

Generations of Mobile Wireless Technology: A Survey

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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 kilometers 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, mobile wireless technologies have experience 4 or 5 generations of technology revolution and evolution, namely from 0G to 4G. Current research in mobile wireless technology concentrates on advance implementation of 4G technology and 5G technology. Currently 5G term is not officially used. In 5G researches are being made on development of World Wide Wireless Web (WWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World.

General Terms

0G, 1G, 2G, 3G, 4G, 5G

1. INTRODUCTION

Mobile wireless industry has started its technology creation, revolution and evolution since early 1970s. In the past few decades, mobile wireless technologies have experience 4 or 5 generations of technology revolution and evolution, namely from 0G to 4G. The cellular concept was introduced in

the 1G technology which made the large scale mobile wireless communication possible. Digital communication has replaced the analog technology in the 2G which significantly improved the wireless communication quality. Data communication, in addition to the voice communication, has been the main focus in the 3G technologies and a converged network for both voice and data communication is emerging. With continued R&D, there are many killer application opportunities for the 4G as well as technological challenges.

2. ZERO GENERATION TECHNOLOGY (0G – 0.5G)

Wireless telephone started with what you might call 0G if you can remember back that far. The great ancestor is the mobile telephone service that became available just after World War II. In those pre-cell days, you had a mobile operator to set up the calls and there were only a handful of channels available.

0G refers to pre-cell phone mobile telephony technology, such as radio telephones that some had in cars before the advent of cell phones. 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.

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).

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 WCCs (Wireline Common Carriers, AKA telephone companies), RCCs (Radio Common Carriers), and two-way radio dealers. The primary users were loggers, construction foremen, realtors, and celebrities. They used them for basic voice communication.

Early examples for this technology are:

1. The Autoradiopuhelin (ARP) launched in 1971 in Finland as the country's first public commercial mobile phone network.
2. The B-Netz launched 1972 in Germany as the countries second public commercial mobile phone network (but the first one that did not require human operators anymore to connect calls).

3. FIRST GENERATION TECHNOLOGY (1G)

1G stands for "first generation," refers to the first generation of wireless telecommunication technology, more popularly known as cellphones. A set of wireless standards developed in the 1980's, 1G technology replaced 0G technology, which featured mobile radio telephones and such technologies as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT).

Its successor, 2G, which made use of digital signals, 1G wireless networks used analog radio signals. Through 1G, a voice call gets modulated to a higher

frequency of about 150MHz and up as it is transmitted between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA).

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.

However, 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. One such standard is NMT (Nordic Mobile Telephone), used in Nordic countries, Eastern Europe and Russia. Others include AMPS (Advanced Mobile Phone System) used in the United States, TACS (Total Access Communications System) in the United Kingdom, C-Netz in West Germany, Radiocom 2000 in France, and RTMI in Italy.

4. SECOND GENERATION TECHNOLOGY (2G - 2.75G)

2G (or 2-G) is short for second-generation wireless telephone technology. It cannot normally transfer data, such as email or software, other than the digital voice call itself, and other basic ancillary data such as time and date. Nevertheless, SMS messaging is also available as a form of data transmission for some standards. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in Finland by Radiolinja (now part of Elisa Oyj) in 1991. GSM service is used by over 2 billion people across more

than 212 countries and territories. 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 Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used. 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 cellphone units were generally smaller than 1G units, since they emitted less radio power.

Some benefits of 2G were 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.

4.1) 2.5G – GPRS (General Packet Radio Service)

2.5G, which stands for "second and a half generation," is a cellular wireless technology developed in between its predecessor, 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 the circuit switched domain.

"2.5G" 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 services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and for

Internet communication services such as email and World Wide Web access. GPRS data transfer is typically charged per megabyte of traffic transferred, while data communication via traditional circuit switching is billed per minute of connection time, independent of whether the user actually is utilizing the capacity or is in an idle state.

2.5G networks may support services such as WAP, MMS, SMS mobile games, and search and directory.

4.2) 2.75 – EDGE (Enhanced Data rates for GSM Evolution)

EDGE (EGPRS) is an abbreviation for Enhanced Data rates for GSM Evolution, is a digital mobile phone technology which acts as a bolt-on enhancement to 2G and 2.5G General Packet Radio Service (GPRS) networks. This technology works in GSM networks. EDGE is a superset to GPRS and can function on any network with GPRS deployed on it, provided the carrier implements the necessary upgrades.

