

# A Survey on Mobile Wireless Networks

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**Abstract**— Wireless communication is a transfer of data without using wired environment. The distance may be short (Television) or long (radio transmission). The term wireless will be used by cellular telephones, PDA's etc. In this paper we will concentrate on the evolution of various generations of wireless network.

**Index Terms**— Wireless, Radio Transmission, Mobile Network, Generations, Communication.

## 1 INTRODUCTION (TECHNOLOGY)

**W**IRELESS telephone started with what you might call 0G if you can remember back that far. Just after the World War 2 mobile telephone service became available. In those days, you had a mobile operator to set up the calls and there were only a few channels were available. 0G refers to radio telephones that some had in cars before the advent of mobiles. Mobile radio telephone systems preceded modern cellular mobile telephone technology. So they were the foregoer of the first generation of cellular telephones, these systems are called 0G (zero generation) itself, and other basic ancillary data such as date and time. Messaging is also available as a form of data transmission for some standards. Second generation cellular telecom networks were commercially launched on the GSM standard.

## 2 FIRST GENERATION – 1G

**1**G stands for 'first generation' and it refers to the first generation of mobile wireless telecommunication technology known as cellphones. Some set of wireless standards developed in the 1980's, First generation technology replaced 0G technology, which featured mobile radio telephones and such technologies as MTS, AMTS, IMTS and PTT. Next, Second Generation (2G), which made use of DS (Digital Signals), First Generation(1G) wireless networks, used analog RS (radio signals). In first generation, a voice call gets modulated to a high-

er frequency of about 160MHz and up as it is transmitted between radio antennas. The technique used for this is FDMA. In terms of overall connection quality, 1G has low capacity, poor voice links, unreliable handoff, and no security since voice calls were played back in radio antennas, making these calls persuadable to unwanted monitoring by 3<sup>rd</sup> parties. First Generation did maintain a few benefits over second generation. In comparison to 1G's AS (analog signals), 2G's DS (digital signals) are very similar on proximity and location. If a second generation handset made a call far away from a cell tower, the DS (digital signal) may not be strong enough to reach the tower. While, a call made from a first generation handset had poorer quality than that of a second generation handset, it survived longer distances. This is due to the AS (analog signal) having a smooth curve compared to the DS (digital signal), which had a jaggy, angular curve.

**FDMA** - Frequency Division Multiple Access, **MTS** - Mobile Telephone System, **AMTS** - Advanced Mobile Telephone System, **IMTS** - Improved Mobile Telephone Service, **PTT** - Push to Talk.

## 3 SECOND GENERATION – 2G

**2**G is short for second-generation and it is wireless telephone technology. It normally cannot transfer data, such as software or email, other than the digital voice call and other basic service provider data such as date and time. Messaging is also available as a form of data transmission. Second generation 2G cellular networks were commercially launched on the GSM (Global system for mobile communication) standard in Finland by Radiolinja. GSM service is used by over 2 billion people across more than 200 territories and countries. The universality of the GSM standard makes international roaming very common between telephone operators, by enabling subscribers to use their mobile phones in many parts of the world. 2G technologies can be divided into TDMA based and

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CDMA based standards depending on the type of multiplexing used. Second Generation makes use of a CODEC Algorithm (Compression- Decompression Algorithm) to compress and multiplex digital data. Through this technology, a (2G) second generation network can pack more calls per Amount of bandwidth as a first generation network. 2G cellphone units were generally smaller than 1G unit, since they emitted less radio power. Some benefits of 2G were Digital signals require less battery power, so the mobile batteries will last longer. Digital coding enhances the voice clarity (quality) and minimizes noise in the particular line. DS (digital signals) would be weak If there is no network coverage in any specific area.

TDMA - Time Division Multiple Access, CDMA - Code Division Multiple Access.

### 3.1 2.5G – GPRS (General Packet Radio Service)

2.5G is a cellular wireless technology developed in between 2G, and its successor 3G. The term "second and a half generation" is used to describe 2G-systems that have implemented a packet switched domain in addition to circuit switched domain. GPRS is an informal term, invented solely for marketing purposes, unlike "2G" or "3G" which are officially defined standards based on those defined by the International Telecommunication (ITU). GPRS could provide data rates from 56 kbit/s up to 115 kbit/s. It can be used for Wireless Application Protocol (WAP) access service, Multimedia Messaging Service (MMS), and for Internet communication services such as World Wide Web access and email. GPRS data transfer is typically charged per megabyte of data transferred. 2.5G networks may support services such as MMS, SMS, WAP, mobile games, and search and directory.

