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Evolution of G: Wireless telephony generations

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Abstract
Evolution of wireless access technology reaches its fourth generation (4G) and a tremendous growth of numbers of mobile subscribers over the last decade revolutionized the way of communication. Wireless access technologies have followed different evolutionary paths but their aim was single i.e. high performance and efficient. The successful Mobile Wireless Technology provides high speed services to the users and become popular and successful as it has simplified the communication. Mobile Wireless Technologies have evolved to four generations of technologies and in present the implementation work of 5G is going on, which is not officially used for any current technology. With the ever-increasing demand for the newest gadgets, faster mobile broadband and increased efficiency of applications such as GPS, we may see the future generations of 5G technologies. These days we let mobiles rule our lives.

Keywords: 0G(0.5G), 1G, 2G(2.5G,2.75G), 3G(3.5G,3.75G), 4G, 5G, Mobile Communication.

1. Introduction
There has been a phenomenal growth in the wireless industry. A shift from fixed to mobile cellular telephony, which results in Network Planning and Optimization related services. The First generation has fulfilled the basic mobile voice, while the Second generation has dealt with capacity and coverage. The third generation focused for higher data rate, multimedia support and spread spectrum followed by Fourth generation providing access to wide range of telecommunication services including advanced mobile services, along with a support for low to high mobility application [4].

2. Applications of Wireless Communications
Wireless systems are becoming an important infrastructure in our society. A virtual global system is a good solution that can efficiently connect many dedicated wireless systems including 2G to 4G cellular systems, wireless LAN, broadcasting systems, etc. Some of the characteristics are: [5].

- Shortwave communication and ultra-shortwave communication, which include army broadcasting and military special communication.
- Microwave communication, for example vision distance microwave relay.
- Satellite communication, such as maritime satellite, television relay, broadcasting and remote sensing.
- Mobile wireless communication, including cellular wireless system, paging system wireless LAN and wireless ATM system.
- Cheaper to install and maintain than wired networks.
- High technology communication systems lead to transfer of information at faster rate.

3. Wireless Telephony Generations
3.1 Zero Generation Technology (0G-0.5G)
Mobile radio telephone services the great ancestors that became available just after World War II, for those mobile services there was a need of a mobile operator who set up the call within the few available channels. Mobile radio telephone systems preceded modern cellular mobile telephony technology. Since they were the predecessors of the first generation of cellular telephones, these systems are called 0G (zero generation) systems and also refer to pre-cellular mobile telephony technology in 1970s [7]. These early mobile telephone systems can be distinguished from earlier closed radiotelephone systems in that they were available as a commercial service that was part of the public switched telephone network, with their own telephone numbers, rather than part of a closed network such as a police radio or taxi dispatch system. The transceiver (transmitter-receiver) was mounted in the vehicle trunk and attached to the "head" (dial, display, and handset) mounted near the driver seat. These mobile telephones were usually mounted in cars or trucks, though briefcase models were also made since they were the predecessors of the first generation of cellular telephones, these systems are called 0G (zero Mobile radio telephone systems preceded modern cellular mobile telephony technology.

3.1.1. Technologies used in 0G (zero generation) systems
PTT (Push to Talk), MTS (Mobile Telephone System), IMTS (Improved Mobile Telephone Service), AMTS (Advanced Mobile Telephone System), OLT (Norwegian for Offentlig Landmobil Telefoni, Public Land Mobile Telephony) and MTD (Swedish abbreviation for Mobilelefonisystem D, or Mobile telephony system D) [6].

3.1.2. 0.5 Generation Technology (0.5G)
0.5 G was the advance version of 0G (Zero Generation or Mobile Radio Telephone system). The group of technologies with improved features than the basic 0G technologies emerged as 0.5 G. This technology had introduced ARP (Autoradiopuhelin) as the first commercial public mobile phone network. This ARP network was launched in 1971 at Finland [8]. ARP was operated on 8 Channels with a frequency of 150 MHz (147.9 – 154.875 MHz band) and its transmission

power was in a range of 1 to 5 watts. ARP used half duplex system for transmission (voice signals can either be transmitted or received at a time) with manual switched system. This Network contains cells (A cell is the geographical area covered by a cellular telephone transmitter. The transmitter facility itself is called the *cell site*) with the cell size of 30 km.

