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OVERVIEW ON 5G AND 6G WIRELESS COMMUNICATION WITH IOT TECHNOLOGY

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Abstract

The meaning of wireless communication is the way of transferring information between two points or more than that, which are not connected by a physical conductor. Most of wireless technologies are using radio waves and distances for radio waves can be very short (a few meters) like Bluetooth or so far away (millions of kilometres) for deep-space communications. Wireless communication went through multiple generations. Recently, 5G network is the latest generation of wireless communication networks that enable a huge transfer amount of data through its channels. 6G network is intended to provide faster wireless network than 5G soon so both can serve Internet of Things (IoT) applications. In this paper we study the 5G and 6G, difference between them and the advantage of using.

Keywords: 5G, 6G, IoT, Wireless communication.

1. Introduction

Internet of Things or simply IoT is a technology widely served over 5G network. Low latency and reliability factors of 5G network are needed to operate IoT applications effectively. For example, vehicles and sensors will be associated with the Internet by utilizing 5G network, and around 35 billion IoT terminals will be associated with the Internet by 2021 [1]. Moreover, it is likewise required to suit different IoT applications with different data transfer capacity and transmission rate including offbeat transmission of IoT terminals in 5G and past, subsequently another waveform to empower adaptable uplink access is unequivocally required. Adaptability is significant in IoT applications since requirements for transmission rate, transmission recurrence and traffic can change as per IoT applications, and it is additionally required to empower nonconcurrent transmission of IoT terminals.

5G means the 5th generation technology of mobile cellular network introduced in 2016. 5G network is designed to connect everything and everyone togethers in terms of machines, objects, and devices. 5G tends to carry more data than its predecessors (1G, 2G, 3G and 4G) which mainly serve the rapid expansion and developing of IoT. As defining the 5G in its wirelessly communication, faster and greater bandwidth compared with the 4G. The most challenging in the 5G is the frequency ranges compared to 4G gives optimal and more millimetre waves recently <6GHz is used and tested [2]. Also, another challenge in the 5G is the Adaptive Antennae Systems (AAS) which are large in size and directly proportioned to the wavelength and multiplying antenna to create greater bandwidth and beam for the frequency (Nxm) in order to build the whole mechanism each antenna in the phase antennae array to construct and expose more beam of frequency creating greater bandwidth and faster connection over the network. This kind of 5G technology takes the full advantage of such challenge is called Over the Air (OTA) [3].

While 6G is the sixth-generation standard successor communication wireless network of 5G which be launched by 2030. It will build on the revamped infrastructure of 5G network. 6G will use higher frequency bands than 5G, hence, it will provide much faster speed and low latency compare it to 5G network. Precisely, 6G technology supposed to provide up to 10Gbps speed while 5G can provide up to 1 Gbps and little higher. Early discussion by research and development (R&D), known in Europe as research and technological development (RTD) constitutes the first stage of developing and visualizing the 6G future network. In particular, many problems associated with deploying millimetre wave radio spectrum that 6G supposed to offer in the future. Millimetre wave radios are expected to be solved by researches and network designers to overcome the challenges facing 6G network. In the next sections, 5G and 6G networks are intended to be studied thoroughly then a comparison between them will be given.

2. 5G Network Architecture

A 5G network architecture consists of four main components: Radio Access Network (RAN), Core Network, Network Slicing and Network Function Virtualization (NFV).

The Radio Access Network (RAN)– consists of different types of facilities such as antenna towers, small cells, masts and home network devices that connect mobile

users with the main core network. Small or macro cells which considers the main innovation of 5G network provides a short range of connection which is measured in (mmWave). 5G macro cells use MIMO (multiple input, multiple output) antennas which enable its users to send and receive data simultaneously [4].

The Core Network – handles and responsible for mobile data transfer and exchange through its distributed servers to obtain better time response latency.

