Multiple Access Techniques in 4G

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Abstract—Yet there are several challenges that inhibit the progress of 4G and researchers throughout the world are contributing their ideas to solve these challenges. Fourth Generation is the next generation of wireless networks that will replace third generation (3G) networks sometimes in future. 4G is intended to provide high speed, high capacity; low cost per bit, IP based services. 4G is all about an integrated, global network that’s based on an open system approach. The goal of 4G is to “replace the current proliferation of core cellular networks with a single worldwide cellular core network standard based on IP for control, video, packet data and VoIP. But while 3G haven’t quite arrived, researchers want to contribute their ideas to the development of an as-yet undefined “wireless world” that could become operational by around 2010. This paper deals with the fundamentals, an overall vision of the 4G features, technologies, layer mechanisms, issues in emerging 4G wireless networks and service providers see for the evolution of 4G mobile systems and where is future research from their perspective necessary.

Keywords—4G Vision, Layer Mechanism, W-OFDM, MC-CDMA, LAS-CDMA.

I. INTRODUCTION

The approaching 4G (fourth generation) mobile communication systems are projected to solve still-remaining problems of 3G (third generation) systems and to provide a wide variety of new services, from high-quality voice to high-definition video to high-data-rate wireless channels. The term 4G is used broadly to include several types of broadband wireless access communication systems, not only cellular telephone systems. One of the terms used to describe 4G is MAGIC—Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service. As a promise for the future, 4G systems, that is, cellular broadband wireless access systems have been attracting much interest in the mobile communication arena. The 4G systems not only will support the next generation of mobile service, but also will support the fixed wireless networks.

The existence of 4G Networks in today's technology-driven society is important indicators of advancement and change. 4G, or Fourth Generation networks, are designed to facilitate improved wireless capabilities, network speeds, and visual technologies. It is anticipated that as these networks continue to thrive, the demand for advanced related technologies will also grow, thereby creating new alternatives for savvy technology users to exceed their desired expectations. The following discussion will evaluate the current state of 3G Networks and will examine the future potential of these networks in expanding technology-based capabilities for consumers and industries alike.

In this paper, we present an overall vision of the 4G networks starting by presenting some of the key features they will provide, and then discussing key challenges the researchers and vendors are attempting to resolve, and finally briefly describing some of the proposed solutions to these problems.

II. HISTORY

The history and evolution of mobile service from the 1G (first generation) 1G was an analog system, and was developed in the 70’s, 1G had two major improvements, this was the invention of the microprocessor, and the digital transform of the control link between the phone and the cell site. 1G analog system for mobile communications saw two key improvements during the 1970s: the invention of the microprocessor and the digitization of the control link between the mobile phone and the cell site. Advance mobile phone system (AMPS) was first launched by the US and is a 1G mobile system. Based on FDMA, it allows users to make voice calls in 1 country.

The 2G (second generation) 2G was based on digital signal processing techniques and regarded as a revolution from analog to digital technology, which has gained tremendous success during 1990s with GSM as the representative. The utilization of SIM (Subscriber Identity Module) cards and support capabilities for a large number of users were 2G’s main contributions 4) 2.5G extended the 2G with data service and packet switching methods, and it was regarded as 3G services for 2G networks. Under the same networks with 2G, 2.5G brought the Internet into mobile personal communications. This was a revolutionary concept leading to hybrid communications.

Before beginning a discussion of 4G technologies and business applications, it is important to understand the current state of 3G networks. There is no official definition by a standards group of what constitutes 3G. The term evolved in the wireless industry and generally includes the International Standards Union’s (ITU) IMT-2000 technology definition and related features. IMT-2000 is an ITU term that defines globally recognized 3G technologies for use in IMT-identified radio frequency bands. Technologies currently recognized as meeting these requirements include WCDMA, CDMA2000, TD-CDMA and EDGE. Over the last decade, several
IV. TECHNOLOGIES THAT SUPPORT 4G

The revolution in 4G will be the optical networking, the new air interface, the portable device etc.

The Transmission Protocols:

A. OFDM

OFDM is a digital modulation technology in which in one time symbol waveform, thousands of orthogonal waves are multiplexed. This is good for high bandwidth digital data transition.

