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Evolution of Mobile Network Tele-Communication

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Abstract

4G – "connect anytime, anywhere, anyhow" promising ubiquitous network access at high speed to the end users, has been a topic of great interest especially for the wireless telecom industry. 4G seems to be the solution for the growing user requirements of wireless broadband access and the limitations of the existing wireless communication system. The purpose of this paper is to provide an overview of the different aspects of 4G which includes its features, its proposed architecture and key technological enablers. It also elaborates on the roadblocks in its implementations. A special consideration has been given to the security concerns of 4G by discussing a security threat analysis model proposed by International Telecommunication Union (ITU). By applying this model, a detailed analysis of threats to 4G and the corresponding measures to counter them can be performed. The paper is particularly designed to introduce the fundamental wireless mobile communications for future or next Generation Technology. It gives an overview of current and future trends in the areas of wireless mobile communications with different applications.

Keywords: Mobile, Networking, Tele-Communication, Generations

Introduction

Wireless telecommunication history can be classified into different generations of network. Each generation has been a giant stride which revolutionized the field of mobile communication. As discussed in paper [1], era of telecommunication started with 1G in 1980 where all the systems where based on analog radio signal technology. Voice was considered to be the main traffic. Various 1G standards defined were Advance Mobile Phone System (AMPS), Nordic Mobile Telephone (NMT), Time Division Multiple Access (TDMA) and Frequency Division Mutiple Access (FDMA). In 1990, 1G was replaced by 2G which provided rich set of services such as high voice quality and global mobility based on the digital radio signal technology. Here also voice was considered to be the main traffic. 2G includes standards such as Global System For Mobile Communications (GSM), General Packet Radio System (GPRS). Both 1G and 2G are based on circuit switched technology for data communication at low speed. 2G was a huge success.

2G was followed by 2.5G which is an intermitent between 2G and 3G. It is based on both circuit switched and packet switched technologies providing high data rate with low power consumption. It uses the infrastructure of Global System for Mobile communications (GSM) and Code division multiple access (CDMA) to provide its services.

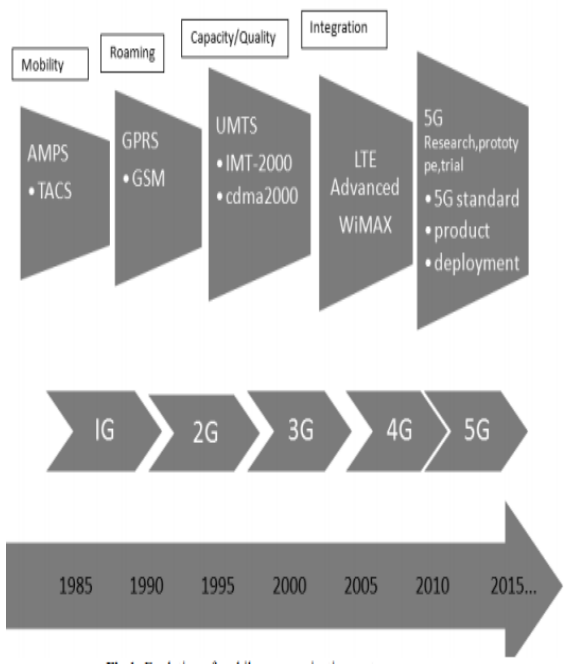

Figure 1: Evolution of mobile communication systems

The future wireless communication system is fifth generation wireless mobile multimedia internet networks can be completely wireless communication without limitation, which makes perfect wireless real world – World Wide Wireless Web (WWWW). That fifth generation is based on 4G technologies. The 5th wireless mobile internet networks are real wireless world which shall be supported by LAS-CDMA (Large Area Synchronized Code-Division Multiple Access), OFDM (Orthogonal frequency-division multiplexing), MCCDMA (Multi-Carrier Code Division Multiple Access), UWB (Ultra-wideband), Network-LMDS (Local Multipoint Distribution Service), and IPv6. Fifth generation technologies offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system. Fifth generation should make an important difference and add more services and benefits to the world over fourth generation. Fifth generation should be more intelligent technology that interconnects the entire world without limits. This generation is expected to be released around 2020. The world of universal, uninterrupted access to information, entertainment and communication will open new dimension to our lives and change our life style significantly.

Evolution

Wireless mobile communication system has become more popular due to rapid changes in mobile technology. Fast development of wireless communication systems are due to very high increase in telecoms customers. The revolution of mobile communications is from 1G-the first generation, 2G-the second generation, 3G-the third generation, 4G-the fourth generation, 5G-the fifth generation.

First Generation (1G) The first generation of mobile communication technology emerged in 1980s. The first generation mobile communication system used analog transmission of speech signal services. In the year 1979, the first cellular system in the world operated by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. At that time the most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS), some other analog systems also introduced in 1980s across the Europe. The main drawback of the first generation is all of those systems offered handover and roaming capabilities but cellular networks were unable to interoperate between the countries. In the year 1982s Advanced Mobile Phone System (AMPS) was launched in United States. AMPS and TACS use the Frequency Modulation (FM) technique and frequency division duplex (FDD) for radio transmission. In this generation uses Frequency Division Multiple Access (FDMA), channel bandwidth is 30KHz.

