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Development of Mobile Technology: A Survey

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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 tele-communication 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, Wireless networks, CDMA, data rate.

I. INTRODUCTION

Mobile technology is the technology used for cellular communication. Mobile code division multiple access (CDMA) technology has evolved rapidly over the past few years. Since the start of this millennium, a standard mobile device has gone from being no more than a simple two-way pager to being a mobile phone, GPS navigation device, an embedded web browser and instant messaging client, and a handheld game console. Many experts argue that the future of computer technology rests in mobile computing with wireless networking. Mobile computing by way of tablet computers are becoming more popular. The most popular tablet at the moment is the iPad, by Apple.

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.The wide spread adaptation of wireless communication was accelerated in the mid 1990's, when governments throughout the world provided increased competition and new radio spectrum licenses for personal communication services (PCS) in the 1800-2000MHz frequency band.The next generation cellular networks being designed to facilitate high speed data communications traffic in addition to voice calls. New standards and technologies are being implemented to allow wireless networks to replace fiber optic or copper lines between fixed points several kilometres apart (fixed wireless access). Similarly wireless networks has been increasingly used as an replacement for wires with in homes, buildings and office settings through the deployment of wireless local area network (WLAN's). The evolving Bluetooth modem standard promises to replace troublesome appliance communication cords with invisible wireless connections with in a person's personal workspace.

After the development of cellular concept the various mobile technologies are evolved. Among all of them the first generation (1G) is the first mobile technology. These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The 1G networks relies on analog systems whereas the 2G networks relies on digital systems. The first generation cellular systems relied exclusively on FDMA/FDD and analog FM. The 2G (second generation) standard is the most popular and commonly used cellular standard. Second generation standards use digital modulation formats and TDMA/FDD and CDMA/FDD multiple access technique. The second generation standard include 3 TDMA standards and 1 CDMA standard such as 1) Global system for mobile (GSM) 2) Interim standard 136 (IS-136) 3) pacific digital cellular (PDC) 4) Interim standard 95 (IS-95). The 3G (Third generation) wireless systems concentrates on multimedia services and internet data rates. This is a set of standards used for mobile devices and mobile telecommunication services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3Gfinds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.4G is the fourth generation of mobile phone mobile communications standards. It is a successor of the third generation (3G) standards. A 4G system provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smartphones, and to other mobile devices. Conceivable applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing and 3D television.

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This paper is organised as follows- section II discussed the 1 G technology. In Section III, the second generation technology, its types and its features are discussed. Section IV gives the idea of 3G technology. Section V gives the concept of 4G technology. Section VI concludes the paper followed by the references.

II. FIRST GENERATION

The first commercially automated cellular network (the 1G generations) was launched in Japan by NTT (Nippon Telegraph and Telephone) in 1979, initially in the metropolitan area of Tokyo. Within five years, the NTT network had been expanded to cover the whole population of Japan and became the first nationwide 1G network. In 1981, this was followed by the simultaneous launch of the Nordic Mobile Telephone (NMT) system in Denmark, Finland, Norway and Sweden. NMT was the first mobile phone network featuring international roaming. The first 1G network launched in the USA was Chicago-based Ameritech in 1983 using the Motorola DynaTAC mobile phone. Several countries then followed in the early-to-mid 1980s including the UK, Mexico and Canada.

1G (or 1-G) refers to the first-generation of wireless telephone technology, mobile telecommunications. These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The main difference between two succeeding mobile telephone systems, 1G and 2G, is that the radio signals that 1G networks use are analog, while 2G networks are digital. Although both systems use digital signaling to connect the radio towers (which listen to the handsets) to the rest of the telephone system, the voice itself during a call is encoded to digital signals in 2G whereas 1G is only modulated to higher frequency, typically 150 MHz and up.

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

2G (or 2-G)is short for second-generation wireless telephone technology. Second generation 2G cellular telecom networks were commercially launched on the GSM standard in 1991. Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted; 2G systems were significantly more efficient on the spectrum allowing for far greater mobile phone penetration levels; and 2G introduced data services for mobile, starting with SMS text messages. After 2G was launched, the previous mobile telephone systems were retrospectively dubbed 1G. While radio signals on 1G networks are analog, radio signals on 2G networks are digital. Both systems use digital signalling to connect the radio towers (which listen to the handsets) to the rest of the telephone system.