EDGE technology is an extended version of GSM. It allows the clear and fast transmission of data and information. It 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.

The use of EDGE technology has augmented the use of black berry, N97 and N95 mobile phones. EDGE transfers data in fewer seconds if we compare it with GPRS Technology. For example a typical text file of 40KB is transferred in only 2 seconds as compared to the transfer from GPRS technology, which is 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 exploiting this technology. If a person is an ex GPRS Technology user he can utilize this technology without paying any additional charges.

5. THIRD GENERATION TECHNOLOGY (3G – 3.75G)

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.

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. ... 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 Wi-Fi or WLAN) 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 short range, high-bandwidth 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). FDMA has only one radio interface known as IMT-FC or frequency code. Third generation technology is really affordable due to the agreement of industry. This agreement took pace 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.

3G has the following enhancements over 2.5G and previous networks:

- Enhanced audio and video streaming;
- Several Times higher data speed;
- Video-conferencing support;
- Web and WAP browsing at higher speeds;
- IPTV (TV through the Internet) support.

5.1) 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 transfer speeds.

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 WCDMA downlink. HSDPA implementations includes Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-Output (MIMO), Hybrid Automatic Request (HARQ), fast cell search, and advanced receiver design.

5.2.) 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 HSUPA mobile telecommunications technology is directly related to HSDPA and the two are complimentary to one another.

HSUPA will enhance advanced person-to-person data applications with higher and symmetric data rates, like mobile e-mail and real-time person-to-person gaming. 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 in later releases up to 5.8Mbps.

6. FOURTH GENERATION TECHNOLOGY

4G refers to the fourth generation of cellular wireless standards. It is a successor to 3G and 2G families of standards. The nomenclature of the generations generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology and new frequency bands. The first was the move from 1981 analogue (1G) to digital (2G) transmission in 1992. This was followed, in 2002, by 3G multi-media support, spread spectrum transmission and at least 200 kbit/s, soon expected to be followed by 4G, which refers to all-IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission. Pre-4G technologies 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 bandwidth and services offers in the 3G. The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. If the Internet Protocol (IP) multimedia sub-system movement achieves what it going to do, nothing of this possibly will matter. WiMAX or mobile structural design will become progressively more translucent, and therefore the acceptance of several architectures by a particular network operator ever more common.

Some of the companies trying 4G communication at 100 Mbps for mobile users and up to 1 Gbps over fixed stations. They planned on publicly launching their first commercial wireless network around 2010. As far as other competitor's mobile communication companies working on 4G technology even more quickly. Sprint Nextel was planned to launch WiMAX over 4 G broadband mobile networks in United States. Some of the other developed countries like United Kingdom 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 Mobile multimedia, Any-where, Global mobility solutions over, integrated wireless and Customized services.

7. FIFTH GENERATION TECHNOLOGY

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 4G standards, which are expected to be finalized between approximately 2011 and 2013. Currently 5G 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 3GPP, WiMAX Forum or ITU-R. New 3GPP standard releases beyond 4G and LTE Advanced are in progress, but not considered as new mobile generations.

5G Technology stands for 5th Generation Mobile technology. 5G 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 technology most powerful and in huge demand in near future.

The gigantic array of innovative technology being built into new cell phones is stunning. 5G technology which is on hand held phone offering more power and features than at least 1000 lunar modules. A user can also hook their 5G technology cell phone with their Laptop to get broadband

internet access. 5G technology including camera, MP3 recording, video player, large phone memory, dialing speed, audio player and much more you never imagine. For children rocking fun Bluetooth technology and Piconets has become in market.

5G technology going to be a new mobile revolution in mobile market. Through 5G technology now you can use worldwide cellular phones and this technology also strike the china mobile market and a user being proficient to get access to Germany phone as a local phone. With the coming out of cell phone alike to PDA now your whole office in your finger tips or in your phone. 5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers. May be in coming days 5G technology takes over the world market. 5G Technologies have an extraordinary capability to support Software and Consultancy. The Router and switch technology used in 5G network providing high connectivity. The 5G technology distributes internet access to nodes within the building and can be deployed with union of wired or wireless network connections. The current trend of 5G technology has a glowing future.

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.

CONCLUSION

Mobiles have become very essential part of our everyday life. Their current development is the outcome of various generations. In this paper we review the various generations of mobile wireless technology, their portals, performance, advantages and disadvantages of one generation over other. This field is still full of research opportunities. 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 IP address 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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