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**TEXAS INSTRUMENTS**

# *Consumer Satisfaction:*
## Embedded WLAN delivers rich content anywhere, anytime

## Introduction

The abundance of rich multimedia content has many consumers dreaming of the day when they'll be able to easily enjoy any tune, any movie, or any bit of multimedia content at anytime from any location. In addition, consumers are developing certain expectations when it comes to the media content they've aquired—they expect that they should be able to experience the content without hassles and extraneous restrictions. Fortunately, wireless local area network (WLAN) technology based on IEEE 802.11 is making its way into consumer electronics (CE) devices.

It wasn't long ago that the transition from dial-up to broadband access transformed the way consumers relate to the Internet. The same transformation—except this time it involves consumer attitudes toward wireless networking—will happen as embedded WLAN connectivity proliferates in CE devices. Soon, consumers will think of wireless networking as another utility, much like electricity. In fact, a sizeable public WLAN infrastructure akin to the electrical grid, albeit on a smaller scale, is already in place and growing. The build-out of the WLAN infrastructure has reached the point where many wireless laptop users take WLAN access for granted in most hotels, airports and coffee shops.

### Content, Content Everywhere…

Many technical factors are pushing the embedding of WLAN technology into CE devices, such as the technology's cost-effectiveness and its increasing throughput rates, as well as its extended coverage and robustness. But just as important, if not more so, are the forces that are at work in the marketplace and which are pulling WLAN technology into CE devices.

Consumer demand for rich multimedia content has skyrocketed in recent years. One example is the explosive sales of digital music. In a recent study market research firm iSuppli noted that digital music will grow from 1.5 percent of all music sales in the U.S. in 2004 to 25 percent by 2008. Other forms of digital content are certainly growing at comparable rates. Given these trends, it is inevitable that consumers will demand more elegant ways of enjoying the content they are acquiring. Consumers have paid considerable amounts of hard-earned cash for content that is difficult to experience because of the encumbrances of wires and other technical limitations. WLAN technology embedded in CE devices offers consumers a glimmer of hope that someday soon they will be free to experience their media content on their terms.

Today, video clips of news events and trailers, entire movies, music, photographs, music videos, pod-casts, animated e-mails, educational multimedia content and much more are flooding the Internet and many consumers are downloading and

saving this rich content. Especially with purchased content like music, games and movies, consumers want to be able to move content from device to device, and take it with them when they leave home. In today's mobile society, consumers balk at any limitations on where and when they might be able to experience their growing cache of rich multimedia content.

Unfortunately, several bottlenecks currently slow down the flow of multimedia content for most consumers. Practically all content must go through a personal computer, which must be cabled to other devices in order to transfer or share this content. Often, the very act of connecting a cable to a connector on the back of a PC is clumsy, awkward and frustrating for consumers. As more wireless networks are deployed in homes and public places, and as WLAN technology is embedded into more CE products, consumers will begin to realize how true networking, not just cable replacement, enhances the enjoyment of multimedia content.

Indeed, wireless networking has evolved considerably since its early days, but the availability of digital content and the need to share it has begun to usher in a wider proliferation of WLAN technology.

## Evolution of Wireless Networking

In general, interest in wireless networks began building with the rise of the Internet, but the accelerated adoption of broadband connectivity in recent years has given WLAN technology another boost. In the year 2005, for instance, market research firm iSuppli estimated that 195 million households worldwide subscribed to one kind of broadband service or another.

Of course, with all of the broadband throughput arriving at the doorsteps of residences across the globe, consumers had to determine what to do with it. Initially at least, the broadband pipe was most often connected to only one PC for fast access to the Internet. Eventually, homeowners wanted to share the broadband bandwidth among several PCs and that usually meant some form of home networking.