Network Slicing – responsible for splitting the network for a particular application, business or industry. For example, such a specific service originally provided by the network can be sliced and operated independently from other users. Hoang et al. [5] conducted one of the studies in this domain. They proposed a model for orchestrating network slices based on the service requirements and available resources. Markov decision process framework was used as a second stage to create and determine the optimal policy. The optimal policy can then manage cross-slice admission control and resource allocation for the 5G networks.

Network Function Virtualization (NFV) – provides a 5G ready core platform to deploy and support new business applications. Precisely, NFV enables to create network functions in real time at needed location within the operator's platform.

One of possible 5G architecture is M-CORD [6]. The M-CORD architecture designed to provide a platform that enables provisioning and scalability. It also provides other services such as performance and behaviour monitoring. Mediating all inter-service dependency is the most important function of CORD. Figure 1 depicts an example of M-CORD architecture attached to the 5G network.

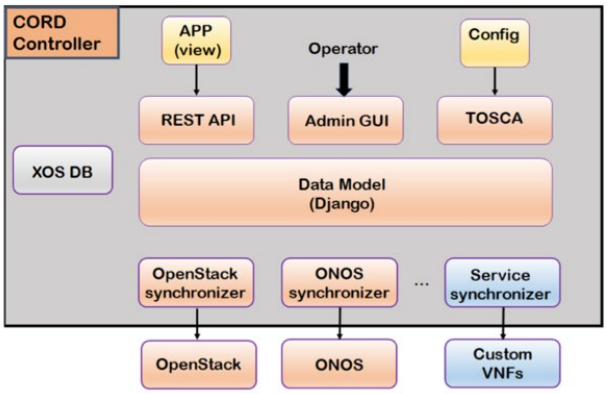

Fig. 1. Architecture of CORD platform [6].

3. 5G Mobile Services

5G services can be categorized into some groups which depends on their characteristics by end-user's experience.

3.1. Immersive 5G services (virtual reality "VR" and augmented reality "AR")

VR and AR are the main components of future communications. The availability of getting a Head-Mounted Display (HMD) by a low-cost and real-time services

needs very fast Internet speed. Furthermore, the service technology should solve the problems about many things such as insufficient quality of images and the methods of information display. Future VR/AR must offer an instance of the site to the user same as real. Future 5G services must handle 4K and/or 8K resolutions to solve the issue about image quality.

3.2. Intelligent 5G services (user-centric computing)

The user is being responded to the content by the network after recognizing on big data-based on information collected, such as interests in specific sports, fashions, businesses…etc. So, future networks are expected to have big data flows than ever. Using of mobile edge computing provided by 5G network enables mobile computing for data to be produced locally hence reduce congestion.

3.3. Autonomous 5G services (smart transportation)

The concept of smart transportation is defined as a transportation system which allows improved safety, efficiency and higher productivity with network infrastructure help. 5G and artificial intelligence (AI) are combined with each other's for enabling technologies such smart transportation systems. Connected cars will enable great features of services such as collision avoidance and route optimization under a high security and high performance of transport network and cloud computing. In addition, next generation of smart cars will need real-time safety systems which can transfer data with other cars and a fixed infrastructure for them. Types of these cars need to process at least 1 Gbps of data rate to make smart decisions, so 5G technology is very important to provide real-time services in future vehicles and to reduce latency.

According to Zikria et al. [7], 5G services is categorized into five services firstly Immersive 5G service includer augmented reality telepresence technology, Intelligent 5G service for crowded area service and Edge/FOG computing, Omnipresent 5G Service Health and smart factories, Autonomous 5G service robot based and drone-based 3D connectivity and finally public 5G services like emergency services and Save Our Soul (SOS) [7].

The importance of 5G services playing a major role in shaping the quality of service in the mobile network. In this regard, cost and energy were considered in [7] to support 5G services. The main purpose was to identify the optimal mix of transport network technologies such as wireless and optical.

4. 5G Technology

As we mentioned before, 5G network is a real wireless world so it needs to be supported by technologies such as IPv6 and world-wide wireless web (WWWW).

