

Review on Generations in Mobile Cellular Technology

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Abstract: This paper investigates different methods of mobile technology. A comprehensive list of references is reported and comparisons of various methods such as 1G, 2G, 3G, 4G is reported. Wireless communications networks have become much more pervasive than any one could have imagined. The wide spread success of cellular has led to the development of newer wireless systems and standards for many other types of telecommunication traffic besides mobile voice telephone calls. Nowadays, a rapid growth in mobile technology has satisfied the customer needs to a great extent but it is still developing to a great height which makes the people's life easier. A broad survey in the development of mobile technology is reported in this paper.

Keywords: 3G, 4G, OFDM, CDMA, data rate.

I. INTRODUCTION

The today's market of wireless communications is developed at a very rapid growth. This development causes due to the increasing number of subscribers. This development in cellular wireless systems is started when the "cellular concept" came in picture. In today's life the mobile phone is very essential tool for every man. The mobile phone technology is evolved from cellular concept; therefore the mobile phone is also referred to as "Cell-phone" or simply "cell". In past years, the pagers are used in place of mobile phone for transmitting information from one place to another. But this communication only contains data signals and not a single voice signal.

Since the mid 1990's the cellular communication industry has witnessed explosive growth. Wireless communication networks have become much more pervasive than anyone could have imagined when the cellular concept was first developed in the 1960's and 1970's. Increasing demand in wireless communication necessitates the rapid growth of cellular network for fulfilling the customers need and also for the competitor service providers.

The wireless communication is a robust, viable voice and data transport mechanism. The cellular systems should be able to support the higher data traffic as well as higher spectrum efficiency.

In section II the older first generation systems are discussed. Section III gives a detailed overview of second generation mobile technology. In section IV third generation systems and its types are discussed. Section V gives information about the possible fourth generation technologies. Conclusion is contained in section VI.

II. FIRST GENERATION

The first generation mobile systems are based on analog technology. The first technology uses frequency modulation (FM) and frequency division duplexing (FDD), frequency division multiple access (FDMA). The common signalling channels were used in first generation cellular systems. Due to the use of analog technology the analog speech signals are provided by the first generation wireless systems. The data transmission between base station and mobile user was insufficient and the low data rate necessitates the next generation cellular systems. The first generation systems are relies on analog systems therefore, the transmission is not secure whereas the second generation systems uses digital modulation so, provides secure transmission of data.

A. AMPS

AMPS is the first U.S. cellular telephone system called advanced mobile phone system. The AMPS system uses 7-cell reuse pattern with provisions for sectoring and cell splitting to increase capacity when needed. AMPS uses frequency modulation (FM) and frequency division duplex (FDD) for radio transmission. It uses FDMA multiple access, Channel bandwidth is 30 KHz. In the United States transmissions from mobile to base stations (reverse link) use frequency between 824-849MHz, while base station transmits to mobile (Forward link) using frequencies between 869MHz and 894 MHz. Data rate of AMPS on control channel is 10 kbps.

B. ETACS

European Total Access Communication systems (ETACS) was developed in mid-1980's and is virtually identical to AMPS except it is scaled to fit in 25 KHz channels used throughout Europe. Another difference between AMPS and ETAC is how the telephone number of each subscriber (called the mobile identification number or MIN) is formatted, due to the need to accommodate different country codes throughout Europe as opposed to area codes in U.S.

III. SECOND GENERATION

The second generation mobile technology is a successor of first generation mobile technology. Due to the analog speech signals, low data rate and insufficient data communication there is a emerging demand of the next generation wireless system that provides high speed data communication as well as voice transmission . Thus, the analog technology in first generation is replaced by digital technology in 2G wireless systems. Instead of analog frequency modulation(FM) technique the digital modulation techniques are used in second generation. The access techniques used in second generation are TDMA(time division multiple access) and CDMA(code division multiple access) along with the frequency division duplexing(FDD) technique. By using the second generation technologies the system capacity is three times greater than the first generation analog systems. Due to the increase in spectrum efficiency is three times compared to the first generation analog systems.

