Requirements for a CableHome Residential Gateway

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Abstract

Cable operators wish to deliver additional services to the end user in a reliable and controllable way. The IP-based home network is the natural infrastructure for delivery of these services in the home.

The CableHome initiative in CableLabs addresses the fundamental problems associated with having multiple IP devices within the home network: how addresses are allocated, how the home network is secured and how the multiple system operators (MSO) can manage this to ensure service delivery.

This paper presents CableHome from the MSO, end user and vendor's perspective.

The Potential of the Home Network for Delivery of Services

Potential and Problems

The home network connects multiple devices to enable the transfer of data to end-points within the home. This creates the opportunity to deliver new services to the end user.

The fundamental problem, however, is that home networks must share some common "look and feel" features to enable delivery of services in a reliable way. These require answers to questions such as:

- How are IP addresses allocated within the home?
- How does the MSO support problems within the home network?
- How do we ensure that the home network is secure?

The discussions of the CableHome[1] forum covered a wide range of potential home network architectures and reviewed the problems arising from them. The home network was divided into logical domains, and devices were categorized into several types.

Following the analysis phase, the CableHome forum focused on defining the requirements for the cable access device. CableHome 1.0 creates a foundation that guarantees home networks will have a consistent "look and feel" to enable services to heterogeneous devices.

Current Market Situation

DOCSIS 1.0 and DOCSIS 1.1 cable modems are bridging devices. This means that in order for several home devices to share an Internet connection, each device must receive an IP address from the MSO. This creates a provisioning burden on the MSO and the end user alike.

More and more users today buy a "home router" type of device to augment the functionality of their cable modem.

These "home router" boxes provide functionality such as a dynamic host configuration protocol (DHCP) server and Address Translation (NAT/NAPT), which allow IP communication between home devices and the global Internet, while requiring only a single IP address from the MSO.

These boxes also provide the end user with some level of additional network security. Most provide NAT functionality; some provide a packet-filtering or stateful firewall. The end user is not always aware of the significant difference in the level of security provided by these two.

Once a user installs a home router, the MSO's ability to support problems in the home network becomes very limited. The behavior of the boxes varies between vendors, and the likelihood of a MSO support call (or even a service visit) rises significantly.

In order to lay the foundation for delivery of services into the home network, these basic problems must be resolved. CableHome 1.0 addresses these issues.

CableHome 1.0 Overview

Devices Affected by CableHome 1.0
CableHome 1.0 is focused on the Home Access (HA) entity. The HA is composed of two components: the DOCSIS cable modem and a new logical entity called the Portal Services (PS). The PS may reside with the cable modem or in an external box connected via Ethernet/USB. Following similar naming convention to PacketCable[2], CableHome designates these two types as "embedded PS" and "standalone PS." An embedded PS is, thus, a cable modem with home router functionality.

In the case of "standalone PS," the additional device is an external "home router" box that complies with CableHome. "Home router" boxes that will comply with CableHome will be very similar to the ones available in the market today but will share the same "look and feel." This enables support from the MSO, optimizes utilization of the MSO's hybrid fiber/coaxial (HFC) plant and provides the infrastructure for the delivery of future advanced services.

Figure 1 illustrates these two options.
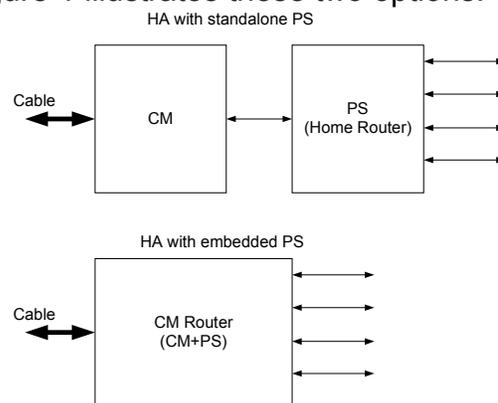
CableHome 1.0 Functionality Definition
1.0 covers the following major areas:
- *Addresses:* How IP addresses are managed within the home network.
- *Management:* With what tools, and to what extent, the MSO supports and controls the HA device.
- *Security:* How the home network is protected with a firewall, as well as the means by which the HA receives/ authenticates with the Head End (HE) and receives keying material.
- *QoS:* CableHome 1.0 defines very limited Quality of Service (QoS) for proper function of PacketCable devices.

Addresses in the Home

CableHome 1.0 defines a flexible means by which multiple devices in the home share a single connection to the external network and are allocated an external IP address used to communicate with the external network.

The HA is responsible for assigning addresses within the home. It performs that by incorporating a DHCP server, which assigns IP addresses within the home. The IP addresses in the home are local to the home network. When accessing the external network, address translation (NAPT) is performed.

Address translation is an effective mechanism for IP address sharing but can cause complications with peer-to-peer applications like telephony. As a remedy, CableHome allows specific devices to receive addresses in the external address domain, or with NAT address translation, thus providing maximum flexibility.

Securing the Home Network

CableHome requires a stateful inspection firewall to secure the home network. The firewall must be manageable by the MSO and enable the MSO to upgrade the firewall functionality via download of a new configuration file.

To ensure the integrity of the management messages delivered to the HA, CableHome defines additional security measures. The identity of the HA is authenticated using Kerberos/PKINIT (the same mechanism used in PacketCable).

