Abstract

With cable subscribers consuming more services on a wider choice of devices, operators are actively architecting their networks to meet this demand while keeping associated costs under control. Media gateways are just one technology that can play an important role in enabling cable operators to integrate residential gateways with applications such as whole home digital video recorder functionality, and extend media (data, video, music, voice) offerings to subscribers anywhere, anytime on any device, with a common UI and seamless user experience (UX) based on unified CA/DRM.

This paper will discuss key elements and considerations in architecting a media gateway for cable systems that addresses the full scope of functionality and affords operators maximum choice going forward. It will look at the benefits and challenges in deploying a media gateway in the cable home today. This paper will also examine the various home networking interfaces such as MoCA, Ethernet and/or wireless, gateways, and how best to build a solution that enables the maximum number of IP devices to access services. It will examine the potential for media gateways to include remote management systems that enable control of gateways and connected devices, and help provide content discoverability and an optimized user interface.

Background

Rapid technological change has increasingly made it possible for consumers to access any digital service on any device, at any time and at any place. This change has been driven by the decreasing costs and increasing capacity of crucial technologies such as storage, networking, positioning and adaptive user interfaces (e.g. camera, touch, gyroscopes) all of which have enabled the proliferation of ubiquitous Internet Protocol (IP) based services on a profusion of new devices and screens.

At the same time, the consumer has changed as well. A younger generation does not remember a time when they could not access TV content on demand (whether by DVR or network streaming) or a time when communicating with friends was more than a few clicks away.
Older generations also find it easier to adapt to new technologies thanks to rich graphical user interfaces and easy connectivity to ubiquitous networking standards such as WiFi.

For a cable operator to meet the ever increasing expectations of consumers, it is imperative that they deliver their own IP based services to new and existing platforms, optimizing the use of new device technologies while at the same time extending and enhancing the capabilities of their existing (legacy) consumer premise equipment (CPE) devices.

If deployed properly, a new IP based service platform can lure new customers and retain existing ones without significantly increasing acquisition costs. If deployed improperly, these same technologies can result in ever increasing customer retention costs.

Media gateway technology is an important tool for delivering IP based media services into and out of the consumer’s home. A “smart” or managed media gateway simplifies the acquisition and consumption of personal and premium media content. An extensible media gateway includes a software environment that is easily upgradable as new services are introduced. And for many operators, a hybrid media gateway simplifies the introduction of new IP based services by transitioning these on top of an existing and robust legacy transport infrastructure.
Media Gateway Architecture

There is no single overriding Media Gateway architecture that meets the needs of every single cable operator. Each operator must select the gateway features, both hardware and software, that reflect the exigencies of their own specific network topologies and operational factors. Indeed some operators may find that they may need to deploy several different types of gateways concurrently (e.g. PON and DOCSIS based) to optimally meet their system requirements.

No matter the features that are initially deployed on their media gateways, the cable operator can expect to be under continual competitive pressure to deploy ever more advanced services through this gateway. Therefore it is imperative that the gateway is designed in a modular fashion that facilitates the deployment of new technologies and services. Though it is difficult to predict such future technologies, past experience indicates that these challenges will include the deployment of ever improving communication and media protocols as well as the ever expanding use of converged sources of IP accessible data.

There are a large number of existing technologies that should be considered when architecting a Media Gateway today. These include access and home network standards, remote management, media formats, graphical user interfaces, application frameworks and service delivery technologies. This section provides an overview of these technologies that must be considered when architecting a media gateway.

Connectivity

A media gateway that is attached to a consumer’s home network or local area network (LAN) facilitates the distribution of the consumer’s own content to multiple devices. A media gateway that performs this same function for cable operator-supplied premium content must also consider additional security and performance requirements. If the gateway bridges the home network to an external or wide area network (WAN, e.g. a cable operator’s access network), then the gateway may need to consider distribution of home based content to devices outside the home, as well as the distribution of external content into the home. All of these capabilities are dependent on the type of network interface technologies included within the media gateway.

WAN

A cable operator-supplied media gateway functioning as a bridge between the external access network and the home network may include not only the cable network interface (DOCSIS 3.0, PON) but also might include the home router functionality that consumers have traditionally deployed on their own.
There are a number of advantages to including home network management in the media gateway. One advantage is that the managed WAN interface provides the cable operator with complete IP visibility to every device and application accessing their content. Another advantage is the opportunity for the cable operator to provide IP home network management services for their customers including the ability to meet guaranteed service level agreements for IP services to any device on the home network.

