International Journal of Electronics and Communication Engineering.
ISSN 0974-2166 Volume 6, Number 1 (2013), pp. 67-73

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4G Technology

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Abstract

The ever increasing growth of user demand, the limitations of the third generation of wireless mobile communication systems and the emergence of new mobile broadband technologies on the market have brought researchers and industries to a thorough reflection on the fourth generation. A pragmatic definition of 4G derived from a new user-centric methodology that considers the user as the “cornerstone” of the design. In this way, the fundamental user scenarios that implicitly reveal the key features of 4G, which are then expressed explicitly in a new framework—the “user-centric” system that describes the various level of interdependency among them. This approach consequently contributes to the identification of the real technical step-up of 4G with respect to 3G. It is supposed to provide its customers with better speed and all IP based multimedia services. 4G is all about an integrated, global network that will be able to provide a comprehensive IP solution where voice, data and streamed multimedia can be given to users on an "Anytime, Anywhere" basis.

Introduction

With the deployment of 3G (3rd generation mobile communication systems) in process, the interest of many research bodies shifts towards future systems beyond 3G. Depending on the time such new systems are planned to be introduced and on the characteristic of improving or replacing existing systems they are called B3G (beyond 3G) or 4G (4th generation mobile communication system). There is no formal definition for what 4G is; however, there are certain objectives that are projected for 4G. These objectives include: that 4G will be a fully IP-based integrated system. 4G will be capable of providing between 100 Mbit/s and 1 Gbit/s speeds both indoors and

outdoors, with premium quality and high security. The term 4G is used broadly to include several types of broadband wireless access communication systems, not only cellular telephone systems. While neither standard bodies nor carriers have concretely defined or agreed upon what exactly 4G will be fourth generation networks are likely to use a combination of WiMAX and Wi-Fi technologies. With 4G, a range of new services and models will be available. These services and models need to be further examined for their interface with the design of 4G.

Before 4G

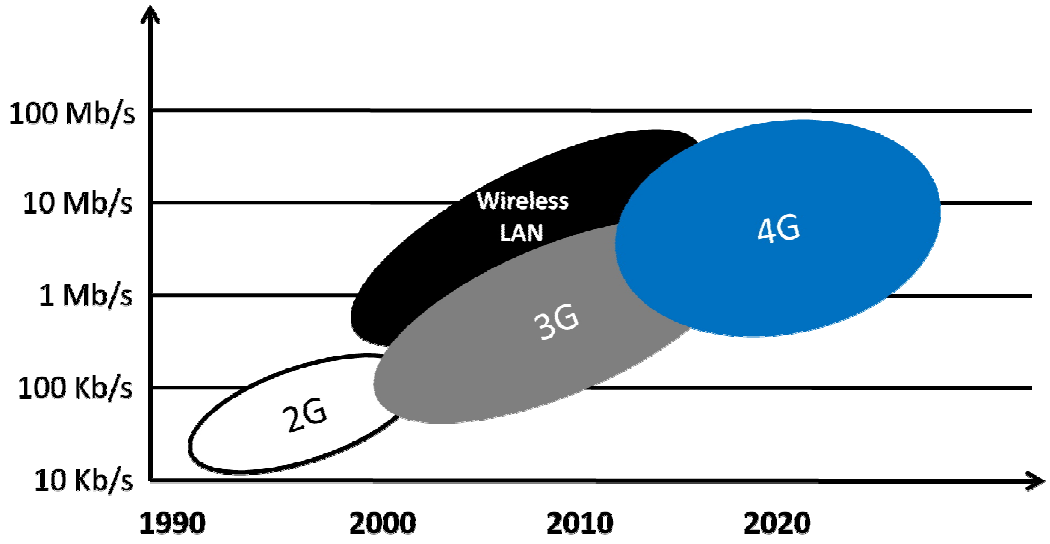
The history and evolution of mobile service from the 1G (First generation) to 4G (fourth generation) is discussed in this section.

1G (First Generation)

The process began with the designs in the 1970s that have become known as 1G. Almost all of the systems from this generation were analog systems where voice was considered to be the main traffic. The first generation wireless standards used plain TDMA and FDMA. These systems could often be listened to by third parties. Some of the standards are NMT, AMPS, Hicap, CDPD, Mobitex, DataTac, TACS and ETACS.