Management

The MSO manages the HA with SNMP.v3 for protection against snooping and spoofing.

Figure 2 below presents a typical home network.

CM IP: 193.5.17.8
NAT IP: 193.5.17.9
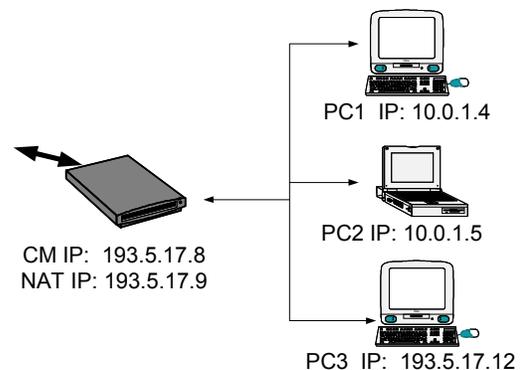PC1 IP: 10.0.1.4
PC2 IP: 10.0.1.5
PC3 IP: 193.5.17.12

Figure 2 presents a home network with three PCs. It assumes an HA with embedded PS (i.e. a cable modem with firewall/NAT functionality). PC1 and PC2 both have local IP addresses that were received from the DHCP server located inside the CM. PC3 gets its IP address from the DHCP server at the Head End. It is an address outside the scope of the home.
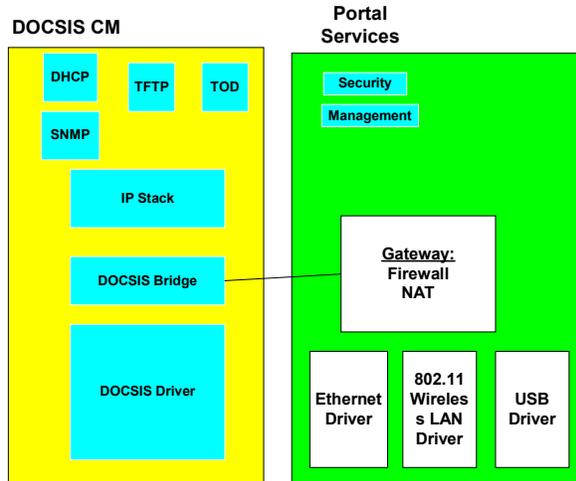
Implementing CableHome 1.0

The layer 2 bridging architecture of the DOCSIS 1.1 cable modem can be naturally extended (with straight-forward APIs) to support CableHome 1.0. The CableHome component performs firewall and NAT processing on packets after the preliminary bridging decisions by DOCSIS are completed.

A security engine (similar to the one in PacketCable) implements the work of HA authentication and key exchange.

Once authenticated, the simple network management protocol (SNMP) agent supports the CableHome MIBs for the management of the HA. Figure 3 illustrates the software architecture of an HA with embedded PS. The HA

contains two logical entities: the DOCSIS cable modem and the PS.

Differentiation

CableHome 1.0 defines the basic functionality that enables multiple devices in the home network to share a secure connection to the external network. For that purpose the HA device must implement the generic DHCP server, firewall, NAT/NAPT and security features.

Areas for vendor customization include such features as VPN support and parental control, as well as the look-and-feel for the end user. Individual vendors will present different content in local Web pages that the user can browse in order to view and modify the box's configuration. To enable this, boxes will likely include DNS and HTTP servers. As well, CableHome does not require any specific physical networking media within the home. Some vendors might offer Ethernet within the home; others might offer a wireless 802.11 access point. All can be CableHome compliant.

Today a cable modem with a single Ethernet port is a simple bridging device. In the future, even these "low end" cable modems may include CableHome functionality, providing the user with firewall security as well as a simple means to enable more than one PC in the home. The user just needs to buy a hub and connect it to the cable modem. Sharing the Internet connection will already be taken care of by the HA component inside the cable modem box.

End User Benefits

A box displaying the CableHome 1.0 sticker will provide the end user with the following benefits:

- *Internet connection sharing:* Ability to share a single Internet connection for multiple devices in the home.
- *Enhanced and well-defined security:* A firewall that can be managed by the MSO and upgraded with new policies.
- *Simple installation:* Devices are easy to install in the home.
- *Support:* Support is available from the MSO if problems arise.

External CableHome Devices

Today there are already millions of cable modems out in the field doing simple bridging only. Users today solve the problem of Internet connection sharing by buying a home router device.

It is expected that in the future, retail users will be able to buy home routers that bear a CableHome sticker. Once CableHome routers are readily available, users will naturally prefer to buy one that has the CableHome sticker.

Next Steps

QoS
CableHome 1.0 addresses QoS in a very limited manner, ensuring PacketCable traffic is handled correctly. It does not provide infrastructure for applications that require well-defined committed throughput and latency. Such an infrastructure will be needed for time critical applications such as voice delivery, video delivery and gaming.

Managing IP Devices
The CableHome 1.0 spec manages only the HA element. It does not specify how IP devices within the home will be managed to ensure they receive the data that is intended for them. Note that the current CableHome 1.0 does provide some visibility to the IP device performance via the CableHome Test Portal.

Conclusion
From an MSO, end user and vendor's perspective, the IP-based home network is the natural infrastructure for delivery of additional services in a reliable and controllable way.

Refererences

[1] http://www.cablelabs.com/cablehome/
[2] http://www.packetcable.com

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