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Evolution of Mobile Wireless Communication to 5G Revolution

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Abstract—Over recent years, the evolution of mobile wireless communication in the world has become more important after arrival 5G technology. This evolution journey consists of several generations start with 1G followed by 2G, 3G, 4G, and under research future generations 5G is still going on. The advancement of remote access innovations is going to achieve 5G mobile systems will focus on the improvement of the client stations anywhere the stations. The fifth era ought to be an increasingly astute innovation that interconnects the whole society by the massive number of objects over the Internet its internet of thing IOT technologies. In this paper present a review of advancement mobile generations by contrasting the type, data transmission rate, challenges, techniques, features and applications used to give by comparing and clarifying the enhancements have been produced till the upcoming 5G revulsion. Also, highlights on innovation 5G its idea, necessities, service, features advantages and applications.

Keywords— Mobile Communications, Wireless, LTE, IOT, 4G, 5G, Mobile Generations

1. Introduction

In the last few years, the world of Mobile Wireless Communication Networks (MWCN) is rapidly growing. The wireless communication started to get more effective and enabled the deployment of several progressive generations of cellular telephone technology, which is now used by many billions of people [1], [2]. The mobile wireless communication has gone through many generations start from 1G first generation was simply utilized only for voice calls however, it was the base of all the generation of mobile [3], [4]. In the 2G second generation made digital phone communication and provide new feature text messaging service. Afterward Third generation 3G appeared which support multimedia techniques also enhanced the process of information transmission rates [5], [6]. The 4G fourth generation very fast and reliable as compare to 3G, which is an advancement to conquer the impediments of 3G and furthermore raises the QoS) Quality of Service) expands the data transfer capacity [7], [8]. From 2010 to till now the 4G users and supporting are most widely used. The new generation called 5G presents the Wireless World Wide Web (WWWW). Since in every generation are providing some techniques and support some new features. This growth leads to increase the numbers of mobile users and mobile phone industry [9],

[10]. The most recent of years have seen fast development in the remote business as far as both versatile innovation and its endorsers [11], [12], [13]. There has been an unmistakable move from fixed to portable cell communication particularly since the turn to the period [14]. Before finish from 2010, there were more than multiple times more versatile cell memberships than fixed phone lines. This brought about network planning and improvement related administrations coming into the sharp center [15], [16]. In many ways the current 3G and 4G networks are not ideal for Internet of Things (IOT). As 5G is not formally in use but it will enhance the services such as e-commerce, e-transactions, e-management [17]. The Internet of Things (IOT) is refers to consist of many devices communicate over the internet to control and easier the life. The upcoming generation of technology is the IOT, it's a current trend and future direction [18], [19]. All things around needs to be able connect to the internet by using high-speed internet such massive devices communicate to each other [20], [21]. In the near future, the main focus on 5G mobile communication have to support the huge deployment of IOT with billions of connected smart objects and sensors [22], [23]. The 5G has been designed to deal with the massive amount of data. The internet of things enables connectivity to billions of devices and future innovations [24]. Mobile and wireless Communication with 5 generations will grow in connectivity; traffic volume will penetrate into every element of society and create an all-dimensional. Which have to respond to these challenges by providing great features to increasing capacity and by enhancing efficiency in energy, spectrum utilization and cost [25].

2. Evolution the Five Generations of Mobile Wireless Communication

This paper evaluates generations of mobile wireless communication from 1st generation to 5th generation and compares the different technologies. It is beneficial to describe previous generations of wireless mobile communications as shown in Figure 1 provides an overview of the generations. With 5G technology still now researching and developing it's another revolution by providing high data speed rate adapt to modern technologies.