To function as a home router, an IPv4 based residential gateway must implement Network Address Translation (NAT) routing and firewalls. Unlike traditional home routers, a managed media gateway may include pre-configured user profiles to facilitate the delivery of managed IP services, for example through the use of IP multicast or DOCSIS bypass technologies.

For cable operators that are contemplating the rollout of both PON and DOCSIS technologies, the media gateway hardware may be architected to support the physical replacement of the cable network access interfaces, enabling a single CPE device to support either of these interfaces (as well as support for Gigabit-Ethernet interfaces). The media gateway hardware may also include other access network functionality such as a PacketCable Media Terminal Adaptor or Femtocell for the linking of home telephones to an external wireless network.

**LAN**

A media gateway that functions as a router between the WAN and in-home LAN must implement all the standard IP communication services for the home network including Domain Name Services (DNS) and Dynamic Host Configuration Protocol (DHCP). The media gateway may also be expected to support additional IP signaling protocols such as Internet Group Management Protocol (IGMP) for acquisition of multicast IP services, Session Initiation Protocol (SIP) for media communications session management and Differentiated Services Code Point (DSCP) for quality of service management.

For physical LAN interfaces a media gateway will generally support 10/100/1000 (Gigabit) Ethernet interfaces. However, if the media gateway is going to replace a consumer’s home router, it generally will be required to support a Wireless LAN (WLAN) interface such as WiFi, of which 802.11n is the latest iteration supporting up to 600Mbit/s. WiFi has become ubiquitous because most consumer residences have lacked Ethernet connections in every room.

Another approach is for the media gateway to support in-home wire-line networking, taking advantage of the physical connections that already exist in the typical residence including phone, power or coaxial cabling. Wire-line technologies avoid the inconsistent quality that comes with the use of more noisy wireless IP standards. A managed media gateway implementing a wire-line standard technology can be assured of consistent bandwidth and guaranteed quality of service for the transport and consumption of the operator’s premium media content.
Recently a number of wire-line technologies have been standardized. These include Multimedia over Coax Alliance (MoCA®). MoCA version 2.0 supports up to 1.4 Gbit/s bandwidth. MoCA is limited to using coaxial cable, which is generally not found in every room of the house. Another standard called HomePlug AV2 has enabled up to 600Mbit/s over power lines that are generally located in every room. G.hn, a recent ITU standard, promoted by the HomeGrid forum, is expecting to support these same bandwidth speeds and is designed to be implemented across every type of household wiring (but which will be incompatible with other wire-line standards like MoCA).

The hardware and software to support these home network standards may be built-in to the media gateway directly or may be attached to it in an upgradable fashion. The media gateway may support extensibility through the use of standard USB or e-SATA ports. USB 2.0 supports up to 480Mbit/s while USB 3.0 may support up to 5Gbit/s. For example, USB 2.0 is sufficient to support existing gateway adaptors for a number of home networking standards such as Bluetooth® for remote control interfaces and Zigbee for home automation application including power, temperature and health monitoring.

**Hybrid**

Perhaps the most flexible media gateways are those that support multiple network inputs, though at the same time these are more expensive than dedicated gateways with a single type of input. An example of this type of hybrid gateway is one that supports traditional QAM / MPEG2 based broadcast video delivery while concurrently supporting a DOCSIS / IP based video delivery solution. Regardless of the method of transport over the cable operator’s access network, the media gateway transforms all media into a format that is suitable for managed distribution over the home IP network.

Use of legacy QAM broadcast delivery is advantageous because it avoids the need to scale the access network to support the additional delivery of IP versions of popular broadcast services, while at the same time supporting delivery of these service to next generation IP devices in the home network.

**Management**

Managing and monitoring the interfaces between the media gateway and other connected devices is an important role of the gateway. In the case of an operator managed gateway, both the operator and the consumer need to have the ability to analyze their network connections. Monitoring is not necessarily limited to network connectivity, but may also include application level monitoring, to provide quick resolution to service affecting problems. A number of standard management protocols are expected to be supported in media gateways. Depending on the activities monitored, these might include both the TR-069 and SNMP standards as well as proprietary formats.
It is important to note that monitoring and management standards are simple protocols. Smart software is required, both within the gateway and within the network, to provide adequate visibility into the complex interplay of application logic. In order to expose a simplified user interface to end users, and to provide advanced information to qualified users as well as customer support personnel, this management information must be translated and formatted by dedicated management systems.

