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Review of 5th Generation Wireless Mobile Network

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Abstract: Mobile wireless communication has experienced few generations. the first Technologies started with an analog system and developed into a digital communication system. 1G made possible for mobile communication, it has bandwidth between 10 kHz up to 30 kHz, this generation was first launched by Japanese company Nippon Telegraph and Telephone (NTT). in the second generation offered a 9.6 kbps data rate which increase up to 300 Kbps. it has second phase with 200 kHz bandwidth. In third generation Voice and data communication were focused. All generations were making diverse new features. Fourth generation (4G) technology was used in many countries around the world with providing high mobility and high-speed data rate by internet protocol (IP). However wireless communication systems facing new challenges every day which even fourth-generation cannot solve. Therefore, experts have already started an investigation also tested on beyond fourth-generation wireless systems with no limitation. To create new generation technology, companies and researchers need to focus five fundamental new technologies. These new technologies will deliver a good data rate less than a millisecond of a slowdown and bring a high speed of downlink. To realize how 5G technology is different from the current generation 4G, we need to understand all of these five technologies.

Keywords: Mobile Wireless, Fifth Generation, Internet of Thinking, Co2

1. Introduction

In 1970s cellular wireless technology started its evolution and revolution. In the last decades, mobile communication has experienced different generations with different features, from the first generation to the fourth generation. Every mobile generation is different in four core characteristics, bandwidth, switching, data rates, and radio access. [1]

The first generation was presented the main concept of cellular network which made mobile communication possible. This generation mainly was analog and had a bandwidth between 10 kHz up to 30 kHz, this rate is depending on systems type and services. The first-generation offered a data rate of 10 kbps. It was access to the FDMA radio and circuit switch. Every generation in mobile communication has its own features while the first generation was suitable for voice facilities. The second generation, analog communication was replaced with a digital signal which significantly developed the cellular communication value. [2] 2G technology offered a 9.6 kbps data rate in the first stage and increased up to 300 kbps in the second stage with 200 kHz bandwidth. Switching was also the packet starting from stage two and wireless access was (TDMA / FDMA). Voice and data communication were the main focus of third-generation also converge network for data and voice is emerging. The third generation began the first phase a peak 2 Mbps data rate and move toward 50 Mbps in successive phases at continuous wide bandwidth of 5 MHz The access scheme of the third generation was CDMA and switching remained to be circuit also packet. But at the 3.5G Start with HSDPA, then focus on packet switching. In 4G technology used Orthogonal Frequency Division Multiple Access with advanced radio interface, Link adaption system and MIMO antenna. In fourth-generation, Low mobility can support up to 1 Gbps data rates and around 100 Mbps for high mobility. Long term evolution (LTE) and Advanced-Long Time Evolution structure are practical 4G system has already used more country or soon will be. [5]

However, the world population and number of consumers who subscribe to the mobile wireless system have increased each and every year. Today Laptops, tablets, and Strength full mobile phones are becoming more useful, this has caused a detonation of mobile wireless services and devices. Similarly,

mobile services providers are facing digital increasing demand for high network capacity, extraordinary data rates, high spectral efficiency, high energy efficiency, and supper mobility required by fresh wireless technology. Depending on that issue fourth-generation definitely face real limitations on the data rate. the researcher started investigations about next-generation named 5th generation (5G) or beyond the fourth generation, the key point of this study is to show technology in 5th generation. [15]. This paper has four main sectors: sector 1 is an introduction. Sector 2 Evolutions of mobile wireless. Sector 3 Fifth-generation technology. And Sector 4 for Conclusion.

2. Mobile Wireless Generations

In the last decade's mobile communication has become more common due to evolutions from the first generation to the fourth mobile generation. The evolution of mobile wireless based on the radio access network, data rates, frequencies, and switching structures. Certainly, these four portions are some essential mechanisms for mobile generations. There are more researches and experimental that carried out by different experts in wireless mobile communications.