**Wireless Data**

MODEM     ROUTER     PC
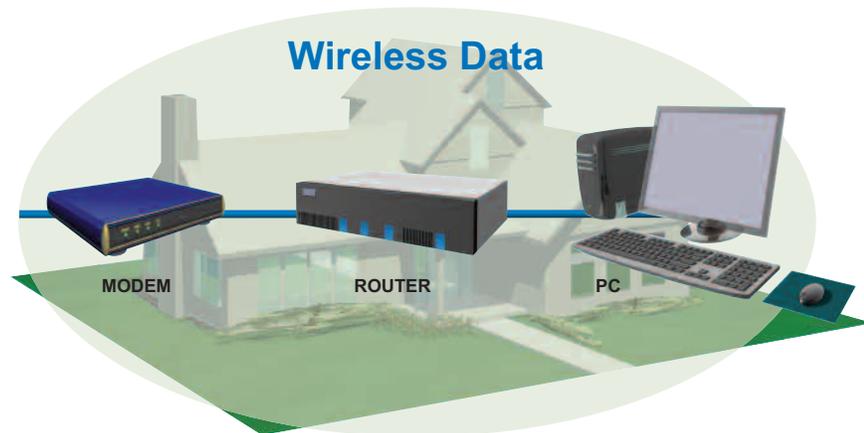
WLAN-based networks were an obvious choice for many consumers who did not relish the thought of clambering through attics to string cables from room to room. Another driving force behind WLAN technology was the increasing affordability of the technology itself. Moreover, its deployment in a wide range of access devices such as standalone routers and access points, and later in combination with DSL and cable modems, again simplified deployment and brought WLAN networking to a broader swath of consumers.

While the marketplace for WLAN-based networking was gaining momentum, various refinements and upgrades to the 802.11 standard have improved the technology's performance parameters. Texas Instruments (TI) expects that 802.11g will continue the growth momentum in the marketplace for quite some time and has therefore made enhancements to its 11g product portfolio. TI's G++™ WLAN technology has been optimized for high throughput rates as well as extended whole-house coverage. In addition, the robustness of G++ technology can overcome the common sources of interference found in many homes and public places, such as microwave ovens, cordless phones and other WLAN networks in close proximity.

Eventually, research and development will yield additional improvements to WLAN performance parameters and these will be incorporated into newer versions of the standard. The next version of the standard, 802.11n, is already under development. At least initially, the cost of 802.11n will make it prohibitive for mass market CE devices. 802.11n will probably be implemented first in higher-priced platforms, such as standalone WLAN access devices like routers and access points and laptop personal computers. Later, it will make its way into residential gateways that combine a WLAN router/access point with a DSL or cable modem. Eventually, when higher manufacturing volumes drive down the cost of chipsets, 802.11n technology will begin to be embedded into CE devices.

Currently, the phenomenal growth in volume of 802.11g WLAN technology in recent years has driven down the cost of chipsets to the point where it is quite cost-effective to embed this technology into CE devices. Indeed, this is already happening.

## *Wireless Networking as a Utility*

More and more CE devices, both stationary and portable, are being equipped with WLAN connectivity. Manufacturers of devices like video gaming consoles, Voice over IP (VoIP) phone systems, portable media platforms such as MP3 and DVD players, IP cell phones and digital cameras are realizing that by enabling connections to the internet wirelessly, they can offer a more compelling user experience. That makes their products more competitive in the fast-changing CE marketplace. In-Stat has predicted a continuation of the

robust growth for WLAN technology in CE devices for the rest of the decade. The analyst firm projects that stationary CE applications of WLAN technology will average a 98 percent annual growth rate through the year 2009. Portable CE applications will average a respectable 29 percent growth rate over the same period. iSuppli recently noted that new portable media players will soon hit the market with embedded WLAN capabilities. Specifically, iSuppli predicts that key MP3 device manufacturers will soon add WLAN connectivity to their products.

TI, as a WLAN technology provider, has responded by tailoring solutions to the stringent requirements of both CE segments. Stationary applications place a premium on higher throughput rates and extended range of WLAN signaling so it can reach the furthest corners of most homes. Throughput rates are important in portable applications as well, but the size of the solution and its power consumption become critical because the solution will be embedded in small handheld devices that operate off of battery power.

The embedding of WLAN technology in a broad range of CE devices is indicative of a subtle shift in consumer attitudes toward the technology. Even today, most laptop users practically assume they will have access to a wireless network whenever they travel. As the build-out of the WLAN infrastructure continues and as WLAN technology becomes an embedded feature in more types of CE devices, consumers will begin to take the presence of wireless networking for granted in much the same way as they assume the availability of electricity or any other utility.

Over time, WLAN technology will take on the trappings of a ubiquitous utility. It will become an enabling capability in the products and devices that are an integral part of many consumers' daily lives. Consumers will come to expect access to WLAN-based networks as a matter of course because that's simply the way CE devices function. That's when WLAN-based networking will be perceived as a utility in the eyes of consumers.

