Extension of Cable-based Services to Home Networks

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Abstract

CableLabs has been investigating technologies that could be used for provisioning and delivering cable-based services throughout the home environment. This paper provides a discussion of several issues surrounding provisioning cable-based services through home networks.

Introduction

CableLab's Home Networking Project has been investigating technologies that could be used for provisioning and delivering cable-based services throughout the home environment. At the outset of this project, two key strategic principles were established for this investigation:

- Different cable services have significantly different requirements to transparently pass through to home networks and must be addressed, in some degree, separately.
  - Cable modems represent a first-generation IP gateway to interconnect to home networks for high-speed data (HSD) services.
  - Video-centric networks are evolving to support home-based client-server convergence entertainment services.
  - Any home networking solution should not degrade existing consumer telephony experience as IP-based telephony products are deployed.
  - At this time, technologies are being developed that embed a cable modem directly in devices that provide each of these service categories. While the number of cable modems embedded in household devices may grow to be significant, the industry would like to optimize the number of DOCSIS cable modems per home that actively communicate with the network in order to more efficiently use bandwidth and simplify network operations.
- The audio/visual entertainment network is seen as largely an island unto itself with limited interactions with other networks present in the home.
  - While communication with other networks is desirable, the set-top box is not seen as a focal point for voice and data delivery.
  - A/V efforts on home networks should concentrate on the issue of video redistribution of SDTV, HDTV, and, possibly, digitized analog video.

In the fall of 1999, CableLabs and its member companies surveyed home networking vendors on the questions of in-home network transport and access system interfaces. The primary lesson learned from this vendor survey is that if no action is taken, current market trends will likely create three separate home networks over which cable services will be delivered:

- A video-centric entertainment network based on 1394 technology.
- An IP data network for distribution of products slated for consumption by PCs and Internet appliances.

- A telephony network that uses a network interface unit (NIU) with an embedded cable modem on which "primary line" voice calls are distributed on the home's twisted-pair infrastructure.

It is important to stress that the above home networking scenarios are likely to evolve absent any proactive development efforts by the cable industry. That is, services connected to these home networks are unlikely to be customized to extend cable services over the home network segment to the benefit of customers. Moreover, this outcome limits the ability of cable operators to deliver services across the different networks. For example: In order to provide a call waiting message on the television, a message must be sent from the NIU serviced by one cable modem to the CMTS in the headend to the cable modem embedded in the set-top box, where it can be inserted into the video data for delivery to the television.

A number of factors, which set bounds on home network architecture, will allow cable operators to effectively extend and create new services over home networks, or permit the integration of a single home networking solution for all services and home locations:

- **Implementation costs**. Use of legacy wiring, installation costs, and component costs should be low enough to ensure a wide utilization of the architecture.

- **Varying service requirements**. The overall architecture should have components that address issues such as the transfer of high volumes of MPEG-2 video data and the provision of power to telephones as part of a primary line service.

- **Hardware divergence in an era of service convergence**. As IP and Internet-based products mature, a huge number of different hardware platforms are being developed in order to consume these services. In order to support network-based services, control of the service demarcation point is of strategic importance. The architecture should be constructed so that these natural market forces can be leveraged to the best advantage of the cable industry.

- **Divergence of business and technology strategies both inside and outside the cable industry**.

Given these strategic confines, the remainder of this document describes several technical issues concerning the extension of cable-based services.

Home Network Technical Issues

As a point of philosophy, consumers will only purchase and use services that provide value. In general, a consumer is inclined to purchase any service for which the perceived value exceeds the cost (this applies also to "free" services). If the performance of the home network degrades the quality of service to a perceived value that is less than the cost, then the customer will not purchase (or use) the service.

The primary considerations for ensuring quality service delivery over cable networks are:

- Support of varying levels of QoS.

- Network performance: Data rate, latency, jitter, and packet loss characteristics.

- Support of cable network management functions: Registration, Administration, Security (RAS), copy protection, billing.

- Support of cable network operations: Installation, configuration management, performance management, and fault management.

Overall, this issue involves a number of closely entwined matters including home network management systems, transport technologies, and protocol issues.

Home Network Management Systems

The widespread use of home networks, as part of the consumption system for cable-based services, will require "bullet proof" home network management systems. It is expected that if a customer consuming cable-based services experiences a problem, then the customer will no longer desire the service even if the source of the problems lies entirely within the functionality of the home network. The ability of a home network management system to appropriately distinguish between an access network-related problem and a home network-related problem will greatly enhance the value of the network to the consumer.

Transport Technologies

Four different types of transport media have been proposed for home network applications:

- Phoneline
- Wireless
- Powerline
- Special wiring

The choice of the technology best capable of supporting cable-based services is a complex issue and depends largely on the specific scenario of implementation. While there is no one technology that can service all applications, there is substantial evidence that phoneline and wireless technologies can serve a majority of scenarios. At this time, 1394 is a rapidly maturing technology for media and IP transport (Sony, NEC, etc.) and has been selected for OpenCable™ interface. Powerline and special wiring systems are in development that show some promise for the delivery of cable-based services. In order to effectively use the capabilities of any of these technologies, the requisite interfaces to the DOCSIS protocols must be developed. Vendors of all of the transport media home networking equipment have high data rate equipment with QoS hooks in development, which use protocols similar to the Ethernet-based technologies of phoneline and wireless technologies. These capabilities and the associated technology are, in general, not completely defined and must be adapted for use with cable-based services. Characteristics of wired transport media and wireless transport systems are summarized in Tables 1 and 2, respectively.

Table 1. Characteristics of wired transport media for home networks.

Wired LAN				
	HomePNA 2.0	MediaWire	1394	AC Wiring
RF Band	7 MHz–14 MHz	0 MHz–25 MHz	100 MHz–800 MHz	0 MHz–10 MHz
Digital Bandwidth	10 Mbps	100 Mbps	400 Mbps	10 Mbps
Wiring	Co-exists w/POTS	Uses POTS	New 6 conductor	Power wiring
Shipping Products	Yes	No	Yes (lower rates)	Yes (lower rates)

Table 2. Characteristics of wireless transport media for home networks.

Wireless LAN			
	HomeRF	802.11b	Bluetooth
RF Band	2.4 GHz	2.4 GHz	2.4 GHz
Digital Bandwidth	1.6 Mbps	11 Mbps	1 Mbps
Distance	Whole house	Whole house	Room
Shipping Products	Soon	Yes	No

Protocol Issues

Several key home networking protocol issues must be resolved in order to ensure the delivery of high quality cable-based products. These issues touch on the three primary CableLabs projects—DOCSIS, OpenCable, and

PacketCable™—and in some cases significantly overlap planned, in process, or already developed specifications of these projects. These issues include:

- Discovery of other devices and applications on the network
- Download Control
- Security (authentication, copy protection, firewalls)
- System Interfaces
  - Quality of service
  - Transport
  - Streaming protocol
- Network Management: Diagnostics and statistics

In some cases, different protocol approaches are used to solve similar issues (e.g., the security approaches on PacketCable and OpenCable). These differences are, in large part, driven by the nature of the specific products being delivered.

Conclusion

The extension of the fundamental bandwidth advantage of cable throughout the home promises to create tremendous value for both consumers and cable operators. The creation of seamless network interfaces will be a complex task involving network management systems, the performance of transport technologies, and network protocol issues. The solution for the delivery of multiple services must be closely coordinated with the CableLabs DOCSIS, OpenCable, and PacketCable projects to ensure that the consumer can enjoy a quality experience, regardless of the device of consumption.