The standards in 2G technology are categorised by following types:

1) GSM(global system for mobile) –

It is very popular and widely used 2G technology by most of the subscribers . The GSM supports 8 times slotted users for every 200KHz radio channels. The popular features of GSM is short messaging service(SMS). SMS allows the users to send a data in alphanumerical format to the other user by simply dialling the users mobile phone number. The uplink frequency(from base station to mobile station) is 890-915 MHz and downlink frequency (from mobile station to base station) is 935-960 MHz. The carrier separation for GSM is 200KHz and bandwidth of GSM is 25MHz. It uses time division multiple access technique along with the frequency division duplexing. In GSM the 0.3 gaussian minimum shift key (GMSK) modulation is used at the data rate of 270.833kbps. The voice channels per carrier is 8 and the frame period is 4.615ms.

GSM includes various types of Teleservices and data services. The teleservices includes emergency calling, facsimile, videotext, teletext. The data services also called as bearer services which includes computer to computer communication and a packet switched traffic. One of the most popular feature of GSM is subscriber identity module (SIM) which gives a unique identity to each subscribers.

2) Interim standard 136(IS-136)-

This standard also known as North American digital cellular (NADC). The IS-136 supports 3 times slotted users for each 30KHz. This technique also uses time division multiple access (TDMA) with frequency division duplexing(FDD). The forward channel frequency is 1850-1910 MHz and reverse channel frequency is 1930-1990 MHz. the channel bandwidth is 60MHz. The 45 DQPSK(differential quadrature phase shift keying) type modulation technique is used. The channel data rate is 46.6kbps.

3) Pacific digital cellular(PDC)-

The standard is similar to that of IS-136. Therefore, the forward and reverse link frequencies are similar to that of IS-136. Multiple access technique is time division multiple access (TDMA) with frequency division duplexing (FDD). The channel data rate is somewhat different compared to IS-136 and is 42 kbps and carrier separation is 25 KHz.

4) Interim standard 95(IS-95)-

This 2G standard is very popular and also known as cdmaone. This standard uses code division multiple access(CDMA) with frequency division duplexing. It supports 64 voice channels per carrier that are orthogonally coded. The forward channel frequency for IS-95 is 824-849 MHz.And the reverse channel frequency is 869-894 MHz. The carriers are separated by 1.25MHz frequency. The signal is modulated by binary phase shift keying (BPSK) modulation with quadrature spreading at the data rate of 1.2288 Mchips /sec.

Although, the 2G standard mobile technologies provides efficient voice data transmission but the internet browsing applications are at very lower speeds. Thus, it is also insufficient for rapid electronic mail (e-mail) services. So, for providing higher data rate transmission for internet browsing applications, e-mail services the 2G standards are modified

and a new standard called 2.5 G standard is developed with backward compatibility with 2G standard. The 2.5G technologies uses wireless application protocols (WAP) by which the web

pages are viewed by the users in a compressed form. Recently, a number of other web compressing protocols are developed in which Ald00 is one of them. The 2.5G technology is evolved from the

