WP133 (v1.0) March 21, 2001

Home Networking Using "No New Wires" Phoneline and Powerline Interconnection Technologies

Author: Amit Dhir, Saeid Mousavi

Summary

In the context of a home networking environment, "no new wires" is the term applied to a suite of technologies that use existing wiring systems to distribute high-speed data and video throughout your house. Phoneline and powerline systems are the two dominant "no new wires" technologies.

Introduction

Until recently, home networks depended on special cables (typically requiring professional installation) to link PCs, audio/video (A/V) equipment, and peripheral devices together, which could be expensive and problematic if the hardware components were in different rooms of the house. Now thanks to recent technological developments, consumers can use their already installed telephone and electrical wiring systems to link multiple computers and digital appliances around the house. This white paper examines a number of key phoneline and powerline technologies that promise to deliver the "holy grail" of home networks without the need to run hundred's of meters of new data cables inside the walls of households.

Home Networking Challenges

Commercial networks are designed to carry data between computers. They typically use fiber optic, twisted pair, or coaxial cables to minimize noise and interference on the network. Most homes do not have dedicated high-speed network cabling installed and the labor costs required to install such wiring is too high for homeowners to fund on their own. For home networking to be successful, solutions must exist that utilize existing wiring infrastructures. Thus, the challenge for companies who are creating technologies for networking our homes need to be based on the following criteria:

1. The technology needs to leverage existing wiring infrastructure
2. It needs to be easy to install and maintain
3. To reduce complexity, the technology needs to use existing standards and software platforms
4. It needs to include a quality of service (QoS) mechanism that provides low latency for telephony and other voice applications
5. Data rates in excess of 10 Mbps need to be supported to allow consumers distribute live video around their homes
6. Needs to be relatively cheap and more importantly, the technology needs to provide a level of security

One of the main requirements for mass proliferation of home networks is the ability for homeowners to utilize the existing wiring infrastructure in their homes. Reuse of the phoneline and powerline wiring infrastructures have become the dominant "no new wires" home networking technologies. This white paper explores the issues and technologies associated with these new and emerging technologies.

Phonelines

About Phoneline-Based Home Networks

Home networking using phonelines connects consumer devices such as PCs, TVs, DVD, and MP3 players to each other and to the Internet using regular phone jacks. There are, however,

several issues that need to be addressed before the success of phoneline-based home networking systems is guaranteed. These include:

Random Wiring Topologies

Rather than the hub structure of business networks, the home phoneline wiring system is a random “tree,” and something as simple as plugging in a telephone or disconnecting a fax machine changes the tree.

Signal Attenuation

The random tree network topology of a phoneline wiring system can cause signal attenuation. In simple terms, attenuation means a reduction of signal strength during transmission of data across the home network. The attenuation on a phoneline network is normally caused by open plugs and unterminated appliances.

> **Note:** Attenuation is the opposite of amplification and is normal when a signal is sent from one point to another. If the signal attenuates too much, it becomes unintelligible.

Signal Noise

Appliances, heaters, air conditioners, consumer appliances, and telephones can introduce signal noise onto the phone wires.

Consistency in Service Levels

The network must be able to function reliably and deliver consistent service levels despite changes that result from someone picking up the phone, accessing a website, or an answering machine recording a message.

Telephone Jacks

Phone jacks are not found everywhere in the home. U.S. households tend to have multiple phone jacks, while households in other countries, particularly Europe, are often limited to one or two phone jacks. Also, the physical location of those jacks with respect to the devices that need to be networked is another problem.

An organization called the Home Phoneline Networking Alliance (HomePNA) has been established to define standards and technologies that will overcome these technical issues.

HomePNA

The HomePNA is a group of more than 130 companies seeking to develop specifications for interoperable, home networked devices using existing phone wiring. The group was founded in June 1998 by 11 companies (3Com, AMD, AT&T, Wireless, Compaq, Conexant, Broadcom, Hewlett-Packard, IBM, Intel, Lucent Technologies, and Tut Systems). Towards the end of 1998, the group created a de facto industry standard when it published an easy-to-use, cost-effective, and proven 1 Mbps home phoneline networking technology in its 1.0 specification. The technology allows computers, peripherals, and other information appliances to connect with each other and to the Internet without interrupting standard telephone service. Utilizing existing telephone wiring, it requires no costly or disruptive rewiring of the home.

HomePNA members began producing HomePNA-compliant products in December 1998. On July 27, 1999, HomePNA announced its first step in the development of its second-generation home phoneline networking technology (HomePNA 2.0). In December of 1999, the organization announced the completion and release of its much-anticipated second-generation home phoneline networking technology. The new specification brings a faster 10 Mbps technology to phoneline networking, while at the same time maintaining backward compatibility with existing 1 Mbps HomePNA technology. The new technology uses selective portions of the 2-30 MHz frequency band to achieve these data rates. The technology foundation for the 10 Mbps HomePNA 2.0 standard is currently based on chipsets from Broadcom Corporation.

