Evolution of wireless mobile communication

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***Abstract*—Mobile wireless technology is evolving at a rapid pace thanks to innovative ways in this sector. It is currently advancing at a dizzying pace and encompasses all areas of mobile as well as wireless communications. These new technologies in this field had allowed too many applications to emerge with our daily life and assets in magical ways such applications internet access, GPS and applications depend on it, video conferences, IoT, vehicle tracking, clouding, and numerous applications. The customer of mobile communication via cellular system can use this application and get the benefit of it regardless of the place or the time (everywhere and every time) which makes it effective and practical to use. The evolution of mobile wireless technologies have gone through several stages of technological revolution and progress in the last few decades. Although it is not the end. The current focus of mobile wireless technology research is on the advanced deployment for 5G technology and beyond that with starting to development of 6G.**

Keywords—0G, 1G, 2G, 3G, 4G, 5G, 6G, WiMAX, mmWAVE, LTE, NR.

I. INTRODUCTION

Since the early 1970s, the mobile wireless sector has been developing, revolutionizing, [1]and evolving its technology, starting with the first generation 1G and progressing to the current 5G. The majority of them refer to improvements in mobile wireless generation G definition, speed, infrastructure, capacity, data size, latency, and so on. Each generation has its own set of ideas, abilities, modern behaviors, and new environments that set it apart from previous generations.

The Mobile Wireless Communication Networks (MWCN) have been rapidly expanded in recent years. Wireless communication began to improve, allowing for the deployment of multiple successive generations of cellular telephone technology, which are now widely utilized by many of billions.

Before the 1G was introduced, the Zero Generation technology known by then as the Mobile Radio Telephone system enables half-duplex communication[2]. However, It based on an analog signal that serves as a carrier. The First Generation was known as Cellular, 1G was simply used only for voice calls however, it was the base of all the generation of mobile[3], 1G signal communication was analog in nature.

The Second Generation of mobile networks used digital modulation by using GSM (The Global System for Mobile communication) technology, and some parts of the world used CDMA. Hence it improved voice quality and added new features like text messaging service. Later it added a limited data rate service.

The third Generation increases the voice quality further and allows mobile phone customers to use internet services such as browsing, video call, and GPS, and several online applications. Due to the poor speeds and inconvenient technology of the earlier generations, 3G was developed. As a result that the fundamental characteristic of the 3G network is that it boosts data transmission speeds and expands capacity for regular voice calls (more users it can hold) as well as applications that require high data rates like gaming, online meetings, and multimedia techniques.

The fourth generation of mobile communications networks is known as 4G. It is a step forward for third-generation (3G) standards. 4G system delivers mobile ultra-broadband Internet connectivity and improves the QoS) Quality of Service) by overcoming the limitations of 3G. Increases data transfer capacity; with 4G, you can easily and seamlessly access the internet and join applications that require a high data rate, such as streaming broadcast and online gaming, and more subscriptions can access the networks due to its big bandwidth.

5G mobile networks are the next great jump in mobile broadband., with Peak download speeds of up to 20 Gbps will enable difficult tasks as, connected vehicles, virtual reality, Remote precision medicine, and a wide range of internet of things (IoT) applications. The internet of things connects billions of devices and allows for future advancements, 5G network was created to handle huge amounts of data with very low latency.

II. 0G (ZERO GENERATION SYSTEM)

This generation, known as the 0G or Mobile Radio Telephone system, was created earlier than the cellular system, which became accessible after the second World War. In the days before cell phones, calls were set up by the mobile operator, and there were only a few channels accessible. This system was analog, with analog signals utilized as carriers for the

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calls. This mobile technology does not support the handover or cell structure. Essentially, a Mobile Radio Telephone system works on half-duplex communication. which means that only one person may speak at a time and the other just listens. It refers to the predecessors of the cellular mobile system that was introduced in the 1970s when some individuals had radio telephones in their automobiles as a type of wireless communication before cell phones became available for use. Before contemporary mobile cellular technology, There were two major components to mobile radio telephony.