Managed media gateways may collect usage metrics and report these back to operators using standard or dedicated protocols. This information can be used by operators to proactively resolve network issues before they become customer affecting. Examples include QoS and QoE metrics, RF noise levels on physical media connected to the gateway, disk storage capacity or disk read errors.

**Media**

The primary purpose of a media gateway is the delivery of media content to any number of connected devices. An operator managed media gateway may choose to deliver this content over proprietary or standard mechanisms. In addition, the gateway may utilize persistent storage to cache media or to permanently store it. For premium content, additional security mechanisms may be required to protect this content from unauthorized use or theft.

**Interoperability**

Digital Living Network Alliance (DLNA) is a standard that has been widely adopted by consumer electronics companies for the sharing of media content. DLNA relies upon a protocol called Universal Plug n Play (UPnP) which is the most widely deployed device-to-device IP protocol enabling zero-configuration device and service discovery. These standards permit the media gateway to acquire information about personal media stored on persistent devices within the customer’s home network, and to expose these assets to other devices on the home network or even outside the home.

DLNA is being extended with a commercial video profile (CVP) that will enable the standard to also support premium content delivered by cable operators through the media gateway to other compliant devices within the home network. These devices are expected to include consumer owned devices such as PCs, televisions, game consoles, tablets, and mobile devices as well as both consumer and operator controlled set-top boxes.

**Storage**

It is likely that the Media Gateway will contain internal storage, but that is not an absolute requirement. A gateway may utilize IP protocols such as DLNA/UPnP or even the Network Attached Storage (NAS) protocol to acquire content from storage devices over either the WAN
and LAN interfaces. The gateway might also utilize physically attached storage devices using either USB or e-SATA.

Each type of storage has advantages that facilitate specific types of gateway application. For instance, a gateway that utilizes internal or attached storage is less affected by network delays in the local processing of media files. This is important if the media gateway is responsible for implementing a multi-room DVR application within the home network.

The gateway might only have a small amount of internal storage to facilitate caching, which would be inappropriate for a DVR application. In this case, caching might be used for a live pause application or for acquisition of adaptive streamed media from the Internet. Such an architecture would create a greater dependency on the home or access network to enable the gateway to access external storage in order to persist recorded DVR content.

**Formats**

At one time all broadcast television content was designed to be viewed on television sets with relatively small differences in screen sizes. Today, that is no longer the case. Every consumer device is designed with a different screen size and graphic processing capability. To avoid unnecessary processing and network transport costs, it is ideal for a gateway to deliver media content in a format that is optimized for the display of the devices to which it is serving the content.

Content compression standards such as MPEG4 enable television content to be compressed to suit most screen characteristics. This compression may be performed dynamically by efficient, dedicated (and therefore expensive) hardware or by less efficient, general purpose hardware and software. These processing requirements will influence how much content can be acquired simultaneously from a media gateway and thereby limits the number and type of connected devices that the gateway is capable of supporting.

Content does not have to be formatted or transcoded by the media gateway. This function might be offloaded to an external processor, for example the cable operator might perform this function in the network, or might enable consumers to perform this function on their own personal computers. But it should be noted that even if transcoding were to occur externally, content handling functions within the gateway may still be required to properly route the content between the external processor and the consumption device.

**Security**

Any discussion of content formats must address security concerns. Content formatting generally requires access to unprotected digital content in a compressed format which may easily be redistributed or otherwise used in an inappropriate manner.
Gateway hardware may be utilized to secure content transformations. For instance the system on chip (SOC) silicon hardware used by many media gateways includes security functions that can be leveraged to protect content during these format transformations. If content is transformed in software, then security hardened software needs to be utilized to minimize the security threats. Digital Rights Management software generally provides this kind of functionality.

It should be noted that performing content transformations outside of the media gateway may reduce the media gateway security requirements but not eliminate them completely. If the gateway is interfacing with a consumption device using an industry standard protocol such as DLNA or the High-Definition Multimedia Interface (HDMI), then clear content may be exposed during the link layer encryption process required by these standards. DLNA specifies the use of Digital Transmission Content Protection (DTCP) and HDMI specifies the use of High-bandwidth Digital Content Protection (HDCP) as link layer protection technologies. To protect the content during these transformations, either hardware or software mechanisms must be utilized.

