Networked Digital Media Standards
A UPnP / DLNA Overview

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Executive Summary

Over the past few years, consumers have embraced digital technologies. Driven by broadband links to the Internet, wired and wireless home networks, and digital devices such as music players, digital cameras, and personal video recorders, they are acquiring, enjoying, and managing a flood of digital content. All of this "digital entertainment" has led them to demand device interoperability, so that they can easily share their pictures, audio, and video throughout their home.

In response, the leading manufacturers in the Consumer Electronics, Mobile Device, and Personal Computer marketplaces have banded together to create an interoperability solution for their diverse products. This organization is the Digital Living Network Alliance (DLNA), and its mission is simple – seamless integration of the consumer's digital devices and content throughout the home.
In order to achieve its goal as quickly and painlessly as possible, DLNA elected to base their solution on established industry standards developed by standards bodies and special interest groups such as the Internet Engineering Task Force (IETF), World Wide Web Consortium (W3C), Motion Picture Experts Group (MPEG), and Universal Plug and Play Forum (UPnP).

Thus, the DLNA Interoperability Guidelines require all devices to have an Ethernet, WiFi, or BlueTooth network connection, use TCP/IP for networking, and implement HTML and SOAP for media transport and management. Media Formats are also specified, with JPEG, LPCM, and MPEG2 support required for image, audio, and video devices respectively. To complement its detailed interoperability guidelines, DLNA also developed a comprehensive certification process and logo program to ensure consumers that products based on DLNA standards deliver the experience that consumers expect – they just work!

Introduction

The Rise of the Digital Home

The past few years witnessed the start of a major revolution in the home. Consumers began to go “digital”, acquiring, enjoying, and managing an ever growing volume of digital content – images from their digital cameras and cell phones, audio downloaded from Internet music stores and “ripped” from CD’s on a home PC, video from their Tivo and DVD’s for their DVD Players. And with that transition comes a new required feature for the device manufacturers in the Consumer Electronics (CE), Mobile Device, and Personal Computer (PC) domains – interoperability. Consumers want an environment where all the devices in the home are capable of sharing digital content—regardless of the source—across the home network. And not one that requires a technical wizard to install and configure. They should be able to easily connect all of their equipment and readily share their growing libraries of digital content. In short, any device, any time, any place, and any content.

This vision of the digital home is one that integrates the PC, CE, and Mobile Device worlds through a seamless, interoperable network, and provides a unique opportunity for manufacturers and consumers alike. It is also one that requires a common set of industry design guidelines to allow companies to participate in the evolving marketplace, while preserving the ability to differentiate products via innovation, simplicity, and value.

