International Journal of Recent Trends in Engineering & Research
ISSN : 2455-1457 Impact Factor : 3.344

Comparative Study on Wireless Mobile Technology: 1G, 2G, 3G, 4G and 5G

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Abstract: Wireless communication is the transfer of information between two or more points that are not directly connected by an electrical conductor. There is one of most common wireless technologies uses radio waves. With radio waves distances can be short, such as a few meters for television or as far as thousands or even millions of kilometers for deep-space radio communications. Wireless communications use other electromagnetic wireless technologies, such as light, magnetic, or electric fields or the use of sound.
In this paper we will show 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 1G to 4G. Current research in mobile wireless technology concentrates on advance implementation of 4G technology and 5G technology.
Index Term : 1G, 2G, 3G, 4G, 5G

I. INTRODUCTION

The wireless network refers to any type of network that is not connected by cables of any kind. It is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into buildings, or as a connection between various equipment locations.
Wireless communications is one of the most active areas of technology development of our time. This development is being driven primarily by the transformation of what has been largely a medium for supporting voice telephony into a medium for supporting other services, such as the transmission of video, images, text, and data. Thus, similar to the developments in wire line capacity in the 1990s, the demand for new wireless capacity started growing at a very rapid pace. Although there are, of course, still a great many technical problems to be solved in wire line communications, demands for additional wire line capacity can be fulfilled largely with the addition of new private infrastructure, such as additional optical fiber, routers, switches, and so on. There has been considerable research effort in recent years aimed at developing new wireless capacity through the deployment of greater intelligence in wireless networks. A key aspect of this movement has been the development of novel signal transmission techniques and advanced receiver signal processing methods that allow for significant increases in wireless capacity without attendant increases in bandwidth or power requirements [1] [2].
Many years after the advent of wireless technology, the problem and hindrances of effective communication is still present. Many people around the world are now using the wireless communication and this has led to the congestion of network, low connectivity speed and low bandwidth. Without wireless networks, internet browsing, the usage of cellular phones which are part of everyday wireless networking that allows easy personal communications is impossible. Wireless networking is also applicable in inter-continental network systems and the use of radio satellites to communicate across the world. This technology allows for an alternative to installing physical network mediums such as, coaxial and fiber-optic cables, which are expensive. Wireless networking

helps save the cost of installation of cable mediums, save time from physical installation, and also creates mobility for devices connected to a network [3].

II. EVOLUTION OF MOBILE TECHNOLOGY

- **Classical 0G** phones stood for the first generation of mobile phones i.e. Satellite phones developed for boats mainly. Networks such as Iridium, Global Star and Eutelsat were truly worldwide (although for physical reasons, think of a satellite as a fixed point above the equator, some Northern parts of Scandinavia aren't reachable), and everybody thought at that time that satellite phones would become mainstream products as soon as devices got smaller and cheaper. This vision proved wrong when the GSM concretely came to life in 1990-91 in Finland.

- **1G:** Firstly, there were analog GSM systems that existed for a few years. And then discover the digital systems.

- **2G:** the second generation of mobile telecommunications still is the most widespread technology in the world; you have basically all heard of the GSM norm (GSM stands for Groupe Special Mobile in French, renamed in Global System for Mobility). The GSM operates in the 850Mhz. and 1900Mhz. bands in the US, & 900 Mhz. and 1.8 Mhz bands in the rest of the world (eg did you know Bluetooth stands in the 2.4Ghz. area, just like your…microwave!? But that is another story, not related to this article) and delivers data at the slow rate of 9.6 Kbytes/sec.

- **2.5G:** For that last reason (9.6 Kbytes/sec doesn't allow you to browse the Net or up/download an image), telecom operators came up with the GPRS (remember all the hype around the Wap) which could enable much faster communications (115Kbytes.sec). But the market decided it was still not enough compared to what they had at home.

- **2.75G:** EDGE, which is a pretty recent standard, allows for downloading faster. Since mobile devices have become both a TV and music player, people needed to be able to watch streaming video and download mp3 files faster – that is precisely what EDGE allows for and that is for the good news. The bad news is that if EDGE rocks at downloading, it is protocol is asymmetrical hence making EDGE suck at uploading ie, broadcasting videos of yours for instance. Still an interesting achievement thanks to which data packets can effectively reach 180kbytes/sec. EDGE is now widely being used.

- **3G:** also called UMTS (Universal Mobile Telecommunications Standard). Aimed at enabling long expected videoconferencing, although nobody seems to actually use it (do you know any?). Its other name is 3GSM, which says literally that UMTS is 3 times better than GSM. One issue though: depending on the deployment level of the area you are in and your device, your phone will (have to be) handle(d) from the GSM network to the UMTS network, and conversely – making billing more complex to understand for the consumers. One of the major positive points of UMTS is its global roaming capabilities (roaming is the process that allows you, at a cost, to borrow bandwidth from a telecom provider that is not yours; you usually use roaming when calling from abroad).

- **3.5G or 3G+: HSDPA** is theoretically 6 times faster than UMTS (up to 3.6 Mbytes/sec)! Practically speaking, this would mean downloading an mp3 file would take about 30 sec instead of something like 2 minutes.

- **4G:** still a research lab standard, at least to my knowledge, that should combine the best of cell phone network technologies with WiMax wireless Internet, voice over IP and IPv6 (a post about the latter soon). Data rates are expected to reach 100 Mbytes/sec[4].

- **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 telecommunication standards beyond the upcoming 4G standards (which is expected to be finalized between approximately 2011 and 2013)[5].

  5G offers Peak per terminal throughput – 10 Gbps outdoors, spectral efficiency. – 5 bps/Hz/cell, areal reliability – 99.5%, round trip delay < 1 ms, seamless coexistence with other radios. These goals are significantly ahead of 4G performance. The new tools that can take us these goals may include Opportunistic OFDMA, 20-60 MHz channel bandwidth, cognitive and opportunistic channel structure, flexible ,variable reuse, cooperative methods, interference management, client relay, hierarchical modulation, distributed MIMO and accumulative methods.

III. COMPARISON OF 1G TO 5G TECHNOLOGIES

Technology/Features	1G	2G/2.5G	3G	4G	5G
Start/ Development	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64kpbs	2 Mbps	2000 Mbps to1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G:TDMA, CDMS, GSM 2.5:GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	Single unified standard	Single Unified standard
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 /WLAN and wwww
Service	Mobile Telephony (voice)	2G: Digital voice, Short Messaging 2.5G: Higher capacity Packetized data	Integrated Higher Quality audio, video and data	Dynamic Information Access, Wearable devices	Dynamic Information Access, wearable device with IA capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	2G: Circuit 2.5G: Circuit for access network & air interface; packet for core network and 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

Table1: General comparison of 1G to 5G technologies [5][7].

IV. 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.

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