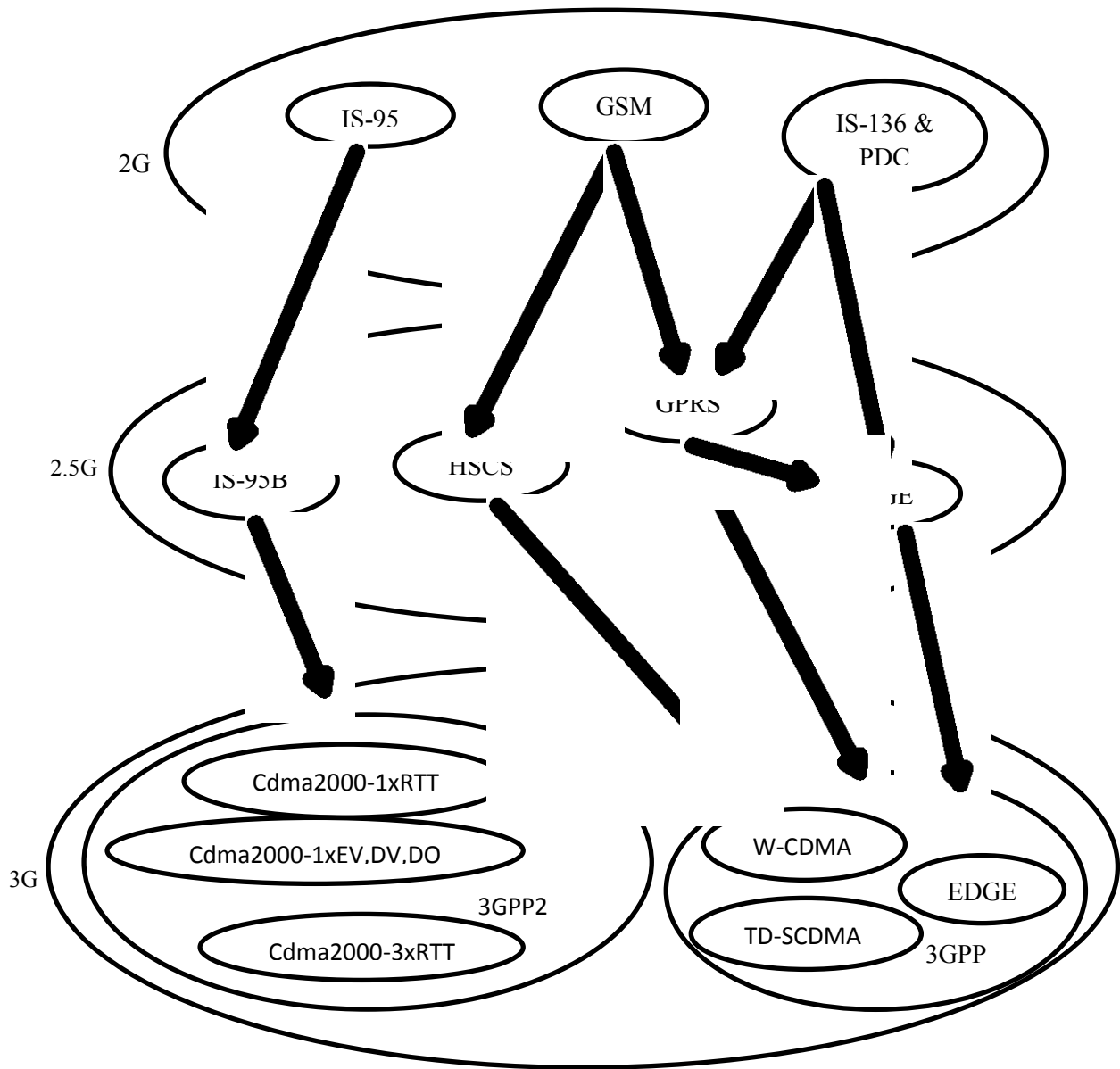


Fig.3.1 Various upgrade paths for 2G technologies.[10]

standards (GSM, PDC, IS-95 and IS-136) in 2G for 2G technologies and also for 3G. In 2.5G IS-95B standard is evolved from the cdma-one standard in 2G which uses channel bandwidth of 1.25 MHz. The high speed circuit switched data (HSCSD) is evolved from GSM standard which allows individual user to use consecutive time slots to obtain the higher speed data access on the GSM networks. It uses 200KHz channel bandwidth and provides transmission rate up to 57.6 kbps. The general packet radio service (GPRS) includes

technology. Figure 3.1 shows various upgrade paths features of both GSM, IS-136 and PDC. It provides a packet data access which is suited for non-real time internet usage, facsimile, e-mail, web browsing where the downloading speed is greater than uploading speed. The enhanced data rate for GSM evolution is more advanced GSM standard which is designed from the common features of GSM and IS-136. It is also referred as enhanced GPRS.

IV. THIRD GENERATION

The third generation (3G) wireless systems provides backward compatibility for 2G and 2.5G. The 3G technology is originally designed for higher speed internet access and various types of web browsing applications. The 3G standard provides various attractive services one of it is video conferencing which enables multiple called parties that can communicate face to face though they are at a long distance. This service is very useful in case of business industries where various conferences are performed by video conferencing. The 3G also provides multimedia services, video calling, gaming services and internet access at a very high data rate.