In addition to increasing data speeds within the home, HomePNA is working to incorporate their technologies into a range of electronic appliances including: PCs, ADSL modems, cable

modems, digital televisions, set-top boxes, and IP based Web phones. Let’s examine each component of a HomePNA-based network and see how they work together.

HomePNA 2.0 Technical Architecture

HomePNA has come to be known as the de facto industry standard for telephone based home networking. It is a robust technology that can achieve data rates up to 32 Mbps in approximately the same bandwidth as the HPNA 1.0 system and be forward compatible with future appliances operating at speeds up to 100 Mbps. It supports up to 500 feet of phone wire between devices connected to RJ-11 jacks. Let’s now examine in greater detail the key components that make up a phoneline based home network.

Network Transport Technologies

Home phoneline networking technology uses standard Ethernet technology, adapting it where necessary to overcome the challenges presented by the home phoneline environment. It includes standard IEEE 802.3 compliant Media Access Control (MAC) and Carrier Sense Multiple Access/Collision Detect (CSMA/CD) as the access method for sharing the base-band signal on the home network bus. Under the Ethernet standard, information is bundled into a package called a frame. Figure 1 depicts the home phoneline networking data frame.

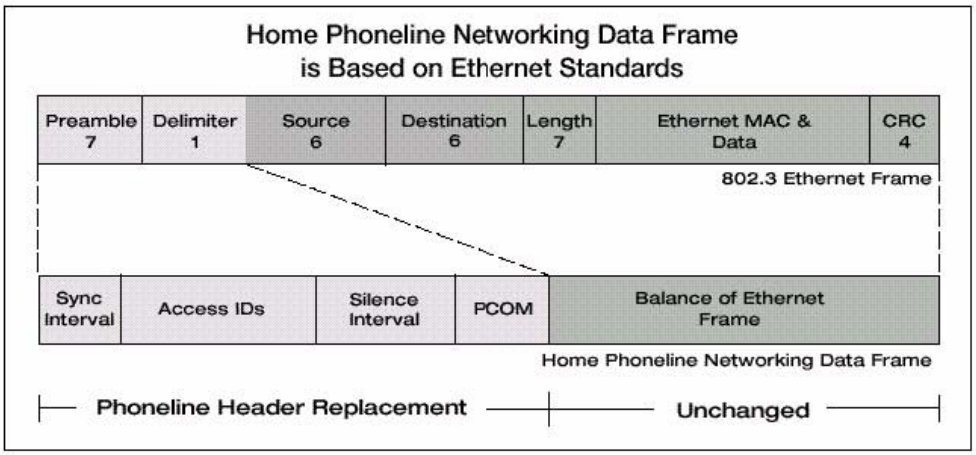

Figure 1: **HomePNA Data Frame**

Data originating from applications within an information appliance connected to a home network is formed into standard 802.3 Ethernet data frames and is passed to the phoneline physical layer (PHY). The PHY circuitry then strips off the first eight octets of the Ethernet frame (the preamble and delimiter fields), and replaces it with a PHY header designed specifically for the rigors of phoneline networking. At the receiver, the reverse process is executed.

This approach enables home phoneline networking to leverage the tremendous amount of Ethernet-compatible software that exists today while meeting the needs of the home environment. An additional requirement of home phoneline networking is the coexistence of multiple services on a single piece of telephone wire. For example, members of the household will need to make telephone calls, while other members of the family may be using the home network for data transfer purposes.

One of the most common methods for simultaneously operating multiple data and voice services over a single pair of wires is multiplexing. Multiplexing is a technical term used to describe the combination of multiple signals (analog or digital) for transmission over a single line or media. There are a number of different multiplexing techniques used to combine different types of signals. HomePNA decided to use a technique called Frequency Division Multiplexing (FDM). This is a multiplexing technique that assigns each communications service a frequency spectrum that is different from all others. Through the use of frequency-selective filters, devices

using one type of service can exchange information without interference from other services that communicate in another frequency band.

Note: A filter is a device that contains a pattern through which data is passed. Only data that matches the pattern is allowed to pass through the filter.

The home network operates in the frequency range between 5.5 MHz and 9.5 MHz.

Figure 2 depicts the spectral usage of three services that can share home phone wiring. POTS, UADSL (universal asynchronous DSL) Internet connectivity, and home phoneline networking share the same line by operating at different frequencies.

