RESIDENTIAL GATEWAYS: FROM THE INSIDE OUT

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Abstract

The Cable TV industry is undertaking one of the most aggressive initiatives in its 51-year history. The digitization of the cable TV network infrastructure is proliferating on a massive scale with equipment deployment, compliance testing, and specification setting all taking place simultaneously. At the same time the consumer electronics industry also has a major digitization initiative occurring. The next generation of home devices will not only be digital, they will also feature "in-home" networking capability. Though monumental, both of these initiatives are occurring somewhat independently. Without a common roadmap of features, functions, and specifications, these two industries will remain out of step in delivering new and innovative services and applications to the digital home.

This paper focuses on the digital network initiatives both the Cable industry and the Consumer Electronics industry are pursuing. Investigating the strategies of these initiatives will demonstrate that without a closer partnership between these two industries, the full capabilities of new digital technologies will not be realized by the end-user. Finally, this paper will address the need for the development of a residential gateway architecture to provide a solution as these two networks continue to evolve.

INTRODUCTION

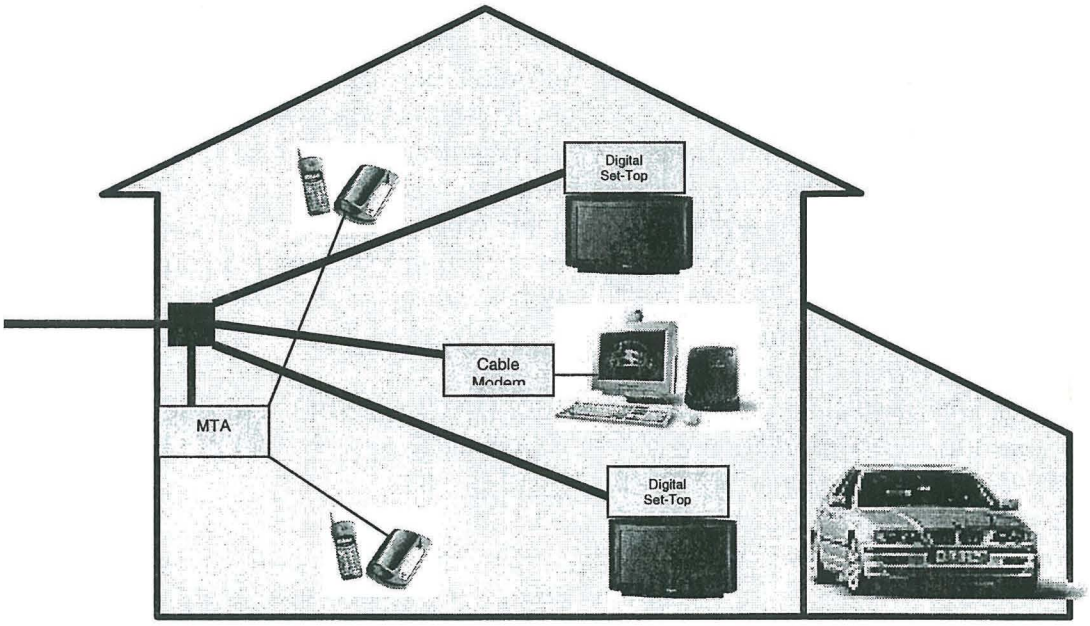
While many cable service providers and consumer electronics vendors will define their own versions of the digital home, it will ultimately be the end consumer who will shape this environment. Most all parties agree that the digital home will be a networked dwelling with connectivity to a digital cable network that delivers advanced services to the home and a consumer electronics network that delivers information and entertainment throughout the home. As these two networks are being defined, designed, and built, each one is evolving with specifications independent of the other. The result will delay successful integration of the digital home and the advanced services being delivered to the home.

THE DIGITAL BROADBAND NETWORK AND NEW DIGITAL TERMINAL

The Cable TV industry is actively progressing in the deployment of digital services. Through the leadership of CableLabs and the support of the major cable operators, the specifications for digital service delivery networks have progressed significantly. Though not completing these specifications at speeds that many would like, to veterans of standards processes, the results achieved to date would be the envy of other industries.