3.1.3. Advantages of ARP

- ARP provided 100% coverage which attracted many users towards it.
- ARP was successful and became very popular until the network became congested.

3.1.4. Disadvantages of ARP

- As ARP did not support the handover, calls would get disconnected while moving from one cell to another.
- The ARP mobile terminals were too large to be fixed in cars and were expensive too.

3.2 First Generation Technology (1G)

In the year of 1980 mobile cellular era had started with significant changes and growth. Set of wireless standards & successor of zero generation was developed and known as 1G which stands for "first generation" more popularly known as cell phones. 1G technology replaced 0G technology, which featured mobile radio telephones and other technologies [9]. First Generation of wireless networks used analog transmission for speech services. In 1979, the first cellular system in the world became operational by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. Two years later, the cellular epoch reached Europe [5, 10]. The two most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS). Other than NMT and TACS, some other analog systems were also introduced in 1980s across the Europe. All of these systems offered handover and roaming capabilities but the cellular networks were unable to interoperate between countries. This was one of the inevitable disadvantages of first-generation mobile networks.

In the United States, the Advanced Mobile Phone System (AMPS) was launched in 1982. The system was allocated a 40-MHz bandwidth within the 800 to 900 MHz frequency range by the Federal Communications Commission (FCC) for AMPS. In 1988, an additional 10 MHz bandwidth, called Expanded Spectrum (ES) was allocated to AMPS and was first deployed in Chicago, with a service area of 2100 square miles2. AMPS offered 832 channels, with a data rate of 10 kbps. Although omnidirectional antennas were used in the earlier AMPS implementation, it was realized that using directional antennas would yield better cell reuse. In fact, the smallest reuse factor that would fulfill the 18db signal-to-interference ratio (SIR) using 120-degree directional antennas was found to be7.Hence, a 7-cell reuse pattern was adopted for AMPS. Transmissions from the base stations to mobiles occur over the forward channel using frequencies between 869-894 MHz the reverse channel is used for transmissions from mobiles to base station, using frequencies between 824-849MHz. AMPS and TACS use the frequency modulation (FM) technique for radio transmission. Traffic is multiplexed onto an FDMA (frequency division multiplexing access) system [11].

In terms of overall connection quality, 1G compares unfavorably to its successors. It has low capacity, unreliable handoff, poor voice links, and no security at all. Since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.

3.3 Second Generation Technology (2G, 2.5G-2.75G)

"Second generation" 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991. This technology is based on global system for mobile communication and replaced the analogy technology by digital communication. 1G technology was used to transfer analog signals. Services such as text message, picture message and MMS are provided by 2G. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that only the intended receiver can receive and read it [3, 5]. It cannot normally transfer data, such as email or software, other than the digital voice call itself. Nevertheless, SMS messaging is also available as a form of data transmission for some standards. 2G networks are basically for voice communications only. The ubiquity of the GSM standard makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the World.

2G technologies can be divided into three different types of 2G mobile technologies based on the system which are designed. Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used [3, 9]. All these mobile technologies have different properties & different working methods. 2G makes use of a CODEC (Compression-Decompression Algorithm) to compress and multiplex digital voice data. Through this technology, a 2G network can pack more calls per amount of bandwidth as a 1G network. 2G cell phone units were generally smaller than 1G unit, since they emitted less radio power.

3.3.1. FDMA (2G Mobile Technology)

Frequency division Multiple Access (FDMA) is a technology whereby the total amount of spectrum is divided in a number of channels. Each channel can be assigned to a different user. FDMA is commonly used in analog mobile radio, including analogue cellular mobile telephone systems like AMPS, NMT and TACS. Between the different used frequency channels is a small amount of bandwidth which is not used. This space is called a guard band. This bandwidth is necessary to cater for instability of the sender, frequency shifts due to movement (the Doppler Effect) and no-ideal filtering.

It works like a radio system by separating the frequency into equal spectrum but affecting the quality of voice. FDMA is an analog system still exists in 2G mobile technology with the digital module of 2G in limited area. Instead of frequency division now cellular based technology which divide geographical areas not frequency and improve the service.

3.3.1.1 Properties

- This technology is first used in 1G mobile as an analog system, introduced in 2G with the increase in its frequency with the help of cellular technology.

- Able to carry digital transmission but digital transmission is not quality wise as good as in case of analog system.
- Facilitate with the feature of analogue system by enabling the accessibility of call.