2G (Second generation)

The 2G (second generation) systems designed in the 1980s were still used mainly for voice applications but were based on digital technology, including digital signal processing techniques. These 2G systems provided circuit switched data communication services at a low speed. All the standards belonging to this generation were commercial centric and they were digital in form. The second generation of wireless mobile communication systems was a huge success story because of its revolutionary technology and the services that it brought to its users.



3G (Third Generation)

To meet the growing demands in network capacity, rates required for high speed data transfer and multimedia applications, 3G standards started evolving. The systems in this standard are essentially a linear enhancement of 2G systems. They are based on two parallel backbone infrastructures, one consisting of circuit switched nodes, and one of packet oriented nodes. The third generation (3G) has been launched in several parts of the world, but the success story of 2G is hard to repeat.

Key Features of 4g

User Friendliness and User Personalization

In order to encourage people to move towards a new technology which is a process that usually takes a long time and a great deal of effort from the operators' side, a combination of user friendliness and user personalization appears to be the winning concept. User friendliness exemplifies and minimize the interaction between applications and users thanks to a well designed transparency that allows the users and the terminals to naturally interact (e.g., the integration of new speech interfaces is a great step for achieving this goal).Users can get traveling information in the most user-friendly way: text, audio, or video format. User personalization refers to the way users can configure the operational mode of their device and preselect the content of the services chosen according to their preferences. Since every new technology is designed keeping in mind the principal aim to penetrate the mass market and to have a strongly impact on people's lifestyles, the new concepts introduced by 4G are based on the assumption that each user wants to be considered as a distinct, valued customer who demands special treatment for his or her exclusive needs. Therefore, in order to embrace a large spectrum of customers, user personalization must be provided with high granularity, so that the huge amount of information is filtered according to the users' choices. Users can receive targeted pop-up advertisements. The combination between user personalization and user friendliness provides users with easy management of the overall features of their devices and maximum exploitation of all the possible applications, thus conferring the right value to their expense.

Terminal Heterogeneity and Network Heterogeneity

4G must not only provide higher data rates but also a clear and tangible advantage in people's everyday life. Therefore, we believe that the success of 4G will consist of a combination of terminal heterogeneity and network heterogeneity. Terminal heterogeneity refers to the different types of terminals in terms of display size, energy consumption, portability/weight, complexity etc. Network heterogeneity is related to the increasing heterogeneity of wireless networks due to the proliferation in the number of access technologies available (e.g., UMTS, WiMAX, Wi-Fi, Bluetooth). These heterogeneous wireless access networks typically differ in terms of coverage, data rate, latency, and loss rate. Therefore, each of them is practically designed to support a different set of specific services and devices.4G will encompass various types of terminals, which may have to provide common services independently of

their capabilities. Therefore, tailoring content for end-user devices will be necessary in order to optimize the service presentation. Furthermore, the capabilities of the terminal in use will determine whether or not new services are to be provisioned, so as to offer the best enjoyment to the user and prevent declining interest and elimination of a service offering. This concept is referred to as service personalization. It implicitly constrains the number of access technologies supportable by the user's personal device.

Technology Used

In March 2008, the International Telecommunications Union-Radio communications sector (ITU-R) specified a set of requirements for 4G standards, named the International Mobile Telecommunications Advanced (IMT-Advanced) specification, setting peak speed requirements for 4G service at 100 megabits per second (Mbit/s) for high mobility communication (such as from trains and cars) and 1 gigabit per second (Gbit/s) for low mobility communication (such as pedestrians and stationary users).Since the above mentioned first-release versions of Mobile WiMAX and LTE support much less than 1 Gbit/s peak bit rate, they are not fully IMT-Advanced compliant, but are often branded 4G by service providers. On December 6, 2010, ITU-R recognized that these two technologies, as well as other beyond-3G technologies that do not fulfill the IMT-Advanced requirements, could nevertheless be considered "4G", provided they represent forerunners to IMT-Advanced compliant versions and "a substantial level of improvement in performance and capabilities with respect to the initial third generation systems now deployed". Mobile WiMAX Release 2 (also known as Wireless MAN-Advanced or IEEE 802.16m') and LTE-ADVANCED (LTE-A) are IMT-Advanced compliant backwards compatible versions of the above two systems, standardized during the spring 2011,and promising peak bit rates in the order of 1 Gbit/s. Services are expected in 2013.