The transceiver and the body. The transceiver was installed in the car trunk, while the body was installed near the driver, and both the transceiver and the body were linked through a cable. the transceiver was a transmitter and receiver to send and receive the signal while the body was a device that had a screen and dial buttons.

Every city had an antenna tower in the center which transmits a local telephone network in the range of 20km. The telephone device must be inside that range and have a powerful transmitter so it can be able to connect to the network. Although it had only 25 communication channels, A few certain types of people only were able to use this technology (0G) and purchase the device (telephone).

0G system used different technologies such as MTS (Mobile Telephone System), PTT (Push to Talk), IMTS (Improved Mobile Telephone Service), OLT (Norwegian for Offentlig Landmobil Telefoni, Public Land Mobile Telephony), AMTS (Advanced Mobile Telephone System), and MTD (Swedish abbreviation for Mobile Telefoni system D)[4].

A. 0.5G

The improved variant of 0G is called 0.5G, it is not a fully cellular system but almost there.

This 0.5G mobile telephone system differed from its predecessor (radio telephone system) in that users were provided with their own phone numbers. It uses the (PSTN) public switched telephone network as a commercial service for communications. The first commercial public mobile phone network that 0.5G technology had been provided was the ARP (Autoradiopuhelin)[5]. In 1971 in Finland it was designed and established for the first time, the ARP used a half-duplex transmission system as like its previous 0G, with a manual switched system. However, This Network (ARP) contains cells, ARP did not support the handover between the cells or roaming.

III. 1G (THE FIRST GENERATION SYSTEM)

1G is the first generation of modern mobile phone technology and the start point to the leap of continuous innovation in the field. In the 1980s The first generation of commercial cellular network system was introduced to the world, supported with many features,

Because it was simple to create and primarily utilized for carrying speech signals, 1G utilized an analog modulation system. The primary innovation of 1G was the invention of cellular technology (Cells), which is why it knowns as the First Generation of Analog Cellular System. The network in 1G wireless technology is made up of numerous cells. And we can define cells as a geographical Land area that is divided into smaller areas, Each cell has a hexagonal shape. Each cell propagates a radio frequency signal that reaches all the parts of the cell, By using the transceiver antenna or base station. By 1979, the world's first cellular system was ready to operate in Tokyo Japan, The credit went to Nippon Telephone and Telegraph (NTT). The 1G Analog system was first implemented in the USA, was known as Analog Mobile Phone System(AMPS), while the system was implemented in Europe and the rest of the world identified as a variation of Total Access Communication System(TACS) and Nordic Mobile Telephone (NMT)[6].

Voice calls delivered over 1G can be modified at higher frequencies, such as 150 MHZ and upwards, as it passes via radio towers. That was done with the technique (FDMA) Frequency-Division Multiple Access. The frequency spectrum inside the cell has been separated into a number of channels. And before any calls were made. Each call is assigned to a specific pair of channels, for transmitting and receiving simultaneously. The main drawback of first-generation mobile network that it used analog signals which had many unfavorable characteristics such

1- Analog signal affected very hard with interference and noises which lead to poor quality of connection, which lead also sometimes to drop calls.

2- It had a very low capacity and troubled handoff (it gets disconnecting while moving between cells)

3- It had no security and did not support advanced encryption methods.

4- Did not support roaming outside the country

IV. 2G (THE SECOND GENERATION SYSTEM)

The second generation of mobile networks started in the late 1980s and was introduced in the 1990s. 2G was a great jump in mobile communication technology mainly for two reasons. It used a digital signal so the most drawbacks of 1G had improved secondly 2G provided services such as text message, picture message and (Multimedia Message Service) MMS. 2G had greater security for both sender and receiver. All text messages are digitally encrypted and sent, which allows for the transfer of data in such a way that only a particular receiver can receive the data.