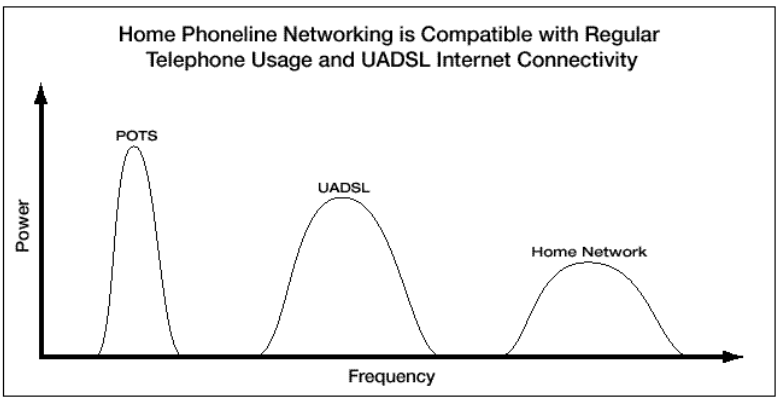

Figure 2: **HomePNA Spectral Usage**

Wiring

The Ethernet technology found in corporate office environments was originally designed to support four types of wiring systems:

- Thick coaxial cable
- Thin coaxial cable
- Unshielded twisted pair
- Fiber-optic cable

These types of expensive cabling systems are not available in most residential homes. Consequently, HomePNA decided to leverage existing infrastructure provided by phone wire inside the home. The use of the phone wiring system means that every RJ-11 modular jack in the house becomes a port on the home network as well as a phone extension.

Network Interface Cards

All the appliances on a HomePNA-based home network need an adapter to control the I/O to the home network. The network interface card (NIC) acts as the physical interface between the appliance and the telephone cable. Without the card, digital appliances would be unable to connect to the network or each other. Network cards are typically connected to each computer or information appliance via an interface slot.

After the card has been installed, the telephone cable is attached to the card's port. Once this connection is made, the computer is physically linked to the home network. All network cards are equipped with onboard microprocessors. The microprocessor is like the card's brain—it is the central point from which the card's various functions is coordinated. The role of the network card is to:

- Prepare data for transmission
- Send data across the in-home network
- Store data prior to transmission
- Control the flow of data between the digital appliance and the transmission medium

The NIC also acts as a translator. When receiving data, it translates electrical signals from the telephone cable into bytes that the processor in the digital appliance can understand. And when transmitting data, it translates the computer’s digital signals into electrical pulses that the telephone cable can carry. HomePNA cards contain the necessary hardware and software routines that are stored in read-only memory that allow you to create a home network using the existing in-home phone wiring system. Some HomePNA certified adapters come with connectors known as RJ-45. These interfaces are slightly wider than RJ-11 connectors and can be used to connect into a sophisticated data wiring system.

Software

As mentioned previously, every device on a home network needs an operating system with networking capabilities. Once a NIC is installed, a driver is required to communicate with other appliances on the network. It is also very important that the driver is configured correctly for the card to operate efficiently. If the card is not configured correctly by the driver, the card will perform less effectively and slows up network performance. HomePNA has decided to use the Network Driver Interface Specification (NDIS) driver model that is integrated with most of the Microsoft Windows operating systems (Figure 3).

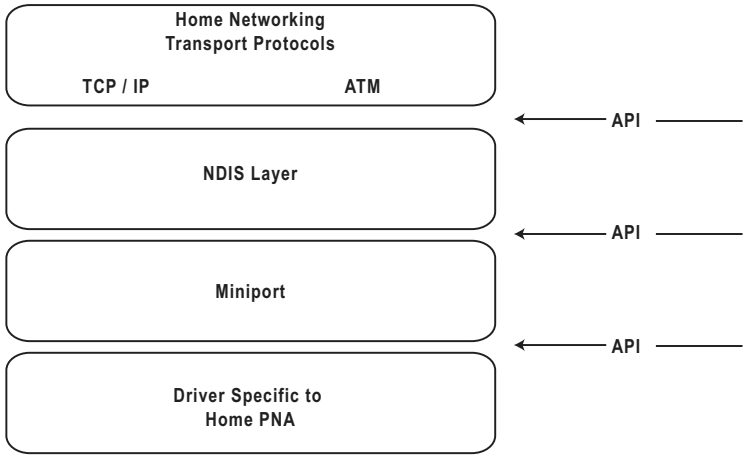

Figure 3: **NDIS Architecture**

As shown in Figure 3, NDIS provides a simplified plug-in driver architecture. At the lowest boundary layer, NDIS contains a driver that is specific to the telephone wiring transmission medium. The layer above this contains a platform independent driver called a miniport. This layer interfaces through a standard Application Programming Interface (API) to the NDIS layer and this layer in turn communicates with the transport protocols that are running across the home network. A major advantage of the NDIS software model is that network cards can be installed in a telephone-based home network without requiring a service call from the local service provider.