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 antenna arrays for multiple-input multiple-output (MIMO) communications.

Comparison of 3G and 4G

Requirement	3G	4G
Speed	384Kbps to 2 Mbps	20 to 100 Mbps
Frequency Band	Dependent on Country	HFB (2-8 GHz)
Bandwidth	5-20 MHz	100 MHz or more
Switching Design Basis	Circuit & Packet	All Digital with packetized voice
Access Technologies	W-CDMA	OFDM & MC-CDMA

Features of Fourth Generation Technology

There are several reasons which are sufficient to answer a simple question- why do we need to adopt 4G technology? Below are some of the features of 4G which make it an “above all” technology.

High Performance

Industry experts say that users will not be able to take advantages of rich multimedia content across wireless networks with 3G. In contrast to this 4G will feature extremely high quality video of quality comparable to HD (high definition) TV. Wireless downloads at speeds reaching 100 Mbps, i.e. 50 times of 3G, are possible with 4G.

Interoperability and Easy Roaming

Multiple standards of 3G make it difficult to roam and interoperate across various networks, whereas 4G provides a global standard that provides global mobility. Various heterogeneous wireless access networks typically differ in terms of coverage, data rate, latency, and loss rate. Therefore, each of them is practically designed to support a different set of specific services and devices, 4G will encompass various types of terminals, which may have to provide common services independently of their capabilities. This concept is referred to as service personalization.

Low Cost

4G systems will prove far cheaper than 3G, since they can be built atop existing networks and won't require operators to completely retool and won't require carriers to purchase costly extra spectrum. In addition to being a lot more cost efficient, 4G is spectrally efficient, so carriers can do more with less.

Devices

More User Friendly Interface

4g devices are expected to be more visual and intuitive rather than today’s text and menu based systems. They will be able to interact with the environment around it and act accordingly.

Enhanced GPS Services

In addition to locating individuals, a 4G version of GPS tech might be able to let people be virtually present in a variety of places.

Scalability

It is most challenging aspect of the mobile networks. It refers to ability to handle ever increasing number of users and services. Since an all IP core layer of 4G is easily scalable, it is ideally suited to meet this challenge.

Challenges in Migration to 4G

Multimode User Terminals

With 4G there will be a need to design a single user terminal that can operate in different wireless networks and overcome the design problems such as limitations in size of the device, its cost and power consumption. This problem can be solved by using software radio approach i.e. user terminal adapts itself to the wireless interfaces of the network.

Selection among Various Wireless Systems

Every wireless system has its unique characteristics and roles. The proliferation of wireless technologies complicates the selection of most suitable technology for a particular service at a particular place and time. This can be handled by making the selection according to the best possible fit of user QoS requirements and available network resources

Security

Heterogeneity of wireless networks complicates the security issue. Dynamic reconfigurable, adaptive and providers. Similarly, billing customers with simple but information is not an easy task.

Network Infrastructure and QOS Support

Integrating the existing non-IP and IP-based systems and providing QoS guarantee for end-to-end services that involve different systems is also a big challenge.

Charging/ Billing

It is troublesome to collect, manage and store the customers' accounts information from multiple services comes from a satellite and calculates the wrong co-ordinates. Criminals can use such techniques to interfere with police work. Jamming happens when a transmitter sending out signals at the same frequency displaces a GPS signal.

Attacks on Application Level

4G cellular wireless devices will be known for software applications which will provide innovative feature to the user but will introduce new holes, leading to more attacks at the application level.

Jamming and Spoofing

Spoofing refers to fake GPS signals being sent out, in which case the GPS receiver thinks that the signals comes from a satellite and calculates the wrong co-ordinates. Criminals can use such techniques to interfere with police work. Jamming happens when a transmitter sending out signals at the same frequency displaces a GPS signal.

Data Encription

If a GPS receiver has to communicate with the central transmitter then the communication link between these two components is not hard to break and there is a need of using encrypted data. Lightweight security mechanisms should be developed.

Conclusion

Migration to 4G networks ensures convergence of networks, technologies, applications and services.4G can serve as flexible platform. Wireless carriers have an opportunity to shorten Investment return, improve operating efficiency and increase revenues.4G - a promising Generation of wireless communication that will change people’s lives.