### 3.2 2.75G – EDGE (Enhanced Data Rates for GSM Evolution)

2.75G uses EDGE(Enhanced Data rates for GSM Evolution)/EGPRS(Enhanced GPRS) technology. This provides a data transfer rate upto 236.8kbits/s. This is the most widely used mobile technology in the world currently. EDGE (EGPRS) is an abbreviation for Enhanced Data rates for Evolution of GSM, is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G GPRS networks. This technology works in GSM networks. EDGE technology is a superset to GPRS and can function on any network which is having GPRS, provided the carrier implements with the upgrades that are necessary. EDGE technology allows clear and fast transmission of data and information. It is also termed as single carrier or IMT-SC. EDGE technology was introduced and invented by Cingular, which is now known as AT& T. EDGE is radio technology and is a part of third generation technologies. EDGE (EGPRS) technology is preferred over GSM due to its flexibility to carry packet switch data and circuit switch data. The use of EDGE technology has augmented the use of N97, black berry and N95 mobile phones. EDGE technology allows data transfer in seconds if we compare it

with GPRS Technology. For example a text file of 40KiloBytes is transferred in only 2 seconds as compared to the transfer from GPRS technology, which will take 6 seconds. The biggest advantage of using EDGE technology is one does not need to install any additional hardware and software in order to make use of EDGE Technology. There are no additional charges for using this technology. If a person is a GPRS Technology user he can use this EDGE technology without paying any additional charges.

## 4 THIRD GENERATION 3G

**B**EFORE 3G is the third generation of mobile phone

technology and superseding 2G, standards, and preceding 4G. It is based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, IMT-2000. 3G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved efficiency. Services include wide area wireless video calls, voice telephony and broadband wireless data in a mobile environment. Additional features also include High-Speed Packet Access data transmission capabilities able to deliver speeds up to 5.8Mbit/s on the uplink and 14.4Mbit/s on the downlink. Spectrum efficiency or Spectral efficiency refers to the amount of information that can be transmitted over a given bandwidth in a specific digital communication system. ... High-Speed Packet Access (HSPA) is a collection of mobile telephony protocols that extend and improve the performance of existing UMTS protocols. Unlike IEEE 802.11 (common names WLAN or Wi-Fi) networks, 3G networks are wide area cellular telephone networks which evolved to incorporate high-speed internet access and video telephony. IEEE 802.11 networks are high-bandwidth networks, short range primarily developed for data. Wi-Fi is a popular synonym for wireless technology used in video games, mobile phones, home networks and more. The notebook is connected to the wireless access point using a wireless PC 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, video conferencing and GPS (global positioning system). The basic feature of 3G Technology is fast data transfer rates. 3G technology is very extensible, since it is able to support 5 major radio technologies. These radio technologies operate under Code Division Multiple Access (CDMA),

TDMA and FDMA. CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). TDMA accounts for IMTTC (time code), IMT-SC (single carrier). FDMA has only one radio interface known frequency code or as IMT-FC. 3G technology is really affordable due to industry agreement. The purpose of this agreement took place in order to increase its adoption by the users. Third generation (3G) systems are compatible to work with the 2G technologies. The main aim of the 3G is to allow for more coverage and growth with minimum investment. There are many 3G technologies such as DECT, CDMA 2000, UMTS, W-CDMA, WiMax and GSM EDGE. Enhanced data rates for EDGE or GSM evolution is termed to as a backward digital technology, because it can operate with older technologies. 3G has the following enhancements over 2.5G (GPRS) and previous networks: Enhanced video and audio streaming, Several Times higher data speed, Video-conferencing support, WAP and Web browsing at higher speeds and IPTV (TV through the Internet) support.

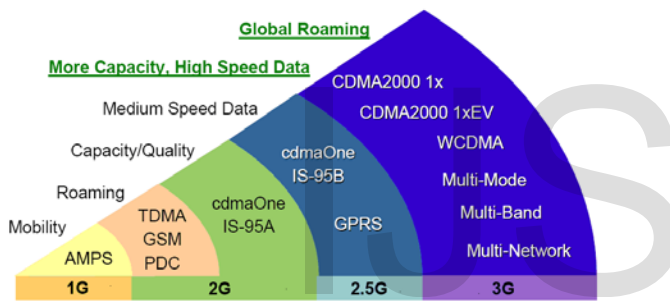


Figure 1: 1G to 3G evolution

3G was introduced by NIT DoCoMo (Japan, in 2001). 3G data transfer rates are 384kb/s to 2Mbps which enables the use of audio/video calls, video conferencing, online conference calls, online gaming, mobile TV etc. 3G also gives greater privacy and security. Even 3G had two revisions leading to 3.5G and 3.75G. The data transfer rates also increased to 2Mbps and reaching up to 14Mbps/s.