3.3.2 TDMA (2G Mobile Technology)

Time Division Multiple Access (TDMA) is a communications technique whereby the total capacity of a transmission channel is shared among multiple users by allocating each a unique time slot.

TDMA is also the popular name for the U.S. D-AMPS mobile communications system, based on the IS-136 standard.2G Mobiles uses Time Division Multiple Access technology in some of its models. It actually divides each cellular channel into three time slots in order to increase the amount of data that can be carried & each of the slots serves one subscriber. The information is broken into tiny data packets, which are transmitted in timed bursts in the 30-megahertz range. At the receiving end, the separate information streams are recovered. TDMA contains technologies GSM (Global Service Mobile Communication), which is the most common technology, uses widely across the world.

3.3.2.1. Properties

- TDMA increases network efficiency by enabling single connections to carry multiple data channels
- TDMA facilitates step-by-step migration to digital operation.
- Flexible and scalable.
- TDMA can be implemented seamlessly across both 800- and 1900-MHz networks.

3.3.3. CDMA (2G Mobile Technology)

Code Division Multiple Access (CDMA) is a multiple access technology whereby a number of users share the same frequency channel at the same time. Each user is assigned a unique code. It is a so-called “spread-spectrum technique” because the data signal is spread over a larger bandwidth than strictly needed to transmit it and is used in a number of mobile communications systems. The second generation standard cdmaOne as well as the 3rd generation standardsCDMA2000 and UMTS use CDMA.

CDMA is a form of multiplexing, which allows a large number of signals to occupy a single transmission channel, optimizing the use of available bandwidth. CDMA is based on a wide spectrum as many calls laid over each other identifying on the basis of unique code. The technology is used in ultra-high- frequency (UHF) cellular telephone systems in the 800-MHz and 1.9-GHz bands.

CDMA employs analog-to-digital conversion (ADC) in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a defined pattern (code), so it can be intercepted only by a receiver whose frequency response is programmed with the same code, so it follows exactly along with the transmitter frequency. There are trillions of possible frequency-sequencing codes; this enhances privacy and makes cloning difficult.

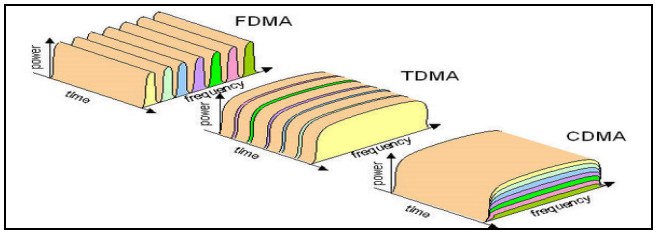

Fig 2: FDMA/ TDMA/ CDMA

3.3.3.1 Properties

- CDMA gives a separate code to a separate phone.
- CDMA is compatible with other cellular technologies, this allows for nationwide roaming.
- Increase the frequency band space by assigning code in sequence.
- Both senders and receivers are able to use a full band with the help of using their codes.
- Contrast to one analog call, nearly dozen calls can be channelized at the same time.

3.3.4. Benefits of 2G

- Digital signals require consume less battery power, so it helps mobile batteries to last long.
- Digital coding improves the voice clarity and reduces noise in the line.
- Digital signals are considered environment friendly.
- Improved privacy is another advantage of 2g technology.
- The use of digital data service assists mobile network operators to introduce short message service over the cellular phones.
- The digital encryption provides privacy and safety to the data and voice calls.
- SMS is also a cheap and easy way to communicate with anyone

3.3.5. 2.5G–GPRS (General packet radio service)

General Packet Radio Service (GPRS) is a packet-data technology that allows GSM operators to launch wireless data services, such as e-mail and Internet access. As a result, GPRS provides operators with the ability to use data to drive additional revenue [5]. GPRS is often called a 2.5G technology because it is a GSM operator's first step toward third generation (3G) and a first step in wireless data services.

Although GPRS is a data-only technology, it helps improve GSM voice capacity. When an operator deploys GPRS, it also can upgrade to a vocoder, a new type of voice coder that turns voice into digital signals before they pass across the wireless network. The vocoder uses Adaptive Multi-rate speech transcoding (AMR) technology, which can handle twice as many simultaneous voice calls as a network that uses the old vocoder. As a result, GPRS allows GSM operators to accommodate additional voice traffic without the expense of acquiring additional spectrum.