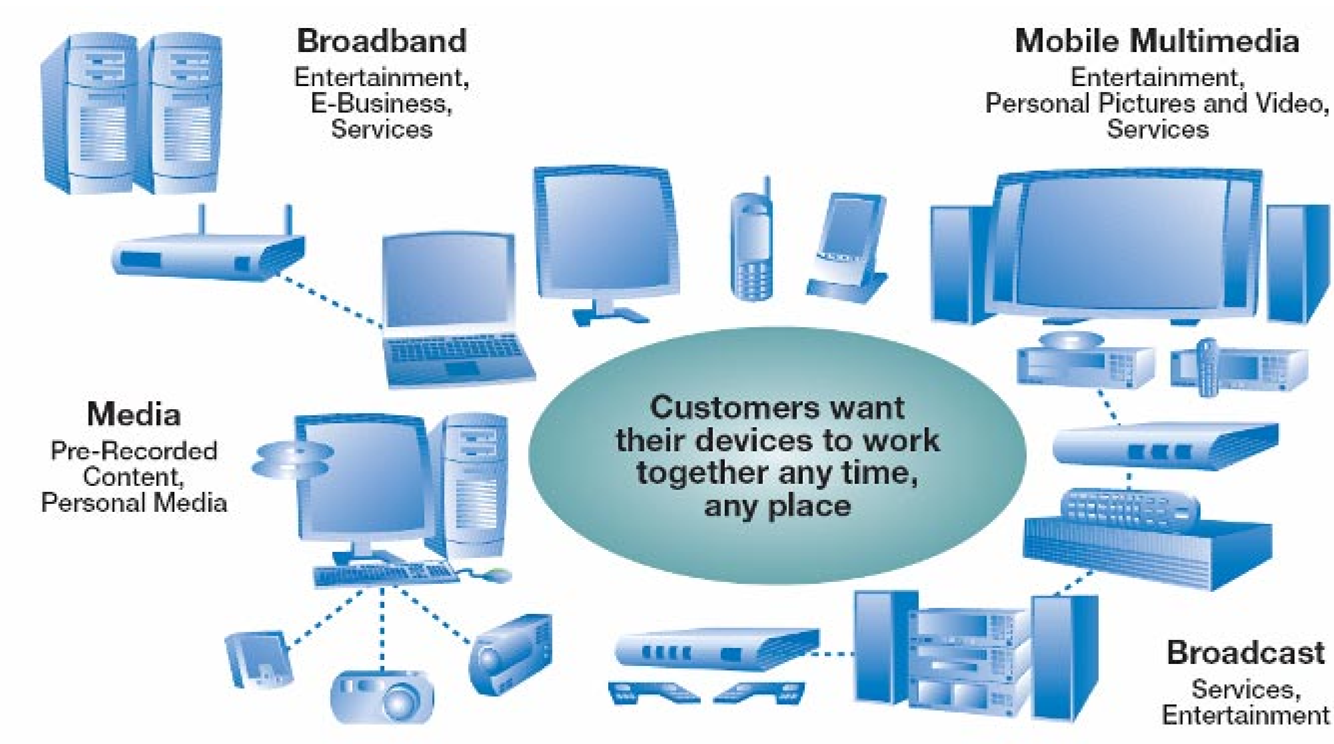
The Digital Living Network Alliance (DLNA) was formed to address the need for a common set of industry design guidelines. The DLNA Home Networked Device Interoperability Guidelines were created by a unique cross-industry effort that combined the efforts of over 100 Consumer Electronics, PC and Mobile Device companies from around the world who worked together with the aim of achieving the world’s first substantial approach to true interoperability between personal computers, consumer electronics, and mobile devices. The Interoperability Guidelines provide product developers with a long-term architectural view, plus specific guidance for IP-networked platforms, devices and applications in the home.

The Evolution of DLNA

The ability of DLNA to deliverable workable interoperability guidelines in less than 12 months is largely due to the pioneering efforts of the Universal Plug and Play Forum (UPnP Forum). The UPnP Forum, http://www.upnp.org/ was established by 14 major PC and CE manufacturers in 1999. Founding members include Microsoft, Intel, HP, Sony, Canon and Panasonic, and today it has more than 800 member companies from industries as diverse as personal computers, consumer electronics, telecom, home automation, security, printing, photography, and building controls. The mission of the Forum is simple: interoperability between devices using industry standards. To that end, the Forum selected TCP/IP as the basis for all network connectivity. Added to TCP/IP were Web standards such as HTTP, HTML, XML, and SOAP that provided the framework for device discovery, device and services description, control, and presentation.

With the core architecture defined, the Forum established a series of working groups to define device and service profiles for specific device categories. These categories include Audio/Video (AV), Internet Gateway Device (IGD), Printing, Scanning, Lighting Control, HVAC, and a number of others. The working groups – composed of member companies from relevant industries – delivered a series of XML schemas representing the baseline set of functions and services that each specific device type was required to support.

The most significant of the working groups efforts (at least in terms of digital media content) was the UPnP AV specification. In fact, it was so important that it became the basis for a new organization – DLNA. DLNA was formed in 2003 by 21 companies including Microsoft, Intel, HP, IBM, Sony, Philips, Toshiba, Pioneer, Motorola and Nokia, with the goal of accelerating the development and deployment of interoperable digital media devices for the home. It currently has more than 200 members, including virtually all of the global brands in PC, CE and mobile electronics. The DLNA web site, http://www.dlna.org/ is the central repository for all documentation. Version 1.5 is the most current release of the DLNA Interoperability Guidelines. In this context, it is important to understand that DLNA is not a standards organization like the IETF or the W3C. Rather, its goal is to realize media interoperability between PC, CE, and Mobile devices using already established industry standards.



DLNA Device Model

The device model used by DLNA is derived from the UPnP Forum fundamental device model. This model consists of Devices, Services, and Control Points.