For hybrid media gateways—or, for that matter, any gateway that receives broadcast content—the protection of the broadcast (or global encryption key) is another important security function. This is because the broadcast key is simpler and less expensive to redistribute than content files, and is correspondingly more valuable. A gateway that receives conditional access protected content must protect the broadcast key in addition to the content. It is important to note that Internet delivered content should also be considered broadcast content, because every receiving device is consuming a common encrypted content file that utilizes a common encryption key.

**Service Delivery**

Though service delivery functionality is not specific to media gateways, the delivery of these services may be facilitated through the use of a media gateway. These functions include the transport, management and securing of applications and associated metadata to the media gateway or to connected devices.

**Transport**

As is the case with content delivery, the media gateway may leverage local persistent storage (either attached or accessible from LAN side interfaces) to cache applications or related metadata for use by the gateway or connected device. Use of local persistent storage minimizes application dependencies on the access network and may significantly increase the performance of these applications.
Examples of applications that may take advantage of local storage include user interfaces (e.g. electronic program guides), multi-room digital video recorders (DVR) and client ad insertion (e.g. inserted at the CPE device). Local storage, whether on the gateway or connected device, enables the application to function independently of the access network, for instance when a network return path is down. Local caching also reduces network concurrency scaling requirements by minimizing the number of network requests (for example limiting the number of network requests required to display an electronic program guide (EPG) during prime-time television viewing).

Applications such as widgets may also be cached in local storage. An operator supplied media gateway would be able to access local storage to deliver device specific applications to each connected device (e.g. Flash, HTML or other formats such as iOS, Android).

**Management**

The media gateway may be used to manage and monitor operator supplied services within the home network. For instance if the gateway is used to access operator applications and data cached locally, then the gateway provides a common collection point for service usage metrics.

The media gateway also provides a control point for operator-supplied application frameworks. For example, asynchronous event notification (such as the receipt of a telephone call, email, or voicemail) may be locally resolved in the gateway providing a common function for all applications to utilize this information. Another example is a local resource controller on the gateway, assuring the network operator that the gateway will not request more services than the access network is capable of supplying (e.g. fast channel change, VOD concurrency limitations). In a hybrid gateway, this resource manager might also control access to limited local resources such as disk space or available QAM tuners.

**Security**

When a media gateway is supplied by a network operator, this device can function as trusted network security proxy. This security proxy function would be predicated upon the use of a secure device boot-loader to assure that only operator signed and approved applications can execute on the gateway. As a result of this local trust model, the network operator may decentralize some of their network access controls. For instance, connected device registration may be initiated directly through the media gateway and all subsequent communications with the operator’s network may originate only through the media gateway, assuring authentication of the application context and all related messaging.

Content consumption business rules might also be delegated to the media gateway, assuring that content may be accessed on all devices in a home network, even when disconnected from the access network. Though standard copy protection interfaces like DTCP-IP and HDCP will utilize very simple content control information (CCI) messages, a DRM system deployed on the
media gateway would support much more complex rights management scenarios as well as enable secure content storage on any device. One example is the ability to entitle devices to skip commercials on local DVR recorded content. Other examples include the ability to limit access to content for specific device types, at specific times or in specific locations or the ability to transfer ownership over locally stored content between devices or users.

User Interfaces

The media gateway may include a number of different user interfaces. For a media gateway that functions as a home router, a management interface may expose local configuration options for the home user, optimized for the “lean forward” experience of a PC user. If this media gateway also attaches to a television, then the same device may expose a different entertainment interface that is optimized for the “lean back” experience of television viewing.

The media gateway software (often referred to as middleware) will determine what types of applications may be deployed. For instance, some media gateways will support a Flash application execution environment, while others will utilize only a HyperText Markup Language (HTML) application server.

The media gateway may output an operator branded user interface in a number of different formats, optimized for each type of connected device. For instance, a media gateway might output both a standard RUI format for consumer owned devices, while at the same time outputting an optimized user interface for operator owned devices.
Media Gateway Deployment Strategies

Broadcast television remains one of the most efficient technologies for delivering mass quantities of popular content to the greatest number of people. But broadcast television is no longer the only content delivery medium available for today’s consumer. Ubiquitous broadband connectivity now permits every consumer to pursue their own individualized content consumption strategy. For some this will involve frequent access to news summaries from a handheld mobile video application, while for others this will include day long sessions immersed in massive multi-player games.