GPRS supports peak download data rates of up to 115 kbps, with average speeds of 40 to 50 kbps, which is comparable to other 2.5G technologies, such as CDMA2000 1x. GPRS speeds are fast enough for applications such as Multimedia Messaging Service (MMS) and a web browsing experience comparable to a wired dial-up modem [9]. GPRS also allows customers to maintain a data session while answering a phone

call, which is a unique and exclusive feature to GSM. GPRS also provides an always-on data connection, so users do not have to log on each time they want data access. The packet architecture also means that users pay only for the data itself rather than for the airtime used to establish a connection and download data.

3.3.6. 2.75–EDGE (Enhanced Data rates for GSM Evolution)

Enhanced Data Rates for GSM Evolution (EDGE) is a technology that enables high-speed packet-data services such as Internet access and streaming multimedia. EDGE with both voice and data traffic moving on the system and supports peak theoretical network data rates of 474 kbps, with average throughput of 70 to 130 kbps on both the downlink and the uplink [12]. The average rates are fast enough to support a wide range of data services, including streaming audio and video, fast Internet access and large file downloads. EDGE also can support Push-to-Talk (PTT) services.

The International Telecommunication Union (ITU), which sets telecom standards for worldwide use, approved EDGE as a 3G standard in July 2000. In July 2003, the world's first commercial EDGE network launched. By 2010 there were more than 500 commercial EDGE networks operating in 200 countries worldwide. Reasons for this worldwide expansion include:

- EDGE is a relatively straightforward, cost-effective network upgrade for most GSM operators. EDGE deployments usually require only software and additional channel cards for the existing GSM-GPRS network infrastructure. This design reduces the cost of deploying EDGE, so operators are better able to price their EDGE services competitively yet profitably.
- EDGE does not require operators to acquire additional spectrum. Instead, it can be deployed in today's most widely used bands. The ability to deploy EDGE in its existing spectrum means that an operator can launch 3G services quickly, in more markets and at a lower cost than technologies that require new spectrum.

3.4. Third Generation Technology (3g, 3.5g – 3.75g)

Third Generation (3G) mobile devices and services transform wireless communications into on-line, real-time connectivity. 3G wireless technology will allow an individual to have immediate access to location-specific services that offer information on demand. 3G is the third generation of mobile phone standards and technology, superseding 2G, and preceding 4G. It is based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, IMT-2000 [12, 13].

3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. Additional features also include HSPA data transmission capabilities able to deliver speeds up to 14.4Mbit/s on the downlink and 5.8Mbit/s on the uplink. Spectral efficiency or spectrum efficiency refers to the amount of information that can be transmitted over a given bandwidth in a specific digital communication system [9]. High-Speed Packet Access (HSPA) is a collection of mobile telephony protocols that extend and improve the performance of existing UMTS protocols.

IEEE 802.11 networks are short range, high-band width networks primarily developed for data. Wi-Fi is the common name for a popular wireless technology used in home networks, mobile Phones, video games and more. The notebook is connected to the wireless access point using a PC card wireless card. A videophone is a telephone which is capable of both audio and video duplex transmission.3G technologies make use of TDMA and CDMA. 3G (Third Generation Technology) technologies make use of value added services like mobile Television, GPS (global positioning system) and video conferencing. The basic feature of 3G Technology is fast data transfer rates.

3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies operate under CDMA, TDMA and FDMA.CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). TDMA accounts for IMT-TC (time code), IMT-SC (single carrier). Third generation technology is really affordable due to the agreement of industry. This agreement took place in order to increase its adoption by the users. 3G system is compatible to work with the 2G technologies. The aim of the 3G is to allow for more coverage and growth with minimum investment.

There are many 3G technologies as W-CDMA, GSM EDGE, UMTS, DECT, WiMax and CDMA 2000.Enhanced data rates for GSM evolution or EDGE is termed to as a backward digital technology, because it can operate with older devices [12].

3.4.1. 3.5g – Hsdpa (High-Speed Downlink Packet Access)

High-Speed Downlink Packet Access (HSDPA) is a mobile telephony protocol, also called 3.5G which provides a smooth evolutionary path for UMTS-based 3G networks allowing for higher data transfer speeds [5].