**4.1 Benefits of 2G and 3G technologies:**

GENERATION	2G Technology	2G+ Technology	2.5G Technology	3G Technology
BENEFITS	Capacity, Battery life	Capacity, Cost, Data	Higher speed data	Multimedia
TECHNOLOGIES	GSM	• HSCSD • SMS data	• GPRS packet radio • EDGE	• W-CDMA (part of UMTS)
	cdmaOne	• IS95B	• 1XRTT • HDR • 1X Plus	• 3XRTT • W-CDMA? (Japan, Korea)
	TDMA	• IS136+	• GPRS • EDGE	• UWC 136
	PDC (Japan)	• Imode	(skip to 3G)	• W-CDMA

Table 1: Benefits and technology comparison between 2G and 3G technologies

**4.2 3.5G – HSDPA (High-Speed Downlink Packet Access)**

High-Speed Downlink Packet Access(HSDPA) is a mobile telephony protocol, also called 3.5G (or "3½G"), which provides a smooth evolutionary path for UMTS-based 3G networks allowing for higher data rates. High-Speed Downlink Packet Access (HSDPA) is a packet-based data service in W-CDMA downlink with data transmission up to 8-10 Mbit/s (and 20 Mbit/s for MIMO systems) over a 5MHz Bandwidth in HSDPA implementations , WCDMA downlink includes Adaptive Modulation and Coding (AMC), Hybrid Automatic Request (HARQ), Multiple Input Multiple Output (MIMO), fast cell search, and advanced receiver design.

**4.3 3.75G – HSUPA (High-Speed Uplink Packet Access)**

The 3.75G refer to the technologies beyond the well-defined 3G wireless/mobile technologies. High Speed Uplink Packet Access (HSUPA) is a UMTS / WCDMA uplink evolution technology. The High Speed Uplink Packet Access (HSUPA) mobile telecommunications technology is directly related to High-Speed Downlink Packet Access (HSDPA) and the two are complimentary to one another. HSUPA (High-Speed Uplink Packet Access) will enhance advanced person-to-person data applications with symmetric and higher data rates, like mobile real-time person-to person gaming and e-mail. Traditional business applications along with many consumer applications will benefit from enhanced uplink speed. HSUPA will initially boost the UMTS / WCDMA uplink up to 1.4Mbps and then increases up to 5.8Mbps.

**5 FOURTH GENERATION 4G**

**4G** (Fourth Generation) it is a new version for Third Gen-

eration and second generation families of standards. The generations generally refer to a change in the non-backwards compatible transmission technology, new frequency bands and fundamental nature of the service. The first was the move from 1981 analogue (1G) to digital (2G) transmission in 1992 and this was followed in 2002 by 3G spread spectrum transmission and multi-media support and at least 200 kbit/s, soon expected to be followed by fourth generation, which refers to all-IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission. Pre-4G technologies before 4G such as mobile WiMAX and first-release 3G Long Term Evolution (LTE) have been available on the market since 2006 and 2009 respectively. It is basically the extension in the 3G technology with more services and bandwidth offers in the 3G (third generation). The expectation for

the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. WiMAX or mobile structural design will become progressively more clear, and therefore the acceptance of several architectures by a particular network operator ever more common. Some companies are trying 4G communication at 100 Mbps for mobile users and up to 1 Gbps over fixed stations. They planned to launch their first commercial wireless network around 2010. As far as other competitor's mobile wireless communication companies working on 4G technology are done even more quickly. The organization Nextel was planned to launch WiMAX over 4 G broadband mobile networks in United States (US). Some of the other developed countries like United Kingdom (UK) stated a plan to sale via auction of 4G wireless frequencies couple of years back. The word "MAGIC" also refers to 4G wireless technology which stands for Global mobility solutions, mobile multimedia, Any-where.

Figure 3: 4G Architecture

The speed is 50 times higher than 3G and provides ultra broadband internet access, video conference, 3D Television and LTE (Long Term Evolution).

