Generations of Wireless Technology

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***Abstract*— Wireless communication is the transfer of information over a distance without the use of enhanced electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometres for radio communications). When the context is clear, the term is often shortened to "wireless". It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, Personal Digital Assistants (PDAs), and wireless networking. In this paper we will throw light on the evolution and development of various generations of mobile wireless technology along with their significance and advantages of one over the other. In the past few decades, the mobile wireless technologies have experience of various generations of technology revolution & evolution, namely from 0G to 4G. An advance implementation of 5G technology which are being made on the development of World Wide Wireless Web (WWWW).**

Keywords*— Wi-Fi, Generations of Wi-Fi, Global System for Mobile, Enhanced Data rate for GSM Evolution Technology*

I. INTRODUCTION

In 1895, Guglielmo Marconi opened the way for modern wireless communications by transmitting the three-dot Morse code for the letter 'S' over a distance of three kilometres using electromagnetic waves. From this beginning, wireless communications has developed into a key element of modern society. Wireless communications have some special characteristics that have motivated specialised 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 privatised. Second, use of spectrum for wireless communications required the development of key complementary technologies; especially those that allowed higher frequencies to be utilised more efficiently. Finally, because of its special nature, the efficient use of spectrum required the coordinated development of standards.

The term is used to describe modern wireless connections such as those in cellular networks and wireless broadband internet, mainly using radio waves. The Mobile wireless industry has started its technology creation, revolution & evolution since early 1970s. In the past few decades, mobile wireless technologies have been classified according to their generation, which largely specifies the type of services and the data transfer speeds of each class of technologies.

II. WHY WE USE WIRELESS COMMUNICATION

There are several kinds of wireless technologies; the main difference being their range. Some offer connectivity over an area as large as your desktop whilst others can cover a medium-sized office space.

Our most familiar wireless network, the mobile phone, covers whole continents.

Wireless technology can offer businesses more flexible and inexpensive ways to send and receive data.

The four key benefits of wireless technology are:

1. Increased efficiency - improved communications leads to faster transfer of information within businesses and between partners/customers.
2. You are rarely out of touch - you don't need to carry cables or adaptors in order to access office networks.
3. Greater flexibility and mobility for users - office-based wireless workers can be networked without sitting at dedicated PCs.
4. Reduced costs - relative to 'wired', wireless networks are, in most cases, cheaper to install and maintain.

ZERO GENERATION

(0G – 0.5G)

0G refers to pre-cellular mobile telephony technology in 1970s. These mobile telephones were usually mounted in cars or trucks, though briefcase models were also made.

Wireless telephone started with what you might call 0G if you can remember back that far. In those pre-cell days, you had a mobile operator to set up the calls and there were only a handful of channels available. 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 sometimes referred to as 0G (zero generation) systems. Technologies used in 0G systems included 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).

0.5G is a group of technologies with improved feature than the basic 0G technologies.

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.

These mobile telephones were usually mounted in cars or trucks, though briefcase models were also made. Typically, the transceiver (transmitter-receiver) was mounted in the vehicle trunk and attached to the "head" (dial, display, and handset) mounted near the driver seat. They were sold through various outlets, including two-way radio dealers. The primary users were loggers, construction foremen, realtors, and celebrities, for basic voice communication.

FIRST GENERATION (1G)

1G (or 1-G) is the first-generation wireless telephone technology, cellphones. These are the analog cellphone standards that were introduced in the 1980s.It refers to the generation of wireless telecommunication technology, more popularly known as cellphones.1G technology replaced 0G technology, which featured mobile radio telephones and such technologies as Mobile Telephone System (MTS) Advanced Mobile Telephone System (AMTS).

Its successor, 2G, which made use of digital signals, 1G wireless networks used analog radio signals. A voice call gets modulated to a higher frequency of about 150MHz and is transmitted between radio towerswith the help of 1G. This is done using a technique called Frequency-Division Multiple Access (FDMA).