HSDPA (High Speed Downlink Packet Access) is an upgrade to UMTS/WCDMA and has become the leading global mobile broadband standard. HSDPA increases the download speeds by up to 3.5 times, initially delivering typical user data rates of 550 to 800 kbps. Improvements to the downlink, through HSDPA, were the first upgrade steps available to operators seeking to deploy mobile broadband services as a part of 3GPP Release 5. There is some confusion regarding the use of acronyms involving HSDPA, and its further evolution to High Speed Uplink Packet Access (HSUPA), as the terms are often used interchangeably along with the acronym HSPA which refers to the both HSDPA and HSUPA in their evolved state.

HSDPA speeds are ideal for bandwidth-intensive applications, such as large file transfers, streaming multimedia and fast Web browsing. HSDPA also offers latency as low as 70 to 100 milliseconds (ms) making it ideal for real-time applications such as interactive gaming and delay-sensitive business applications such as Virtual Private Networks (VPNs).

3.4.2. 3.75g – Hsupa (High-Speed Uplink Packet Access)

High Speed Uplink Packet Access (HSUPA) is an upgrade to UMTS-HSDPA that uses the Enhanced Dedicated Channel (E-DCH) to constitute a set of improvements to optimize uplink performance. These improvements include higher throughput, reduced latency and increased spectral efficiency. HSUPA was standardized in 3GPP Release 6 and combined with High

Speed Downlink Packet Access (HSDPA), is commonly referred to as High Speed Packet Access (HSPA) [5, 12]. In other words, Release 5 HSDPA upgraded to Release 6 HSUPA is considered mobile broadband HSPA.
HSUPA results in an approximated 85 percent increase in overall cell throughput on the uplink and an approximated 50 percent gain in user throughput. HSUPA also reduces packet delays. HSUPA improves HSDPA uplink speeds from 384 kbps to a peak theoretical network rate of 5.8 Mbps while providing 14 Mbps peak theoretical network rates on the downlink. Many operators initially launched HSPA at the peak rates of 3.6 Mbps, upgraded their networks to 7.2 Mbps or 14.4 Mbps.

3.5. Fourth Generation Technology (4g- All Ip)

Fourth generation wireless telecommunication is an evolution in wireless technology based on internet protocol with high speed data transfer rates, remote connectivity anywhere in the world, less signal attenuation, ultra-broadband Internet access, IP telephony, gaming services, and high quality faster multimedia streaming.
The first successful field trial for 4G was conducted in Tokyo, Japan on June 23rd, 2005. NTT Do Co Mo was successful in achieving 1Gbps real time packet transmission in the downlink at a moving speed of about 20km/h. Two 4G candidate systems are commercially deployed: the Mobile WiMAX standard (first used in South Korea in 2007), and the first-release Long Term Evolution (LTE) standard (in Oslo, Norway and Stockholm, Sweden since 2009). In the United States, Sprint (previously Clearwire) has deployed Mobile WiMAX networks since 2008, while Metro PCS became the first operator to offer LTE service in 2010 [14, 15].
The stage of broadband mobile communications that will supersede the third generation where the carriers that use orthogonal frequency-division multiplexing (OFDM) instead of time division multiple access (TDMA) or code division multiple access (CDMA), even when their data speeds are not as fast as the International Telecommunication Union (ITU) specifies. According to the ITU, a 4G network requires a mobile device to be able to exchange data at 100 Mbit/sec. A 3G network, on the other hand, can offer data speeds as slow as 3.84 Mbit/sec.

3.5.1. Development of 4g

The 4G system was originally visualized by the Defense Advanced Research Projects Agency (DARPA). The DARPA selected the distributed architecture, end-to-end Internet protocol (IP), and believed at an early stage in peer-to-peer networking in which every mobile device would be both a transceiver and a router for other devices in the network eliminating the spoke-and-hub weakness of 2G and 3G cellular systems. The idea came from development of 2.5GPRS systems, in which cellular systems were provided with dual infrastructures: packet switched nodes for data services, and circuit switched nodes for voice calls [16]. In 3g and 4G systems, the circuit-switched infrastructure is abandoned, and only a packet-switched network is provided.