4.1. IPv6

In the 5G system, IPv6 is needed to be used in mobility because of the subnet of multiple layers and a lot of addresses. IPv6 addresses use 128 bits, which is four times more than IPv4 addresses that only use 32 bits. The first 32 bit for home address of a device, second 32 bit may use for protecting address, third 32 bit for establishing a connection between wire line and wireless network and the last 32 bit of IPv6 address may be used for VPN.

Using IPv6 has some advantages such as more efficient packet processing, more efficient routing, scalability and security.

4.2. World wide wireless web (WWWW)

World Wide Wireless Web is a feature that enable users to use wireless-based Web applications. 5G connections to end points in the field should be 1-10 Gbps, peak download and upload data rate should be in the range from 1 to 10 Gbps, end-to-end round-trip delay (latency) by 1 millisecond, 1000x bandwidth per unit area, number of connected devices should be 10-100x, availability in percentage will be 99.999%, coverage will be100%, network energy usage should be reduced by 90% and up to ten-year battery life for low power, machine-type devices. 5G technology constructed with various bandwidth and supported to spread wide area coverage of signals and wireless connection. According to Jain et al. [8], 5G can have better capacity and better Quality of Service (QoS). 5G connection can be implemented with many bandwidths. For example, Radio Spectrum is new bandwidth can corporate over 100 MHz with the concept of Cognitive Radio (CR) under 1 gigahertz to meliorate rustic wireless broadband access & 500 megahertz of the band betwixt 1 & 5 GHz increasing its effectively and efficiency. Moreover, Ultra Dense Ran operate in less power 10-100GHz with less power access node in the desired network [8].

In many aspects, 5G generation can't tell its totally harmful for the next coming generations According to Hockett [9], no scientific neither health evidence can give its harmfulness. However, such emissions of radiations waves can cause cancer and mutations. In 2011 World Health Organization (WHO) radio frequency wave may harm the human and to animal no such evidence according to the laboratory of the emitted waves. Possibility of microwaves that are emitting can affect by heat as the electromagnetic fields are radiating from the cell phones the limit range make it possibly dangerous and damageable in 2.4 million GHz can damage the human cells, but the emitting from 4G and 5G ranges from 2 GHz to 70 GHz. With various information no scientific relief can give appropriate evidence and can predict that the 5G is safe for our body or no.

4.3. Software defined networking (SDN) and network function virtualization (NFV)

There are technologies emerging in the development of 5G mobile network and become attractive solutions such as SDN and NFV. SDN technology enables the construction and deployment of 5G network to deliver softwarization & virtualization of 5G [10]. One the other hand, NFV process a new concept for the implementation and operation of network functions by leveraging standard IT virtualization technologies [11]. SDN and NFV can be used to overcome challenges such as uninterruptible and robust exchange of data and bottleneck of core network because of massive mobile traffic. SDN and NFV can be utilized to manage and deploy 5G core network architecture.

4.4. Mobile edge computing (MEC)

MEC is another emerging technology that together with IoT provide IT services and cloud computing environment at the edge of the core network. 5G mobile

stations are leveraged by MEC where cloud computing services are pushed to this level [3].

5. 5G Advantages and Disadvantages

5G as any technology has benefits as well as drawbacks. Advantages such as high speed and large bandwidth offering will support more than 60,000 connections. Moreover, 5G gather all networks in one single platform. Furthermore, it provides subscribers supervision tools to take a quick action. Additionally, 5G is compatible with previous network generations. Finally, 5G is built to provide uninterruptible and consistent connectivity around the globe.

On the other hand, there are some noticed disadvantages such as high cost, infrastructure building obstacles and security concerns.

6.5G and governments

There is no doubt that government regulations shape the use and the adaptation of 5G network. Jeon et al. [12] investigated the impact of government's 5G policy announcements on telecommunication operators' firm value in China. Results show that government policy announcement in general impacts telecommunication operators' stock returns negatively. Moreover, the drop in firm value is more pronounced when government announces policies with a higher level of interference. Mensah et al. [13] suggested that governments and key stakeholders are advised to deliver needed infrastructure that can drive the faster development of 5G mobile network which will be a trigger to the enrichment and transformation of mobile government services.