2G system uses CDMA and TDMA as digital mobile access technology. CDMA allocates each user a special code while TDMA divides signal to time slots each user has its own slot [8]. TDMA technologies used in 2G are GSM, PDC, iDEN, and iS-136. However, GSM was the first 2G System. CDMA

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technology used in 2G is IS-95. 2G technology developed by introducing the GSM technology (Global system for mobile communication) It provides a good voice quality with limited data services. 2G also introduced some extra services like faxes and voice mail.

The Global System for Mobile Communications (GSM) is a standard developed by (ETSI) European Telecommunications Standards Institute to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices, It was first deployed in Finland in December 1991[9], but GSM was really available only in 1992, By the mid-2010s, GSM had established itself as a worldwide standard for mobile communications, with a market share of over 90% and operations in over 219 nations and territories.[10]

GSM uses TDMA access technology to multiplex up to 8 calls per channel in the 900 and 1800 MHZ bands. GSM didn't only deliver voice calls but also circuit-switched data at a speed up to 14.4kbps.

Original GSM system led to some advanced technology such as 2.5G (GPRS) and 2.75G (EDGE).

A. 2.5G GPRS (General Packet Radio Services)

GPRS is a data rate enhancement of 2G network by launching packet-based services in addition to the circuit-switched service, hence GPRS provided data rates from 56 Kbps up to 384 Kbps, using database HLR(Home Location Register), VLR(Visitor Location Register), EIR(Equipment Identity Register), and AUC with HSCSD technologies. Sevices such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and internet communication services including e-mail and World Wide Wireless Web (WWWW) access are all available in GPRS technology.[8]

B. 2.75G EDGE (Enhanced Data rates for GSM Evolution)

EDGE (Enhanced Data rates for GSM Evolution) is a mobile technology used on top of GSM networks. It supports nearly three times faster speeds than the previous GPRS system. In theory, the maximum speed is 473 kbps for 8 timeslots but it is typically limited to 135 kbps in order to conserve spectrum resources. Both the mobile phone and the network must support EDGE, otherwise, the phone will turn automatically to GPRS. The EDGE technology is a more advanced version of the GSM technology. It enhances the fast transmission of data and information. EDGE meets the requirements for a 3G system but is usually classified as 2.75G. EDGE was deployed beginning in 2003 initially by Cingular (which is known today as AT&T) in the United States. [11]

V. 3G (THE THIRED GENERATION SYSTEM)

The third-generation mobile network was introduced in 2000 with a high-speed data rate (from 144Kbps to 2Mbps) and more reliability than previous generations. 3G is based on a plan developed by the International Telecommunication Union (ITU) to create a global frequency band in the 2000 MHz area that will enable a single, universal wireless communication standard for all nations worldwide. This standard is called The International Mobile Telephone 2000 (IMT-2000). 3G employs packet-switching technology, although it needs a different infrastructure than 2G. 3G mobile phones provide multimedia apps and mobile internet access due to higher data rates and bandwidth. 3G technology allows for higher data transmission rates and is the first to support video conversations.[12]

3G has three types of cellular access technology.

CDMA 2000, which is based on IS-95 and IS-95B technologies. CDMA 2000 has a 1.25 MHz channel width and speed is 144Kbps, introduced by North American wireless Telecommunication standards groups.

WCDMA (Wideband code division multiple access) or known as UMTS (Universal Mobile Telecommunication Service) has 5MHz channel width and speed is 2Mbps. FOMA (Freedom of mobile multimedia access) was the world's first commercial WCDMA service that was launched by NTT Docomo in Japan in 2001.

