

Whitepaper

Home Networking over COAX

Executive Summary

With the rise of applications like IPTV and multi-room DVR, **the home network has become critical to the quality of the broadband and television experience.** Triple play service providers need to take an active role in the installation and management of the home network in order to keep customers happy with their television service. As a result, there has been considerable focus on wired connections in home, particularly over existing wiring media (power lines, phone lines, and coax cables) that do not require a time-consuming and expensive rewiring project.

Approximately 80 percent of U.S. homes already have coaxial cabling and outlets are typically located where subscribers would want to put a television – living rooms, bedrooms and entertainment rooms. This whitepaper explores the three major home networking technologies over coaxial cable: MoCA, HPNA, G.hn, and IEEE P1905.1. The unique advantages and limitations of each technology are discussed.

Introduction: The Importance of the Home Network

The role of the home network has changed dramatically over the past years, and will continue to change. Once used solely for web surfing and data transfer between home computers, **the home network is now responsible for delivering triple play services throughout the home.** Today and over the coming years, consumers will rely on the home network to talk on the telephone and watch television programming and movies.

The addition of IPTV has played a significant role in transforming the home network. IPTV is a commercial TV service offered by broadband service providers that delivers digital TV via an IP over broadband connection. For subscribers, their IPTV service is subscription television, just like traditional cable TV – and subscriber expectations for service quality and reliability are just as high as with cable TV service.

In addition, the proliferation of entertainment devices entices consumers with the promise of the 'connected home' where data and content flow seamlessly from device to display anywhere in the home. For example, users can start on-demand or recorded DVR content in the living room, and continue watching as they move to the bedroom. As the number of televisions in the home grows, so does the need to offer multiple connectivity ports, along with the ability to move content from device to device.

The Home Network and Service Providers

Service providers, including MSOs and telco providers, have invested billions of dollars to upgrade and build advanced network infrastructure to deliver triple play service. Yet, while the outside plant has been a key focus, the in-home network has primarily been viewed as the subscriber's responsibility.

As the home network becomes crucial to the quality of the broadband experience, particularly when it comes to IPTV and multi-room DVR, **broadband service providers need to take an active role in the installation and management of the home network.** An inferior home network can reflect poorly on the entire broadband service – putting customer satisfaction and retention rates in jeopardy. While service providers once delivered broadband to the door, today's home network is considered a critical part of the service provider's network.

Wireless Networking in the Home

Wireless is the most popular LAN technology in homes today, as consumers worldwide embrace the convenience, flexibility and low cost of wireless freedom. The technology has proven to ideal for a range of applications in the home such as web surfing on laptops or streaming a video to a tablet or computer. However, wireless transmission can often be a problem when it comes to IPTV. Home and building construction can create dead spots, where wireless service is less reliable, fast, or unavailable altogether. When poor conditions exist, wireless devices compensate by lowering the data rate. This can result in glitches and pixilation on the TV screen. Consumers may still be willing to accept such quality issues while streaming a movie to their smart phone, but have much lower tolerance for less than perfect quality while watching content on their big screen.

Wireless Disadvantages

- Walls or other construction elements can create dead spots in the home -- places where there is either spotty service or no service altogether
- Poor transmission conditions or long distances result in lower wireless data rates; this in turn, can result in glitches and pixilation in video content
- The latest 802.11n standard may still operate at lower speeds when legacy 802.11b/g equipment is detected

Wired Networking in the Home

Since HD applications like IPTV and Follow-Me DVR are top priorities for consumers and service providers alike, the focus on wired connections has intensified, including the use of high-speed transmission over in-home power lines, phone lines, and coax cables.

The key question is which in-home networking technology will best support advanced services like IPTV and whole-home DVR?

And how will that technology fit in with current field deployments?

Two factors must be taken into account when determining the right in-home networking technology:

- **Existing Infrastructure:** Rather than the cost of installing new wiring with CAT5/6 or dealing with potential quality issues with wireless for IPTV, in-home networking can use a home's existing wiring (coax, phone, power)
- **Quality:** To meet high consumer expectations for subscription television service, the in-home networking solution should provide dedicated bandwidth for video with no interference from other high-bandwidth traffic like gaming.

Why Network over Coax?

Using existing wires eliminates the high costs associated with installing Ethernet CAT5 cable. There's no need to drill holes through a customer's floors or walls to add in new wiring. Installers don't need to crawl up into the attic or leave behind wires staples to the walls. Coax is already found in the majority of U.S. households, making it a perfect conduit for in-home networking applications. According to Kurt Scherf, VP and Principal Analyst at Parks Associates, "80 percent of U.S. homes have coaxial cabling, and outlets are found to a high degree in the rooms where distributed video will be enjoyed most widely, including bedrooms and entertainment rooms."