This audience fragmentation means that the broadcast television market share will continue to shrink as new services are introduced to consumers. But broadcast television will never disappear completely as long as consumers enjoy the shared social experience of live television, whether through popular reality shows like American Idol, or through major sporting events.

Today’s cable networks are optimized for broadcast media delivery. Generally speaking, cable broadband capacity today cannot handle the wholesale switchover to IP based media delivery, especially if this includes the elimination of broadcast television. The decreasing deployment costs of DOCSIS 3 are expected to eventually make it feasible for any operator to switch to an all-IP based delivery. This IP transition will occur at a different rate for every operator as they balance their product mix against the fluctuating demands of consumers for various types of media.

This section describes deployment strategies that cable operators can utilize to meet these evolving market demands.

Content Consumption

Bandwidth

For the foreseeable future, cable network bandwidth over access networks will remain constrained due to the competing requirements of legacy and next generation applications. The plethora of new IP services is expected to place even more pressure on the management of this “last mile” bandwidth.

The simultaneous delivery of both IPTV and QAM versions of a television channel over the access network could be avoided through the use of transformation technologies – for instance by transforming IPTV services into digital QAM services for delivery to legacy CPE or alternatively by transforming legacy QAM services into IPTV services for delivery to next generation CPE.
A media gateway situated between the access network and the home network enables the operator to avoid the duplicate delivery of a digital service in multiple formats. One example is a media gateway that inputs legacy QAM services and outputs IP services. Another example is a media gateway that inputs IP services and outputs either analog or digital QAM services for legacy CPE. In either case, a hybrid media gateway supports the output of both legacy and next generation services, passing through these services to CPE devices in the home.

Deployment of a hybrid media gateway architecture enables a flexible migration of legacy services to next generation formats without requiring the expensive duplication of bandwidth on the access network.

**Scalability**

The gateway architecture that is chosen by each operator reflects the scalability and robustness characteristics of their IP access network – which will change over time. The Media Gateway architecture represents a technological trade-off between the positioning of service and application logic within the consumer premises and the positioning of this logic further up in the access network.

By positioning more application logic in CPE devices, the cable operator minimizes network dependencies and reduces network scalability requirements. On the other hand, by positioning more of the application logic outside of CPE, the operator can achieve lower device integration and operations costs.

A representative example is the live pause of broadcast television channels. When local storage is utilized, the access network is unaffected by any number of concurrent local DVR recordings. When network based storage (outside of the consumer’s premises) is utilized, the operator must scale the network to meet multi-user concurrency requirements for even the most popular live events. Network based application response time cannot be less than consumers have come to expect from competitive DVR services. To achieve sufficient quality of service, the operator must scale network based application servers to meet the worst-case demands, typically prime time access of the most popular programs. On the other hand, relying upon network based application servers can reduce the need to perform CPE specific integrations as any network supplied DVR service will be treated the same as any other streaming video service.

An operator need not be limited by these two extremes. For instance, with smart software, a media gateway that supports both local and remote storage could flexibly support both local and remote network applications, allowing each to scale independently, or to cooperatively assist each other. As network capabilities scale up, individual application and services may be granularly migrated from the CPE device into the network. Alternatively, local resources may be used to opportunistically avoid the massive scaling of network resources (as the live pause example demonstrates).
Other media gateway functions besides storage are similarly affected by network scalability. For instance, sharing media between a gateway and a connected device may require content format transformations to suit the CPE device requirements. An operator may choose to account for the most prevalent forms of content transformation directly on the media gateway device, thus avoiding the need to perform these transformations on the network. For instance, as the operator tracks CPE devices registered on the home network, pre-provisioning of properly formatted media within a local storage device would avoid the need to perform real-time encoding either in hardware on the gateway or elsewhere within the network.

**Content Discovery**

Next generation IP services from cable operators will directly compete with similar types of IP services from competitors. The quality and quantity as well as availability of media content will play a big role in this competition. For consumers to fully appreciate these attributes of their service, a cable operator’s user interface becomes a critical factor. In this regard, content discovery is even more important than content consumption. Content discovery includes the ability to search for content in a flexible manner by any type of content attribute, as well as tools to recommend and promote content based on any type of consumer attribute.

