Migrations amid Generations of Wireless networks

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Abstract
This article presents an overview of migrations among various generations with emphasis on trends in the areas of wireless networking. Migrations from one type of network to another are being experienced due to advances in wireless communication since the days of ingenious inventions of Alexander Graham Bell and Guglielmo Marconi. Today's wireless technology serves the plethora of person to person communication demands rather than point to point communication. These all advances are due to the technological growth, standards and services required. The nomenclature of the generations generally refers to a change in the nature of the service, non backwards compatible transmission technology and new frequency bands. The first move was from 1981 analogue (1G) to digital(2G) transmission in 1992. This was followed in 2002 by the 3G multi media support, spread spectrum transmission and at least 200kbit/s ,soon followed by 4G which refers to all IP packet-switched networks, mobile ultra-broadband (gigabit speed) access and multi carrier transmission. Pre-4G technology such as mobile WiMAX and first release 3G Long Term Evolution (LTE) have been available in market since 2006 and 2009 respectively.

Introduction
"It is dangerous to put limits on wireless"- Guglielmo Marconi (1932). In 1897 the innovation of electromagnetic waves and the air interface was proved as the first milestone on the legendary road of usage of radio spectrum in a shared way. And after almost a century in 1980s mobile wireless communication started showing its impressions. Traditionally communication was restricted to voice traffic between two fixed locations rather than between two people. Introduction of wireless technology transited point to point communication to the person to person communication. Increased penetration of cordless and cellular phone all across the world revealed this fact. Amplified demands of consumers endeavors the next generation of wireless systems which provided person to person communication of both circuit and packet multimedia data. So this paper places emphasis on generations of cellular mobile communication services. In 1930s initial AM mobile systems were used for public safety in United States which was replaced by FM systems after World War II. At that time wireless system configuration was single cell topology which is similar to the broadcast model. In 1950s and 1960s automatic channel trunking was introduced and implemented under the label Improved Mobile Telephone Services (IMTS) to increase the spectrum efficiency. Spectrum congestion and poor service in mobile telephone business started to occur as the market got saturated with IMTS. The government could not allocate Spectrum in proportion to increased demands for mobile services. So entire radio system for large areas was restructured to achieve high capacity within limited radio spectrum. The first generation cellular and cordless telephone networks have been successfully deployed throughout the world in early and mid 1980s. These were based on analog technology with FM modulation. Advanced Mobile Phone Services (AMPS) was a typical example of first generation cellular telephone systems. Second generation wireless systems employed digital modulation and advanced call processing capabilities. However it required complex processing capabilities but offered two major advantages like possibility of using spectrally efficient radio transmission schemes and provision for implementation of a wide variety of integrated speech and data services such as facsimile, paging and low date rate network access. Example of 2G wireless systems are Global system for mobile communications (GSM), Personal Digital Cellular (PDC), Digital Enhanced Cordless Telecommunications (DECT), Personal Access Communication System (PACS), Personal Handy phone System (PHS). Third generation wireless systems has been evolved as matured 2G networks. 3G of wireless network provides high speed bandwidth to hand held devices. The high data transfer rates will allow offering multimedia services combining voice and data. The main aim of 4G – 7G networks is to provide universal access and global roaming with expected support of multidimensional high speed wireless communications.

First Generation cellular wireless communication

First generation is popularly known as cellphones that means mobile radio telephones and technology for this was Mobile Telephone Systems (MTS), Improved Mobile telephone Systems(IMTS) and Push to talk(PTT). 1G wireless network used analog radio signals. In terms of overall connection quality, it offered low capacity, unreliable handoff, poor voice links and no security. In 1G voice call gets modulated to a higher frequency and it was distributed between radio towers using a technique called FDMA(Frequency Division Multiplexing Technique). However, 1G maintained a few advantages over 2G. In comparison to 1G's analog signals, 2G's digital signals are very dependent 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 hand set had generally poorer quality than that of a 2G handset, it survived longer distances. This is due to the analog signals having smooth curve compared to the digital signals, which had a jagged, angular curve. Different 1G standards were used in different countries like NMT (Nordic Mobile Telephone) in Nordic countries, Eastern Europe and Russia. AMPS (Advanced Mobile Phone Systems) used in United States.