Devices are network entities that provide services and can contain other nested devices. An example would be a VCR. It is a device that provides a tape transport service, a tuner service, and a timing service, while a DVD/VCR Combo would have all those services plus a nested DVD device.

Services are the basic unit of control. They provide actions, and maintain status via state variables. A VCR's tape transport service has actions such as play, fast-forward, and rewind, and a state variable for the tape counter.

Control Points are network entities that are capable of discovering and controlling other devices on the network. Although a Control Point may be managing multiple devices, all interactions occur only between the Control Point and the individual device. The Control Point coordinates the operation of each device to yield the desired final result.

With the development of the UPnP AV (and thus DLNA) specifications for digital media content devices, the basic device model was extended. All control interaction still only passes between Control Point and Device(s), but the Devices themselves interact with each other to pass digital content using a non-UPnP ("out-of-band") communications protocol. This might be an Ethernet connection between a PC sending audio to a stereo system or an s-video cable between a DVD player and a TV monitor. In summary, the Control Point configures the Devices as needed, initiates the flow of content, and gets out of the way.

DLNA Device Classes

In order to better define the characteristics of devices and the services they offer, the DLNA Interoperability Guidelines define twelve Device Classes organized into three Device Categories. **Device Categories** are based on a shared set of media formats and network connections that exist within a specific environment, with the focus on interoperability between devices within that category. This does not prevent a device from belonging to more than one device category. All that is required is compliance with the media formats and network connectivity of both categories. A **Device Class** specifies the functional capabilities of a device regardless of its physical attributes. In fact, a single physical device can, and frequently does incorporate multiple Device Classes. Since DLNA certifies at the Device Class, any certified product must comply with all the requirements of its Device Class.

The **Home Network Device (HND)** category is made up of five Device Classes that are in use in the home network, and rely on the same media formats and network connectivity requirements.

- **Digital Media Server (DMS)**
  Acquires, records, stores, and makes available digital media content, as well as enforcing content protection requirements. DMS products will often have intelligence, such as device and user services management, rich user interfaces and media management functions, including aggregation, distribution, and archiving. Examples of DMS devices include:

  - PC Server on an Ethernet based home network
  - Personal Video Recorder
  - Advanced Set-top Boxes
  - Dedicated Music Servers
  - CD/DVD Jukebox
  - Digital Cameras and Camcorders
  - Cell Phones with Digital Cameras

- **Digital Media Player (DMP)**
  Finds content offered by a DMS and provides playback and rendering capabilities. DMPs are not visible to other devices on the network such as DMCs. Examples of DMP devices include:
  - Digital TVs
  - Stereo / Home Theater Systems
  - Game Consoles
  - PDAs
  - Multimedia Mobile Phones

- **Digital Media Renderer (DMR)**
  Similar to DMPs in that they render or play content they receive from a DMS. Unlike DMPs, they are unable to find content on the network, and must be setup by another network entity – a DMC. A combination DMP/DMR device can both find a DMS on its own, or be controlled by an external DMC.

- **Digital Media Controller (DMC)**
  Finds content offered by a DMS and matches it to the rendering capabilities of a DMR, setting up the connections between the DMS and DMR. An intelligent remote control is one example of a DMC device; a personal digital assistant or multimedia mobile phone can also function as a DMC.

- **Digital Media Printer (DMPr)**
  Provides printing services to the DLNA home network. Photo printing is the primary usage of a DMPr, but more traditional printing applications also support a DMPr. When selected for media output, a DMPr combines images with an XHTML template to create the printed page. DLNA provides several basic photo templates to assist new vendors in quickly adding photo printing to their DLNA device. It is straightforward to add printing to device applications because the DMPr is based on the UPnP Print Service and the W3C XHTML Print specification. Some examples of DMPr devices include a networked photo printer and a networked all-in-one printer.

Also, an application running on a PC may expose DMPr functionality to an ordinary USB-attached printer.

The **Mobile Handheld Device (MHD)** category is made up of five Device Classes that share the same usages models as the HND Device Category, but have different requirements for media format and network connectivity. The MHD category includes these Device Classes and functionalities:

- **Mobile Digital Media Server (M-DMS)**
  Offers and distributes content. A mobile phone and a portable music player are examples of M-DMS devices.

- **Mobile Digital Media Player (M-DMP)**
  Finds content offered by a M-DMS and plays the content locally on the M-DMP. A media tablet designed for viewing multimedia content is an example of a M-DMP device.

