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A Critical Review of Various Generations of Mobile Network Technologies

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Abstract

Mobile Network Technologies have made the world a global digital village. Today we live in a fast changing work environment which has its own demands of communicating and connecting with people as fast as possible without the constraints of demography of users. The continuous demands and requirements for wireless communication systems have led to the need for a better understanding of fundamental issues in communication theory and electromagnetic applications. The mobile communication technologies have evolved by leaps and bounds since inception and growing competition and need implications have piloted the design of highly-capable wireless systems. Devices continue to shrink in size while growing in processing power. Consumers are demanding more advanced and useful applications. Hence, there is need of capacity building in wireless communications. Several major cellular wireless communication techniques have been proposed in order to meet these user expectations from analog to digital and then to hybrid IP based latest generation. The advent of 1G (AMPS based), 2G (CDMA based), 3G (GPRS based), 4G (based on 2G, 3G, Wi-Fi, Wi-PAN or Bluetooth and Wi-Max technologies) technologies has been phenomenal. The "G" in wireless networks refers to the "generation" of the underlying wireless network technology. The present paper reviews the advantages, limitations and effects of various generations of technologies in communication. Some gaps in research of these have been identified here and suggestions for future improvements proposed.

Keywords- Mobile Technologies, Bluetooth, AMPS, Wi-Fi, 3G, 4G, wireless system

1. Introduction

Today we live in a fast changing world which has its own demands of communicating, connecting with people as fast as possible i.e. in minimum time possible without the consideration of location of the user. The continuous demands and requirements for wireless communication systems have led to the need for a better understanding of fundamental issues in communication theory and electromagnetic and the implications for the design of highly-capable wireless systems.1G was introduced in early 1980's ,basically used for voice calling or voice communication and very little thought was given about exploring the other usage of this network such as internet browsing but as the technology evolved 2G, 3G and finally 4G were introduced covering various other areas such as packet data transfer , video calling , ultra fast broadband connections etc. This paper mentions those aspects and basically discussing the evolution from 1G when apart from calling, using it as a modem was considered to 4G which provides us super fast internet browsing facility on the go, its advantages and disadvantages and future projects which will lead to further evolution and exploring of other new areas

2. Discussions

2.1) 1G

The "G" in wireless networks refers to the "generation" of the underlying wireless network technology.The first network in this G category was the First generation Mobile Network (popularly known as 1G).1G networks (NMT, C-Nets, AMPS, TACS) are considered to be the first analog cellular systems, which started early 1980s. There were radio telephone systems even before that. 1G networks were conceived and designed purely for voice calls with almost no consideration of data services (with the possible exception of built-in modems in some headsets).The important technology behind 1G was AMPS. In 1970, Bell Labs in New Jersey proposed a cellular telephone concept as advanced mobile telephony system (AMPS). AMPS is a standard cellular telephone service placed into operation on October 13, 1983 by Illinois Bell. It uses narrow-band FM with a usable audio frequency band of 300-3 kHz and maximum frequency deviation of ±12 kHz for 100 per cent modulation. According to Carson’s rule, this corresponds to 30 kHz. AMPS uses frequency-division multiple access (FDMA), where transmissions are separated in the frequency domain. Subscribers are assigned a pair of voice channels (forward and reverse) for the duration of their call. Analogue cellular channels carry both voice using FM and digital signaling information using binary FSK.1G began to be used in various countries in different Standards. One such standard is NMT (Nordic Mobile Telephone), used in Nordic countries, Switzerland, Netherlands, Eastern Europe and Russia. Others include AMPS (Advanced Mobile Phone System) used in the North America and Australia,[1] TACS (Total Access Communications System) in the United Kingdom, C-450 in West Germany, Portugal and South Africa, Radiocom 2000[2] in France, and RTMI in Italy. In Japan there were multiple systems. Three standards, TZ-801, TZ-802, and TZ-803 were developed by NTT (Nippon Telegraph and Telephone Corporation[3]), while a competing system operated by DDI

(DainiDenden Planning, Inc.[4]) used the JTACS (Japan Total Access Communications System) standard.1G speeds vary between that of a 28k modem (28kbit/s) and 56k modem (56kbit/s),meaning actual download speeds of 28kbit/s to 56kbit/s.

Problems with 1G Networks:

As 1G was using Analog Technology led to its downfall as:

1. Analog Signals does not allow advance encryption methods hence there is no security of data i.e. anybody could listen to the conversion easily by simple techniques. The user identification number could be stolen easily and which could be used to make any call and the user whose identification number was stolen had to pay the call charges.
2. Analog signals can easily be affected by interference and the call quality decreases.