7. 6G Generation Challenges and Opportunities

6G, the future communication network which is supposed to be launched by 2030 depends on the integration of all the telecommunication networks such as earth imaging satellite networks, satellite networks, navigation satellite networks and sensing satellites. Using of 6G can provide network position connectivity and services like weather information to mobile users. Nano antennas will be implemented in different geographical locations around the globe such as villages, airports, hospitals, and many other places to supply the globe information to their remote observer stations. With the respectably ongoing accomplishment that millimetre wave frequencies are feasible for portable interchanges, broad estimations and research have been directed on frequencies from 0.5 to 100 GHz, and a few worldwide remote standard bodies have proposed channel models for frequencies beneath 100 GHz. By and by, little is thought about the radio channel over 100 GHz where there are a lot more extensive unused data transfer capacity spaces accessible. 6G network will bring great advantage for its various frequency ranges than the 5G more than 100GHz, reviews the aftereffects of recently distributed proliferation estimations at D-band (110-170 GHz), gives the structure of a 140 GHz wideband channel sounder framework, and proposes indoor wideband spread measurements and entrance estimations for normal materials at 140 GHz which were not recently explored [14].

7.1. 6G standards

6G satellite system will be developed by 4 standards designs which are: GPS system, Galileo system, COMPASS system and GLONAS system, the illustration Fig.1 shows a simple description of the four standards (GPS system by USA, Galileo system by UK, COMPASS system by China and GLONASS system by Russia).

7.2. 6G network components

In general, the 6G mobile system will integrate 5G wireless mobile system and satellite network for the global coverage which consist of telecommunication satellite network that is used for data, voice, video broadcasting and Internet. Moreover, it includes earth imaging satellite network which is for weather and environmental information collection. The coverage will also include navigation satellite network which is for global positional system (GPS).

7.3. 6G and global area network (GAN)

A global network (GAN) is any communication network which spans the entire Earth, a network, composed of interconnected of different networks that cover an unrestricted geographical area, moreover as we mentioned before, 6G should cover different geographical locations so by integration with the four standards systems we talked about, 6G will give the real meaning of GAN to the world.

7.4. 6G implementation requirements

The implementation of 6G technology must consider some factors, such as cost and use of various devices, additional cost of maintenance and acquire needed knowledge of its advantages/disadvantages and its effects in the long run. Major requirements to establish 6G can be addressed below.

New communication infrastructures are a main requirement which include new architectures, 3D connectivity and having links with very high data rate which is exploiting sub-THz. Furthermore, another requirement is artificial intelligence mechanisms which includes machine learning tools at the end nodes of the network. With the emerging of machine learning and Artificial technology with the vast growth of IoT and smart devices, the 6G generation implemented to give optimal solution, high capacity and high-speed Internet as Letaief et al. [15] visualized 6G network. In their research, they claimed that hardware Algorithm Co-Design with huge scales of antennas overcoming the loss of waves. However, this hardware being hard to be adopted as their high in use and consuming more electricity and power. With the use of the algorithm and AI based models the 6G will operate in friendly way and give optimal solution to the whole system. The artificial intelligence of such 6G services will be implemented in many gadgets and places like drones, cars, and self- robots. In this way with various technologies empowered the 6G technology and giving full stack of functionality [15]. Interaction's mechanisms are also vital need which include human to human and human to machine with five sense interactive communications.

7.5. 6G network architecture and radio over fiber

Radio over Fiber (ROF) offer very high bandwidth through its channels. ROF is designed to handle over 1 GBs speed rate and for wide and remote locations so it will be a great way for 6G Internet technology. Here we will consider some technology factors which can be applied.

7.5.1. Using of air fiber transponders

Air fiber is a product manufactured by Ubiquiti Networks and it is designed for point-to-point broadband wireless links and long-remote connections, its technology allows for precision-aligned data links between two locations which increased reliability and reduced potential interference and interruptions. Air fiber transponders can cover up to 100+ km coverage radius so signals can be carried out efficiently. Also, air fiber towers offer Hybrid Division Multiplexing (HDD). HDD is the combination of Frequency Division Multiplexing (FDD) and Time Division Multiplexing (TDD). HDD enable 6G network to transmit into full duplex mode to achieve high speed network.