HomePNA Features

Leverages Existing Standards

The importance of leveraging standards cannot be overestimated. Given the preponderance of IEEE 802.3 Layer II networking across the Internet infrastructure, HPNA has chosen a technology that uses 802.3 framing and Ethernet behavior.

Quality of Service (QoS)

The initial motivation for home networking is sharing resources among multiple PCs such as Internet access, files, and printers. However, the ultimate applications that will dominate home networks are the transport of digital audio, digital video, and digital voice (IP telephony). Latency in voice connections must be controlled below 10 to 20 ms on the home network

segment if voice quality is to be maintained. Streaming video and audio connections must receive an application-determined minimum bandwidth from the network.

Although the aggregate throughput rate of 10 Mbps for HPNA 2.0 is more than adequate for many application scenarios, burst loads presented by TCP transfers between PCs, without some QoS mechanism, would at times make the network unable to meet the latency and guaranteed bandwidth service requirements. Furthermore, bandwidth allocation within a given class of service should be fair. The traditional Ethernet MAC 2 layer exhibits a phenomenon known as packet capture, which can result in long access latency distributions. The HPNA 2.0 MAC layer introduces eight priority levels and an improved collision resolution technique that eliminates packet capture.

Robustness

The primary difference between twisted-pair Ethernet and other technologies is the quality of the communications channel. Running over Category 5 cable, Ethernet encounters a channel that has a number of very nice properties. They include point-to-point communication, proper termination, a well-characterized channel response, and very low cross talk. In contrast, all of the no-new-wires media available for networking within homes have the problem that the communications channel can be severely impaired. HomePNA has developed a robust suite of technologies that are capable of overcoming the challenges associated with networking appliances on a typical in-home phone wiring system.

Performance

History has taught us that higher network speeds are always better. In the context of a home networking environment, several external influences persuade us that we require at least 10 Mbps. The common broadband access technologies such as ADSL and the DOCSIS cable modems require home networks with data rates of 6 Mbps or more to share the access bandwidth. Moreover, applications such as multiple DVD streams or high-definition digital video make it easy to imagine that even 10 Mbps isn’t enough. Therefore, the alliance designed the HPNA 2.0 system to achieve data rates above 10 Mbps in approximately the same bandwidth as the HPNA 1.0 system.

Future Compatibility

Once installed, home networks are likely to remain in place for many years. Worse yet, as home network interfaces become embedded in appliances, it may become almost impossible to replace them. Thus, a good home networking technology ideally has built into the current generation appliance a plan for interoperability with future generations. HomePNA has been designed to be forward compatible with future stations operating at speeds up to 100 Mbps.

Security

HomePNA provides excellent security. This is because each home has a unique phone circuit (phone number) from the phone company’s central office.

Cost

Finally, there is the issue of implementation cost and complexity. As has become very well understood over the last ten years by the computer and networking industries, volume is everything. With decreasing prices for computer equipment—especially for the home—a successful home networking technology must be inexpensive. A typical HomePNA card will cost you around $100.

HomePNA 2.0 Product Range

Some of the products that will use HomePNA 2.0 technology are:

- PCs
- Modems (including cable, xDSL, satellite, analog)
- Network hubs
- IP telephones

- Digital TVs and set-top boxes
- Home security and automation
- Network appliances

Market Outlook for Phoneline Home Networking

According to a recent IDC report there is upside short-term and long-term growth predictions for phoneline home networking. The analyst group predicts that by 2004, phoneline technologies will account for 72 percent of the total home networking market's installed base.

Xilinx Phoneline Solutions

Figures 4, 5, and 6 show the PHY and MAC layers of the HomePNA. Xilinx Spartan™-II FPGAs provide low cost HomePNA functionality in consumer products and provide an interface from HomePNA to other home networking technologies. While most ASSPs interface to a couple of popular interfaces only, programmable solutions enable connectivity to multiple interfaces such as USB 2.0, wireless LANs, Bluetooth, HomeRF, IEEE 1394, etc.