The 3G standard is categorised in two types which are as follows:

A. 3GPP(3G partnership project for wideband CDMA standard) -

This standard is based on backward compatibility with GSM and IS-136/ PDC. The 3GPP standard involves wideband code division multiple access (W-CDMA), time division synchronous code division multiple access (TD-SCDMA) and enhanced data for GSM evolution (EDGE). The W-CDMA is also called as universal mobile telecommunication system (UMTS). The W-CDMA uses both frequency division duplexing (FDD) and time division duplexing (TDD). This technique is backward compatible with GSM and forward channel bandwidth is 5 GHz. The data rate is up to 2 Mbps. Its spectral efficiency is six times greater than GSM system. The TD-SCDMA is a popular GSM compatible standard. It has 1.6 MHz bandwidth and uses TDD duplexing technique. The channel bitrate is up to 2.227 Mbps.

B. 3GPP2(3G partnership project for CDMA-2000 standard) -

This 3G technology is backward compatible to 2G CDMA technique i.e. IS-95 and 2.5G technique i.e. IS-95B. The CDMA-2000 standard uses both FDD and TDD duplexing methods. The downlink frequency can be implemented using either direct spreading or multi carrier and uplink frequencies supports the simultaneous combination of multicarrier and direct spreading. The 3G – CDMA 2000 1xRTT (radio transmission technology) implies a single 1.25 MHz radio channel. The data rate is up to 2 Mbps.

V. FOURTH GENERATION

The fourth generation mobile communication system is developed after the third generation (3G) mobile phone standards. A fourth generation system (4G) provides various features which are not involved in Third generation standards or any other generation before 3G (i.e. first generation and second generation). The features included in 4G are Video conferencing, gaming services, IP telephony, high definition (HD) mobile TV. It also provides Internet access facility at a very rapid speed which is known as mobile ultra-broadband internet access.

The fourth generation mobile systems uses orthogonal frequency division multiplexing (OFDM), Multiple input multiple output (MIMO), software defined radio (SDR) technologies. The OFDM technology is similar technology as FDM (Frequency division multiplexing) technology but a technological difference is that in OFDM the subcarriers are orthogonally spaced to each other to reduce the interference. It also reduces the Frequency selective fading which affects severely the transmitted signal at a channel. Due to the orthogonal arrangement of subcarriers the cross-talk between sub channels is eliminated. One advantage of OFDM is that intercarriers guard bands are not necessary.

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OFDM also improves the spectral efficiency. The OFDM technology uses a fast Fourier transform (FFT) to convert the time domain signal in to frequency domain signal. The use of FFT algorithm reduces the computational time and also increases the overall efficiency of the system .The second technology used in fourth generation standard is Multiple input multiple output (MIMO). In this system the number of multiple antennas is used at transmitter and the number of multiple antennas is used at receiver to improve the bit error rate (BER) and data rate so as to maintain the system capacity. This technology provides a reliable communication. To reduce the problems of global roaming the software defined radio (SDR) is developed. The software defined radio technology implements the radio functionality as a software module running on a generic hardware platform. This technology is advantageous because of its flexibility, interoperability, connectivity and re-configurability. Along with this advantage it also faces some drawbacks such that it increases complexity and physical size of terminal. The second disadvantage is that the ADC's (analog to digital converters)are insufficient.

The fourth generation standards mobile system provides data rates greater than 200 Mbps. While, third generation mobile systems provide the data rates up to 2 Mbps. Thus, fourth generation systems promises the users for to provide better data rates. Due to the higher data rate a speedy communication is possible which makes users lives easier. By implementing the fourth generation technology the high date speed networks connects simultaneously which offers the faultless handoffs around all over the geographical regions. The faultless handoffs provide efficient communication over a wireless link. The cognitive radio network technology guarantees the secure connection.

The innovations in fourth generation mobile technology includes following:

- The mobile communications comprises two levels: a) access to the mobile network and b) access to the mobile services.

Table 1 : Results [18]

Technology	1G	2G	3G	4G
Design Began	1970	1980	1990	2000
Implementation	1981	1991	2001	2010
Services	Analog voice	Digital voice, short message	Higher capacity, data rates up to 2 Mbps	Higher capacity, completely IP-oriented,multimedia,data to hundreds of megabits
Standards	AMPS, ETACS, NMT etc.	TDMA,CDMA,GSM	WCDMA, CDMA-2000	Single standard
Data Rate	NA	14.4 kbps	2 Mbps	>200 Mbps
Multiplexing	FDMA	TDMA, CDMA	CDMA	OFDM
Core Network	PSTN	PSTN	Packet network	Internet

- The mobile phone system architecture will be open to converge multiple radio transmission technologies (RTT's) in to one single device.
- For efficient utilization of wireless spectrum more technologies are developed.
- The power efficiency is key issue in mobile device.
- By inserting the open wire architecture(OWA)-powered mobile radio transmission technology(s) card any portable consumer electronics device can be a mobile phone device.