2.1 First Generation (1G)

1G it is the original of mobile networks which is an analog system developed in 1980s. It uses analog radio signal which has frequency 150 MHz, only voice transmission call modulation is done such as mobile cell Phone System and whole communication systems utilize the recurrence balance FM system to radio communication traffic was multiplexed into an FDMA (Frequency Division Multiple Access) recurrence division various access system [26]. This generation it is unreliable, without security. In any case, 1G innovation experienced various disadvantages. Which are used and introduced the AMPS (Advanced Mobile Phone System) and TACS (Total Access Communications System). It speeds up to 2.4Kbps [27].

2.2 Second Generation (2G)

The next generation of mobile networks, 2G has driven below a GSM (Global System for Mobile Communication) normal in Finland through 1991.The 2G calls could be scrambled and computerized voice calls were altogether clearer. Some of its significant features included could send text messages (SMS), picture messages, then voice and image messages (MMS) in their telephones [28]. It used digital signal for transmission rather than analog. It implemented the concept of CDMA Code Division Multiple Access. CDMA gives every client with an uncommon

code to convey ended multiple physical channels. To communicate more and more users multiple access techniques are used, i.e. FDMA, TDMA, and CDMA. After 2G near 1995 existence the 2.5G it includes voice with data this process progress enhanced data rate for GSM Evolution (EDGE). In the intermediate interval the GPRS (General Packet Radio Service) was introduced which had the feature of packet switching which suitable for internet. Data speed up to 64Kbps [29].

2.3 Third Generation (3G)

3G utilizes extensive trademark wireless networks by expanded transmission system support benefits that give a data transmit rate of at any rate 2 Mbps. It was introduced in 2000 including the reliability and high speed data transfer. An association called the 3GPP (3rd Generation Partnership Project) was formed to help with deployment of 3G network had proceeded with the work by characterizing a versatile framework that satisfies an IMT 2000 normal. Inside Europe that were named universal mobile telecommunication system Universal Terrestrial Mobiles Systems which that ETSI ambitious International Mobile Telecom IMT2000 that ITU T term of a 3 era framework though CDMA and transport technology Enhanced Data GSM Environment EDGE is a 3G digital network [30]. The 3G's expanded information transmission abilities multiple times quicker than 2G. The features increased are bandwidth and data transfer rate to fit a web-based application, audio, video file and ended IP (for example Skype). The peak data rates of 100-300 Mbps [31].

2.4 Fourth Generation (4G)

In this generation a noticeable change occurred provide wider bandwidth, high security and high speed internet access. This generation based on Long Period Evolution (LTE). LTE is a 4G remote interchange standard created by the 3G Partnership Project (3GPP.) The 4G is anticipated offering progressively upgraded adaptations of similar headways guaranteed via 3G (e.g. improved multimedia, video gushing, worldwide access, and around the world transportability through a wide range of gadgets. The speeds identified by the International Telecommunication Union (ITU) which is 100 Mbps [32]. The 4G was first sent in Stockholm then Oslo Norway through 2009 by way of a Long Period Evolution (LTE) 4G normal. That was therefore presented all through the world complete top notch video flowing a reality for many buyers, 4G offers quick mobile web admission (up to one Gb for every second for stationary clients) which encourages gaming, administrations HD recordings then HQ video conferencing [27].

2.5 5G Revolution and Application

Five generation is the next generation of wireless mobile broadband technology. Including main features which are higher speed, reduce latency, the ability to support massive devices simultaneously and energy saving. Nowadays, with challenge of modern technology applications required to support from 5G strength for fit various services. The development of 5G is still continuous till now which makes a real wireless as World-Wide Wireless Web (WWWW). 5th Generation communication network based on combination of 4G and Wireless System for Dynamic Operating Mega Communication (WISDOM), Which is unique concept towards a new wireless communication [31]. The 5G has a high speed for transmission data because according to communication fundamentals, the short frequency and large bandwidth more upper efficient

network. The 5G has been assigned the spectrum 30GHz to 300GHz in this frequency range, this allows only for communication over short distances and with bandwidth greater than 1Gbps [33].