2.1. First Generation

In 1979 a Japanese company Nippon Telegraph and Telephone (NTT) was launched the first commercial mobile network (1G). in view year NTT network expanded its services to the whole japan population and become a nationwide network. Nordic Mobile Telephone (NMT) launched a full services 1G technology in Finland, Denmark Sweden, and Norway by 1981 and become the first mobile cellular network that Providing international roaming services. [6]

USA launched 1G for the first time using the Motorola DynaTAC phone in Chicago 1983. Many countries run the first generation in the early 1980 including the United Kingdom and Canada. 1G was an analog system and only suitable for voice service with 2.4 kbps speed by using frequency division multiple access with 30 KHz channel capacity and 824 MHz up to 894 MHz for the frequency band. The first generation needed more improvement in many sections such as; security, transmission quality, area coverage, spectral efficiency, system capacity, and more services. Because of these drawbacks experts and researchers introduce a new generation with the name of the second generation. [4]

2.2. Second Generation

The second-generation (2G) was launched in 1991 as a commercial with the name of global system mobile communication, the first 2G system was used in European countries. GSM is the greatest respected standard of all the mobile revolutions and was used in almost 212 countries around the world. GSM styles roaming service very common, enabling foreign clients to use their devices from one country to abroad. The second-generation basically used two different radio access, one of them was time division multiple access another one was code division multiple access with the frequency 850 MHz up to 1900 MHz

GSM communication used a data rate of 22.8 Kbps with eight channels per carrier. The second generation contains 2G, 2.5G, and 2.75G. Every stage was used at a different data rate. GSM has benefits over 1G where phone conversations are digital signals; more efficient spectrum. The second generation introduced a data service for mobile-initiated (SMS). Second-generation technology provides several cellular networks such as picture messages, multimedia services, and text messages. All 2G network services are encrypted. 2G also introduced data services for mobile phones. Weak digital signal, angular decay, reduced sound range was being three common drawbacks of the second generation. But the reality is second-generation technology advantages are far more. [2]

2.3. Third Generation

The third generation of wireless offers great speed bandwidth to portable devices with IP-based service. ITU officially approved a five family of 3G principles known as international mobile telecommunication (IMT-2000), which are portions in the third-generation framework; this standards-based on CDMA, WCDMA, and TD-SCDMA and two standards based on TDMA, namely FDMA/TDMA and TDMA-SC (EDGE). The CDMA standards are the primary 3G principles. The main features of 3G technology facilities are voice calls, video calling, GPS, MMS, Roaming service, and fast internet service. [11]

Universal mobile telecommunication system licenses have been given across Europe and Asia through the 3rd Generation partnership project (3GPP) group. UMTS technology deals with data rates up to 2 Mbps for stationary devices, 384 Kbps for slowly moving devices, and 128 kbps for fast-moving devices like handset in moving vehicles. the frequency band is 1.8 up to 2.5 GHz. 3.5G uses HSDPA, also for multiple-input multiple-output system (MIMO) data broadcast is up to 20 Mbps. Enhancing data rate, radio access, and coverage are the main points of mobile generations, therefore third-generation technology has completely enhanced over second-generation 2G and previous networks in many ways. After this development, Universal Mobile Telecommunications Service take another step forward for 3.9G or long-term evolution this stage was to introduce the next generation of mobile technology. [2]

2.4. Fourth Generation

4G stand Fourth-generation technology which provides 100 Mbps for high mobility like cars and trains and 1 Gbps for low mobility such as stationary users. In addition, the 4G system usually provides video calls and other services of 3G, wireless modems services, mobile broadband internet, voice over IP, video conference, and cloud computing are features

of this generation. Fourth-generation technology does support internet protocol (IP) instead of traditional circuit-switched telephone service with access through GPRS, EDGE. In 2007 Worldwide Interoperability for Microwave Access (WiMAX) standard launched the first commercially 4G system and in 2009 the first announcement for LTE standard in EU countries. LTE-Advanced systems or 4G technology, have recently used around the world based on the GSM/EDGE and UMTS/HSPA, 3GPP, MIMO smart antenna technology, and 802.16e. [12]