**Human Interfaces**

Content discovery is highly dependent on the physical human interface technology that is available to consumers on each type of device. For example, touchscreens facilitate the rapid arrangement of items because human touch is not limited to grid-like patterns. Similarly, microphones and cameras can facilitate arrangement of content via sound or visual attributes that would not be easy to categorize by use of keyboard or keypad data entry.

The ability to leverage multiple human interface technologies to facilitate content discovery is expected to be an important factor in differentiating between the user interfaces from competing service providers. For example, by using a multi-touch capable tablet device as a remote control for a large screen television, the consumer benefits from the simplicity of searching for content on a tablet with the value of viewing that content on a larger screen.

**Presentation Standards**

There is not going to be a single “standard” presentation technology for deploying an operator’s branded user interface across multiple device types, at least not in the foreseeable future. Device specific human interface capabilities (e.g. multi-touch, large screen) will remain an important factor affecting the types of applications that will be presented to the consumer on each device type, and the manner in which these applications are presented.

The popularity of devices, and the presentation technology that these devices utilize, will be an important consideration in the manner by which a cable operator prioritizes the next
generation applications that they plan to deploy. For example, the recent deployment of Java virtual machine (JVM) based middleware for tru2way has enabled operators to deploy applications written in Java. Similarly, the popularity of Android mobile devices will influence operators to deploy their applications in Android which uses a Dalvik virtual machine technology. Consumer popularity for Apple iOS based phones and tablets will also influence an operator’s decision to deploy their applications in these proprietary frameworks.

**Remote User Interface**

Some remote user interface (RUI) technologies such as CEA-2014 (based on HTML4) or the coming deployment of HTML5 compliant web browsers will eventually enable cross-platform application development and deployment across device types. However, these RUI technologies may place limits on the developer’s ability to implement device specific optimizations, or the use of device specific features. To overcome these limitations, use of the device’s native application framework may be preferred.

Still the ability to write applications that run across device types helps to lower the overall cost of application ownership and therefore can be expected to make RUI technology popular for cable operators.

Another important advantage of RUI technology is its ability to offload the application execution context, thereby reducing the processor requirements on the presentation device. For instance, the application logic for a search query may be optimized by using a network device with access to larger processing capabilities and storage devices. The small processor on a CPE device will never be able to achieve the same results as a dedicated network processor because it takes much more time to parse through the same amount of data, even when the network process is performing this function for large numbers of concurrent CPE devices.

In addition, the presentation function itself may be offloaded to external processors by use of technologies such as RVU. RVU delivers bitmaps to enable the CPE device to display an image of a screen that is being drawn remotely on a separate processor.

**Topology**

The media gateway function may reside at any number of physical locations, both within the consumer premises as well as outside of it. Many operators are seeking to reduce or even completely eliminate the need to provide operator supplied CPE devices to their customers. This goal may be achieved over time as more and more consumer devices, especially connected televisions, adopt a common set of standards such as WiFi, DLNA and HTML5 browsers.

However, the very large pre-installed base of existing “disconnected” televisions will continue to demand operator supplied network interface equipment for the foreseeable future. Existing
leased set-top boxes may be able to meet much of this demand as long as the operator is able to continue to deploy newer advanced services and user interfaces on these devices.

In many parts of the world, for example Europe and North America, it is not uncommon to find households with three or more televisions. Deployment of an operator supplied media gateway may cost less than the deployment and ongoing support of legacy CPE. The combined cost of an operator supplied media gateway and IP clients may be less than the cost of an equal number of legacy set-top devices, especially those offering an equivalent level of service, plus the gateway can also support consumer supplied retail devices.

There are both “headed” and “headless” versions of an in-home media gateway. “Headed” refers to the fact that the gateway may also act as a set-top box, being able to connect directly to a television through either analog or digital interfaces such as HDMI. Use of the headed model is advantageous in that it reduces the number of connected devices that need to be supplied by the operator. However, the Headless approach may be more advantageous in some circumstances because the gateway can be physically reside in a location independent of the television. For a WiFi enabled gateway, the television may not be optimally positioned to transmit to the whole home.

There are other gateway topologies that physically position the gateway outside of the home. These external gateways may be physically placed on the outside of the home or indeed anywhere else in the “last mile”. The advantage of these external gateways is that they can be scaled to support multiple households, perhaps in some models even scaling to support entire nodes. Through virtual machine technologies, such gateways may be scaled to support a large number of application contexts – sharing and thereby optimizing the use of common resources (e.g. processor, memory, tuners) across multiple households. An operational advantage of these external gateways is that they may be accessed and upgraded without having to interface with customers, significantly reducing truck-roll costs. However, as with any network based option, these gateways must be scaled to support the worst-case shared resource contention requirements of the connected devices.