2.2) 2G

2G(GSM, CDMAOne, D-AMPS) are the first digital cellular systems launched early 1990s, offering improved sound quality, better security and higher total capacity. GSM supports circuit-switched data (CSD), allowing users to place dial-up data calls digitally, so that the network's switching station receives actual ones and zeroes rather than the screech of an analog modem.After a certain period of time an enhanced version of 2G network was introduced (2.5G),improving the efficiency.(GPRS, CDMA2000 1x) are the enhanced versions of 2G networks with theoretical data rates up to about 144kbit/s. GPRS offered the first always-on data service. Technology behind 2G is CDMA which is a form of direct-sequence spread-spectrum technology that allows many users to occupy the same time and frequency allocations in a given band/space. [3]CDMA assigns each user a unique spreading code to spread the baseband data before transmission, in order to help differentiate signals from various users in the same spectrum. It is the platform on which 2G and advanced 3G services are built.GPRS: **General packet radio service**(**GPRS**) is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM). GPRS was originally standardized by European Telecommunications Standards Institute (ETSI) in response to the earlier CDPD and i-mode packet-switched cellular technologies. It is now maintained by the 3rd Generation Partnership Project (3GPP).GPRS usage is typically charged based on volume of data transferred, contrasting with circuit switched data, which is usually billed per minute of connection time. Usage above the bundle cap is either charged per megabyte or disallowed.

Problems with 2G:

In less populous areas, the weaker digital signal transmitted by a cellular phone may not be sufficient to reach a cell tower. This tends to be a particular problem on 2G systems deployed on higher frequencies, but is mostly not a problem on 2G systems deployed on lower frequencies. National regulations differ greatly among countries which dictate where 2G can be deployed.Analog has a smooth decay curve, but digital

has a jagged steppy one. [1]This can be both an advantage and a disadvantage. Under good conditions, digital will sound better. Under slightly worse conditions, analog will experience static, while digital has occasional dropouts. As conditions worsen, though, digital will start to completely fail, by dropping calls or being unintelligible, while analog slowly gets worse, generally holding a call longer and allowing at least some of the audio transmitted to be understood.

2.3) 3G

3G is the next generation of technology which has revolutionized the telecommunication industry. Apart from increasing the speed of communication, the objective of this technology is to provide various value added services like video calling, live streaming, mobile internet access, IPTV, etc. on the mobile phones. These services are possible because the 3G spectrum provides the necessary bandwidth.Technically speaking 3G is a network protocol which refers to the generations of mobile phones and telecommunication equipment which are compatible with the International Mobile Telecommunications-2000 (IMT-2000) standards stated by International Telecommunication Union (ITU). The basic requirement for compiling to IMT-2000 standards is that the technology should provide peak data rates of at least 200 kbit/s. It's worth mentioning that speed isn't the only criteria for deciding whether the network protocol is 3G or not. 3G isn't just any high speed network but a protocol which has its own standards defined under IMT-2000 by ITU.3GTechnologyis designed for multimedia communication. It provides services like higher data transfer rates. One of its key visions is to provide seamless global roaming, enabling users to move across borders while using the same number and handset. [4]According to ITU it is expected that IMT-2000 will provide higher transmission rates:a minimum speed of 2Mbit/s for stationary or walking users, and 348kbit/s in a moving vehicle.With the introduction of 3G, a wide variety of its applications were also introduced which were not even in frame during the 1G and 2G networks due to the speed constraints. Some other applications or fields which were explored after the introduction of 3G are:

- Making Remote Access Network Connectivity for small branches/ temporary locations simple and easy using 3G Network
- Reduce Long Distance Voice Call Charges using VOIP Communications and 3G Network
- Video conferencing from anywhere in the world

2.4) 4G

In a world of fast changing technology, there is a rising requirement for people to communicate and get connected with each other and have appropriate and timely access to information regardless of the location of the each individuals or the information. The increasing demands and requirements for wireless communication systems ubiquity have led to the need for a better understanding of fundamental issues in communication theory and electromagnetic and their implications for the design of highly-capable wireless systems. In continuous development of mobile environments, the major service providers in the wireless market kept on monitoring the growths of

4th generation (4G) mobile technology. 2G and 3G are well-established as the mainstream mobile technology around the world. 3G is stumbling to obtain market share for a different reasons and 4G is achieving some confidence.The 4G technology includes the best features of 2G, 3G, Wi-Fi, Wi-PAN (Bluetooth), and WiMax technologies with additive features. Packing so much intelligence in smaller and smaller physical space, esp. User Equipment (UE) 4G can be defined as:

"IP + WPAN + WLAN + WMAN + WWAN + any other stragglers = 4G"

The entire network would be packet-switched (IP Based). All switches would be digital. Higher bandwidths of 100MHz, and data could be transferred at much higher rates the cost of data transfer would be comparatively very less and global mobility would be possible. The security features will be much better. The smart antennas will be used and improved access technologies like OFDM and MC-CDMA (Multi Carrier) will be used.

4G Characteristics

- Convergence Services
- Broadband Services
- Interactive BCN (ALL-IP) with Home-Networking, Telemetric, Sensor-Network
- Flexibility and Personalized Service

3 Conclusions

Mobile Network Technologies have integrated the world as a global family where distances are no longer any hindrance for communication. The demand for wireless communication systems has resulted in the evolution of newer generations of wireless network technologies. From 1G to 4G, all these technologies have eased the living and communication standards but have their own sets of problems. More research is needed to evolve better technologies for faster and safer communication.

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