To improve the current generation and introduce the next one in mobile communication, long term evolution LTE stands that standardization, the first advanced LTE was launched eight years before in Spain. LTE used OFDM and MIMO antenna technology, LTE-A is better than normal LTE for increasing the capacity and speed of downloading and uploading. This standard was developed by 3GPP. Advanced LTE needs types of equipment with a special chip designed to exertion properly. LTE-A in 4G has many goals like increasing peak download data rate, reducing the latency of radio access network (RAN) up to 10 milliseconds, and enhancing broadcasting. High capacity is one of the main features that the Fourth generation has upgraded to the preview generations. 4G towers can carry more people in peak times. In traditional tower may be able to support at least 100 people at the greatest speed, however, a 4G tower can support at least 350 people. Fourth-generation also reduces the latency to create a high-speed data rate. [1, 14]

3. Fifth Generation Technology

New generation Technology is the only way to face the growing demands of mobile data users and consumers. communication services providers and technology companies with the help of technology experts have been working together to develop new technology features. As we need to improve the current mobile generation 4G, 5G mobile technology characterize the next generation of mobile communication technologies and to support new features and services we expected the fifth generation to provide good capacity services, high data speed, and internet of things. The key evolution compared by current-generation 4G, LTE, and even LTE advanced is the enhancement in many fields such as; speed, internet of things and low latency. Next generation technology will provide significant advantages for industry and also provide customer benefits adding economic prosperities. In 2017 the government of South Korea invested almost two billion-US-dollar in fifth-generation infrastructure developments and tested trial network and it will be fully available at the end of 2020. [7, 8]

United States of America, Japan, and the European Union and also testing trial 5G technology, however, South Korea and China have the biggest possibility. Next-generation will commercially arrive as soon as possible, fortunately some countries are already using 5G like China but still need some enhancement. High-level connectivity and better coverage are great key points that might be seen in fifth-generation technology. World-wireless www is the main focus of the next-generation network. It is whole wireless access with no limits. Home mechanization, security and smart transportation are benefits from the mobile network. The new revolution of 5G technology has an amazing competence to maintenance software. 5G technology use switch technology and Routing to provide high connectivity services. Serialized generation evolution and revolutions for cellular technology makes a lot of developments from first generation to the fourth-generation technologies. [5]

Providing brand new services and features is the way new generations are coming in mobile communication and consumers was interesting to using that new feature, so next generation of a mobile wireless network will offer new amazing things which make one of the extraordinary generations in this period. Some of these features are the flowing:

a. Smart antenna.
b. excellence service area.
c. low power to reduce energy consuming.
d. Low latency.
e. enhanced network coverage area.
f. high speed data connection with massive.
g. broadcasting data.
h. signal trafficking system.
i. internet of thing (IoT).

3.1. Why 5G Mobile Technology

Nowadays mobile users want better data rate speed and reliable facilities than the current generations (4G), fortunately, there are expectations beyond fourth generation (5G) such as; Smart antenna, excellent service area, low power to reduce energy consumption, Low latency, enhanced network coverage area, high-speed data connection with massive broadcasting data, downlink speed up to 10 Gbps in stationary users, signal trafficking system, internet of thing, wireless-based web applications include full multimedia, not damaging to human health, developing data coding and modulation technique. Mobile wireless communication expertise acknowledged these networks will boost the growth of other technology field such as virtual reality (VR), autonomous driving, and IoT. In fifth-generation technology, low latency is one of the most important features, the latency in 5G is faster than 4G latency approximately twenty times. Next-generation is not only being fastest generation in the cellular wireless network but also has the capability to change other zones such as health care, energy, and automotive sections. It will allow these sections to move from Local area network to wide area network and it will decrease installation fees and increase flexibility all these needs are pushing us to contribute new generation with new smart technologies and basically, we have to focus on traditional fluctuations and challenges for past and present generations. [7]