TD-SCDMA (Time division synchronous code division multiple accesses) introduced by China wireless Telecommunication standards groups, It is a Time Division Duplex (TDD) 3G technology with a Bandwidth of 1.6 MHz [13]. In Europe, the 3G telecommunications network is known as UMTS (Universal Telecommunications Telecommunication Network), while in the United States, it is known as CDMA 2000. Additional 3G stock from China was also accepted by the IMT 2000, i.e. TD-SCDMA and WCDMA are the air interface systems for UMTS. [14]

In comparison to 2.5G and prior networks, 3G offers the following benefits:

reliable faster data transmission.

Support for video conferencing.

Streaming audio and video have been improved.

Support for IPTV (internet television).

GPS (global positioning system)

Web and WAP (wireless application protocol) surfing at a faster rate.

A. 3.5G HSDPA (High-Speed Downlink Packet Access)

HSDPA (High-Speed Downlink Packet Access), commonly known as 3.5G, is a mobile telephony technology that provides a smooth evolutionary path for UMTS-based 3G networks, allowing for faster data transmission speeds and higher data rates. HSDPA is a WCDMA downlink packet-based data service that enables data transmission speeds of up to 8-10 Mbps (and up to 20 Mbps for MIMO systems) across a 5MHz bandwidth. Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-Output (MIMO), Hybrid Automatic Request (HARQ), quick cell search, and

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sophisticated receiver design are all used in HSDPA systems.[15]

B. 3.75G HSUPA (High-Speed Uplink Packet Access)

HSUPA (High-Speed Uplink Packet Access) is an uplink evolution mechanism for UMTS (WCDMA). HSUPA is a mobile telecommunications technology that is closely connected to HSDPA and complements one another.

HSUPA will improve advanced person-to-person data applications such as mobile e-mail and real-time person-to-person gaming by providing greater and symmetric data rates. The increased uplink speed will assist traditional commercial applications as well as numerous consumer apps. HSUPA will improve the UMTS / WCDMA uplink to 1.4Mbps at first, and then to 5.8Mbps in advance versions.

Limitations of 3G:

- The cost of cellular infrastructure and base station upgrades is quite significant.
- Different handsets are required.
- Roaming and data/voice integration have yet to be realized.
- The power consumption is excessive, which means that your phone's battery life is drained.
- Closer base stations are required, yet they are costly.
- The expenses of spectrum licenses, network infrastructure, and handset subsidies for customers are enormous.
- Some issues with Connectivity. [16]

VI. 4G (THE FOURTH GENERATION SYSTEM)

The fourth generation of mobile communication systems debuted in 2010, known as 4G. It is the successor to 3G and enables mobile devices with ultra-high-speed internet connectivity, improved speeds, reduced latency, and pure voice calls, 4G has high QoS (Quality of service) and better security. 4G can provide up to 100 Mbps peak rates in full-mobility (moving at a speed of 60 Kmph) and 1Gbps in low-mobility local area coverage.

4G cellular networks are used for applications that need high-speed data rate and minimum latency such as IP telephony, online gaming services, location-based services, high-definition mobile TV, video conferencing, high security, low cost per bit, and 3D television. [17]

A. OFDMA (Orthogonal Frequency Division Multiplexing Access)

3G used a hybrid technology that combines CDMA and IS-95, whereas in 4G a new technology is introduced called OFDMA. OFDMA is based on the principle of division multiple accesses, however, this is neither time like TDMA nor code divided CDMA, but rather a frequency domain equalization procedure. 4G uses coded orthogonal frequency division multiplexing (COFDM) technology to remove the effects of Multipath fading and inter-symbol interference (ISI). OFDMA is used on the downlink, and SC-FDMA will be used for the uplink due to OFDMA presenting a high Peak-to-average Power Ratio it is not possible to use it on the uplink. OFDM comes from the fact that high serial bit stream data is delivered over a large (parallel) number of sub-carriers (obtained by dividing the available bandwidth), each has a distinct frequency and are orthogonal to one another. [18]