1G has some of the disadvantages regarding overall connection quality. It has low capacity unreliable handoff, poor voice links, and no security since voice calls were played back in radio towers, making these calls susceptible to unwanted dropping or interference by third party. 1G did maintain a few advantages over 2G. In comparison to 1G's analog signals, 2G's digital signals are very reliant on location and proximity. If a 2G handset made a call far away from a cell tower, the digital signal may not be strong enough to reach it. While a call made from a 1G handset had generally poorer quality than that of a 2G handset, it survived longer distances. This is due to the analog signal having a smooth curve compared to the digital signal, which had a jagged, angular curve. As conditions worsen, the quality of a call made from a 1G handset would gradually worsen, but a call made from a 2G handset would fail completely. Different 1G standards were used in various countries. Advanced Mobile Phone System (AMPS) was a 1G standard used in the United States. Nordic Mobile Telephone (NMT) was a 1G standard used in Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), as well as in its neighboring countries Switzerland and Netherlands, Eastern Europe, and Russia. Italy used a telecommunications system called RTMI. In the United Kingdom, Total Access Communication System (TACS) was used. France used Radiocom 2000.

In West Germany, Portugal, and South Africa, a telecommunications system known as C-450 was used.

Two competing systems in Japan, Nippon Telegraph and Telephone (NTT) and DDI, developed various standards: NTT developed TZ-801, TZ-802 and TZ-803, while DDI developed a standard called Japan Total Access Communications System (JTACS).

SECOND GENERATION (2G-2.75G)

2G (or 2-G) is the second-generation wireless telephone, which is based on digital technologies. 2G networks is basically for voice communications only, except SMS messaging is also available as a form of data transmission for some standards. Second generation (2g) telephone technology is based on GSM or in other words global system for mobile communication. Second generation was launched in Finland in the year 1991. 2G network allows for much greater penetration intensity. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multi media messages). 2G technology is more efficient. 2G technology holds sufficient security for both the sender and the receiver. 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. Second generation technologies are either time division multiple access (TDMA) or code division multiple access (CDMA). TDMA allows for the division of signal into time slots. CDMA allocates each user a special code to communicate over a multiplex physical channel. Different TDMA technologies are GSM, PDC, iDEN, iS-136.CDMA technology is IS-95. GSM has its origin from the Group special Mobile, in Europe. GSM (Global system for mobile communication) is the most admired standard of all the mobile technologies. Although this technology originates from the Europe, but now it is used in more than 212 countries in the world. GSM technology was the first one to help establish international roaming. This enabled the mobile subscribers to use their mobile phone connections in many different countries of the world's is based on digital signals ,unlike 1G technologies which were used to transfer analogue signals. GSM has enabled the users to make use of the short message services (SMS) to any mobile network at any time. SMS is a cheap and easy way to send a message to anyone, other than the voice call or conference. This technology is beneficial to both the network operators and the ultimate users at the same time. Another use of this technology is the availability of international emergency numbers, which can be used by international users anytime without having to know the local emergency numbers. PDC or personal digital cellular technology was developed in Japan, and is exclusively used in JAPAN as well. PDC uses 25 KHz frequency. Docomo launched its first digital service of PDC in 1993.integrated digital enhanced network (iDEN) was developed by MOTOROLA, as a major mobile technology. It enabled the mobile users to make use of complex trunked radio and

mobile phones. iDEN has a frequency of about 25Khz.i DEN allows three or six user per mobile channel.iS-136 is a second generation cellular phone system. It is also known as digital AMPS. 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. The use of digital data service assists mobile network operators to introduce short message service over the cellular phones. Digital encryption has provided secrecy and safety to the data and voice calls. The use of 2G technology requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area, digital signals would be weak. 2.5G is a group of bridging technologies between 2G and 3G wireless communication. It is a digital communication allowing e-mail and simple Web browsing, in addition to voice.

THIRD GENERATION (3G)

3G refers to the third generation of mobile telephony (that is, cellular) technology. The third generation, as the name suggests, follows two earlier generations.

The first generation (1G) began in the early 80's with commercial deployment of Advanced Mobile Phone Service (AMPS) cellular networks. Early AMPS networks used Frequency Division Multiplexing Access (FDMA) to carry analog voice over channels in the 800 MHz frequency band.