3.2. Challenges

Mobile communication network-facing huge increase

number of devices and subscribers all over the world this growth is one of the critical challenges in a wireless network. A billion connections are connected to the network these connections create a necessary increase for data rate and capacity. [12] In addition, developing new technology devices need a huge budget and may consume more energy which can cause cumulative carbo dioxide for incidental. Nowadays Co2 emission case is the main issue for our world. Infect increase of energy consumption in wireless communication systems is no big deal for the Co2 issue of today but it came up soon. However, more than half percent of energy consumption in the world is mobile communication systems. other challenges are on the battle such as Increasing capacity without increasing cost, huge data rate, Device-to-device network, unified coverage, Real-time information for critical services and Air interface, Fast and flexible deployment architecture. [2]

Figure 1 shows 5G wireless system challenges. (See figure 1)

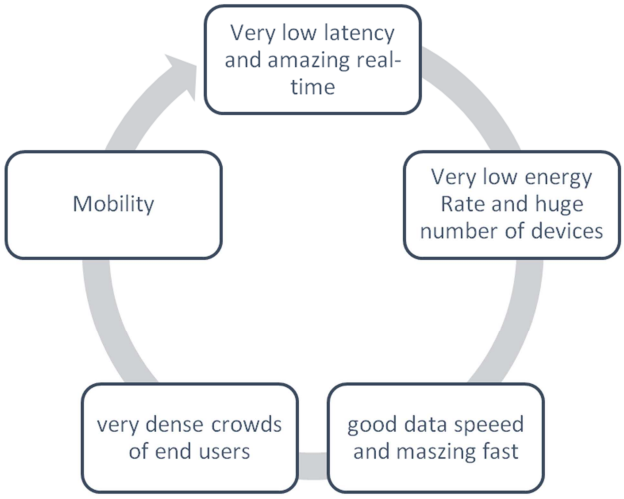

Figure 1. *5G wireless system challenges.*

3.3. Developments Toward 5G

To develop a brand-new generation, we need five fundamental new technologies such as; Millimeter-wave, small cell, MIMO, beamforming, and full-duplex. This new technology will deliver a good data rate less than a millisecond of a slowdown and bring a high speed of downlink. To realize how 5G technology is different from the current generation, we need to understand all of these five technologies.

3.3.1. Millimeter Waves

Presently, wireless communication has running slow services and less bandwidth for everybody because more subscribers and devices are consuming more data rate, consumers use specific frequencies on the radio spectrum those radio frequencies are under 6 GHz, unluckily this frequency starting overcrowd. One way to solve that problem is to open new swath of spectrum which has never used before for mobile communication with the transmission on millimeter waves which use high frequencies than a radio wave. From 30 GHz to 300 GHz bandwidth is frequencies use to broadcast millimeter waves while the traditional mobile generations were used radio waves by 3 GHz up to 6 GHz Frequencies. Millimeter waves has one to ten mm in length while radio waves measure ten cm in length. Radar and satellite systems are used millimeter waves before. This technology offers good speed but all new technology devices have disadvantages which need a dilemmatic solution, millimeter waves can't easily travel through buildings and can be absorbed by rain. So, this problem needs to open another new technology named small cells antenna. [8]

3.3.2. Small Cells

In 5G when a subscriber starts moving from one point to another behind buildings, the user can lose his/her signal which means higher frequency millimeter waves have harder traveling over obstacles and rain can absorb because of losing line of sight transmissions. Small cells are low-power portable radio access that requires the least power to provide services with ranges of between ten meters to 20 kilometers while microwave cell can cover around 32 kilometers. These small antennas stand as base stations and could install nearby each other according to radio waves to transceiver signals around obstacles without weakening. Small cell technology has low latency and reliable services and less complex solutions so this is the perfect solution for fifth-generation to bring enhance and fast broadband services to the users. [9]