The mobile communications are becoming congested in the world faced the increasing demand for data from users, and to support new services. Therefore, 5G networks are designed to fit growing demands for data from industrial users and its challenges of new technology such machine communication. Also, increasing the total number of internet-connected devices, both consumer device applications provided by wireless technologies 5G for (e.g., smart watches, smart meters, industrial devices and sensors). These devices, when connected, from the Internet of Things (IoT) techniques. The IoT has extended that focus on mobile communications services which is between people and things. The future applications of IOT such as mobile health, internet of vehicles, smart home, industrial control, and environmental monitoring will drive the explosive growth of IoT applications. Furthermore, the big data generated by IoT applications will become a base and Cloud will be storage and processing. The 5G network will revolutionize every business sector. Through the year 2020, with an estimated 20 billion devices connected [34]. The vision of applied wireless mobile 5G applications in the daily life of the society for near future of the Mobile Broadband (MBB) service and Internet of Things (IoT). A portion of the modern applications utilization supported by 5 G: e.g charges mobiles utilizing our very own heartbeat, to know the specific time of our labor in nanoseconds, Video-conferencing and real-time video applications .Augmented Reality (AR) and Virtual Reality (VR) service , smart city, building and city services with IoT , Self-drives car ,application in education , autonomous vehicles and industrial automation and in health applications [35]. The 5G provides the large broadcasting of data in Gigabit and supports virtual private network. Furthermore, 25Mbps connectivity speeds with data bandwidth higher than 1Gb. The uploading and downloading speed of 5G is very high [36].

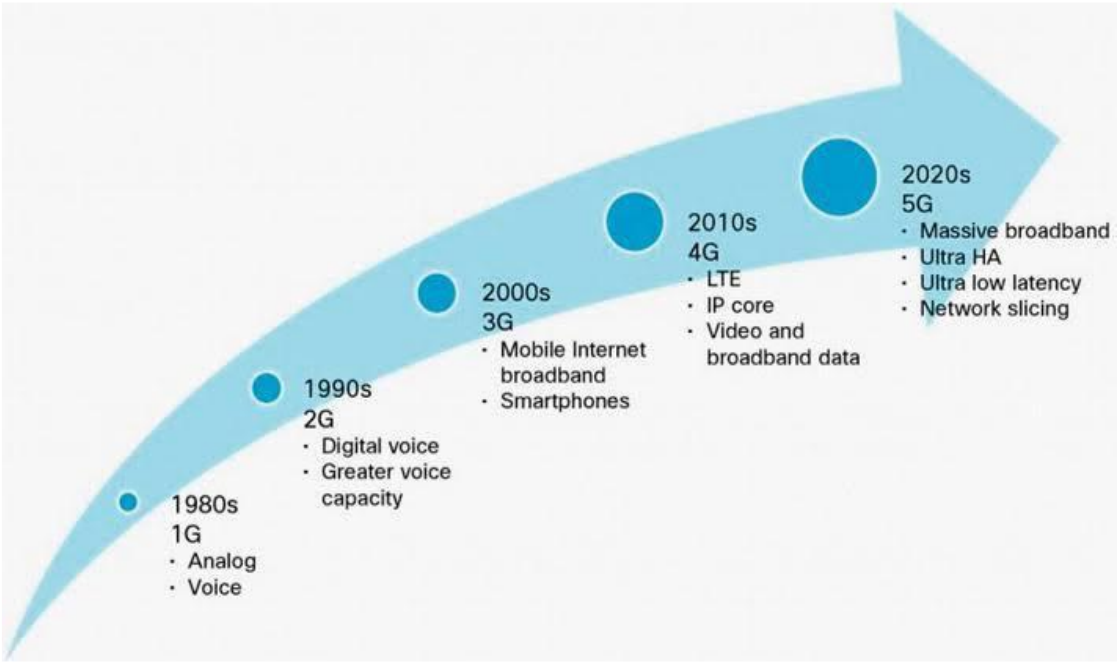

Figure 1. Evaluation of Wireless Mobile Generations.