A few use-case scenarios best illustrate how, in the not too distant future, consumers will come to think of WLAN networking.

## Digital Cameras On-the-Go

Many consumers take digital cameras with them when they go on vacation. If they take a lot of photos and they want to free up the memory in the camera or they want to share their photos immediately, they also have to bring a laptop computer on their trip. To share an image with the relatives back home, the camera must be cabled to the laptop and the image or images transferred from the camera to the laptop. Then, the laptop must be connected to the Internet and the images attached to an e-mail and sent. With WLAN technology embedded in a digital camera, vacationers can simply go to a Wi-Fi® hot spot

in an airport or hotel upload the images directly from the camera to a website or send an email, and all of the relatives will be able to enjoy them.

## Pay-as-you-go Portable Music

Acquiring music for portable media players, such as MP3 devices, can be a laborious process void of any spontaneity. Music is downloaded to a PC that's cabled to the Internet. Then, the portable player is cabled to the PC and the tunes are transferred to the player where they can be enjoyed. With WLAN connectivity in the MP3 player itself, consumers will be able to enter a hot spot, such as a prominent chain of coffee shops, hear a song playing on the store's loud speakers and, on the spur of the moment, purchase that particular tune. The MP3 player could access the Internet via the coffee shop's Wi-Fi connectivity, purchase the tune and download it directly. The coffee shop itself could enhance its revenues by offering its own service for purchasing and downloading music just as many such establishments sell CDs today.

## *Centering Wireless Home Networks*

Beyond the shift in consumer perceptions of wireless networking as a utility, the proliferation of WLAN-based networking as an embedded feature in CE devices will also affect changes in the way wireless home networks are deployed. In fact, many CE devices will engage their embedded WLAN capabilities more often in the home than they do in public-access hot spots. In addition, lots of CE products like video gaming consoles, home theaters, stereo systems and others are stationary and will never venture outside the home network. The only wireless network accessed by stationary CE devices will likely be the home's WLAN-based network.

To date, most wireless home networks have been totally unmanaged entities. Wireless routers or access points simply provide residences with Internet access and some level of device-to-device wireless connectivity. Now, as large amounts of multimedia content are stored on and moved around wireless home networks and as more and more CE devices join these networks, the need for a centralized traffic cop to oversee issues relating to network management is emerging.

To a certain extent, personal computers have served as the de facto storage repository for wireless home networks simply because the PC has been the only device in the house with a hard disk. Unfortunately, this can become problematic, especially when a laptop computer functions in this role. Content stored on a laptop is often unavailable to other users on the home network because the laptop's owner has removed it from the network for one reason or another. Moreover, PCs and laptops have not been optimized to manage wireless networks. Ease-of-use issues can be formidable for many consumers who may not be technically adept.

As a result, dedicated residential gateways are emerging and becoming the centerpiece of wireless home networks. Gateways are economical embedded devices that interface with the broadband communications channels outside the residence and coordinate the wired and wireless networks inside the house. Unlike a PC which must be capable of a wide array of functionality, the residential gateway is dedicated to networking tasks. Because of this, gateways are much more cost-efficient when it comes to managing a network than a PC could ever be. In addition, a gateway with a hard disk could provide a convenient central storage facility for content, as well as for configuration data for all of the home's CE devices and other information that should be accessible from the network at all times.

Because a gateway is connected to the broadband channel coming from a service provider, it can function as a support platform for the service provider. Rather than forcing consumers to take responsibility for maintaining their wireless home networks, many users will prefer that service providers perform these tasks for them. Service providers can perform periodic support and maintenance on gateways remotely from their central offices and this type of service can be completely transparent to the residents of the home.



**STATIONARY**    **Wireless Media**    **PORTABLE**

HOME THEATER
RESIDENTIAL GATEWAY
MEDIA PLAYER
DIGITAL CAMERA
MP3 PLAYER
GAMING
VIDEO PHONE
VoIP PHONE
WIRELSS IP CELL PHONE

### Resolving Issues

Certainly the future is bright for the continued proliferation of wireless networking and the embedding of WLAN technology into CE devices, but there are a few unresolved issues which the industry is now addressing. In fact, TI is playing a role in the resolution of these issues.