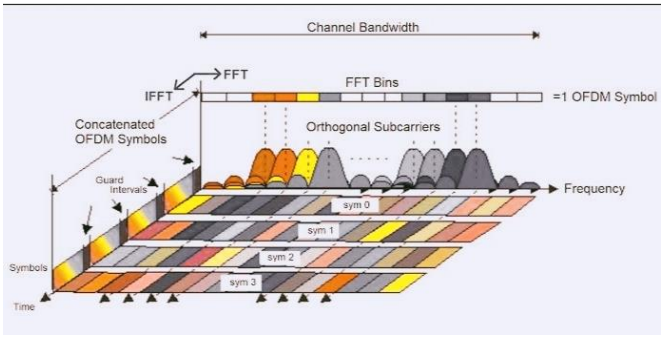

Fig. 1. Frequency-Time Representative of an OFDM

B. LTE (Long Term Evolution)

LTE is a 3GPP-developed mobile communication standard that aims to be the fourth generation of mobile communication. It was presented as a 4G system candidate and accepted by the ITU as satisfying 4G standards on Release 10, commonly known as LTE-A. The usage of multiple antenna techniques is another advancement of LTE systems. MIMO (Multiple-Input Multiple-Output) technology was used for the first time in LTE. The use of multiple antennas can increase the overall communication performance greatly by increasing channel capacity and reducing latency and noise. Different from previous generations' access technologies (TDMA, FDMA, and CDMA), LTE uses OFDMA (Orthogonal Frequency-Division Multiplexing Access) as multiple access technology. On OFDM the transmitted signal decomposed to ‘n’ signals (by using a serial/parallel converter).

C. LTE Advanced

LTE is introduced as the fourth generation (4G) mobile communication by 3GPP in Release-8, with some modification in Release-9, LTE has set a benchmark in achieving a peak downlink data rate of 300 Mbps and better Quality of service than the previous 3G network. However, it is far beyond the initial establishment and expectations of 4G. Due to the massive increase of mobile data traffic with new applications and services, it is mandatory to upgrade the LTE system. 3GPP launched LTE-A in Release-10, which met the criteria of the requirements of International Mobile Telecommunication-Advanced (IMT-Advanced) with a substantial upgrade that featured a peak data throughput with a downlink speed of 1 Gbps and an upload speed of 500 Mbps. LTE-A brought some new technologies as well as

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enhancements to earlier technologies in order to meet future needs and execute IMT-Advanced criteria. In release-10 LTE-A suggested CA (channel aggregation) enables a larger bandwidth of up to 100 MHz [20]. This technique, also known as channel aggregation, combines several (up to five) CCs (component carriers) of various frequencies to generate a larger total transmission bandwidth, which is utilized to deliver the increased throughput required by the LTE-A system. [21]

D. WiMAX

WiMAX stands for (Worldwide Interoperability for Microwave Access) is a wireless microwave MAN (Wireless Metropolitan Area Networks) technology that can offer up to 1 Gbps over a distance of up to 30 miles. WiMAX, also known as IEEE 802.16, is a technology that is comparable to Wi-Fi but may deliver substantially faster data transmission rates. It is also based on the IEEE 802.16 standard, as opposed to the IEEE 802.11 standard used by Wi-Fi.[22] It is a technology that was built to focus on solving the problems of point-to-multipoint broadband outdoor wireless networks. Mobile WiMAX offers best-in-class security features such as mutual user authentication, configurable key management protocol, solid traffic encryption, management, and control plane message protection, and security protocol optimizations for quick handovers to make internet access more convenient. [23]

VII. 5G (THE FIFTH GENERATION SYSTEM)

The fifth generation of mobile technology started in South Korea and it became the first country to provide 5G (the fifth-generation mobile wireless standard) on December 1, 2018, and it's safe to say that the mobile industry has come a long way from the first mobile phone in 1973. We could never have foreseen how mobile gadgets have transformed our world.[24]