Coax Networking Technologies

There has been extensive development over the past decade for transmission models using a home's coax cabling and several competing technologies exist -- each with their own set of advantages and limitations. In this section, we'll explore each of the two current coax networking technologies: HomePNA 3.1 and MoCA 1.0/1.1 as well as discuss three major upcoming networking technologies: MoCA 2.0, G.hn and IEEE 1905.1.

HomePNA 3.1

HomePNA (HPNA) technology initially defined home networking over the existing phone wires. The HPNA 1.0 specification was released in 1998 and operated at just 1 Mbps. With HPNA 3.1, the technology now works over coax cables, as well as phone wiring supporting data rates up to 320 Mbps. HPNA products are certified for use by the HomePNA Alliance.

The coax specification for HPNA defines four frequency ranges between 4-52 MHz and uses quadrature amplitude modulation (QAM). HPNA is interoperable with ADSL, VDSL, and other services that operate below 12 MHz. However, HPNA 3.1 cannot share the same cable plant with VDSL services above 12 MHz, as well as cable television services that use the 5-42 MHz and 5-65 MHz return paths.

HPNA Advantages

- Provides guaranteed quality of service, including guaranteed jitter, latency and error rate for each stream
- Guarantees QoS without using high frequency RF components (keeps the price of home networking equipment low)

- Offers integrated support for remote diagnostics and management, including TR-069
- Provides multi-spectrum operation, with VDSL, ADSL, POTS, and broadcast TV spectrum coexistence
- Multiple HomePNA networks can coexist on the same wiring in the home

HPNA Disadvantages

- Uses a single carrier modulation scheme: this results in highly dispersive channels with large echoes.
- No forward error correction
- Requires frequency diversity in order to achieve acceptable BER (Bit Error Rate) performance; this significantly reduces throughput in poor channels
- Sole sourced with limited market traction to date -- less opportunity for discounting and manufacturing economies of scale
- Not compatible with VDSL services above 12 MHz

MoCA 1.0/1.1

MoCA (Multimedia over Coax Alliance) uses existing coax and operates at 500 MHz and above, making it compatible with IPTV, CATV, and DBS. MoCA 1.0 was approved in 2005 and supported up to 135 Mbps throughput; MoCA 1.1, released in 2007, increased throughput to 175 Mbps.

MoCA uses 50 MHz channels in the 850-1525 MHz spectrum. Channels are organized into multiple bands across the spectrum. Only one channel per band is used on a physical network, although multiple MoCA networks can be formed over the same coaxial plant using different bands. Operating above 500 MHz is critical in home networks, as low RF networks can be susceptible to noise from household appliances, such as blenders, coffee grinders, and treadmills. While low RF standards can offer noise mitigation techniques to minimize noise, this ultimately results in lower throughput. Rather than attempting to minimize the affect of noise, it's better to operate where there's less noise -- and that's above 500 MHz.

MoCA Advantages

- No interference or crosstalk from existing networks
- More than 70 certified products to date and has a large silicon vendor base

- Majority of North American providers (both cable and satellite) are deploying MoCA-enabled CPEs -- leading to manufacturing economy of scale
- Works with existing splitters and loose connectors (makes for easier installs compared with some HPNA deployments)
- Operates in higher frequency spectrum where there's less interference from household appliances
- Works in all three pay TV segments: cable, satellite, and IPTV. In fact, MoCA converges DirecTV video and AT&T broadband without the need for bridges

MoCA Disadvantages

- Different frequencies for each carrier makes a universal retail model difficult
- Standard only supports coax -- not twisted pair or power lines

HomeGrid: G.hn

Approved June 2010, G.hn is an International Telecommunication Union (ITU) standard, approved last June, for high-speed networking over all existing in-home wiring types: coaxial cable, phone lines and electrical wiring. It's designed for theoretical speeds as high as 1 Gbps, although performance will vary depending on the medium used. It's claimed that coax should deliver 800 Mbps, power lines 200-400 Mbps, and phone lines 200 Mbps. The G.hn initiative is supported by the Home-Grid Forum.

G.hn interoperability testing has begun in 2011, and consumer products using G.hn may hit the market by end of 2011. However, to date, silicon chipsets are limited to sample quantities and a small number of manufacturers. Experts believe that the complexity of handling three transmission media (coax, phone, power) is partly to blame for the slower development of G.hn compared with other coax-based technologies.