Second Generation (2G) Second generation enabled to provide the services such as text messages, picture messages and Multimedia messages (MMS) for various mobile phone networks. The second generation telecommunication networks were commercially launched on the Global system for Mobile communications (GSM) standard in 1991.Three primary goals and 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. Second generation can be divided into two standards based multiple access used: TDMA based and CDMA based. 2.5G was GPRS which could enable much faster communications uses packet switching and circuit switching domain to provide data rate up to 144kbps. 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.

Third Generation (3G) Third generation technology is carried out by the International Telecommunication Union (ITU) in the year 1980. 3G communication frequency spectrum between 400 MHz to 3GHz. 3G technology approved by both the government and communication companies unanimously. 3G technical specifications were made available to the public united the name International Mobile Telecommunications-2000 (IMT-2000). The first commercial 3G technology was launched by NTT DoCoMo in Japan on 1 October 2001 of W-CDMA. It was initially somewhat limited in scope; broader availability of the system was delayed by apparent concerns over its reliability. 3rd generation is a set of standards used for mobile devices and mobile telecommunication services and networks that comply with the IMT-2000. Advantages of using 3rd generation in fixed Wireless Internet Access,

Wireless Voice Telephony, Video calls, Mobile Internet Access and Mobile TV. Many of the 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 Kbps (about 0.2 Mbps). 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 Mbps to smart phones and mobile modems in laptop computers. CDMA technology can sharing infrastructure with the IS-95 2G standard. The mobile devices are typically CDMA-2000 and IS-95 hybrids.

Fourth Generation (4G) Increasing growth of user demand and also the emergence of new technologies in the mobile communications have triggered researchers and industries to come up with comprehensive manifestations of the upcoming fourth generation (4G) wireless communications in mobile technology. The main concept in fourth generation for the transition to the All-IP is to have a common platform for all the technologies that have to develop so far and to harmonize with user expectations of the many service to be provided. The main difference between the All-IP and GSM/3G is that the functionality of RNC and BSC is now distributed to BTS and a set of servers and gateways. In contrast to 3G, the new 4G framework to be established will try to accomplish new levels of user experience and multi service capacity by also integrating all the mobile technologies that exist (e.g. GSM, GPRS, IMT-2000, Wi-Fi, Bluetooth, ZigBee). 4G technology data transfer will be much faster and will be less expensive. 4G will be so smart for friendly operating functions flexibility and any desired service with reasonable quality of services (QoS) at anytime, anywhere. Fourth generation mobile communication technology started in 2010 but will mass market in about 2015-2016.

Forth generation technology may provide peak data rate of 1Gbps for downlink and 500Mbps for Uplink. 4G is considered as Long Term Evolution (LTE) and gives the additional features of 3G, like wireless broadband access, Multimedia Messaging Service (MMS), Video chart, Mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services: voice and data. 4G is widely accepted that the individual (wireless or/and wire) access networks will interface to core and/or backbone network elements over the IP protocol, the lingua franca of networking technology. Regardless of their particular technological blueprints these wireless access networks are expected to have a dynamic address assignment mechanism that is capable of associating a short-lived or long-lived IP address to the respective wireless interface at the mobile terminal, A transparent IP forwarding service that is accessible over the logical termination of the IP layer at the mobile terminal and one or more gateways at the wireless access network infrastructure. IMT-Advanced 4G standards will usher in a new era of mobile broadband communications, according to the ITU-R.

IMT- Advanced provides a global platform on which to build next generations of interactive mobile services that will provide faster data access, enhanced roaming capabilities, unified messaging and broadband multimedia. According to ITU, "ICTs and broadband networks have become vital national infrastructure similar to transport, energy and water networks but with an impact that promises to be even more powerful and far-reaching. These key enhancements in wireless broadband can drive social and economic development, and accelerate progress towards achieving the United Nations' Millennium Development Goals, or MDGs." .The current agreements on the requirements for IMT-Advanced are:

- Regarding latency, in the Control plane the transition time from Idle to Connected should be lower than 100ms. In the active state, a dormant user should take less than 10ms to get synchronized and the scheduler should reduce the User plane latency at maximum.
- In the same scenario with 10 users, cell edge user spectral efficiency will be 0.06 in DL 4 × 2. In the UL, this cell edge user spectral efficiency must be 0.03 with MIMO 2 × 4.
- Mobility up to 350 km/h in IMT-Advanced. IMT-Advanced system will support scalable bandwidth and spectrum aggregation with transmission bandwidths more than 40MHz in DL and UL.
- Backward compatibility and inter-working with legacy systems.