3. Literature Review

In the last few years, many works by the researchers performed about the generations of Mobile communication and the new vision about the trend 5 generation. In this section of this paper, number of important studies completed in the mobile generations will be surveyed: In 2016, Gopal and P. G [37], proposed the comparison between 4G and 5G wireless technology in relation to its speed, frequency band, switching design basis and forward error correction is studied. Also, they discussed about the near future 5G will replaces 4G and mentioned 5G new applications. In 2017, Yadav, M., et al. [38], evaluated the mobile communication generation passed as so far till to the future for next generation by different mobile technologies. There are no boundaries for progress of mobile communication after 5G upcoming 6 G technology by providing high speed internet access up to 11 Gbps. The 6 G will combine 5G wireless mobile system and satellite networks. Also, they discussed the new generation is 7 G depend it by his concept of satellite functions for mobile communication. The 7.5 G very high speed communication and top download with Satellite network techniques. In 2017, Pavia,L., et al. [39], presented the analyze security mechanism used for 2G,3G,4G. The Global System for Mobile Communications (GSM) technique used for second (2G), Universal Mobile Telecommunication System (UMTS) technique used for third (3G) and Long Term Evolution (LTE) technology used for fourth generation (4G) mobile communications networks. Also, for G5 and IOT application introduced new security systems which are automation and monitoring security by using machine learning and artificial intelligence algorithms. The authors concluded the demand of developing new techniques for prevention and protection against attacks on devices. In 2018, Alsulami and Akkari [40], proposed the main role to act and to access high communication requirements of the IoT it is 5G wireless networks. The 5G designed to drive for IoT applications. The authors presented comparison among the connectivity options in 3G, 4G, and 5G for the IOT. Also, several enabling technologies of 5G in IOT have been focused such as D2D, MWT, Relays, WSDN and NFV.

In 2018, Neumann, G., et. al. [41], introduced three strategies to combine 5G mobile networks and industrial Ethernet to a hybrid topology. The first one which Connected homogeneous which is islands, the second is a virtualized controller, the third it extends the second strategy by a remote production site. They depended a methodology of integrating TSN/Industrial Ethernet with 3GPP 5G. In 2018, Bendale and Prasad [42], proposed a scheme on security of 5G mobile network by adding new features. This research introduced a brief knowledge about 5G wireless networks in the different technologies which can be applied to 5G Wireless such as IOT, MIMO, D2D and SDN, HetNet and IDS. In 2019, Rashid and Razak [43], discussed the challenges for big data analytics in 5G. The expected that 5G will deal with a billion of devices and thus the bandwidth consumption will increase the size of data. They presented a flow model for 5G deals with massive and heterogeneous of data by implementing a different machine learning algorithms. The flow model showed that 5G networks can be optimized on the basis of big data analytics solutions. In addition, they concluded that various applications like big data will require support from 5G wireless system. In 2019, Botir S., et. al. [44], presented comprehensive explanation about mobile wireless generations. They compared generations of mobile wireless communication and developments that took place. They analyzed features of different generations such as bandwidth, core network, multiplexing, switching. They concluded that the 5G is very fast to transmit big of data and more reliable. The observed that 5G adds distinctive features correspond to modern

technology and supported by LAS-CDMA, OFDM, MCCDMA, Network-LMDS, and UWB. They suggested that five generations will be completed and used around 2020.