The second generation (2G) emerged in the 90's when mobile operators deployed two competing digital voice standards. In North America, some operators adopted IS-95, which used Code Division Multiple Access (CDMA) to multiplex up to 64 calls per channel in the 800 MHz band. Across the world, many operators adopted the Global System for Mobile communication (GSM) standard, which used Time Division Multiple Access (TDMA) to multiplex up to 8 calls per channel in the 900 and 1800 MHz bands.

The International Telecommunications Union (ITU) defined the third generation (3G) of mobile telephony standards IMT-2000 to facilitate growth, increase bandwidth, and support more diverse applications. For example, GSM could deliver not only voice, but also circuit-switched data at speeds up to 14.4 Kbps. But to support mobile multimedia applications, 3G had to deliver packet-switched data with better spectral efficiency, at far greater speeds. However, to get from 2G to 3G, mobile operators had make "evolutionary" upgrades to existing networks while simultaneously planning their "revolutionary" new mobile broadband networks. This lead to the establishment of two distinct 3G families: 3GPP and 3GPP2.The 3rd Generation Partnership Project (3GPP) was formed in 1998 to foster deployment of 3G networks that descended from GSM. 3GPP technologies evolved as follows.

• General Packet Radio Service (GPRS) offered speeds up to 114 Kbps.

• Enhanced Data Rates for Global Evolution (EDGE) reached up to 384 Kbps.

• UMTS Wideband CDMA (WCDMA) offered downlink speeds up to 1.92 Mbps.

• High Speed Downlink Packet Access (HSDPA) boosted the downlink to 14Mbps.

• LTE Evolved UMTS Terrestrial Radio Access (E-UTRA) is aiming for 100 Mbps.

GPRS deployments began in 2000, followed by EDGE in 2003. While these technologies are defined by IMT-2000, they are sometimes called "2.5G" because they did not offer multi-megabit data rates. EDGE has now been superceded by HSDPA (and its uplink partner HSUPA). According to the 3GPP, there were 166 HSDPA networks in 75 countries at the end of 2007. The next step for GSM operators: LTE E-UTRA, based on specifications completed in late 2008.

A second organization, the 3rd Generation Partnership Project 2 (3GPP2) -- was formed to help North American and Asian operators using CDMA2000 transition to 3G. 3GPP2 technologies evolved as follows.

• One Times Radio Transmission Technology (1xRTT) offered speeds up to 144 Kbps.

• Evolution Data Optimized (EV-DO) increased downlink speeds up to 2.4 Mbps.

• EV-DO Rev. A boosted downlink peak speed to 3.1 Mbps and reduced latency.

• EV-DO Rev. B can use 2 to 15 channels, with each downlink peaking at 4.9 Mbps.

• Ultra Mobile Broadband (UMB) was slated to reach 288 Mbps on the downlink.

If you want augmented bandwidth, multiple mobile applications and clarity of digital signals, then 3G (Third Generation Technology) is your gateway. GSM technology was able to transfer circuit switched data over the network. The use of 3G technology is also able to transmit packet switch data efficiently at better and increased bandwidth. 3G mobile technologies proffers more advanced services to mobile users. It can help many multimedia services to function. The spectral efficiency of 3G technology is better than 2G technologies. Spectral efficiency is the measurement of rate of information transfer over any communication system. 3G is also known as IMT-2000.

FOURTH GENERATION (4G)

- 4G is the name of technologies for high-speed mobile wireless communications designed for new data services and interactive TV through mobile network. 4G Mobile Technology is in progress and still not set standards are defined. Many changes rather improvements are expected in the coming 4G mobile technology. First and foremost priority is giving to the security issue. International Telecommunication Union using Radio defined 4G mobile technology as IMT-

Advanced (International Mobile telecommunication Advanced). Expected issues considered to be resolved in this 4G mobile technology are as follows;