2G technologies can be divided into TDMA-based and CDMA-based standards depending on the type of multiplexing used. The main 2G standards are:

- GSM (TDMA-based), originally from Europe but used in almost all countries on all six inhabited continents. Today accounts for over 80% of all subscribers around the world. Over 60 GSM operators are also usingCDMA2000 in the 450 MHz frequency band (CDMA450).
- IS-95 orcdmaOne (CDMA-based, commonly referred as simply CDMA in the US), used in the Americas and parts of Asia. Today accounts for about 17% of all subscribers globally. Over a dozen CDMA operators have migrated to GSM including operators in Mexico, India, Australia and South Korea.

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- PDC (TDMA-based), used exclusively in Japan
- iDEN (TDMA-based), proprietary network used by Nextel in the United States and Telus Mobility in Canada
- IS-136 D-AMPS (TDMA-based, commonly referred as simply 'TDMA' in the US), was once prevalent in the Americas but most have migrated to GSM.

A. Capacity:

Using digital signals between the handsets and the towers increases system capacity in two key ways:

- Digital voice data can be compressed and multiplexed much more effectively than analog voice encodings through the use of various codecs, allowing more calls to be packed into the same amount of radio bandwidth.
- The digital systems were designed to emit less radio power from the handsets. This meant that cells had to be smaller, so more cells had to be placed in the same amount of space. This was made possible by cell towers and related equipment getting less expensive.

B. Advantage

- While digital calls tend to be free of static and background noise, the lossy compression used by the codecs takes a toll; the range of sound that they convey is reduced. You will hear less of the tonality of someone's voice talking on a digital cellphone, but you will hear it more clearly.

C. Disadvantages

- In less populous areas, the weaker digital signal 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, digital a jagged steppy one. 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 a few words to get through.

IV. THIRD GENERATION

3G technology is the result of ground-breaking research and development work carried out by the International Telecommunication Union (ITU) in the early 1980s. 3G specifications and standards were developed after fifteen years of persistence and hard work. The technical specifications were made available to the public under the name IMT-2000. The communication spectrum between 400 MHz to 3 GHz was allocated for 3G. Both the government and communication companies unanimously approved the 3G standard. The first pre-commercial 3G network was launched byNTT DoCoMo in Japan in 1998, branded as FOMA. It was first available in May 2001 as a pre-release (test) of W-CDMA technology. The first commercial launch of 3G was also by NTT DoCoMo in Japan on 1 October 2001, although it was initially somewhat limited in scope; broader availability of the system was delayed by apparent concerns over its reliability. 3G, short for 3rd Generation, is a term used to represent the 3rd generation of mobile telecommunications technology. This is a set of standards used for mobile devices and mobile telecommunication services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3Gfinds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV.

Several telecommunications companies market wireless mobile Internet services as *3G*, indicating that the advertised service is provided over a 3G wireless network. Services advertised as 3G are required to meet IMT-2000 technical standards, including standards for reliability and speed (data transfer rates). To meet the IMT-2000 standards, a system is required to provide peak data rates of at least 200 kbit/s (about 0.2 Mbit/s). However, many services advertised as 3G provide higher speed than the minimum technical requirements for a 3G service. Recent 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers.

The following standards are typically branded 3G:

- The UMTS system, first offered in 2001, standardized by 3GPP, used primarily in Europe, Japan, China (however with a different radio interface) and other regions predominated by GSM 2Gsystem infrastructure. The cell phones are typically UMTS and GSM hybrids. Several radio interfaces are offered, sharing the same infrastructure:
  - The original and most widespread radio interface is called W-CDMA.
  - The TD-SCDMA radio interface was commercialised in 2009 and is only offered in China.
  - The latest UMTS release, HSPA+, can provide peak data rates up to 56 Mbit/s in the downlink in theory (28 Mbit/s in existing services) and 22 Mbit/s in the uplink.

- The CDMA2000 system, first offered in 2002, standardized by 3GPP2, used especially in North America and South Korea, sharing infrastructure with the IS-95 2G standard. The cell phones are typically CDMA2000 and IS-95 hybrids.

A. Features

1. Data rates

ITU has not provided a clear definition of the data rate users can expect from 3G equipment or providers. Thus users sold 3G service may not be able to point to a standard and say that the rates it specifies are not being met. While stating in commentary that "it is expected that IMT-2000 will provide higher transmission rates: a minimum data rate of 2 Mbit/s for stationary or walking users, and 384 kbit/s in a moving vehicle," the ITU does not actually clearly specify minimum or average rates or what modes of the interfaces qualify as 3G, so various rates are sold as 3G intended to meet customers expectations of broadband data.