- **Mobile Digital Media Controller (M-DMC)**
  Finds content offered by an M-DMS and match it to the rendering capabilities of a DMR, setting up the connections between the server and renderer. A personal digital assistant and an intelligent remote control are examples of M-DMC devices.

- **Mobile Digital Media Uploader (M-DMU)**
  Sends content to an M-DMS with upload functionality. A digital camera and a camera phone are examples of M-DMU devices.

- **Mobile Digital Media Downloader (M-DMD)**
  Finds and downloads content exposed by an M-DMS and plays the content locally on the M-DMD after download. A portable music player is an example of a M-DMD device.

The **Home Infrastructure Device (HID)** category is made up of two Device Classes. These devices are intended to allow HNDs and MHDs to interoperate.

- **Mobile Network Connectivity Function (M-NCF)** devices provide a bridging function between the MHD network connectivity and the HND network connectivity.

- **Media Interoperability Unit (MIU)** devices provide content transformation between required media formats for the HND Device Category and the MHD Device Category.

The twelve devices classes provide plenty of opportunity for sharing digital content across the home network. Today, the most common DLNA usage is music sharing. A typical scenario might include multiple music servers (DMS) such as a CD jukebox attached to the network with a digital media adapter, a PC Server with music downloaded from the Internet, and a dedicated, hard drive based music server. Multiple users could listen to the available content from a music player (DMP) anywhere in the house – a high-end component system in the living room, a mini stereo in the garage, or a PC in the den.

Distributing digital video across the home network is another rapidly developing usage. The major television vendors were showing flat screen TVs with an integrated DMP at CES 2006, setting the stage for the widespread sharing of video. In this case, the video servers (DMS) will be personal video recorders, advanced set-top boxes, PCs with Internet content, and DVD jukeboxes. In addition, current generation TVs can be attached to the network via digital media adapters, allowing them to share the same content. This will also allow you start watching a show on the large screen TV in the living room and finish watching on the bedroom TV without missing a beat.

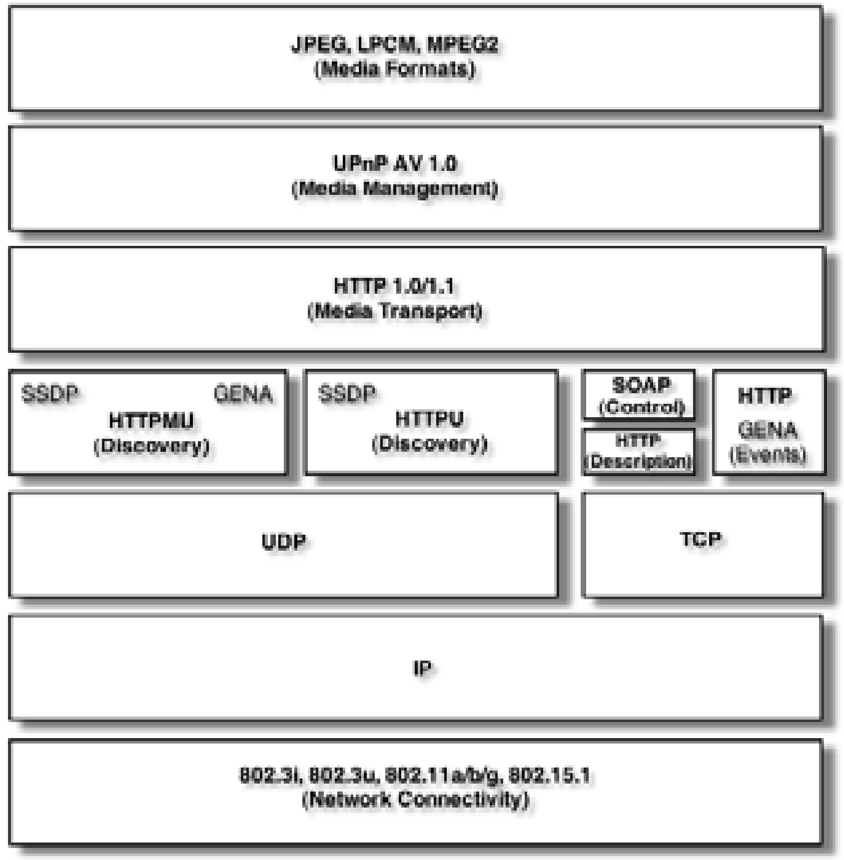
Another rapidly developing area is the sharing of digital images. Today, most digital image sharing is done by looking over someone's shoulder at pictures on a digital camera or cell phone. With DLNA enabled device like digital cameras, photo printers, and digital picture frames, sharing becomes a whole new experience. Digital cameras can connect to the home network via built-in WiFi or a network dock and act as an image server (DMS) for the home network. The images can then be viewed on any TV in the house, stored in the family photo archive on the PC in the den, printed on the photo printer, and uploaded to a digital picture frame for an impromptu slide show. Even cell phone/camera combinations can act as image servers via native Bluetooth support or the bridging provided by the M-NCF device class.