Based on IMT-2020 specifications, 5G is expected to achieve peak data speeds of up to 20 Gbps. Although in addition to greater peak data speeds, the speed of 5G is not the only important factor. 5G is planned to provide substantially more network capacity by extending into a new spectrum, such as mmWave. 5G may also provide significantly lower latency for faster responses and a more consistent user experience, ensuring that data speeds remain high. [25]

Maybe the most important feature of 5G is the ability to support a massive number of devices simultaneously and without conserving much energy, this will create the opportunity to advance new techniques such as IoT. The IoT has broadened the mobile communications services that connect people and things, such as new features as smart homes, mobile health, internet of cars, industrial control, environmental monitoring, and smart cities. Every device and everything will be connected to the internet, and the cloud will serve as a big data storage with the ability to analyze and process that massive data. [26] Hence 5G is required to provide extremely high and reliable data connection with minimum latency. 5G will become a revolutionary jump to every business sector with billions of connected devices.

5G, like 4G LTE, is based on OFDM (Orthogonal frequency-division multiplexing) and will follow the same mobile networking concepts as 4G LTE. The new 5G NR (New Radio) air interface, on the other hand, will improve OFDM much further, giving it far more flexibility and scalability. In comparison to 4G LTE, 5G will not only provide faster and better mobile broadband services, but it will also expand into new service sectors such as mission-critical communications and linking the huge Internet of Things.[27] This is made feasible by many new 5G NR air interface design strategies, such as a new self-contained TDD sub(Time-division duplex) frame design.

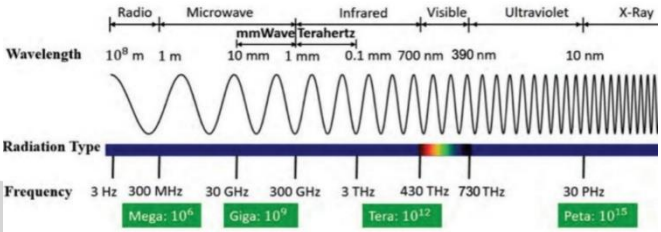

Fig. 2. Spectrum and wavelength of mmwave

A. 5G new radio (NR)

The 5G new radio standard, often known as 5G NR, is a collection of specifications that will eventually replace the LTE network's 4G wireless communications technology. One of the main goals of 5G NR is to assist the expansion of wireless communication by improving the efficiency of the electromagnetic radiation spectrum. The 3rd Generation Partnership Project (3GPP) produced the 5G NR standard, and the first iteration of 5G NR was released in 3GPP Release 15. 5G NR is intended to provide fiber-equivalent bandwidth transmissions necessary for demanding applications such as streaming video, as well as low bandwidth transmissions utilized in huge machine-to-machine (M2M) communications. [28]

New engineering approaches are used in 5G NR to transfer more data across the core network quicker and revolutionize the discrete operations of the air interface, which is the client device's contact with the network provider radio gear.

The core 5G NR design will encompass three foundational elements:

MmWave; Spectrum variety ranging from several hundred kilohertz to millimeter-wave to support diverse use cases, cell sizes, and data speeds, this new spectrum will able a massive number of users to communicate with huge data at the same time.

Optimized OFDM-based waveforms and multiple access and advanced channel coding techniques;

They will be enhanced with more sophisticated capabilities to offer high performance with low complexity, to handle

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various spectrum bands, spectrum kinds, and deployment patterns, and to effectively support and multiplex all of the distinct use cases. [29]

Massive MIMO and evolved beam forming capabilities;

Massive MIMO is an expansion of MIMO that goes beyond conventional systems by adding a significantly greater number of antennas to the base station. The "huge" number of antennas aids in the concentrate of energy, resulting in significant gains in throughput and efficiency [30].

VIII.6G (THE SIXTH GENERATION SYSTEM)

6G is a telecommunications standard that is presently being developed for wireless communications technologies that support cellular data networks. It will be the 5G's successor and will have an extremely high data rate up to 1000Gbps,[31] and with a latency of less than 1 microsecond, and it is expected to be available in 2030.