WHY THE LEAP TOWARDS 4G

The vision which considers 4G as an extension to 3G cellular services is called as the linear 4G vision. But the extent of 4G capabilities goes beyond the cellular services. Envisioning 4G as high speed delivery of services via the most efficient network available from the pool of wireless networks is called as the concurrent 4G vision. One of the major reasons of 3G being unable to repeat the success story of 2G was the provision of only few additional services over 2G. It was not encouraging enough for the customer's to change their equipments. It suggests a user-centric approach for the design of 4G to avoid mismatch between the user's expectations and the services provided by 4G. Using the discussion in paper, features of 4G which cater to the end-user's expectations and the problems of the current generation networks can be listed as follows:

User friendliness

4G aims at providing myriad of services to the end users at high speed. The applications developed to avail these services should be highly user friendly minimizing the interaction between the application and the user. For example, integration of speech recognition technology in the user interfaces would ease the use of the applications for every layman.

User personalization

High data transfer rates and ubiquitous coverage of 4G networks would provide users access to large repository of data and services. Users should have flexibility to filter these data and services as per his preferences by configuring the operational mode of their devices, so that he can preselect the service features he wants to use. For an example, user in a mall interested in buying clothes should receive alerts about various discount offers on clothes rather than about the other accessories.

Terminal and Network heterogeneity

Terminal heterogeneity refers to the different types of terminals in terms of the size, weight, display features, power consumption, etc. Network heterogeneity means the different types of access networks like WiMAX, Wi-Fi (Wireless Fidelity), UMTS (Universal Mobile Telecommunications System) and so forth which differ in their coverage area, data rate, latency and data loss rate. Each of these terminals and services cater to different user requirements. In 4G, all these terminals and networks will provide common services independent of their capabilities. This is also called as service personalization.

High Performance

Low transfer rates of 3G restrict the user's ability to take advantage of the rich multimedia contents across the wireless networks. 4G is expected to provide wireless download speeds of about 1Gbps in local area network (LAN) and 100 Mbps in wide area network (WAN), about 260 times greater than the 3G wireless networks.

Interoperability

Multiple standards of 3G restrict the user's mobility and interoperation across different networks. 4G targets at providing a unified global standard which will facilitate global mobility and service portability. In other words, end user can subscribe to different services from different service providers using the same mobile device.

Intelligent Networking

3G is based primarily on cell or base station WAN design. 4G aims at building hybrid networks utilizing both the Wireless LAN concept and WAN design. Thus, the world would have base stations everywhere providing ubiquitous network coverage to users at high speed. For example, a user walking on road is browsing internet using GPRS (General Packet Radio Service-WAN design). The moment he enters a mall with Wi-Fi (LAN design), seamless hand-over from GPRS to Wi-Fi would take place without the user's knowledge.

Network Convergence:

Network convergence is the efficient coexistence of multimedia, voice and data communication within a single network.Currently the telecommunication environment is divided into wireless and fixed line communication. To avail these different kinds of services, the end user require different devices such as cellular phones, fixed line phones, laptops and PDA's. Once the fixed mobile convergence is in place in 4G, the distinction between these services will disappear. The current 3G technology is not able to capture the market share

as done by the fixed line services partly because of its low bit rates of 384kbps and because of the high costs associated with these services. But with the emergence of 4G aiming at global integrated IP based network, the wireless sector will be able to match the fixed line sectors in terms of both costs and speed. 4G will lead to convergence in terms of both devices and services. Thus, handset capabilities, MP3, camera, mobile broadband services would be made available in a single device. Service convergence will result from availability of telecommunication and internet on a single platform. This would force the fixed line sector to jump in the competitive wireless market. In response, the wireless operators will also jump into the fixed line sector. Thus slowly the boundaries between these markets will disappear. Thus, the end user will benefit from one business providing variety of services. He will experience high quality service at affordable prices. Thus fixed mobile convergence will act as a catalyst for stimulating markets to come up with new innovative and cost effective ideas.

Scalability

Scalability in mobile networks is the ability to handle the increasing numbers of users and services. 4G will use IPv6 addressing scheme which will support large number of wireless devices eliminating the need for Network address translation (NAT). NAT is technique of sharing limited number of addresses among large number of devices. The huge expanse of current internet world signifies the scalability support of IP. Thus, the use of IP as core network layer will make 4G easily scalable.

Lower power consumption

Battery technology has not been able to keep pace with the growing telecom industry. 2G devices required one battery while 3G required two batteries. Battery drain is a persistent problem of wireless devices. 4G aims at breaking this directly proportional rule. Shorter communication links is one of the few solutions proposed to cater to this requirement.

Low costs

4G is designed to be spectrally efficient with no requirement to buy costly extra spectrum. It is not development of a completely new system rather built on the top of the existing networks. 4G will also support backward compatibility with 2G and 3G devices. All these factors will make 4G much cheaper than the current generation networks.

Conclusion

The advent of 4G is sure to revolutionize the field of telecommunication domain bringing the wireless experience to a completely new level. It would provide wealth of features and services making the world a smaller place to live. For the future generation the 5G technology helps to promote stronger links between people working in different fields creating future concepts of mobile communications, nanotechnology, cloud computing and internet service. In 5G technology expecting more bandwidth would not be the answer but utilizing the existing bandwidth through innovative network design is need of the hour. In 5G expecting the network management modules need to more intelligent i.e., cognitive software will make the task of radio resource scheduling simpler.

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