- It is considered to embed IP feature in the set for more security purpose as high data rates are send and receive through the phone using 4G mobile technology.
- 4G mobile technology is going to be able to download at a rate of 100Mbps like mobile access and less mobility of 1GBps for local access of wireless
- Instead of hybrid technology used in 3G with the combination of CDMA and IS-95 a new technology OFDMA is introduced 4G. In OFDMA, the concept is again of division multiple accesses but this is neither time like TDMA nor code divided CDMA rather frequency domain equalization process symbolizes as OFDMA.
- CDMA sends data through one channel but with the division of time in three slots. While CDMA also sends data through one channel identifying the receiver with the help of code. Whereas in 4G mobile technology OFDMA is going to introduce in which data packets sends by dividing the channel into a narrow band for the greater efficiency comprises a prominent feature of 4G mobile technology.
- IEEE 802.16m is processing for the IEE802.16e comprising the 4G brand will define it as WMBA (Wireless Mobile Broadband Access). This is a plain indicator for the internet availability. The implementation is in progress to avoid the call interference in case of data download from a website. It will propose 128 Mbps downlink data rate and 56Mbps uplink data rate which is an extra ordinary step in 4G mobile technology. The service will limit as the availability of hotspot is condition for the internet connectivity.
- Parallel with WiMAX, LTE is intended to incorporate in 4G mobiles. It is also a wireless technology for the broadband access. The difference between WiMAX and LTE is that LTE goes for the IP Address. It follows the same TCP / IP concept inherited from networking technology. Restricted for the IP addresses it will provide great security as well as high data transferability, avoid latency, having the ability to adjust the bandwidth. LTE is compatible with CDMA so able to back n forth the data in between both networks.
- 3GPP Organization is going to introduce two major wireless standards; LTE and IEEE802.16m. Former is granted permission for the further process while second is under consideration and that will become a part of 4G mobile technology.
- IPv6 is approved by Version as a 4G standard on June 2009.

FIFTH GENERATION (5G)

5G network is assumed as the perfection level of wireless communication in mobile technology. Cable network is now become the memory of past. Mobiles are not only a communication tool but also serve many other purposes. All the previous wireless technologies are entertaining the ease of telephone and data sharing but 5G is bringing a new touch and making the life real mobile life. The new 5G network is expected to improve the services and applications offered by it.

GSM (Global System for Mobile Communication)

GSM or global system for mobile communication is a digital cellular system. It was originated in Finland Europe .however now it is throughout the world. GSM (Global System for Mobile Communication) accounts for 80% of total mobile phone technologies market. There are over more than 3 billion users of GSM (Global System for Mobile Communication) now. GSM technology got its popularity, when people used it to talk to their friends and relatives. The use of GSM (Global System for Mobile Communication) is possible due to the SIM (subscribers identity module) GSM (Global System for Mobile Communication) is easy to use, affordable and helps you carry your cell phone everywhere. GSM (Global System for Mobile Communication) is a 2G technology. There are many frequency ranges for GSM (Global System for Mobile Communication) however 2G is the most used frequency. GSM (Global System for Mobile Communication) offers moderate security. It allows for encryption between the end user and the service base station. The use of various forms of cryptographic modules is part of GSM technology.

EDGE Technology (Enhanced Data Rates for GSM Evolution Technology)

EDGE technology is an extended version of GSM. It allows the clear and fast transmission of data and information. EDGE is also termed as IMT-SC or single carrier. EDGE technology was invented and introduced by Cingular, which is now known as AT& T. EDGE is radio technology and is a part of third generation technologies. EDGE technology is preferred over GSM due to its flexibility to carry packet switch data and circuit switch data. EDGE is termed as backward compatible technology; backward compatible technology is that technology which allows the input generation of older devices. EDGE technology is supported by third generation partnership projects; this association helps and supports the up gradation of GSM, EDGE technology and other related technologies. The frequency, capability and performance of EDGE technology is more than the 2G GSM Technology. EDGE technology holds more sophisticated coding and transmission of data. EDGE technology can help you connect to the internet. This technology supports the packet switching system. EDGE develops a broadband internet connection for its users. EDGE technology helps its users to exploit the multimedia services .EDGE technology do not involve the expense of additional hardware and software technologies. It only requires the base station to

install EDGE technology transceiver. EDGE technology is an improved technology which almost supports all the network vendors. All they have to do is to upgrade their stations. EDGE technology has its edge because it can make use of both switch circuit technology and packet circuit technology. EDGE technology is also believed to support EGPRS or in other words enhanced general packet radio service. It is important to have GPRS network if one wants to use EDGE technology because EDGE can not work without GSM Technology. Therefore it is an extended version of GSM Technology.

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