Second Generation cellular wireless communication

The second generation of cellular communication appeared in 1990s with the first digital cellular networks. The shift from analog to digital is driven by its higher capacity and the improved cost, speed and power efficiency of digital hardware. It became a success with the growth in number of subscribers and value added services. Second generation networks allowed a limited data support in the range of 9.6 kbps to 19.2 kbps. It can not normally transfer data such as email or software, other than the digital voice call itself. 2G cellular telecom networks were commercially launched on GSM standard in 1991. 2G networks were mainly circuit switched networks. The great market potential led to a proliferation of second generation cellular standards: three different standards in the U.S. alone, and other standards in Europe and Japan, all incompatible. Roaming throughout the U.S. and the world using one cellular phone standard was impossible due to the fact that different cities have different incompatible standards. 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. Although the processing complexity of these digital systems is more than analog counterparts, they possess three inherent benefits:

- The possibility of using spectrally efficient radio transmission schemes.
- Facilitation of the implementation of a wide variety of integrated speech and data services
- Enhanced security features

Cordless technology is a companion to cellular radio. It has low mobility, low power and two way tether less voice communication. Its intended application is in private residential to private business environments such as Private Automatic Branch Exchange (PABX) with two way calling capability. So it is capable of as long as low cost infinite access point in urban densely populated areas. 2.5G networks are an extension of 2G networks where circuit switching is used for voice and packet switching for data transmission. 2.5G networks supported services such as WAP, MMS, SMS mobile games and search and directory. EDGE(Enhanced Data rates for GSM Evolution) is and extended version of GSM it allowed the clear and fast transmission of data and information.

Third Generation cellular wireless communication

The third generation of mobile cellular systems was proposed by many problems of 2G and 2.5G networks like low speeds and incompatible technologies such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) in different countries. 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 wide range of more advanced services while achieving greater network capacity through improved spectral efficiency. 3G technologies make use of value added services like mobile television, GPS (Global Positioning System) and video conferencing. 3G provided high speed bandwidth to handheld devices: 128 kbps for mobile stations, 2 Mbps for fixed applications. 3G wireless networks have the bandwidth to provide converged voice and data services. 3G services combine superior voice quality telephony; high speed mobile IP services, information technology, rich media, and diverse content. The high data transfer rates will allow 3G networks to offer multimedia services combining voice and data. 3G mobile cellular systems are intended to unify the diverse systems into seamless radio asymmetric data capabilities in all operating environments. The International Telecommunication Union (ITU) has standardized the 3G networks. There are five approved 3G standards which are part of 3G framework:

Three standards based on CDMA, namely CDMA 2000, WCDMA and TSCDMA.

Two standards based on TDMA, namely FDMA/TDMA and TDMA-SC (EDGE). Parody of 3G offered rich multimedia services on more bandwidth with better security and reliability. 3G used always online IP connectivity. 3G also offered new radio spectrum which relieved overcrowding of radio spectrum in existing

systems. Interoperability between service providers and backward compatibility between devices of existing networks elevated the cost of upgrading base stations and cellular infrastructure. It included network deployment costs, handset subsidies to subscribers. It was a paradigm shift from voice centric network to multimedia centric networks. 3G devices offered services of phone, TV and PC (Personal Computer). Various services that 3G networks offered are:

- Always on connection with users paying only for sending and receiving packets.
- Instant messaging and email with multimedia attachments.
- Location based services.
- Global roaming capability.
- Web surfing.
- Personalized services, where content can be pushed to users.
- Receiving Faxes
- Broadband multimedia data services like video conferencing and streaming video.
- Getting maps and directions with a multi modal user interface.
- Customized entertainment.
- Simultaneous access to multiple services, each service offering some combination of voice, video, data etc.

  HSDPA (High Speed Downlink Packet Access) is a mobile telephony protocol is also called as 3.5G. It is packet-based data service in W-CDMA downlink with data transmission up to 8-10 Mbit/s over a 5MHz bandwidth in WCDMA downlink. HSUPA (High Speed Uplink Packet Access) is core of 3.75G. It enhanced 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. The HSUPA mobile telecommunications technology is directly related to HSDPA and these two are complimentary to each other.

