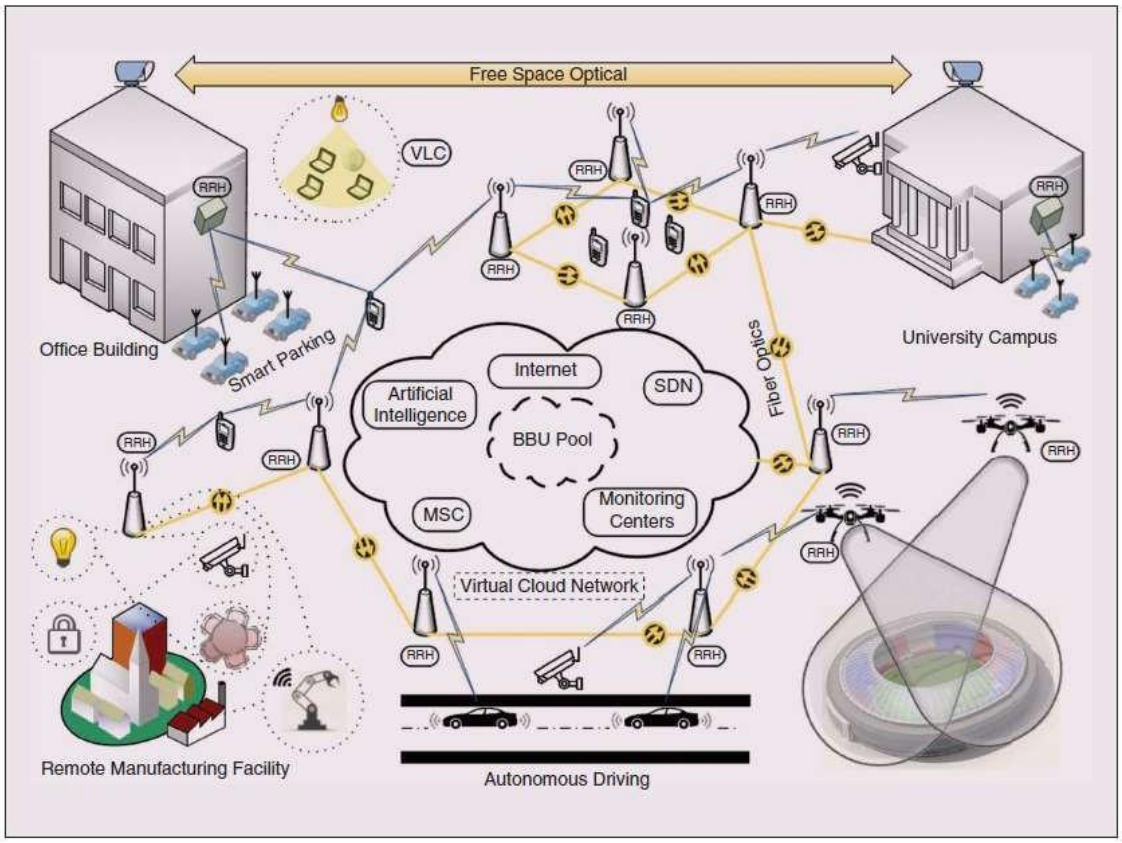

Fig.1: 6G network architecture. BBU: baseband unit, SDN: software-defined network, MSC: mobile switching centre [9]

The comparison of various wireless mobile communication generations from first generation to six generation has been discussed in Table 1 as follows:

Table 1: Comparison of wireless communication generations from 1G to 6G [13], [14].

S.No.	Features	1G	2G	3G	4G	5G	6G
1.	Year of development	1970-1980	1980-1990	1990-2000	2000-2010	2015 onwards	2030 onwards
2.	Data rate (bps)	2.4K	64K	2M	200M-1G	>1G	10-11G
3.	Technology used	Analog	Digital	Broadband code division multiple access (CDMA) and internet protocol (IP)	IP and local area network (LAN), wireless area network (WAN), wireless local area network (WLAN), personal area network (PAN)	4G and world wide web (WWW)	5G and satellite communication

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ISSN: 0193-4120 Page No. 16695 - 16700