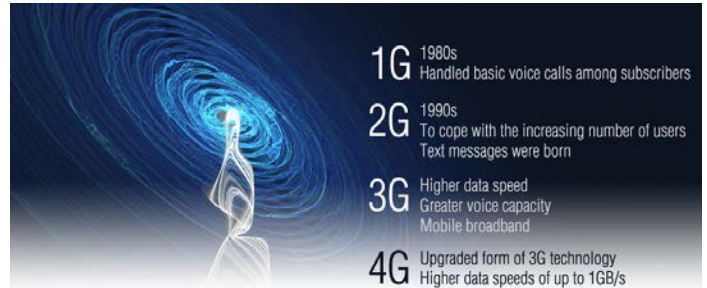


Figure 4: Feature highlights from 1G to 4G

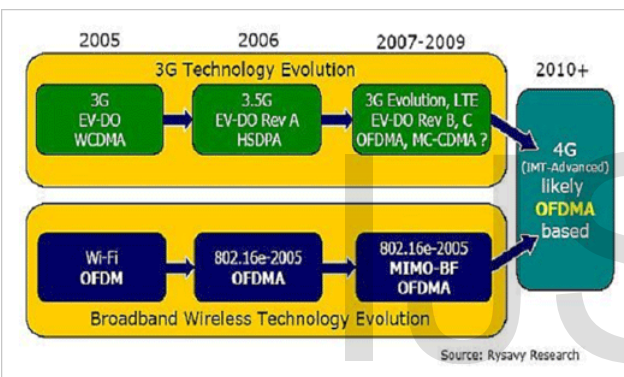
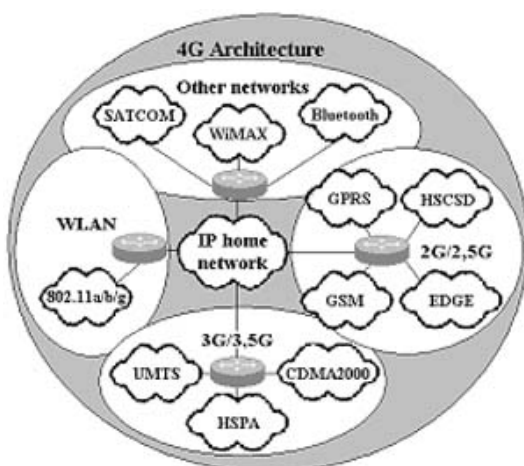


Figure 2: 3G Technology + Wireless Technology = 4G

The next generation, 4G mobile phones are all set to provide data transfer rates of 100Mbit/s to 1Gbit/s and spectral bandwidth upto 40MHz. Such speeds are not even present in wired networks commercially.

### 5.1 4G Architecture



## 6 FIFTH GENERATION – 5G

THIS technology has not been officially launched but is expected to provide all major features offered by 4G mobile technology and IMT-Advanced System. Through 5G technology now any one can use worldwide cellular phones. With the coming out of cell phone alike to PDA now your whole office in your phone or in your fingertips. Fifth Generation technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile OS. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days fifth generation technology takes over the world market. 5G Technologies have an capability to support Consultancy and Software. The Router and switch technology used in 5G network providing high connectivity. The fifth generation technology distributes internet access to nodes within the building and can be deployed with union of wireless or wired network connections. The current trend of 5G (fifth generation) technology has a glowing future. 5G systems are expected to remove the limitations of network access range and uses multi-user (MIMO) Multiple Input and Multiple Output. It is more cost and energy efficient. 5G (5th generation mobile networks or 5th generation wireless systems) is a name used in some research papers and projects to denote the next major phase of mobile telecommunications standards beyond the upcoming fourth generation standards, which are expected to be finalized between approximately 2011 and 2013. Currently Fifth Generation is not a term officially

used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as WiMAX Forum, ITU-R or 3GPP. New 3GPP standard releases beyond 4G and long Term Evolution (LTE) Advanced are in progress, but it is not considered as new mobile generations.

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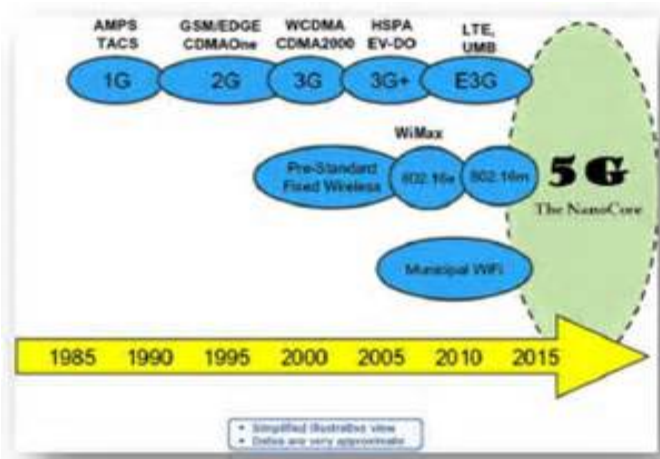