Using a cell phone/camera as an image server for the home network is just one example of how MHDs can interoperate with a home's HNDs over the home network, permitting a variety of usage scenarios. Examples include:

- A PDA can function as an intelligent remote control for a digital media server and renderer. Intelligent cell phones can also server as controllers (DMC).
- A portable music player can pull audio from a PC based media server for later listening (M-DMD).
- A portable music player can upload audio to a PC based media server (DMS) so it can be shared throughout the home.

DLNA Architecture

The following graphic shows the functional components of DLNA 1.5 in the context of the Interoperability Guidelines networking architecture.



Media Formats

Media Formats describe how digital content is encoded and formatted for each of the three classes of media: image, audio, and AV. The media format profiles are very explicit, with attributes, parameters, system, and compression level details defined in sufficient detail to ensure interoperability between DLNA compliant devices. The current baseline set of media formats that each specific device type must support are listed in the table below.

In addition to the baseline media formats that must be supported, DLNA also defines a set of optional media formats and provides specific rules about using optional formats between compatible devices and conversion between optional and mandatory formats. The optional formats are also shown in the following table:

Media Class	Mandatory Formats	Optional Formats
Image	JPEG	PNG, GIF, TIFF
Audio	LPCM	AC3, AAC, MP3, WMA9, ATRAC3plus
Video	MPEG2	MPEG1, MPEG4, VC1, MPV1

The focus on media formats is a dividing line between the work of the UPnP Forum and DLNA. The UPnP Forum focused on achieving device interoperability, which was accomplished. But the lack of prescribed media profiles prevented the UPnP architecture from delivering media interoperability and led to the founding of DLNA.

Media Transport

Media Transport defines how content moves across the network. DLNA devices that send or receive any media content to/from the network must support HTTP 1.1 (including chunked transfer encoding, persistent connections, and pipelining) as the baseline transport mechanism. In addition, Real-time Transport Protocol (RTP) is available as an optional media transport protocol. But, the mandatory requirement for HTTP 1.1 must always be met.

Media Management

Media management enables devices and applications to identify, manage, and distribute digital media content across network devices. The DLNA Guidelines incorporate the UPnP Forum AV and Printer technology as the basis for DLNA media management. The services provided by this technology are: Content Directory, Connection Manager, AV Transport, and Rendering Control.

Content Directory

The Content Directory service provides a mechanism for each content server on the network to provide a uniform directory of all its available content to any interested devices on the network. Every content server **must** have an instance of this service.

This service might be used to display a list of songs stored on an MP3 player, still-images comprising various slide shows stored on a PC, movies stored in a DVD jukebox, TV shows currently being broadcast by a Set-top Box, songs stored in a CD Jukebox, TV programs that had been downloaded to a PVR, photos stored in a digital camera, and many more. Nearly any type of content can be listed via the Content Directory service, even for devices that support multiple types of content. The information about the content (metadata) returned by the Content Directory service includes properties such as its name, artist, creation date, size, etc. In addition, the metadata also indicates the transfer protocols and data formats that are supported for each piece of content on the server. This information is used by the Control Point to determine if a given Media Renderer is capable of rendering the content in its current format or if some type of transcoding is required.

Connection Manager

The Connection Manager service determines how the digital media content can be transferred between two devices on the network. Each device that sends or receives content **must** implement the Connection Manager service. This service provides a mechanism for devices to:

- Match capabilities between server and render devices.
- Set up and tear down connections between devices.
- Discover information about current transfers in the network.