3.5.2. Objectives of 4g Wireless Systems

The 4G technology is expected to cover data rate deficiency in previous generations like 1G, 2G, and 3G etc. This service is also expected to achieve quality of services. It may provide many multimedia services which would not only include only voice chat and video calls but also MMS, HDTV, video chat and voice over the internet.
This network provides interactive roaming with existing LAN and digital broadcasting system. This network's goal is to provide a speed of 100 mbps data rate of moving customers and 1GBps for stationary users. By getting this, the consumers get and connectivity with high speed anywhere across the uninterrupted service world. This system has very smooth handover over heterogeneous networks.
The next target of this 4G technology is to provide flawless connectivity and international roaming across innumerable networks of the world. It will also provide high multimedia support in order to get approval from ITU. The interoperability with existing network infrastructure is another prominent feature of this technology. It is an all IP switched network and several working groups purpose that it should offer an open internet protocol. The early 4G technology comprises of flash OFDM, 802.16e, wireless or mobile Wi-max and HC SDMA.
In the today's world, the demand of wireless network users combined with the efforts of 4G working groups' technology and edge over its previous counterparts [16]. This 4G technology would revolutionize the world of cellular networks with amazing Wireless broadband speed. Due to this new technology, job opportunities for many people must be fulfilled. ITU is the deciding factor for further development in the 4G technology.

3.6. Fifth Generation Technology (5g)

5G Technology stands for 5th Generation Mobile technology. A new revolution of 5G technology is about to begin because 5G technology going to give tough completion to normal computer and laptops whose marketplace value will be effected. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of telecommunications. The new coming 5G technology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. 5G mobile technology has changed the means to use cell phones within very high bandwidth. User never experienced ever before such a high value technology. Nowadays mobile users have much awareness of the cell phone (mobile) technology. The 5G technologies include all type of advanced features which makes 5G mobile technology most powerful and in huge demand in near future. The gigantic array of innovative technology being built into new cell phones is stunning.
This next generation of Wi-Fi promises to be very exciting since 802.11ac will address some critical pain points faced by users of 802.11n today – more bandwidth and more simultaneous users. To help explain the technology, we put together a new Fundamentals video. You'll learn about new features such as:

- Operating in the 5GHz band.
- Wider channels (80MHz & 160MHz) which means more capacity in the band.
- Increased modulation with 256 QAM (Quadrature Amplitude Modulation), providing a significant increase in throughput over 802.11n which has 64 QAM.
- Downlink Multi-User MIMO which allows an AP to transmit to multiple clients simultaneously.

- Up to 8 Spatial streams which doubles the number of spatial streams used in 802.11n.

5G technologies will change the way most high-bandwidth users access their phones. With 5G pushed over a VOIP-enabled device, people will experience a level of call volume and data transmission never experienced before.5G technology is offering the services in Product Engineering, Documentation, supporting electronic transactions (e-Payments, e-transactions) etc. As the customer becomes more and more aware of the mobile phone technology, he or she will look for a decent package all together, including all the advanced features a cellular phone can have. Hence the search for new technology is always the main motive of the leading cell phone giants to out innovate their competitors. Recently apple has produced shivers all around the electronic world by launching its new handset, the I-phone. Features that are getting embedded in such a small piece of electronics are huge.

3.6.1. Features of 5g Technology

- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- The advanced billing interfaces of 5G technology makes it more attractive and effective.
- 5G technology also providing subscriber supervision tools for fast action.
- The high quality services of 5G technology based on Policy to avoid error.
- 5G technology is providing large broadcasting of data in Gigabit which supporting almost 65,000 connections.
- 5G technology offer transporter class gateway with unparalleled consistency.
- The traffic statistics by 5G technology makes it more accurate.
- Through remote management offered by 5G technology a user can get better and fast solution.
- The remote diagnostics also a great feature of 5G technology.
- The 5G technology is providing up to 25 Mbps connectivity speed.
- The 5G technology also support virtual private network.
- The new 5G technology will take all delivery service out of business prospect
- The uploading and downloading speed of 5G technology touching the peak.
- The 5G technology network offering enhanced and available connectivity just about the world.