2. Security

3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is the intended one and not an impersonator. 3G networks use the KASUMI block cipher instead of the older A5/1 stream cipher. However, a number of serious weaknesses in the KASUMI cipher have been identified.

B. Applications of 3G

The bandwidth and location information available to 3G devices gives rise to applications not previously available to mobile phone users. Some of the applications are:

- Mobile TV
- Video on demand
- Video Conferencing
- Telemedicine
- Location-based services
- Global Positioning System (GPS)

V. FOURTH GENERATION

The 4G (fourth generation) of mobile phone mobile communications is a successor of the third generation (3G) standards. A 4G system provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smartphones, and to other mobile devices. Conceivable applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing and 3D television. Recently, Android and Windows-enabled cellular devices have fallen in the 4G category. One base advantage of 4G is that it can at any point of travelling time provide an internet data transfer rate higher than any existing cellular services (excluding broadband and Wi-Fi connections). Two 4G candidate systems are commercially deployed: the Mobile WiMAX+ standard (at first in South Korea in 2006), and the first-release Long Term Evolution (LTE) standard (in Scandinavia since 2009). It has however been debated if these first-release versions should be considered as 4G or not.

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The term "generation" used to name successive evolutions of radio networks in general is arbitrary. There are several interpretations of it, and no official definition has been made despite the large consensus behind ITU-R's labels. From ITU-R's point of view, 4G is equivalent to IMT-Advanced which has specific performance requirements as explained below. But according operators, a generation of network refers to the deployment of a new non-backward-compatible technology. This usually corresponds to a huge investment with its own depreciation period, marketing strategy (if any), and deployment phases. It can even be different among operators. From the end user's point of view, only performance and cost makes sense. It is expected that the next generation of network performs better and cheaper than the previous generation, which is not that simple to state. Indeed, while a new generation of network arrives, the previous one can keep evolving to a point where it outperforms the first version of the new generation. In many countries, GSM, UMTS and LTE networks still coexist. It is thus much less ambiguous to use the name of the technology/standard, possibly followed by its version number, than a subjective arbitrary generation number which is destined to be challenged endlessly.

As opposed to earlier generations, a 4G system does not support traditional circuit-switched telephony service, but all-Internet Protocol (IP) based communication such as IP telephony. As seen below, the spread spectrum radio technology used in 3G systems, is abandoned in all 4G candidate systems and replaced by OFDMA multi-carrier transmission and other frequency-domain equalization (FDE) schemes, making it possible to transfer very high bit rates despite extensive multi-path radio propagation (echoes). The peak bit rate is further improved by smart antennaarrays for multiple-input multiple-output (MIMO) communications.

1) Key features

The following key features can be observed in all suggested 4G technologies:

- Physical layer transmission techniques are as follows:
  - MIMO: To attain ultra-high spectral efficiency by means of spatial processing including multi-antenna and multi-user MIMO
  - Frequency-domain-equalization, for example *multi-carrier modulation* (OFDM) in the downlink or in the uplink: To exploit the frequency selective channel property without complex equalization
  - Frequency-domain statistical multiplexing, for example (OFDMA) or (single-carrier FDMA) (SC-FDMA, or linearly precoded OFDMA, LP-OFDMA) in the uplink Variable bit rate by assigning different sub-channels to different users based on the channel conditions
  - Turbo principle error-correcting codes: To minimize the required SNR at the reception side

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,CDMA2000	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

Table 1 : Comparison of different mobile technology[18]

- Channel-dependent scheduling: To use the time-varying channel
- Link adaptation: Adaptive modulation and error-correcting codes

- Mobile-IP utilized for mobility
- IP-based femtocells (home nodes connected to fixed Internet broadband infrastructure)

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 3Gand 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 communicationssystems toward 4G realization", IEEE Communications Surveys & Tutorials, vol. 8, no. 1,1st Quarter 2006, pp. 2-22.
[3] Mishra, Ajay K. "Fundamentals of Cellular NetworkPlanning 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, MohamadNoorman 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. Findamental, 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] Rappaport, "Wireless communication",Third edition
[11] Jun-zhao Sun， .Features in Future： 4G Visions from A TechnicalPerspective[C].IEEE Global Telecommunications Conference 2001.Vol 6.
[12] V. Gazis, "Evolving Perspectives of 4th GenerationMobile Communication Systems," IEEE PIMRC 2002,Coimbra, Portugal, Sept.2002.
[13] T. B. Zahariadis et al., "Global Roaming in Next-GenerationNetworks,"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", IEE 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 Confererence, 19-21 Nov. 2008