It is important to note that these various gateway technologies are not mutually exclusive. Cable operators that have already deployed leased multi-room DVRs may be able to upgrade the software on these devices to function as media gateways. Over time new hardware and software may be added to support upgraded functionality such as newer home networking technologies.
Other

There are many additional factors that affect the deployment characteristics of a media gateway. Perhaps the most significant non-technical factor is the influence of regulation. In every region of the world, broadcast television has been regulated in one form or another. One justification for this has been the influence of mass media on the political process. Other factors such as universal accessibility and national security requirements have also influenced television regulation (e.g., closed captions / subtitles and emergency alerts). A media gateway that functions as a broadband access point encounters additional broadband regulations that are generally designed to ensure ubiquitous and/or equal access to Internet services (e.g., broadband plans, net-neutrality). More recently, government regulations on home electronics have sought to reduce the energy impact of these devices – which can be especially difficult for IP connected devices responding to programmatic controls for periodic network updates. In general, the more functionality that a media gateway performs the more likely that it will become subject to some form of governmental regulation.

For operator supplied gateways, other commercial factors must be considered. Existing content provider agreements may limit or exclude certain kinds of content from being transported or consumed by the operator, but such restrictions may not apply to consumers. These restrictions might for example limit the ability of the consumer or the operator to stream their recorded content through an operator supplied gateway to external devices. There may be other advanced features that are found on consumer owned gateways that might have to be replicated such as Dynamic DNS and Home VPN support.
Conclusion

Deploying a managed home network in order to deliver advanced services is a competitive imperative for most cable operators. But the competitive benefits of such deployments could be easily offset by additional operational costs if the managed gateway solution is not designed to avoid these costs.

Customer support costs will increase if customers come to expect a similar level of service on all home network devices and if the operator is unprepared to deliver this. Though in theory all devices with a standardized interface should act in a similar manner, in reality this is rarely the case.

A way to avoid these additional operational costs is for the cable operator to limit support to specific home network devices. However, competitive pressures will probably not make that a tenable option. Alternatively, a phased approach is a sensible strategy for operators to ensure that a gateway will support any connected device or standard interface, over time. Such a step-by-step approach ensures that cable operations support staff can be properly trained to support the use of new devices, or at least to recognize what features a standard technology is capable of supporting (e.g. limited access to highlight fonts on a particular device type).

Upgradable and smart gateway software can be used to significantly reduce support calls in the first place. By self-identifying service affecting issues, the managed gateway can communicate with users via on-screen displays, web portal messages and even audio messages on connected telephones. If a service issue can be self-corrected by a home user, then software wizards can help the user with these tasks, avoiding the cost of involving an operator’s customer support personnel.

One example is the identification by the media gateway of a new device attached to the home network. If the gateway contains software that identifies the new device as one supporting cable operator (or approved third party) applications, then during device registration the gateway may alert the user regarding the availability of such device-optimized applications, thereby minimizing the device support costs that might arise from the use of less optimal device-agnostic interfaces. Even if a standard based interface is the only one available on a particular device, then a “first use” wizard could walk the user through the limitations of the standardized interface, thereby avoiding the possibility that the operator’s customer support personnel will be contacted.

An equally important aspect of smart gateway software is its ability to provide detailed visibility into the transport, service and application level protocols being utilized by cable operator customers. Only through such management interfaces can cable operator support personnel quickly resolve real-time customer affecting issues, or through the on-going collection of metrics avoid future problems. Such metrics also help operators to better
understand their customers, and thereby streamline the introduction of new devices, new features, as well as on-going network optimizations, all without affecting their customers.

There is no better time than today for operators to launch new media gateway functionality. Though there may be cheaper hardware or faster software in the future, current gateway functionality is more than sufficient to meet customer demands, and to withstand competitive pressures. Though there are lots of choices and trade-offs that should be considered, perhaps the most important consideration is upgradability. As long as new hardware may be added without affecting existing deployments, and as long as new software features may be field upgradable, then operators can be assured that they can continue to keep up with new standards and technologies, even as they strive to be the best service providers in the market.