4.	Standard	Advanced mobile phone service (AMPS)	Global system for mobile communications (GSM), enhanced data rates for GSM evolution (EDGE), general packet radio service (GPRS)	CDMA 2000,wireless code division multiple access (WCDMA)	Long term evolution (LTE), worldwide interoperability for micro wave access (WiMAX)	Large area synchronized code division multiple access (LAS-CDMA), orthogonal frequency division multiple access (OFDM), ultra-wide band (UWB), internet protocol version 6 (IPv6)	Global positioning system (GPS), global satellite navigation system, (GLONASS), Galileo systems
5.	Multiplexingtechniques used	Frequency division multiple access (FDMA)	Time division multiple access (TDMA)and CDMA	CDMA	CDMA	CDMA	CDMA
6.	Switching Methods	Circuit switching	Packet and circuit switching	Packet except circuit switching with air interface	Packet switching	Packet switching	Packet switching
7.	Handoff Type	Horizontal Handoff	Horizontal Handoff	Horizontal & vertical Handoff	Horizontal & vertical Handoff	Horizontal & vertical Handoff	Horizontal & vertical Handoff
8.	Services used	Voice	Digital voice, short message service (SMS), packetized data	Integrated data, audio and video	Dynamic information and wearable things	Dynamic information and wearable things with artificial intelligence (AI)	Very fast internet access

III. APPLICATIONS FOR FUTURE 6G:

The era of 6G has lots of high degree of wide range new heterogeneous applications. These are as follows:

• Big Data: Big data analytic is the first application of AI. In 6G four types of analytics such as descriptive, diagnostic, predictive and prescriptive can be applied to protect the data privacy, integrity, and security with laws and regulations to make a proper balance between risk and benefits [3], [14].

• Intelligent communications: To make the wireless communication system more reliable, efficient with combination of channel and hardware impairments various design parameters must be controlled and optimized. This can be done in 6G paradigm of intelligent physical layer which is capable of self-

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January - February 2020
ISSN: 0193-4120 Page No. 16695 - 16700

optimization and self-learning by combining the sensing and AI technologies [3], [15].

• VLC: VLC system is used in visible band (400-700nm) band and consists of light emitting diode (LEDs) for high speed wireless communication. Due to the numerous advantages of using in THz band, free from electromagnetic interference, environment friendly and cost effective communication can be utilized for 6G [16].

• Advance AI: Due to the advancement of big data, AI and deep learning has become the active research area. AI will be integrated into 6G fully. Some of applications are smart edge networks, super internet of things smart industry, transportation having self-evaluation, flexibility, maintainability and energy efficient properties [16], [17].

• Space, ground and sea integration system: The integration of space, ground & sea integrated system extends the range of communication on the basis of cellular network. The space-ground-sea integrated network connects satellites and ground mobile and internet communication system for global coverage. It can be used for various communications such as emergency conditions, IoTs, terrain and broadcast services [16].

IV. KEY ISSUES IN 6G DEVELOPMENT:

In 6G development there are some key issues. These are as follows:

• Network Security: It is the one of the critical challenge in 6G. It consists of physical layer and integrated network layer security. The new securities approaches must be of low complexities with high securities levels. One of the security technique is low-density parity check (LDPC) [5].

• Power Supply: In future communication technologies, it will become more necessitates making a simple power efficient 6G network for continuous growth of mobile applications. For this different wireless energy harvesting method as well as passive components can be used [5].

• Hardware Design: For 6G development, large numbers of high frequency i.e. upto THz transmitters and receivers are required. For this, mmWave and terahertz band from nanometres to micrometres antennas are required. For this, on chip optoelectronics integration, advance high speed semiconductors and antenna techniques can be used [5].

• New theories & technologies: To realize the 6G in reality, wide spectrum resources are needed. For this some basic concepts, theories and technologies including sampling methods, channel coding & modulations needed to be broken for the requirement analysis of 6G [16].

• Non-technical: Spectrum allocation and regulations for using 6G system spectrum requires the coordination allocation of different regions and countries around world for uniform spectrum band. Further, satellite communication will face more policies and rules restrictions. This should be solved globally as it is very complex problem. Also, the 6G era will face customers usage habits as a challenging problem because users thinking hobbits need to be change quickly for adapting new rules and regulations [16].

V. CONCLUSION

In this paper, 6G wireless communication is summarized an intelligent and universal connected network. The architecture and requirements of 6G are discussed including key issues such as network security, power supply, hardware design, non-technical issues and new theories and technologies. Then the applications of 6G are discussed: big data, intelligent communication, VLC, advance AI, space, ground & sea integration system and deep sea communication.

As the future will be totally based on data oriented societies through which users connect through internet of everything (IoE) to form a connected universal. The 6G vision is an innovative and attractive candidate for future communication

Published by: The Mattingley Publishing Co., Inc.