DOCSIS-based cable modems, OpenCable digital set-tops, and PacketCable IP telecommunications devices will all populate the new digital home of the future. Independently specified to offer high-speed data, digital video, and voice services, respectively, these new digital devices will also be

developed to deliver multiple services. For example, an OpenCable compliant digital set-top box can be equipped with a DOCSIS modem for two-way communications. This two-way communication would provide the capability to deliver cable modem service, as well as IP telephony and video conferencing. Additionally, cable modems could be used to supply not only high-speed data services but IP telephony services as well. Therefore, connection to the end devices (e.g., TVs, PC, telephones) will then become the next hurdle for the cable operator to overcome. The home wiring and installation challenges play an increasingly important operational role. Added complexity for provisioning and installing the new digital devices can limit the speed of rollout, and the result will be delayed success.



The process for interoperable standards

The time cycle to develop a specification and then utilize that specification for final delivery of interoperable products can take a considerable amount of time. In the case of cable modems, the DOCSIS process, gaining momentum in early 1996, resulted in CableLabs certified modems becoming available in March 1999. Both PacketCable and OpenCable specification processes are now ongoing. Therefore, any additional initiatives that extend beyond current DOCSIS, PacketCable, and OpenCable activities will have to factor in the element of time.

Current interfaces to the home

These digital specifications define many interoperability interfaces in an end-to-end system. Probably the most significant interface point is to and from the home. The interface within the home is usually dictated by existing standards (i.e., defined or de-facto). The current home devices interfaces are NTSC signals to the TV, Ethernet to the PC,

and twisted pair to the telephone. The NTSC video interface was defined more that 40 years ago and Ethernet was define more than 20 years ago.

	Analog TV	Digital TV	PC	Telephone
DOCSIS			Ethernet, USB, PCI	
Open Cable	NTSC Coax	IEEE 1394		
Packet Cable			Ethernet, USB, PCI	Twisted Pair

The home interfaces, to date, define connections directly to the TV, PC, or telephone. Connections to intelligent networks within the home are not being defined in the current Cable industry standardization initiatives. Home networks are becoming a growing market segment with the Consumer Electronics and computing industry actively defining specifications and products.

Consumer Electronics Industry

The consumer electronics industry sees market growth for new digital devices in the home. Recent CEMA figures show digital television penetration at 30% of US home in the year 2006. Enhancing the entertainment experience is the primary driver for these devices, though the information component of entertainment will continue to play a larger role in the home.

The sources of content continue to move from broadcast and stored media (e.g., tape and disk) to real-time availability of content and information. Therefore, an increasing reliance of network delivered content and information is impacting the way end consumers expect to receive these services. As a result, the home will grow with new digital terminals, but in order to take advantage of network available content, these new devices will need to interface seamlessly with the adjacent broadband network.

These new devices include

- Digital TVs (including HDTV)
- DVDs (Digital Versatile Discs)
- Digital Cameras (video and still)
- Digital VHS
- Digital Hi-Fi

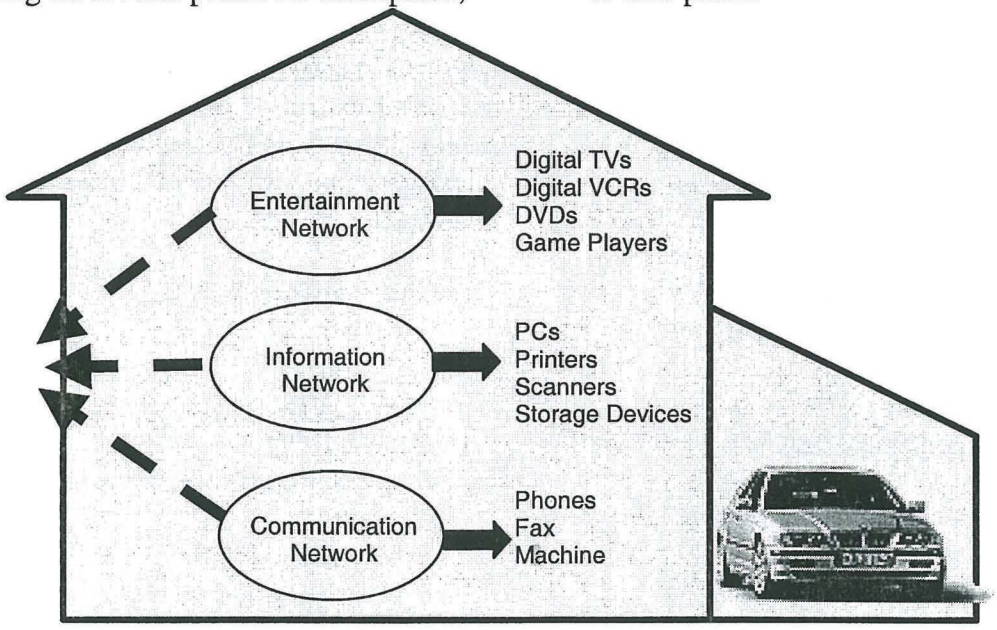
Containing processor intelligence, these new devices will be capable of communicating with other devices. The goal is to create new levels of user capabilities for entertainment and learning that are not possible today. With increasing deployment throughout the digital home, these capabilities will be expanded to involve home control and security applications.