Fourth Generation (4G) cellular wireless communication

4G is a super enhanced version of 3G i.e. an entirely packet switched network with all digital network elements and extremely high available bandwidth. The vision of 4G is the provision of broadband access, seamless global roaming, Internet/data/voice, fully convergent, flexible, all-IP network. 4G mobile technology is giving more convenience and ease in lifestyle. 4G also promised of worldwide roaming using a single handheld device. 4G is built upon second phase of 3G, when all networks are expected to embrace Internet Protocol (IP) technology. 4G networks supports quality of service that refers to measure of performance for a system reflecting its transmission quality and service availability. While considering QOS 4G include: varying rate channel characteristics, bandwidth allocations, fault tolerance levels, and handoff support among heterogeneous wireless networks. 4G technology will benefit every individual regardless of time and place. This technology stands to be the way to communicate and connect all the time with more ubiquitous means. So it offers ubiquitous networking, e-commerce (or even m-commerce), unified messaging, and peer to peer networking expanded to the mobile and wireless surroundings, home- networking, telemetric and sensor- network service. 4G supports connection speeds of up to 50 times faster than 3G networks and also offer three dimensional visual experiences for the first time. At the same time, a low data rate transmission cost is also maintained. In order to meet this, service providers have designed personal and customize services for the diverse users. It is stated that 4G is deployed with software defined radios (SDR) allowing the equipment to be upgraded to new protocols and services via software upgrades. The benefit of SDR to manufacturers is through a decrease in the number of separate platforms which will be needed for the purpose of diverse wireless technologies.

Fifth Generation (5G) cellular wireless communication

5G system is an intelligent technology which will enable us to interconnect to the whole world without any limits. 5G is the result of researches on wwww, DAWN (Dynamic Adhoc Wireless Network) and Real Wireless World. Currently 5G is not an official term used for any official document. But this is publicized by telecommunication companies. According to this 5G has changed the means to use cell phones within very high bandwidth. 5G technology will include all the advanced features which will make 5G the most powerful and high in demand in future. This innovative technology will let the user to hook the 5Gtechnology cell phone with their laptop to get broadband internet access There are two views of 5G systems: evolutionary and revolutionary. In evolutionary view the 5G systems will be capable of supporting wwww that will allow a highly flexible network such as a robot with built-in wireless communication with artificial intelligence. The evolutionary view of 5G include a support of wireless world wide web (wwww) allowing a high flexible and reconfigurable dynamic adhoc networks. In revolutionary view it is going to be a new revolution in the market.

User can use worldwide cellular phones with 5G mobile IP where each phone will have a permanent "home" IP address along with a "care-of" address that will represent its actual location. 5G technology has astonishing data capabilities and it can also tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has the power to take over the world market because it can offer best technologies at very less priced handsets with the supported software and consultancy. So 5G has definitely a bright future.

Table 1: Comparison of 1G-5G Technologies

Features	1G	2G/2.5G	3G	4G	5G
Initiation	1970/1984	1980/1999	1999/2002	2000/2010	2010/2015
Data Bandwidth	2kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Technology	Analog cellular technology	Digital Cellular Technology	Broad Bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/PAN and WLAN	Unified IP and seamless combination of broadband, LAN/WAN/PAN and WLAN and wwww
Standards	AMPS	2G: TDMA,CDMA,GSM 2.5G: GPRS,EDGE,1xRTT	WCDMA, CDMA 2000	Single unified standard	Single unified standard
Service	Mobile Telephony (voice)	2G: Digital voice, short messaging 2.5G; Higher capacity packetized data.	Integrated high quality audio, video and data	Dynamic Information access, wearable devices	Dynamic Information access, wearable devices with AI capabilities
Multiplex-ing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Switching	Circuit	2G: Circuit 2.5G : Circuit for access network and air interface, packet for core data	Packet except circuit for air interface	All packet	All packet
Core Network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical

Next Generation (6G-7G) cellular wireless communication

Next generation wireless network standards are currently being defined. Next Generation wireless networks include the cellular evolution towards packet based networks which will make use of multiple broadband, QOS (Quality of Service) enabled transport technologies. Service related functions will be independent from underlying transport related technologies. It will support generalized mobility which will allow consistent and ubiquitous provision of services to users.

Conclusion

Mobile phones have become an essential part of everyone's daily life. The previous, current and future trends in mobile phone systems are considered as evolutionary path for migration from first generation mobile phone systems and is continuing to the development of 5G, 6G and 7 generation cellular phone systems. In this paper we review the various generations of cellular wireless communication services, technologies behind, performance, advantages and disadvantages of one generation over another. And it includes further research on new generations in the areas of wearable devices with AI capabilities and ubiquitous computing.

References:

[1] M.Zeng, AAnnamalai,and Vijay K.Bhargava University of Victoria ”Recent Advances in Cellular Wireless Communications”.
[2] Shakil Akhtar Professor, Clayton State University “2G-5G Networks : Evolution of Technologies, Standards, and Deployment.
[3] R. Ramjee, T. La Porta, Salgarelli, S. Theul, K. Varadhan Bell Labs, Lucent Technologies Holmdel, NJ “IP- based Access Network Infrastructure for Next Generation Wireless Data Networks.