January - February 2020
ISSN: 0193-4120 Page No. 16695 - 16700

system. The 6G wireless communication will surly provide the THz frequency range, support approximately more than 1000 nodes per person and having instant connectivity anywhere and anytime in spite of various key issues.

REFERENCES:

[1] S. J. Nawaz and S. Member, "Quantum Machine Learning for 6G Communication Networks : State-of-the-Art and Vision for the Future," IEEE Access, vol. 7, no. Ml, pp. 46317–46350, 2019.

[2] L. Zhang, Y. Liang, and D. Niyato, "6G Visions : Mobile Ultra- Broadband , Super Internet-of-Things , and Artificial Intelligence," China Commun., vol. 16, pp. 1–14, 2019.

[3] K. B. Letaief, W. Chen, Y. Shi, J. Zhang, and Y.-J. A. Zhang, "The Roadmap to 6G: AI Empowered Wireless Networks," IEEE Commun. Mag., vol. 57, no. 8, pp. 84–90, 2019.

[4] A. Palatnik and Y. R. Tischler, "Solid-State Rhodamine 6G Microcavity Laser," IEEE Photonics Technol. Lett., vol. 28, no. 17, pp. 1823–1826, 2016.

[5] P. Yang, Y. Xiao, M. Xiao, and S. Li, "6G Wireless Communications: Vision and Potential Techniques," IEEE Netw., vol. 33, no. 4, pp. 70–75, 2019.

[6] T. S. Rappaport et al., "Wireless communications and applications above 100 GHz: Opportunities and challenges for 6g and beyond," IEEE Access, vol. 7, pp. 78729– 78757, 2019.

[7] E. CalvaneseStrinati et al., "6G: The Next Frontier: From Holographic Messaging to Artificial Intelligence Using Subterahertz and Visible Light Communication," IEEE Veh. Technol. Mag., vol. 14, no. 3, pp. 42–50, 2019.

[8] B. Zong, C. Fan, X. Wang, X. Duan, B. Wang, and J. Wang, "6G Technologies: Key Drivers, Core Requirements, System Architectures, and Enabling Technologies," IEEE Veh. Technol. Mag., vol. 14, no. 3, pp. 18–27, 2019.

[9] Y. Al-Eryani and E. Hossain, "The D-OMA Method for Massive Multiple Access in 6G: Performance, Security, and Challenges," IEEE Veh. Technol. Mag., vol. 14, no. 3, pp. 92–99, 2019.

[10] Z. Zhang et al., "6G Wireless Networks: Vision, Requirements, Architecture, and Key Technologies," IEEE Veh. Technol. Mag., vol. 14, no. 3, pp. 28–41, 2019.

[11] L. Dong et al., "Lasing from Water Solution of Rhodamine 6G/Gold Nanoparticles: Impact of SiO2-Coating on Metal Surface," IEEE J. Quantum Electron., vol. 48, no. 9, pp. 1220–1226, 2012.

[12] X. Huang, J. A. Zhang, R. P. Liu, Y. J. Guo, and L. Hanzo, "Airplane-Aided Integrated Networking for 6G Wireless: Will It Work?," IEEE Veh. Technol. Mag., vol. 14, no. 3, pp. 84–91, 2019.

[13] M. Anju and U. Gawas, "International Journal on Recent and Innovation Trends in Computing and Communication An Overview on Evolution of Mobile Wireless Communication Networks: 1G-6G," vol. 5, no. May, pp. 3130–3133, 2015.

[14] E. Basar, M. Di Renzo, J. De Rosny, M. Debbah, M.-S.Alouini, and R. Zhang, "Wireless Communications Through Reconfigurable Intelligent Surfaces," IEEE Access, vol. 7, no. June 2018, pp. 116753–116773, 2019.

[15] L. Zhu, Z. Xiao, X.-G. Xia, and D. Oliver Wu, "Millimeter-Wave Communications With Non-Orthogonal Multiple Access for B5G/6G," IEEE Access, vol. 7, pp. 116123–116132, 2019.

[16] Y. ZHAO, G. YU, and H. XU, "6G mobile communication networks: vision,challenges, and key technologies," Sci. Sin. Informationis, vol. 49, no. 8, pp. 963–987, 2019.

[17] K. David and H. Berndt, "6G Vision and requirements: Is there any need for beyond 5g?," IEEE Veh. Technol. Mag., vol. 13, no. 3, pp. 72–80, 2018.

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