Fig 5: 5G Overview

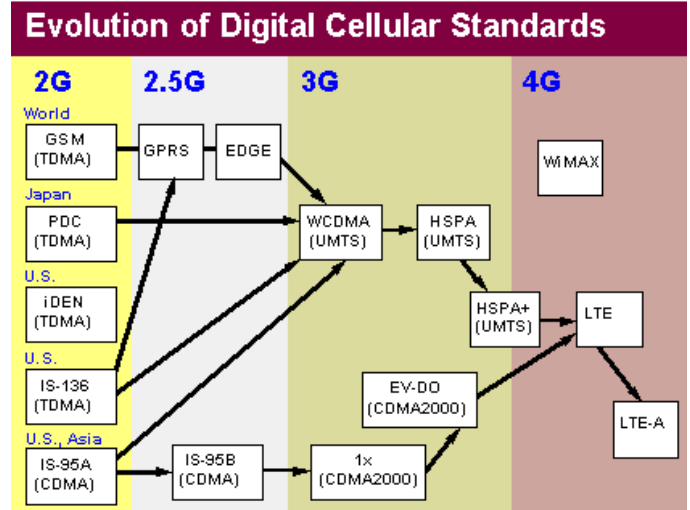


Figure 6: Digital Cellular Standards (DES) Evolution

## 7 COMPARISON OF SPEED, TECHNOLOGY AND

Generation	Speed	Technology	Features
<b>2G</b>	9.6/14.4 kbps	TDMA, CDMA	2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. 2G enabled mobile phones can be used for data along with voice communication.
<b>3G</b>	3.1 Mbps (peak) 500-700 Kbps	CDMA 2000 (1XRTT, EVDO) UMTS, EDGE	3G provides amazing internet browsing speeds. Opens the door to a whole bag of opportunities with video calling, video streaming, etc. In 3G, universal access and portability across different device types are made possible. (Telephone & PDA's)
<b>3.5G</b>	14.4 Mbps (peak) 1-3 Mbps	HSPA	3.5G supports even higher speeds and enhances higher data needs.
<b>4G</b>	100-300 Mbps (peak) 3-5 Mbps	WiMAX LTE	Speeds for 4G are increased to lightning fast in order to keep up with data access demand used by various services. It also supports HD streaming. HD phones can be fully utilized on a 4G network.

Table 2: 2G to 4G comparison based on Speed, Technology and Features

## 9 PREDICTION OF MOBILE COMMUNICATION SYSTEM GENERATIONS:

Figure 3: Network evolution image for the 3.9-generation mobile communications system

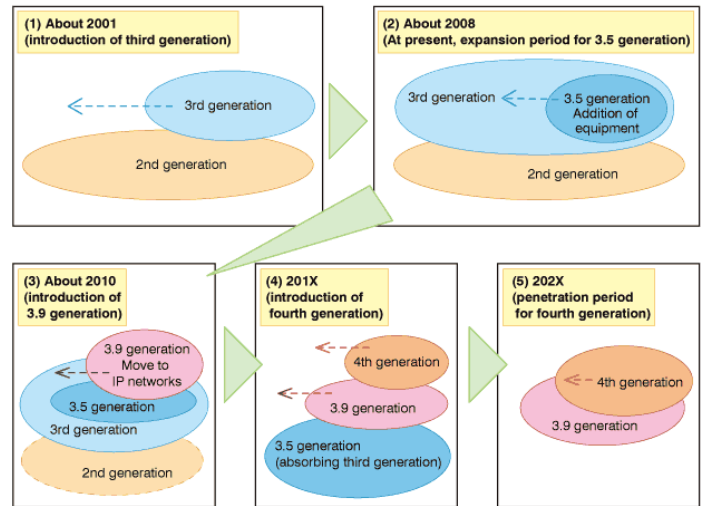


Figure 7: Evolution prediction of mobile technologies

## 8 DIGITAL CELLULAR STANDARDS EVOLUTION

## 10 CONCLUSION

**M**OBILES have become very essential part of our life. Their current development is the outcome of different generations. In this paper we comparatively review the various generations of mobile wireless technology, performance, their portals, disadvantages and advantages of one generation over other. Research opportunities are very high in the field. In conclusion, our survey reveals that there are following major area of research:

- 1.) Real wireless world with no more limitation with access and zone issues.
- 2.) Wearable devices with AI capabilities.
- 3.) Internet protocol version 6(IPv6), where a visiting care-of mobile IPaddress is assigned according to location and connected network.
- 4.) Pervasive Networks providing ubiquitous computing: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them.

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