With an eye toward the future, consumer electronics manufacturers clearly see the need to network these devices in an open and interoperable

manner. There are many industry initiatives that will drive the features and functions of the home network. Successful growth for home networks will occur only in an open standards environment. Interconnection with multiple devices from multiple vendors is the ultimate goal.

THE HOME NETWORK

Home networking initiatives are taking on several paths. As anticipated, there are several developments occurring in home networking. Shown below are several home networks that will connect devices in the home. These individual networks are classified as an entertainment network, an information network, and a communication network. Today, the terminal devices drive the architecture of these networks. However, as the differentiation of communication, entertainment, and information begins to subside with advancing technology, the convergence of these networks will start to take place.



The Communications Network consists of the in-home wiring today. Today's in-home twisted-pair wiring is an extension of the local exchange company network, with "dial tone" designed devices to connect with a central office. However, any in-home station-to-station connectivity must be done through the local exchange company switch.

The Information Network market approach resembles that of the office network. This allows PCs and peripheral devices to be networked together as more and more PCs proliferate in homes. Additionally, shared devices such as printers and scanners drive the need for networking. Application-based networking, such as gaming or Internet sharing, are also drivers for the Internet Protocol (IP)-based home network.

The Entertainment Network is in its infancy. Digital consumer devices can be networked together to either process or store entertainment content. Applications are starting to evolve that will allow multimedia to enhance the home entertainment experience. In order to tap the potential of these exciting entertainment services, standards must be set so that interoperability between different brands of digital devices can be interconnected.

Many industry alliances and consortia have been formed to set specifications for home networks. The alliances and consortia, such as Home Audio/Video Interoperability (HAVi), Universal Plug and Play, and Home API, are focused to create interoperable specifications for digital home devices and computing devices. Additionally, these initiatives allow for the development of distributed applications on the home network.

To accomplish this, the requirements for a home network consist of:

- The physical medium to connect the devices (e.g., power line, twisted pair, coax, wireless, optical)
- A set of software API to insure interoperability among terminal devices
- An addressing scheme that allows connectivity
- A defined execution environment that allows for control and 3rd party applications
- Capability to carry both asynchronous an isochronous data
- Easy user installation and management

THE HOME NETWORK ARCHITECTURE

The home network can be a peer-to-peer network or it can have a controller. It becomes both economically and technically important to define the level of interoperability between the home network and the digital cable network. Interoperability must go beyond the physical interface and take advantage of the networking capabilities being defined for the home. Without this interface, network services will only be available to TVs, PCs, and telephones with co-resident network equipment (e.g., set-tops, cable modems, and multimedia adapters). With this interface, the following applications can be realized:

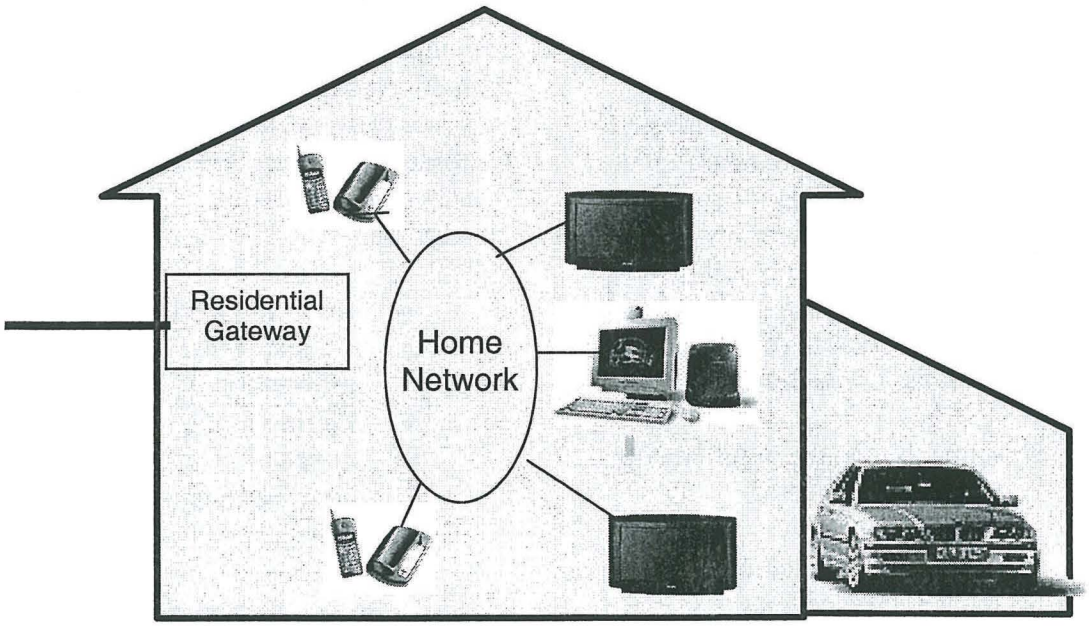
- Receiving a telephone call and displaying caller ID information on a TV window
- Starting a video-on-demand program, pause, and watch the remaining portion in another room
- At your PC, completing research on the web and allowing the results to be viewed by someone watching television in a different room, and saving the results on a common storage device
- On your PC, editing highlights of your daughter's ballet recital recorded on your digital camcorder, and then forwarding them to her grandparents' TV set.

These services become available only when the broadband network becomes interoperable with the home network. These services merely scratch the

surface for the type of imaginative applications that can be realized. Before this can occur, several issues must be clarified. Ideally, a gateway architecture needs to be established that will interface the two networks.

THE RESIDENTIAL GATEWAY

The Residential Gateway is positioned as the interface between the HFC broadband network and the home network. A Residential Gateway becomes the point of interoperability between the broadband network and the home network. As changes occur in the networks inside and outside the home, the Residential Gateway can "mediate" the changes without the need to update every home digital appliance.



This becomes the potential collaboration point between the two industries.

The major functional requirements needed for a Residential Gateway are:

- Distribution of different services to multiple digital terminals
- Provide access to home control functions
- Request network bandwidth and Quality of Service from the home network to the broadband network

The technical requirements for a Residential Gateway will help to determine if this gateway is network provided equipment, part of the home network, or a compromise between the home and the broadband network. These technical requirements are:

- Address resolution between home devices and network connections
- Memory and processing requirements to run the home network communications protocols

- Flexibility to interface with yet to be defined/invented home digital terminals

Residential Gateway Architecture

The Residential Gateway will evolve along two different paths. These will be a network centric path and a home centric path.

The standards and specifications of the Cable TV digital plant drive the network centric path. Many operators are looking to digital set-tops with a combined video, voice, and data networking capability as a residential gateway. The connection to the network is already being defined by the efforts of CableLabs and the digital specifications of DOCSIS, OpenCable, and PacketCable. The digital connection to the home is specified today with an IEEE 1394 interface initially defined for HDTV pass through. In order to expand that interface for home network functions will require a clear definition as to how the home network will interconnect the digital set-top.

With the rapid and diverse technical evolution of the home network, the interface from the digital set-top and the home network becomes difficult to define. Beyond the physical IEEE 1394 interface, the communications protocols and API need to be specified. Depending on which home network technology is to be interfaced, even the IEEE 1394 interface may change. Additional processing power and memory need to be allocated within the box to insure that all features and functions can be supported across this interface.

The Residential Gateway may evolve from the dominant home network technology that gets a successful foothold in the residential market. This gateway approach will evolve from the consumer side and will have network requirements that can use the current Cable TV digital specification initiatives. This residential gateway architecture operates as a home controller. The benefit of this architecture is that the gateway can be home network specific, regardless of the type of technology used in the home network.

CONCLUSION

As both the home network and the digital cable network evolve, new capabilities will continue to be introduced resulting in exciting new services, applications, and experiences to the end-user. As the cable industry continues to set forth specifications allowing new digital services to the home, these specifications must be expanded to look into the home, which includes the home network.

In this rapidly changing world of home networks, a residential home gateway will be defined, built, and deployed as an extension of the computing consumer electronics devices that are deployed.

To take advantage of new service opportunities driven by digital devices and home networks, the Cable TV industry must expand the current specification initiatives to take account home networks, which will become pervasive, as well.