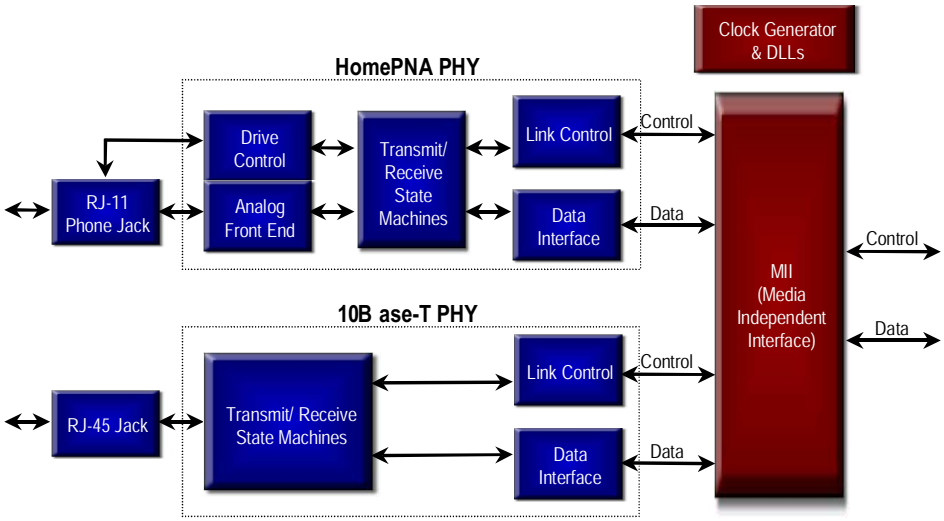

Figure 4: **HomePNA and Ethernet PHY Layer**

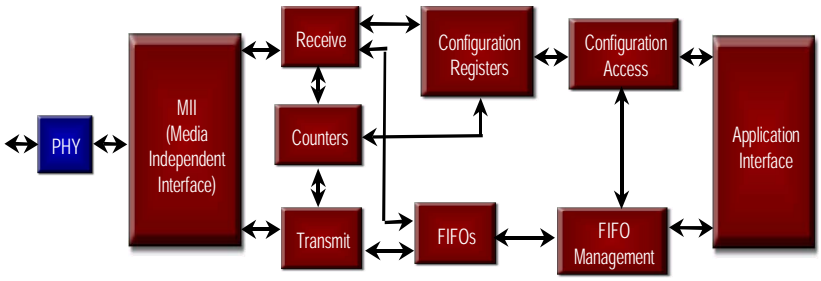

Figure 5: **HomePNA and Ethernet MAC Layer**

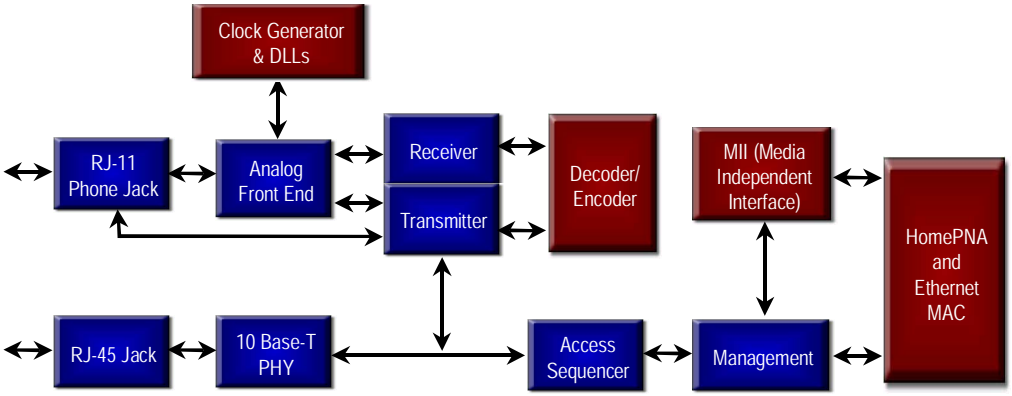

Figure 6: **HomePNA PHY and MAC Layers**

Powerlines

This is an emerging home networking technology that allows consumers to use their already existing electrical wiring system to connect home appliances to each other and to the Internet. Home networks that utilize high-speed power-line technology can control anything that plugs into an outlet. This includes lights, televisions, thermostats, and alarms.

In conventional terms, the powerline connects the home to the electric utility company in order to supply power to your home. But powerline communications falls into two distinct categories: access and in-home (see Figure 7).

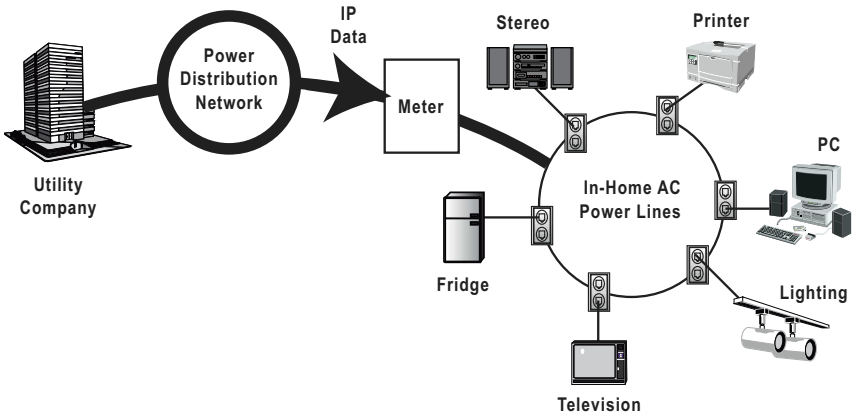

Figure 7: **Powerline Networks**

Access powerline technologies send data over the low-voltage electric networks that connect the consumer’s home to the electric utility provider. The powerline access technologies enable a “last mile” local loop solution that provides individual homes with broadband connectivity to the Internet. *In-home* powerline technology communicates data exclusively *within* the consumer’s premises and extends to all of the electrical outlets within the home. The same electrical outlets that provide power will also serve as access points for the network devices.