When making connections, the Connection Manager service is the interface between the devices and the TCP/IP stack.

AV Transport

The AV transport service enables control over the "playback" of audio and video streams including the ability to Stop, Pause, Seek, etc. This service type defines a common model for AV transport control suitable for a generic user interface. It can be used to control a wide variety of disc, tape, and solid-state media devices such as CD players, VCRs, and MP3 players. Depending on the supported transfer protocols and data formats, this service may or may not be implemented.

Although most media will be sent across the network as data it may be more efficient to transfer the media data stream using other means. An example is when a personal video recorder is the media source and a TV set is the media renderer (player). An Ethernet connection would not be as efficient as an s-video connection. Using a transfer medium that is not part of the TCP/IP network is called an **out of band transfer**. These transfers are not defined by the UPnP AV specification but are recommended and supported by the manufacturer of the media equipment.

Rendering Control

Most rendering devices contain a number of dynamically configurable attributes that affect how the current content is rendered. For example, video devices, such as TVs, allow user control of display characteristics such as brightness and contrast, while audio devices allow control of audio characteristics such as volume, balance, and equalizer settings. The Rendering Control service is intended to provide control points with the ability to query and/or adjust any rendering attribute that the device supports.

The Rendering Control service enables a control point to:

- Discover the attributes supported by the device.
- Retrieve the current setting of any supported attribute.
- Change the setting of any modifiable attribute.
- Restore the settings defined by a named preset.

Device Discovery and Control

Device discovery and control enables a device on the home network to discover the presence and capabilities of other devices on the network and collaborate with these devices in a uniform and consistent manner. DLNA incorporates the UPNP Forum Device Architecture 1.0 as the basis for its device discovery and control.

Discovery

Device discovery is the first step in UPnP networking. When a new device is added to a network, the UPnP discovery protocol (SSDP) allows the device to advertise its services to all control points on the network via a multicast. Similarly, when a new control point is added to the network, SSDP allows the control point to search for devices of interest using a multicast. Thus, by listening to the standard multicast address, control points and devices can be made aware of new services being offered on the network and respond to service requests. In each case, the response is a discovery message that contains a small number of essential specifics about the device or its services, e.g., its UPnP type, its universally unique identifier (UUID), and a URL to more detailed information. When a control point discovers a new device or service of interest – either as a result of a device's advertisement or a specific search – the control point must then use the URL in the discovery message to retrieve a description of the device and its capabilities.

Device Description

A UPnP device description includes vendor-specific manufacturer information like the model name and number, serial number, manufacturer name, URLs to vendor-specific Web sites, and a URL for presentation. For each service included in the device, the device description lists the service type, name, a URL for a service description, a URL for control, and a URL for eventing. A device description also includes a description of all embedded devices. Note that a single physical device may include multiple logical devices. A UPnP device description is written by the device vendor, and is expressed in XML syntax and based on a standard UPnP Device Template produced by the UPnP Forum working committee.

Service Description

A UPnP service description includes a list of commands, or *actions*, the service responds to, and parameters, or *arguments*, for each action. A service description also includes a list of variables. These variables model the state of the service at run time, and are described in terms of their data type, range, and event characteristics. Like a UPnP device description, a UPnP service description is written by a UPnP vendor. The description is in XML syntax and is based on the standard UPnP Service Template.

Retrieving a UPnP device description is straight forward: the control point issues an HTTP GET request on the URL in the discovery message, and the device returns the device description. Retrieving a UPnP service description is a similar process that uses a URL within the device description.

Control

Once the device and its service descriptions are retrieved, a control point can ask those services to invoke actions and the control point can poll those services for the values of their state variables. Invoking actions is a form of remote procedure call; a control point sends the action to the device's service, and when the action has completed (or failed), the service returns any results or errors. Polling for the value of state variables is a special case of this scenario where the action and its results are predefined.

To control a device, a control point invokes an action on the device's service. To do this, a control point sends a suitable control message to the control URL for the service (provided as part of the service element in the device description). These messages are encapsulated in SOAP, and sent via HTTP requests. In response, the service returns any results or errors from the action – again using SOAP and HTTP. The effects of the action, if any, may also be reflected by changes in the variables that describe the run-time state of the service. When these state variables change, events are published to all interested control points.