7.5.2. Fly sensors and nano antenna

Thinking of the communications in hard locations such as space, sea, aircraft and areas separated from land connectivity will consider the effectiveness of using nano antennas and fly sensors to provide interconnectivity among these towers for Integrated network. Also, nano antennas can be installed on skyscrapers buildings to extend the wireless range since the main purpose of 6G is to replace wired connections and achieving the speed which cannot be reached by physical links.

7.6. 6G features and issues

In this subsection, we introduce the features and issues associated with 6G.

Many features are associated with 6G such as ultimate high-speed Internet service, network packet switching, high level of security, storage capability improvement, intelligent batteries, high Mobile-TV resolution and 3D Internet concept production. Moreover, as 5G extending its data signals may encounter propagated data loss and can't achieve as 6G transforming because of many factors like rain attenuation, waves scattering in rough surfaces, human body shadowing and vegetation. So, in this case, 5G shortest bandwidth can't be predicted because of these factors [16]. Furthermore, 6G delta-orthogonal multiple access (D-MOA) method for the heavy registering can manage nodes of the entire network and can enable security and optimization of such system using nonorthogonal multiple access (NOMA) that avoid possible overlapping between clusters [17].

On the other hand, there are still issues associated with 6G such as roaming. Nawaz et al. [18] highlighted a main problem of 6G and suggested an optimal solution in their research paper. They claimed that power supplies the 6G uses trillion of efficiency of power it needs with specified wireless types of architecture it solved with wireless energy harvesting and wireless power transfer. Secondly, the security issue from the 5G extended to 6G to have low complexity and higher secured levels. Many security techniques can be implemented in 6G like MIMO and low-density parity check LDP-C, so the problem can be solved by distributed key management giving efficient management of the whole physical layer of the

6G network. Moreover, the hardware design with the vast transmissions and sized of the modems and antennas, these components will be solved by optoelectronic incorporation (integrating the optical and electronic modules) is assuring method for high-frequency communication systems. [18].

Average speed and performance of 6G

6G technology can range between 100GHz to 1THz frequencies. It can provide higher frequency than 5G capacity (10 to 1,000) times. 6G delivers peak download data rate more than 10 GBs and peak upload data rate of more than 10 GBs. Once the 6G is implemented it can access more than 100 GHz compared with the 5G speed and capacity of 6G with various technologies over the spaces and air. Furthermore, Prepared data and emerging models will be improved with mm Wave indoor wireless network design, site localization studies, and future gigabyte Wi-Fi with IoT [19].

8. Simple Description of Comparison between 5G and 6G

Now if we collect the common data of 5G and 6G to make a simple comparison we can mention year of usage, speed of service, usage's technology, standards, core network and handoff which are described in Table 1.

Table 1. 5G and 6G comparison.

	4G	5G	6G
Year	2015	Actually 2020	2030
Speed	2MBs to 1GBs	1GBs and higher	> 10 GBs
Technology	Integration of broadband LAN/WAN/PAN and WLAN	4G + WWWW	5G + Satellite
Standards	Al access convergence including OFDMA, MCCDMA, network-LMPS	WiMAX LAS CDMA, OFDM, MC-CDMA, UWB, Network-LMDS, IPv6	GPS, COMPASS, GLONASS, Galileo systems
Core Network	Internet	Internet	Internet
Handoff	Horizontal & Vertical	Horizontal & Vertical	Horizontal & Vertical

9. Conclusion

This paper overviewed 5G and 6G networks from different aspects such as infrastructure, components, mobile services, implementation requirements, advantages and disadvantages of each. The outcomes of this study clarify the 5G and 6G fundamental concepts behind each. Challenges facing 6G network to be upgraded from 5G network is also studied. A comparison between each network is studied to illustrates the main differences between the two networks and how that affect IoT Internet applications.

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