Although the access and in-home solutions both send data signals over the powerlines, they are fundamentally different technologies. Whereas the access technologies focus on delivering a long-distance solution, competing with xDSL and broadband cable technologies, the in-home powerline technologies focus on delivering a short-distance high-bandwidth solution (10 Mbps) that would compete against other in-home interconnection technologies such as phoneline and wireless. As we have covered the powerline access technologies in Chapter 2, we will limit our discussions in this chapter to in-home powerline technologies.

Advantages of In-Home Powerline Technologies

- **Ubiquity of electrical outlets:** One of the main advantages of using power lines for home

networking is the availability of multiple power outlets in every room. Thus, it eliminates the need to do any additional rewiring in your home.

- **Capable of transmitting data:** Powerline networking is able to take advantage of the unused capacity of the power cable to transmit data over the existing home power cabling.
- **Distribution of audio:** Connecting your stereo to the in-home powerline wiring network will allow you to distribute music throughout the house.
- **Speed:** With advancements in technology, powerlines are becoming capable of distributing data as fast as 10 Mbps.

Disadvantages of In-Home Powerline Technologies

- **Noise:** The greater amount of electrical noise on the line limits practical transmission speeds to somewhat lower values.
- **Note:** Vacuum cleaners, light dimmers, kitchen appliances, and drills are examples of noise sources that affect the performance of a powerline-based home network.
- **Minimum-security levels:** Powerlines do not necessarily provide a secure media.
- **Data attenuation:** Due to the presence of numerous elements on a powerline network, data attenuation is likely to be an issue.
- **High costs of residential appliances:** Powerline network modems are more costly than modems used to connect to a phoneline network.
- **Lack of global standards:** There are regularity issues in some international markets that are preventing the development of a global standard for distributing data over existing in-home powerline systems.

Components of an In-Home Powerline

Elements of an in-home powerline network include:

- House wiring inside of the building
- Appliance wiring (power cords)
- The appliances themselves (load devices)
- The circuit breaker
- Powerline networking modems

Technical Obstacles of In-Home Powerline Networks

Typical data and communications networks (like corporate LANs) use dedicated wiring to interconnect devices. But powerline networks, from their inception, were never intended for transmitting data. Instead, the networks were optimized to efficiently distribute power to all of electrical outlets throughout a building at frequencies typically between 50-60 Hz. Thus, the original designs of electrical networks never considered using the powerline medium for communicating data signals at other frequencies.

For this reason, the powerline is a more difficult communications medium than other types of isolated wiring like the Category 5 cabling used in Ethernet data networks. The physical topology of the electrical network, the physical properties of the electrical cabling, the appliances connected, and the behavioral characteristics of the electric current itself all combine to create technical obstacles.

Typical Applications of Powerline Technologies

Powerline technologies have two primary uses within the context of a home network, namely, data networking, and home control.

Data Networking

With today’s technologies, this medium can be also used to distribute IP data around the house.

Home Control and Automation Systems

Powerlines have been used for home automation for many years. The most important types of home automation applications include controlling lights, ventilators, security systems, sprinklers and temperature levels within the home. The home control networking systems market is undergoing a significant transition from closed-loop solutions to open, IP-aware solutions. The result is that the U.S. home automation and controls equipment market is expected to grow from $1.1 billion in 1999 to $3 billion in 2005. This is according to Allied Business Intelligence's (ABI) report “Home Automation Systems and IP-Based Control.”

Home control and automation systems are normally based on one of the three major powerline technologies—CEBus, LonWorks, or X-10.

CEBus Technical Overview

CEBus is a standard proposed by the Electronic Industries Association. It defines a set of rules for consumer products to communicate with each other. The CEBus based products consist of two fundamental components—a transceiver and a microcontroller. Data packets are transmitted by the transceiver at about 10 Kbps. The CEBus protocol uses a peer-to-peer communications model so that any node on the network has access to the media at any time. The CEBus standard includes commands such as volume up, fast forward, rewind, pause, skip, and temperature up or down one degree. These commands are based on a language called common application language (CAL). CEBus uses spread spectrum technology to overcome communication impediments found within the home's electrical powerline.

> **Note:** Spread spectrum signaling works by spreading a transmitted signal over a range of frequencies, rather than using a single frequency. The CEBus powerline carrier spreads its signal over a range from 100 Hz to 400 Hz during each bit in the packet.