The industry of 6G technology is predicted to enable significant breakthroughs in imaging techniques, metaverse technologies, and location awareness of the devices. Using artificial intelligence (AI). The computational infrastructure of 6G will automatically determine the best location for computing the received data, including decisions about data (storage, processing, and sharing). 6G networks are intended to be more heterogeneous (diverse) than their predecessors and to accommodate applications other than existing mobile usage scenarios, such as virtual reality (VR) and augmented reality (AR), the internet of things (IoT), omnipresent instant messaging, electric vehicle auto communication and pervasive intelligence[32]. We visualized 6G as a future technique of enabling super-smart cities to develop and become affordable with ubiquitous autonomous systems everywhere. The current 5G infrastructure, such as Software-Defined Networking, Network Slicing (NS)[33], and Network Function Virtualization (NFV), as well as new infrastructure, will be added, all are anticipated to enable the 6G to be operated.

Feature	1G	2G	2.5G	3G	3.5G	4G	5G	6G [34]
Introduced	1981	1991	1995	2001	2006	2010	2020	2030
Data rate	2kbps	14.4kbps	64kbps	3.1Mbps	14.4Mbps	1Gbps	10Gbps	1000Gbp
Technology standards	AMPS, NMT, TACS, C-Netz	GSM, IS-95	GPRS, EDGE, 1xRTT	UMTS, CDMA2000	HSPA	LTE, WiMAX	NR, mmWave, (D2D)	Super massive MIMO, Sub mm Wave
Multiplexing [35]	FDMA	FDMA, TDMA	FDMA, TDMA	CDMA	CDMA	OFDM+MIMO,MC-CDMA	OFDM,Massive MIMO	NOMA, …
Core Network	PSTN	PSTN	PSTN	PSTN & some IP network	PSTN & some IP network	Completely IP based	Completely IP based	Completely IP based
Architecture	Circuit switch	Circuit switch	Packet switch	Circuit & packet switch	packet switch	packet switch	packet switch	packet switch
Services	Mono voice	Voice, SMS	Voic, SMS,Data service	Superior voice quality & always on broadband	Enhancement of data rate	Streming, coverage area expansion & low letancy	Extremely fast and more reliable ever	Super massive connections, (IoE), VR, AR, cloud computing.

Fig. 3. Difference between 1G to 6G [36]

CONCLUSION

Mobile communication technologies have improved in a dramatic way over the past few decades before the first generation the 0G was the first try for this massive technology that we live now, and with the first generation, the picture started to become clear with the new design of cells and connecting between them although it had no handover and it had many sound quality issues due to the usage of the analog signal as a carrier. the second generation was really a big jump with new technology used back then, For it used digital signal as a carrier. Therefore the voice quality improved in a noticeable manner and it used a bunch of new services such as SMS, and here for the first time, the

GSM has been introduced with the competitive technology in some countries called CDMA. And later some enhancements were added to the 2G which make it capable

to send the data, and the packet switch was used for the first time. 3G came with a huge data rate improvement and lower latency with great reliability. It is so effective even many countries are still using it now. 4G was a high jump in technology with ten-times high-speed data rate and enormous capacity for users. Very low latency and streaming become available everywhere because of the new OFDM accessing

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technology, and 4G is used as broadband too. 5G just started to spread and be used in different countries. 5G has the capacity to manage a tremendous number of users at the same time hence it creates an opportunity for the IoT devices to connect with each other with extremely low latency. However, it can't be used in a wide range like 4G due to its mmwave getting distracted by buildings and trees. 6G is not yet completed and it won't be ready till 2030, but we can take a view of what the future will be with these super massive technologies. Although we know this extreme data rate will not be used for our technology that we know now but for future applications that will need Tbps and seamless micro latency.

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