VI. CONCLUSION

This paper presented a detailed survey of development of mobile technologies and the journey from 1G to 4G. From all above discussion it can be revealed that mobile technologies are developed at very rapid growth. The 1G mobile systems gives a start up to the cellular concept while, 2G systems provides various features to the users. The 3G mobile systems provides various attractive multimedia services. 4G system increases the data rates to a great extent. It also has high spectrum utilization ratio and low transmitting power.

REFERENCES

- [1] Li Weiwei, Comparison and Transition of Key Technologies on 3G and 4G, GUANGDONG COMMUNICATION TECHNOLOGY, 2004.
- [2] Marcus L. Roberts, Michael A. Temple, Robert F. Mills, and Richard A. Raines, "Evolution of the air interface of cellular communications systems toward 4G realization", IEEE Communications Surveys & Tutorials, vol. 8, no. 1, 1st Quarter 2006, pp. 2-22.
- [3] Mishra, Ajay K. "Fundamentals of Cellular Network Planning and Optimization, 2G/2.5G/3G...Evolution of 4G", John Wiley and Sons, 2004.
- [4] Pereira, Vasco & Sousa, Tiago. "Evolution of Mobile Communications: from 1G to 4G", Department of Informatics Engineering of the University of Coimbra, Portugal 2004.
- [5] Kamarularifin Abd Jalil, Mohd Hanafi Abd. Latif, Mohamad Noorman Masrek, "Looking Into The 4G Features", MASAUM Journal of Basic and Applied Sciences Vol.1, No. 2 September 2009
- [6] Fumiyuki Adachi, "Wireless past and Future: Evolving Mobile Communication Systems". IEICE Trans. Fundamental, Vol. E84-A, No.1, January 2001.
- [7] S. Y. Hui and K. H. Yeung, "Challenges in the Migration to 4G Mobile Systems," IEEE Communication Magazine, vol. 41, no. 12, Dec. 2003, pp.54-59.
- [8] Bill Krenik, "4G Wireless Technology: When will it happen? What does it offer?", IEEE Asian Solid-State Circuits Conference, November 3-5, 2008 / Fukuoka, Japan
- [9] Zhang Jian, The Development Trends of 4G Technology, GUANGDONG COMMUNICATION TECHNOLOGY, 2004
- [10] T. S. Rappaport, "Wireless communication Principles and Practices", Third edition, PEARSON Publication.
- [11] Jun-zhao Sun, "Features in Future : 4G Visions from a Technical Perspective[C]. IEEE Global Telecommunications Conference 2001. Vol 6.
- [12] V. Gazis, "Evolving Perspectives of 4th Generation Mobile Communication Systems," IEEE PIMRC 2002, Coimbra, Portugal, Sept. 2002.
- [13] T. B. Zahariadis et al., "Global Roaming in Next-Generation Networks," IEEE Commun. Mag., no. 2, Feb. 2002, pp. 145-51.
- [14] J. Ibrahim. "4G Features", Bechtel Telecommunications Technical Journal, vol. 1, no. 1, pp. 11-14, (2002)
- [15] Jun-Zhao Sun, J. Sauvola, D. Howie. "Features in Future: 4G Visions from a Technical Perspective", IEEE Global Telecommunications Conference, GLOBECOM '01, vol. 6, pp. 3533-3537, (2001).
- [16] Y. Raivio. "4G - Hype or Reality", IEEE 3G Mobile Communication Technologies, Conference Publication, No 477, pp 346-350 (2001).
- [17] J. M. Pereira. "Fourth Generation: Now it is Personal!", Personal, Indoor and Mobile Radio Communications, vol. 2, pp. 1009-1016, (2000).
- [18] Jamil.M. "4G: The Future Mobile Technology", in TENCON 2008 IEEE Region 10 Conference, 19-21 Nov. 2008