3.3.3. Massive Memo

Massive MIMO or Multiple input multiple output systems is a multi-user MIMO system that functions multiple users through multiplexing over the channel with favourable propagation. Massive Multiple input multiple output technology (Massive MIMO) has the capacity to send and receive millimeter waves from many users at the same time. MIMO was used before in 4G base stations, but massive MIMO has only practiced in engineering Labs and a few base stations as a test. Massive MIMO also offers two main advantages; the first advantage is excellent spectral efficiency and the second one is superior energy efficiency. However Massive MIMO propagates signals in every direction at the same time which can cause signal interference, this problem accelerates the development of new equipment to traffic the signals. [10]

3.3.4. Beamforming

Third generation and fourth generation antennas propagate the signal in every direction without focusing on each signal sender or receiver that creates the possibility to cause huge interference. To reduce snooping fifth-generation wireless network, introduce beamforming technology that can help massive MIMO for traffic signaling system, it allows the base station to communicate on the specific user instead of every direction. Also increasing mobile data rates by broadcasting over Mw and grumbling up spectrum efficiency with massive MIMO, wireless communication expertise's are trying to reach the high data rate and low latency required for fifth-generation through full-duplex. [9, 10]

3.3.5. Full Duplex

Transferring data or exchanging information from one device to another is call communication. This process can be simplex, half-duplex or full-duplex. Simplex can be one-directional or unidirectional communication, which means one of the two points of the connection can transmit and the other one can only receiver. In full-duplex communication, each side can send and receive a signal equally but not simultaneously. When point A transfer's data, you can only receive point B. full-duplex is a double side communication rating, in which any direction can transfer and receive data at the same time. [4] A common use of full-duplex is the telephone network. The duplexer is mostly used when communication between the two devices is required all the time.

Traditional generations users can transmit and receive data at the time over same frequency it may cause interference the only solution had used was different frequencies to transmit and receive data. To transmit and receive data at the same time in the same frequency 5G uses a new technique known as 5G full-duplex. experts have used silicon transistors to develop good-speed switches that end the backward roll of these waves and enable them to transmit and receive at the same time on the same frequency. [9, 11]

3.4. ITU-R Requirements

International Mobile Telecommunication-2020 (IMT2020) issued some requirements for 5G devices and services. The 5G system mainly serves eMBB, URLLC, and mMTC. Below tables shows us some ITU requirements for the 5G system.

Table 1. *eMBB Minimum requirements. [13]*

Scenario	Downlink rate	Uplink rate
eMBB	20 Gbps	10 Gbps

Table 2. *eMBB Minimum requirements for spectral efficiencies. [13]*

Scenario	Downlink rate	Uplink rate
eMBB	30 bit/s/Hz	16 bits/s/Hz

Table 3. *The target values for the user experienced data. [13]*

Scenario	Downlink rate	Uplink rate
eMBB	100 Mbps	50 Mbps

Table 4. *Latency. [13]*

Scenario	Latency
eMBB	4 ms
URLLC	1 ms

4. Conclusion

In the last 40-years, wireless communication has practiced different development in many ways. After the first, second, third, and fourth generation, the 5th generation going to be a brand-new mobile revolution for the world in addition every change in Telecommunication comes with smart technologies. These new technologies mostly are still under production, some of them confirmed and overall standards are under process. The fifth-generation network already on the going with a trial situation. The evolution and revolution of wireless and cellular system focusing on four main aspects: bandwidth, switching, data rates, and radio access. Right now, the fifth generation is not available for us. Not at all particular standard or requirement has been carried out but the international telecommunication union radio ITU-R will public soon wireless standardization authorities. In fact, fifth-generation technology is not only unlimited wireless communication but is the foundation of the internet of thinking IOT and virtual reality VR.

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