In 2019, Manam, V., et al, [45], explained and described mobile wireless generations over the years. They compared between all generations technologies in terms of speed, technic used, distinct features. Rather than, discussion of the advantages and disadvantages of 1, 2, 3, 4, and 5 generations. In 2020, Abidin, I., et. al. [46], presented the features of 5G. It describes the five generations with highlight on 5G. They focused on using WISDOM technique in 5G as a reason to be faster data transmit comparing with LTE techniques in 4G. They concluded that 5G is a combination of 4G and WISDOM technique. In 2020, AHMAD et al. [47], described the different mobile generations that are: 0G, 1G, 2G, 3G, 4G, and 5G. Also, the author made a comparison among the generations from 1st one to the 5th one in terms of different features. The author addressed that using Millimeter Wave (mmWave) technique in 5G for fastest data delivery, provides higher frequency that is from 30-300GHz with bandwidth greater than 1Gbps. In 2020, Pawarand and Deshpande [48], introduced the revulsion of 5G network and rapid development depend it on spectrum sharing (SS) techniques and cognitive radio (CR) technology. They proposed to make the capabilities of 5G to support different services such as communicate machine to machine, IOT, enhancing mobile broadband and enhancing different challenges faced 5G technology.

4. Discussion and Comparison

At the previous sections, reviewing and analyzing some of important previous researches about the evolution of mobile wireless communication networks from 1G to 5G been addressed. We can conclude that: First generation 1G used only for voice. Second generation 2G used for voice and sending data like messages (SMS) and (MMS) in their telephones. Third generation 3G can be used for multimedia services and expanded information exchange abilities multiple times quicker than 2G. Additionally, 2G prompted the ascent of new administrations, for example, video conferencing. While fourth generation 4G that is the generation using currently before the invention of 5G. Because of that fifth generation is not been used widely yet, but according to the reviewed researches, it can be available in wide range during 2020 with bandwidth higher than 1Gbp. Table 1, illustrates a number of researches, each one has specific method represents an overview among these five generations. So, a comparison among them is produced depending on previous evaluations in terms of generation type, deployment, system technologies, bandwidth, standards and services.

Table 1: comparison of different mobile technologies of the addressed previous researches

Ref. No.	Gen.	Deployment	Technologies system	Bandwidth	Techniques standards	Services and Applied
[27] **2016**	4G	-	Unified IP, seamless integration of broadband LAN/WAN/PAN and WLAN	2Mbps to 1Gbps	OFDMA,MC-CDMA, network-LMPS	Dynamic information access, wearable devices, HD streaming, global roaming
	5G	2020	Unified IP, seamless integration of broadband LAN/WAN/PAN/WLAN and	1Gbps and higher as per need	CDMA and BDMA	Dynamic information access, wearable devices, HD

			advanced technologies based on OFDM modulation used in 5G			streaming, any demand of users ,IOT applications
[38] **2017**	1G	1970 - 1980	analog	14.4 Kbps	AMPS,TACS	Only Voice
	2G	1980 -1990	digital	14-64kbps	GSM , IS-95, JDC , IDEN	Digital voice, Short messaging
	2.5 G	2000- 2003	GPRS, EDGE	14-64kbps	GPRS	Digital voice, Short messaging
	3 G	2000	Broad Bandwidth /CDMA /IP	2Mbps	UMTS (WCDMA)	Integrated High audio, video and data.
	3.5 G	2006 – 2010	HSPA	14.4 Mbps 1-3 Mbps	HSDPA/HSUPA	High speed voice/data/video
	4G	2010	LTE , WiMAX	100mbps	LTE-TDD LTE-FDD Mobile WiMAX	Dynamic information access, wearable devices.
	5G	2020	WWWW	1 to 10 Gbps	broadband LAN/W , AN/PAN &WWWW	Dynamic information access, wearable devices with AI capabilities.
	6G	-	Nano antennas specially designed	will be10-11 Gbps	-	various home automation
	7G	-	satellites	15 GB	-	Multimedia telecommunication satellite
[39] **2017**	2 G	-	digital	-	AMPS ,GSM	-
	3 G	-	digital	-	UMTS	-
	4 G	-	LTE	-		-
	5 G	-	-	-		IOT, will apply ML and AI algorithms.
[40] **2018**	3 G	-	digital	3.1Mbps		IOT
	4 G	-	LTE	100Mbps		IOT
	5 G	2020	-	-	D2D,MWT , *Relays , (WSDN),* NFV	IOT
[41] **2018**	5 G	2020	TSN/Industrial Ethernet with 3GPP	-	3GPP	Industrial Ethernet Technology
[42] **2018**	5 G	2020	-	-	*HetNet , D2D, Massive MIMO, IoT ,IDS ,*	Security wireless 5 G