To avoid data collisions, CEBus uses a Carrier Sense Multiple Access/Collision Detection and Resolution (CSMA/CDCR) protocol. Similar to HomePNA, this media access control protocol requires an information appliance to wait until the line is clear, which means that no other packet can be transmitted before it can send a packet.

A CEBus-based home network is comprised of a control channel and potentially multiple data channels on each of the CEBus media. CEBus control channel communication is standardized across all media, with a consistent packet format and signaling rate, and is used exclusively to control devices and resources of the network, including data channel allocations. Data channels typically provide selectable bandwidths that can support high data rates and are used to send data such as audio, video, or computer files over the network. The characteristics of a data channel can vary greatly depending upon the medium and connected device requirements. All data channel assignments and functions are managed by CEBus control messages sent via the control channel.

LONWorks (Local Operation Networks)

LONWorks technology is an important new solution for control networks developed by Echelon Corporation. There are over six million LONWork based appliances installed worldwide. A LONWorks system includes all the necessary hardware and software components for implementing complete end-to-end control systems—from silicon to software.

In a LONWorks network, no central control or master-slave architecture is needed. Intelligent control devices, called *nodes*, communicate with one another using a common protocol. Each node in the network contains embedded intelligence that implements the protocol and performs control functions. In addition, each node includes a physical interface (transceiver) that couples the node *microcontroller* with the communications medium.

> **Note:** A microcontroller is best described as a highly integrated chip that has been designed to perform very specific tasks on your home network.

LONWorks is an “open” technology and is accessible to all. A typical node in a LONWorks control network performs a simple task. Devices such as proximity sensors, switches, motion detectors, and sprinkler systems may all be nodes on a home network.

The following elements make up a LONWorks home control system:

1. A Neuron chip, which is basically a microcontroller specifically designed to offer the most cost-effective solution available for network enabling and embedding intelligence into home control devices.
2. Appliances on a LONWork enabled home network use a protocol to communicate with each other. This protocol is known as *LonTalk* and has been approved as an open industry standard by the American National Standards Institute (ANSI)—EIA 709.1.

The LONWorks Network Services (LNS) architecture provides a range of network services to appliances that are connected to your control system.

LonWorks control networks can be easily integrated with the Internet. This built-in capability allows for seamless networking between IP-based devices and control devices. LONWorks powerline-based systems also support remote monitoring of home appliances through standard Web browsers.

X-10

X-10 is a communications protocol that allows compatible home networking products to talk to each other via the existing electrical wiring in the home. Basic X-10 powerline technology is almost 20 years old and was initially developed to integrate with low cost lighting and appliance control devices.

X-10 originally started out as unidirectional only; however, capability has recently been added for bidirectional communication if needed. Nevertheless, the vast majority of X-10 communication remains unidirectional only. X-10 controllers send signals over existing AC wiring to receiver modules. The X-10 modules are adapters that connect to outlets and control simple devices. X-10 transmission rate is limited to only 60 bps which makes it unsuitable for carrying Internet type traffic around the house. By using X-10, it is possible to control lights and virtually any other electrical device from anywhere in the house with no additional wiring (see Figure 8).

The X-10 technology and resource forum designs, develops, manufactures, and markets products that are based on this standard. Today, scores of manufacturers make X-10-compatible products; more than 100 million such products have been sold, according to X-10 group. These home automation products are called “powerline carrier” (PLC) devices and are often installed by builders who want to offer home automation as an additional selling feature. The home automation line consists of “controllers“ that automatically send signals over existing electrical wiring to receiver “modules“, which in turn control lights, appliances, heating and air conditioning units, etc.

With the X-10 standard, you can literally walk into a nearby electronics store and purchase all of the necessary equipment required to automate your home. The main disadvantage for legacy X-10 technology is the fact that it has very limited capability in terms of both speed and intelligence. It is a technology relegated to control applications only due to its low data rate and rudimentary functionality. However, the ultimate goal of the X-10 technology is to innovate itself

into a higher-speed protocol that facilitates communication between home PCs and controlled home appliances.

