

# Broadband Solutions for Residential Customers

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## HOME NETWORKING OVERVIEW

In recent years, home networking has undergone significant changes due to the proliferation of technologies that support converging consumer electronics, mobile, and computer networks. An increased number of networked appliances may assume a networked home with an always-on Internet connection. Home networks host a proliferation of linked devices and sensors including enhanced or new applications which can be categorized as follows:

- Home automation and controls
- Networked appliances
- Mobile
- Home/SOHO Office
- Entertainment (audio, video, gaming, IPTV, etc.)
- Personal services (banking, shopping, healthcare, learning, etc.)
- Storage devices
- Social networking
- Local and remote management

Broadband adoption has marked an increasing number of subscribers worldwide due to several factors such as increasing number of PCs in households, broadband access services, standardization, emerging technologies and applications, government policy, and market players. Japanese manufacturers are attempting to seamlessly interconnect wireless personal area network with mobile phones, whereby home network service could be controlled by remote users. Starting in 2007, ABI Research forecasts that converged intelligent home network services (home automation and networked digital appliances) will take off in the South Korean market (ABI, 2007). Home networking is evolving rapidly to digital home and smart home environments (MIT Project, 2007). Digital Living Network Alliance defines a digital home consisting of

“a network of consumer electronics, PCs and mobile devices that co-operate transparently, delivering simple, seamless interoperability” (DLNA, 2007).

The rapid developments are in all areas: devices, services, and access. Consumers have gone from using their home network primarily to share broadband connections delivering video and audio over IP around the home. Content management and service provisioning is key to offering entertainment services including personalization, context awareness, and positioning (Kozbe, Roccetti, & Ulema, 2005). Networked consumer systems and devices, including network-centric entertainment systems, have become one of the major focus areas of the communication and entertainment industries (Rocetti, Kozbe, & Ulema, 2005). The introduction of iPod device and of iTunes Music Store service brought digital entertainment into home. Other factors that contributed to this success include:

- Advances of multimedia technology such as high-quality video and sound.
- Advances in wireless communications and interactive applications taking nomadic entertainment experiences to new dimensions.
- Compatibility among devices.
- Increased revenue on game software and devices, surpassing the revenues achieved by the movie industry.

In this chapter, an update of the chapter of the first edition (Hentea, 2005), we focus on recent advances and trends for broadband access and services. The rest of the chapter is organized in sections as follows: the next section contains recent enhancements of broadband access; then, we provide an overview of emerging services and technologies in one section, followed by a brief review of the standards in the next section. We conclude with a perspective on the future developments.

## **HIGH-SPEED BROADBAND ACCESS**

Broadband access technologies are described in Hentea (2005). Today, digital subscriber line (DSL) and cable modem technologies are the predominant mass-market broadband access technologies that typically provide up to a few megabits per second of data to each user. Since their initial deployment in the late 1990s, these services have exhibited considerable growth. However, the availability of wireless solutions potentially accelerated this growth. There are two fundamentally different types of broadband wireless services. The first type attempts to provide a set of services similar to that of the traditional fixed-line broadband but using wireless as the medium of transmission. This type, called fixed wireless broadband, can be thought of as a competitive alternative to a DSL or cable modem. The second type of broadband wireless, called mobile broadband, offers the additional functionality of portability, nomadicity, and mobility.

However, there are issues with the services based on these technologies. Many services are not performing at the best quality. For example, when mixing interactive and noninteractive traffic over DOCSIS, ADSL, or Wi-Fi (IEEE 802.11b) wireless links, substantial delay is introduced to downstream traffic due to sharing the medium along their end-to-end path, despite available link capacity. These delays, on the order of 100 ms for the DOCSIS network and 50 ms for the Wi-Fi network, are significant when the broadband is part of an overall service supporting voice over IP (VoIP), interactive online gaming, or similar delay-sensitive applications (But, Nguyen, & Armitage, 2005). Therefore, high-broadband access technologies are emerging. One stimulus to current developments is due to recently finalized standards for WiMAX technology. As a wireless access network, WiMAX has shown great potential to provide broadband transmission services to residential premises. WiMAX technology has evolved through four stages (Andrews, Ghosh, & Muhamed, 2007):

1. Narrowband wireless local loop systems (WLL)
2. First generation line-of-sight (LOS) broadband systems
3. Second generation non-line-of-sight (NLOS) broadband systems
4. Standards-based broadband wireless systems.

Essential capabilities such as mobile WiMAX's fast data upload speed will revitalize advanced wireless Internet applications like user-created content, already a popular application. While commuting, consumers can upload their pictures or videos onto their personal blogs or networking sites, and share them instantaneously with their friends and family. Personal broadcasting in real time will become a reality. The combination of mobile WiMAX with other technologies and services, such as Wi-Fi or mobile TV, will allow for new services to emerge. Mobile WiMAX can also create truly "smart" homes and "with Mobile WiMAX, the era of personal broadband will truly begin" (Lee, 2007).

Trials using Samsung's Mobile WiMAX systems are currently underway by global operators including Sprint-Nextel in the U.S., Telecom Italia in Italy, and Etisalat in the United Arab Emirates. Samsung's vision of Mobile WiMAX is that the technology will pave the way for 4G network and become the front runner of the IP-based mobile broadband era (Lee, 2007). In addition, emerging services and infrastructures are evolving. We provide an overview of most recent trends in the next section.

## **EMERGING INFRASTRUCTURE AND SERVICES**

Multicast TV and voice over IP services are the new services; their integration with data transport is called triple play. These services are provided through either the same connectivity box (the modem) or a dedicated set-top box. In the near future, operators plan to open the service delivery chain (MUSE, 2007). Instead of being tied to a single service provider for television and phone over IP, the end user will have a variety of choices and will gain from competition in both price and diversity. This business model is referred to as multiplay. Residential gateway is the device connecting the home network to the WLAN or Internet. We provide a brief description of the capabilities and requirements for the emerging gateway in the following subsection.

Another emerging service is Internet Protocol Television (IPTV), which is considered the killer application for the next-generation Internet. IPTV service provides television over IP for residential and business users at a lower cost. These IPTV services include commercial-grade multicasting TV, video on demand (VoD), triple play, voice over IP (VoIP), and Web/e-

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