[49] **2019**	5G	2020	-	-	MIMO , URLLC QOE	Big data analytics (FCN) application
[44] **2019**	1G	1970- 1980	Analog Cellular Technology	2kbps	FDMA	Mobile Technology (Voice)
	2G	1990- 2004	Digital Cellular Technology	64kpbs	TDMA, CDMA	Digital Voice, SMS, Higher Capacity
	3 G	2004- 2010	CDMA , UMTS, EDGE	2Mbps	CDMA	High Quality Audio
	4 G	Now	Wimax , LTE	1Gbps	CDMA	Dynamic information Access
	5 G	Soon (Probably by 2020)	Unknown	More than 1Gbps	CDMA	Unknown
[45] **2019**	1G	1970-1980	Analog Cellular	2kbps	AMPS, NMT, TACS	voice
	2G	1990	Digital Cellular	64kbps	TDMA ,CDMA	Digital Voice, SMS, lower rate data
	3 G	2001	CDMA	2Mbps	CDMA/ IP	High Audio, video calls, mobile broadband
	4 G	2010	LTE - WIFI	1Gbps	Undefined IP,LAN,WAN	Wearable device , high data rate
	5 G	2020	Multi radio waves	Higher 1Gbps	-	Device-to device , IOT
[46] **2020**	1G	Developed 1980	Analog Cellular	--	-	-
	2G	1990	Digital Cellular	-	-	-
	3 G	2001	CDMA	Network download 7.2 Mbps	--	high data transmission, video calls and video conference
	4 G	2009	LTE	100Mbps	OFDM	IP is used for networking
	5 G	2020	Integrated Radio Access Technology (RAT)	Higher 1Gbps	(WISDOM)	Support WWWW ,IOT
[47] **2020**	1G	1970-1984	Analog Cellular	2kbps	AMPS	Mobile Telephony (Voice)
	2G	1980-1999	Digital Cellular	14-64kbps	TDMA, CDMA, GSM 2.5G: GPRS, EDGE, 1xRTT	Digital Voice, SMS, high capacity
	3 G	1990-2001	Broadband CDMA, IP Technology	2Mbps	WCDMA, CDMA	Integrated high-quality audio, video and data
	4 G	2000/2010	Unified IP & seamless combination of broadband LAN/WAN/PAN & WLAN	200Mbps	Single Unified Standard	Dynamic Information access, wearable devices
	5 G	2014/2015	Unified IP & seamless combination of broadband LAN/WAN/ PAN, WLAN & www mm Wave	Higher 1Gbps	Single Unified Standard	Dynamic Information access, wearable devices with AI capability
[48] **2020**	5G	2020	-	very large bandwidth	SS and CR	(IOT), Enhanced mobile broadband, ultra-reliable, low latency communication, massive machine communicate

5. Conclusion

In this paper, after we reviewed many researches, we can conclude that development of mobile wireless communication networks done very quickly from 1G until to 3G it is only for voice sends message data and other activity. Different types of mobile generations were explained, taking in consideration that mobile wireless communication 5G technology become another revolution in a mobile marketplace. The 5G technology has a bright future since it can deal with the best advancements and offer a precious receiver to their clientele. The 4Generation and 5Generation methods give proficient services with high rates data transmission with a noticeable change for the better in communication field. However, 5G technology covered unified-IP, seamless-combination of broadband using LAN/WAN/PAN. Adding to that more than 1Gbps provided as bandwidth, single-unified-standard technique depended beside dynamic-information-access and wearable-devices with AI capability services.

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