B. W-OFDM

W-OFDM enables data to be encoded on multiple high-speed radio frequencies concurrently. This allows for greater security, increased amounts of data being sent, and the industry’s most efficient use of bandwidth. W-OFDM enables the implementation of low power multipoint RF networks that minimize interference with adjacent networks. This enables independent channels to operate within the same band allowing multipoint networks and point-to-point backbone systems to be overlaid in the same frequency band.

C. MC-CDMA

MC-CDMA [12] is actually OFDM with a CDMA overlay. Similar to single-carrier CDMA systems, the users are multiplexed with orthogonal codes to distinguish users in (multi-carrier) MC-CDMA. However in MC-CDMA, each user can be allocated several codes, where the data is spread in time or frequency.

D. LAS-CDMA [6]

Link Air Communications is developer of LAS CDMA (Large Area Synchronized Code Division Multiple Access) a patented 4G wireless technology. LAS-CDMA enables high-speed data and increases voice capacity and latest innovative solution, CDD, merges the highly spectral efficient LAS-CDMA [13] technology with the superior data transmission characteristics of TDD. This resulting combination makes CDD the most spectrally efficient, high-capacity duplexing system available today.

Layer Mechanism:
The functionalities provided by each layer and its modules are briefly described below:

A. Application

This layer/level comprises of the third party applications that also include value added services provided to the subscribers.

B. Network

Acting as the linchpin, this layer/level provides service control and mechanism essential for dynamic cross layer coordination between different layers. This layer maintains interaction among services, mobility management, resource management and QoS management sub layers through several well-defined message interfaces as shown in figure 4. The functionalities carried out by these sub-layers include location management; address management; handover control; authentication and charging; congestion control; resource negotiation; and end-to-end QoS provisioning of real-time and non real-time data.

C. Physical

This layer/level consists of physical aspects of the core network and heterogeneous access networks.

D. Reconfigure

The convergence sub-layer provides a common signaling mechanism for the physical layer/level and allows access independent network functionalities (services, mobility management, resource management and QoS management sub layers) to communicate with different RANs in a transparent
1. Low cost: To make broadband services available to the user to exchange various kinds of information, it is necessary to lower charges considerably in order to keep the cost at or below the cost of existing service.

2. Coverage of Wide Area: One feature of mobile communications is that it’s availability and omnipresent. That advantage is important for future mobile communication as well. In particular, it is important to maintain the service area in which the terminals of the new system can be used during the transition from the existing system to a new system.

3. Reliability: Wide Variety of Services Capability Mobile communication is for various types of users. In the future, we expect to make the advanced system performance and functionality to introduce a variety of services not only the ordinary telephone service. Those services must be made easier for anyone to use.

VII. APPLICATION

1) Virtual Presence: This means that 4G provides user services at all times, even if the user is off-site.
2) Virtual Navigation: 4G provides users with virtual navigation through which a user can access a database of the streets, buildings etc.
3) Tele-Geoprocessing Applications: This is a combination of GIS (Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.
4) Tele-Medicine and Education: 4G will support remote health monitoring of patients. For people who are interested in lifelong education, 4G provides a good opportunity.
5) Crisis Management: Natural disasters can cause breakdown in communication systems. In today’s world it might take days or 7 weeks to restore the system. But in 4G it is expected to restore such crisis issues in a few hours.
6) Multimedia and Video-services: 4G wireless systems are expected to deliver efficient multimedia services at very high data rates. Basically there are two types of video services: bursting and streaming video services. Streaming is performed when a user requires real-time video services, in which the server delivers data continuously at a playback rate. Bursting is basically file downloading using a buffer and this is done at the highest.

VIII. CONCLUSION

4G networks may eventually deliver on all the promises. At times, it seems that technological advances are being made on a daily basis. These advances will make high speed data/voice-over-Internet-protocol (VoIP) networks a reality. In the meantime, it is important for industry to develop a strong 3G offering that is palatable for the general public. Equally as important, industry must ensure that expectations are realistic and that services meet and exceed those expectations. If all goes according to what the industry envisions, it may be sooner, rather than later that we will see wireless communications evolve. This evolution will give the general public as well as the public safety community amazing functionality from the convenience of a single handheld device.

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