3.7. Benefits of Using Wireless Technologies

- **Completes the access technology portfolio** - Customers commonly use more than one access technology to service various parts of their network and during the migration phase of their networks, when upgrading occurs on a scheduled basis. Wireless enables a fully comprehensive access technology portfolio to work with existing dial, cable, and DSL technologies.
- **Goes where cable and fiber cannot** - The inherent nature of wireless is that it doesn't require wires or lines to accommodate the data/voice/video pipeline. As such, the system will carry information across geographical areas that are prohibitive in terms of distance, cost, access, or time. It also sidesteps the numerous issues of ILEC colocation.
- Although paying fees for access to elevated areas such as masts, towers, and building tops is not unusual, these fees, the associated logistics, and contractual agreements are often minimal compared to the costs of trenching cable.
- **Involves reduced time to revenue** - Companies can generate revenue in less time through the deployment of wireless solutions than with comparable access technologies because a wireless system can be assembled and brought online in as little as two to three hours.
- This technology enables service providers to sell access without having to wait for cable-trenching operations to complete or for incumbent providers to provide access or backhaul.
- **Provides broadband access extension**- Wireless commonly both competes with and complements existing broadband access. Wireless technologies play a key role in extending the reach of cable, fiber, and DSL markets, and it does so quickly and reliably. It also commonly provides a competitive alternative to broadband wire line or provides access in geographies that don't qualify for loop access.

4. History

Wireless world is ruled by standards – regulatory standards (FCC) and communications standards (IEEE, 3GPP). Wireless handsets, PDAs and computers connect to the Internet and to voice services predominantly through Wi-Fi/802.11 or cellular/3GPP networks [1].

Starting of wireless communication system was with the invention of wireless telegraph in1896 by G. Marconi. Over the last century, advances in wireless technologies have led to the radio, the television, the mobile telephone, and communication satellites. Of all the advances in data communication and telecommunication perhaps the most revolutionary is the development of digital cellular networks which came in existence around 1990. Before this analog signal were used for wireless communication which were only capable of low data transfer rates due to less bandwidth. Digital signal came with high data rates and high channel capacity.

In 1895, Guglielmo Marconi opened the way for modern wireless communications. He transmits three-dot Morse code for the letter ‘S’ over a distance of three kilometers using electromagnetic waves as medium to carry the signals. This was the beginning of wireless communications [2]. The concept of mobile wireless communication began in the 1920s. Wireless communications have some special characteristics that have motivated specialized studies. First, wireless communications relies on a scarce resource – namely, radio spectrum state. In order to foster the development of Wireless communications (including telephony and Broadcasting) those assets were privatized. Second, use of spectrum for wireless communications required the development of key complementary technologies, especially those that allowed higher frequencies to be utilized more efficiently. Finally, because of its special nature, the efficient use of spectrum required the coordinated development of standards [3]. It was 1970s when mobile wireless communication became a real

industry and the mobile telephones were sold as a real commodity [5]. Up to now, mobile wireless communication has gone through four generations in the past forty six years. And currently it is heading for the fifth generation. In the following, the features of each generation are presented.

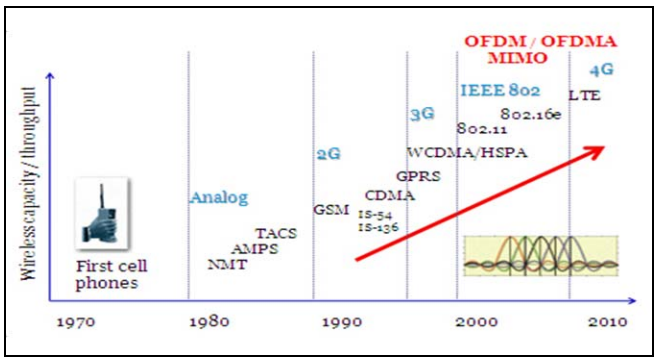

Fig1: Wireless Technology- Overview & History.

5. Conclusion

Wireless or not, each technology has its advantages and disadvantages. Wireless technologies often tend to increase convenience and decrease 'safety'. Wireless technology is certainly able to improve our life quality. Especially since wireless communication systems are becoming cheaper, easier to implement and smaller every day, so more and more devices can profit from it. Wireless solutions can be time saving, easier to use, and more mobile. Still, the issues mentioned in this paper needed to be taken into account every time a new wireless application considered.

Only if we make responsible choices in replacing wired technology by its wireless alternative, we will be able to continue to improve our life quality, in the near as well as distant future. Finally, more research needs to be conducted about the long-term health effects of different levels and frequencies of RF exposure.

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