### Digital Rights Management (DRM)

Creative content providers will not be motivated to develop and provide their content unless they have assurances that their commercial copyrights are protected. In addition, interoperability problems that restrict the platforms on which content can be played only limit the size of the available market for content providers, discouraging them further. Industry-accepted DRM solutions will expand the marketplace for all suppliers of content and technology.

### Ease-of-use

Consumers will not tolerate a complex installation and set-up process. Consumers will return most products and claim they are not working properly if the product can't be turned on and used in less than 30 minutes. First impressions are lasting and word-of-mouth can be deadly. A harrowing out-of-the-box experience will retard the marketplace acceptance of any CE device with WLAN connectivity. TI has implemented Wi-Fi Simple configuration compliant software to enable quick, easy, and secure WLAN networking.

### Quality-of-Service

With the vast quantity of rich multimedia content that is already available on WLAN networks, assurances of bandwidth availability will be required for certain applications like streaming video or music, voice conversations and, eventually, high-definition television programming. TI has implemented full 802.11e QoS.
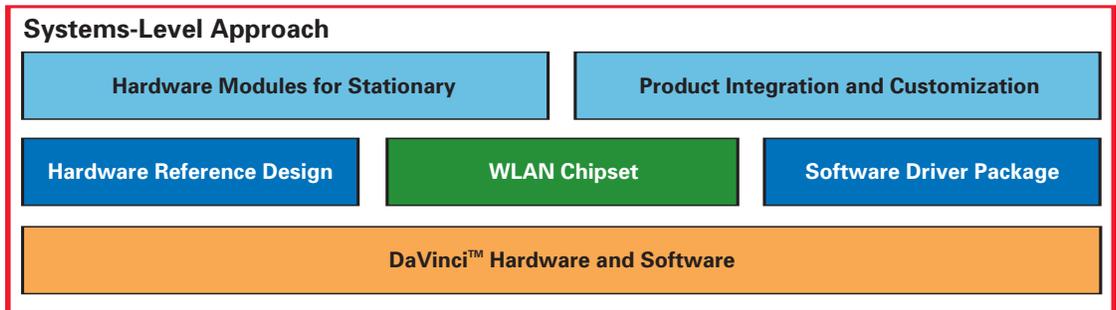
### Security

Protecting a WLAN-based network from intruders or bandwidth hijackers will require authentication that a device or application has been authorized to access the network. Avoiding cumbersome and time-consuming delays for security authentication will be critical for a compelling user experience. Of course, wireless networks and the devices connected to them must also be protected from viruses and other forms of malicious attack. TI provides fully 802.11i security.

### TI—At the Forefront of Wireless Networking

The momentum behind embedding WLAN technology in CE devices is undeniable. Experts can disagree on the rate of growth, but the trend is inevitable because it serves an increasing set of consumer needs in the marketplace.

For CE manufacturers with little expertise in WLAN technology, TI is able to offer years of experience developing industry-leading wireless networking technology as well as extensive expertise in embedded applications. TI has become a market leader at integrating wireless networking with other technologies, such as DSL and cable modems, and VoIP systems. This expertise is now being focused on doing the same for CE products.

TI's WLAN solutions are supported by a comprehensive set of tools, support programs and third-party providers of integration services and technology. With this array of technology and support programs at their disposal, CE manufacturers are able to quickly and efficiently integrate WLAN connectivity so they can focus on differentiated functionality that will make their products more competitive in the marketplace.

| Integrated STB, PVR | Peer-Peer DVD Audio Player | IP-based Home Security | HDTV |
|---|---|---|---|

**Systems-Level Approach**

| Hardware Modules for Stationary | Product Integration and Customization |
|---|---|

| Hardware Reference Design | WLAN Chipset | Software Driver Package |
|---|---|---|

**DaVinci™ Hardware and Software**

*Consumer Electronics Building Blocks*

TI's CE WLAN Developers Kits (CE WLAN DK) are a case in point. The CE WLAN DK 1.0 is targeted at stationary CE products. It is a complete set of software and hardware components that interfaces directly to TI's DaVinci™ digital video processors and takes advantage of TI's G++ WLAN technology. TI will introduce its CE WLAN DK 2.0 for portable applications later this year.

**For More Information**

For more information on TI's WLAN solutions for wireless networking, go to

**www.ti.com/cewlan**

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