Most importantly, G.hn still needs to undergo a full technology qualification and development cycle to determine performance in real-world applications. The following qualification lifecycle stages are still required for G.hn: IC development and qualification, initial lab trials, CPE product development and qualification, initial field trials, and CPE compliance and interoperability testing. These stages will all take considerable time.

G.hn Advantages

- Potential economies of scale, as manufacturers can develop products that support all three forms of traditional home wiring

G.hn Disadvantages

- Slower market traction -- chipsets are still limited to sample quantities
- No large field trial data is available yet; as a result there are still considerable unknowns surrounding the technology, such as: what bit rates can G.hn guarantee at 95% or better outlet coverage?
- Not backward compatible to existing technologies. Many North American and European operators have already deployed MoCA or HomePlug networks; will they be willing to migrate to G.hn without support for their existing home networking standards?
- Low RF can be subject to potential ingress noise -- the effects on performance are still unknown due to minimal field testing

MoCA 2.0

The latest MoCA 2.0 standard boosts rates up to 400 Mbps throughput and 700 Mbps PHY (MoCA 2.0 is compatible with 1.0/1.1). Three traffic classes are supported—high (voice), medium (streaming media) and low (interactive and best effort) priority.

MoCA 2.0 Advantages

- No interference or crosstalk from existing networks
- Backward compatible to MoCA 1.1 with more than 70 certified products to date
- Works with existing splitters and loose connectors (makes for easier installs compared with some HPNA deployments)
- Operates in higher frequency spectrum where there's less interference from household appliances
- Works in all three pay TV segments: cable, satellite, and IPTV.

MoCA 2.0 Disadvantages

- Different frequencies for each carrier makes a universal retail model difficult
- Standard only supports coax -- not twisted pair or power lines

IEEE 1905.1

A new standard is on the horizon that promises to serve as a bridge to and from Ethernet wiring, HomePlug AV for electrical wires, MoCA 1.1 for coax, and Wi-Fi.

While G.hn proposes a unified MAC and PHY to support coax, phone line, and powerline on the same chipset, P1905.1 takes a different approach and ties these different networking technologies together via an abstraction layer. It plans to create a meshing fabric that aggregates wireless and wired streams on the home network, and can switch between connection types when one begins to degrade in performance.

No other wireline standard encompasses wireless capacity, giving P1905.1 a big advantage. Consumers could use MoCA to wire a television in the bedroom where their Wi-Fi performance is weak. Or a P1905/Wi-Fi adapter could be used for the last 5 ft. to connect a TV to the home network.

When ratified, P1905.1 will be the only specification that offers full backward interoperability with home networking technologies like IEEE 1901, IEEE 802.11, IEEE 802.1 and MoCA 1.1. Note that HPNA, the latest MoCA version, and G.hn are missing from the interoperability list, although G.hn backers are pushing for interoperability. Incorporating MoCA 1.1 is important given the large base of installed MoCA devices standardized by broadband and pay-TV service providers. A new technology would either need to offer a significant improvement in performance, feature set, or cost reduction to compel service providers to upgrade to a solution that isn't compatible with their existing MoCA base.

A group was set up under the auspices of IEEE to develop P1905.1. They held their first meeting in December 2010 and meetings are scheduled throughout 2011 and 2012. Although IEEE approved the technology, there's no formal timetable yet for ratification or development of the standard.

Conclusion

The growth of home entertainment services and networked devices will pick up speed over the next decade. Pressure will continue to intensify for a high performance in-home network that can handle HD video, subscription TV service, gaming, voice, data, and more. For the consumer watching IPTV on a flat panel plasma display, the quality of the home network is as essential as the service provider's outside plant infrastructure. To win the race for customer satisfaction, **service providers need to carefully consider how entertainment and bundled services are distributed within the home** with networking technologies that can be deployed today and evolve to meet future requirements.

About Actiontec

Actiontec Electronics develops broadband connectivity and broadband-powered solutions that simplify and enrich the digital life – delivering a unified experience that encompasses communications, entertainment, home management, and more. Actiontec offerings range from the market's broadest selection of IPTV-capable broadband home gateways for bringing IP-based video services into the home, to DSL modems, wireless networking devices, routers and digital entertainment devices. The company's carrier-class products are easy to install, manage, and use, and are sold through retail channels and broadband service providers. The company is committed to protecting the environment through energy efficient products and other green-friendly practices. Founded in 1993, Actiontec is headquartered in Sunnyvale, CA, and maintains branch offices in Colorado Springs, CO; Shanghai, China; and Taipei, Taiwan.

Appendix: Industry Links

HomePNA Alliance: www.homepna.org

HomeGrid Forum: www.homegridforum.org

MoCA: www.mocalliance.org