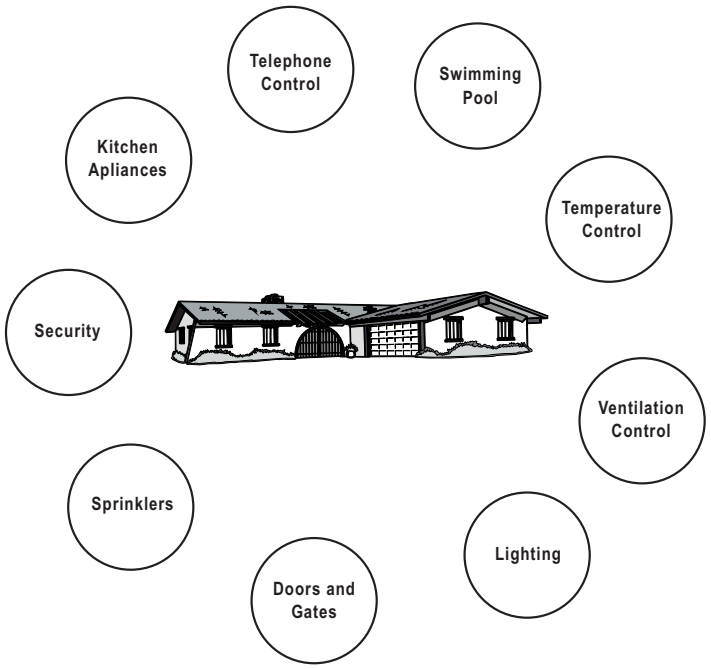

Figure 8: **X-10 Control Capabilities**

Key In-Home Powerline Solutions

In addition to CEBus, LonWorks and X-10, here are some more key players in the in-home powerline segment of the home networking

Inari

As a product company, Inari became well known for its PassPort Plug-in Network home networking product. Today, Inari is focussing its efforts on providing powerline chipsets to modem, gateway, and network interface card vendors as well as to OEM partners in the consumer electronic marketplace.

Enikia

Enikia’s product line consists of powerline Ethernet transceiver chipsets that enable data transmission speeds of 10 Mbps and above. Device OEMs purchase Enikia’s chipsets or license Enikia’s intellectual property in order to embed this technology into intelligent devices. Enikia’s solution makes it possible for computers, as well as other “smart” appliances, to communicate with one another over the home’s electrical network.

Intellon

Intellon's powerline carrier technologies enable high-speed communication and extend the reach of the Internet to individual products without adding new wires. The companies PowerPacket technology was recently selected by the HomePlug Powerline Alliance as the basis for its industry specification for powerline home networking.

Standardization of In-Home Powerline Networks

To allow powerline home networks to compete effectively with phoneline and wireless technologies, an organization called HomePlug Powerline Alliance was established in 2000 to create an open specification for home powerline networking products. The 13 founding HomePlug members include 3Com, AMD, Cisco Systems, Compaq, Conexant, Enikia, Intel, Intellon, Motorola, Panasonic, Radio Shack, SONICblue, and Texas Instruments.

Past challenges of powerlines include a lack of industry specifications and multiple sources of electric noise. HomePlug is overcoming these challenges through the Alliance’s efforts to create a specification and advanced, optimized algorithms in semiconductor technologies. HomePlug has chosen Intellon’s high-speed powerline networking technology as the baseline upon which to build the Alliance’s first-generation specification.

Xilinx Powerline Solutions

Due to the evolving standards in the powerline home networking industry, programmable logic is necessary to future-proof your solution. While providing ASSP capabilities for powerline technologies such as CEBus, LonWorks, and X-10, Spartan-II FPGAs interface to other home networking solutions. In the system, Spartan-II FPGAs also provide front-end interface to multiple broadband access technologies. This combination, with the advanced features of Spartan-II FPGAs, helps lower the overall system cost.

Conclusion

Phoneline-based networking has emerged as one of the most viable, economical approaches to networking in the home. Phonelines offer consumers an established in-home wiring system for networking devices in different parts of the house. Phoneline technology transmits data between multiple phone jacks within the home. Phoneline technology currently leads the “no new wiring” technologies in product development (with existing products ranging from 1-10 Mbps).

The HomePNA organization is promoting the adoption of a single, unified phoneline networking industry standard and to rapidly bring to market a range of interoperable home networking solutions. Founded in June 1998, HomePNA has grown to include nearly 130 members spanning the networking, telecommunications, hardware, software, and consumer electronics industries. HomePNA has defined a standard specification that simplifies the implementation of a home network over the phonelines. HomePNA has chosen to standardize on Ethernet based technology, allowing consumers to link appliances at speeds up to 10 Mbps over existing home telephone wires.

The second “no wires” solution uses your existing in-home powerline network. Powerlines are currently the most pervasive home networking media. Powerline networking is available worldwide, affording the use of multiple outlets in every room at a lower cost per connection point. The powerline network is also a power source, leveraging existing outlets to enable communications. Additionally, the convenience of connecting any device through a power outlet will enable exciting new products with breakthrough levels of entertainment, information access, and telephony services.

CEBus, X-10, and LONWorks core technologies are the most popular technologies used to deliver data over lines that previously delivered only electricity. The HomePlug Powerline Alliance is a non-profit corporation established to provide a forum for the creation of an open specification for home powerline networking products and services.

Xilinx FPGAs, CPLDs, and IP provides valuable solutions for phoneline and powerline products, and in enabling consumer products to be home networked without installing new wires.

Revision History

The following table shows the revision history for this document.

Date	Version	Revision
03/21/01	1.0	Initial Xilinx release.