To determine the current value of a state variable, a control point may poll the service. Similar to invoking an action, a control point sends a suitable query message to the control URL for the service. In response, the service provides the value of the variable; each service is responsible for keeping its state table consistent so control points can poll and receive meaningful values

As long as the discovery advertisements from a device have not expired, a control point may assume that the device and its services are available. If a device cancels its advertisements, a control point must assume the device and its services are no longer available.

Eventing

As the section on Description explains, a UPnP service description includes a list of actions the service responds to and a list of variables that model the state of the service at run time. If one or more of these state variables are evented, then the service publishes updates when these variables change, and a control point may subscribe to receive this information. Throughout this section, *publisher* refers to the source of the events (typically a device's service), and *subscriber* refers to the destination of events (typically a control point). Both subscriber and publisher messages are delivered via a version of HTTP that has been extended using General Event Notification Architecture (GENA) methods and headers developed by the UPnP Forum.

To start receiving events, a subscriber sends a *subscription message*. If the subscription is accepted, the publisher responds with a duration for the subscription. To keep the subscription active, a subscriber must renew its subscription before the subscription expires. When a subscriber no longer needs eventing from a publisher, the subscriber cancels its subscription.

The publisher notes changes to state variables by sending *event messages*. Event messages contain the names of one of more state variables and the current value of those variables, expressed in XML. A special *initial event message* is sent when a subscriber first subscribes; this event message contains the names and values for all evented variables and allows the subscriber to initialize its model of the state of the service. To support scenarios with multiple control points, eventing is designed to keep all subscribers equally informed about the effects of any action. Therefore, all subscribers are sent all event messages, subscribers receive event messages for all evented variables (not just some), and event messages are sent no matter why the state variable changed (either in response to a requested action or because the state the service is modeling changed). An example of this would be the volume control on digital TV that was a DMP/DMR combined device. Turning the physical volume control on the device would send an event message to the network with the new volume level. Conversely, a DMC could send a volume action to the TV that would result in it changing its volume and sending an event message to the network to that effect.

Some state variables may change value too rapidly for eventing to be useful. One alternative is to filter, or moderate, the number of event messages sent due to changes in a variable's value. Some state variables may contain values too large for eventing to be useful; for this, or other reasons, a service may designate one or more state variables as *non evented* and never send event messages to subscribers. To determine the current value for such non-evented variables, control points must poll the service explicitly

Presentation

Presentation exposes an HTML-based user interface for controlling/monitoring the status of a device. It augments the standard UPnP control and eventing mechanisms by providing a browser based avenue for sending actions to a device and receiving notification of state changes from a device.

The URL for the presentation page is provided by the device description. To retrieve the presentation page, an HTTP GET request is issued to the presentation URL and the device returns the presentation page. Loading the page into a browser will, provided the page enables it, allow the user to control the device or view its status. Unlike the interactions defined by the UPnP Device and Service Templates, the capabilities of the presentation page are completely specified by the device vendor. The implementation details are also up to the device vendor, but the use of an embedded web server in conjunction with the device's native capabilities is the most common method of implementing this feature.

Network Stack

The basis for UPnP Networking (and thus DLNA) is the TCP/IP v4 protocol. Every device must implement a DHCP client, and search for a DHCP server when first connected to the network. If a DHCP server is discovered, the device must use the IP address assigned by the server. If no DHCP server is discovered, the device must use Auto-IP to generate a link-local IP address.

Auto-IP uses an implementation dependent algorithm to generate an address in the 169.254/16 range. The first and last 256 addresses in this range are reserved and must not be used. After developing an address, the device must determine if the address is available by using an ARP probe. If the device receives a response, the address is assumed to be in use and the device must generate and test a new IP address.

A device that has configured via Auto-IP must periodically check for the presence of a DHCP server. If a DHCP server is discovered, the device must switch to the IP address allocated to it by the DHCP server. In order to switch between IP addresses, the device must cancel any outstanding UPnP Discovery advertisements and re-issue them under the new address.

In addition to IP addressing, UPnP makes extensive use of both the UDP and TCP protocols. Discovery is done via an HTTP Multicast over UDP and is used by devices to advertise their presence to the network and by control points to discover what devices exist on the network. Definition, control, and eventing services are delivered via HTTP over TCP.

Network Connectivity

Three network connection technologies are incorporated in the DLNA 1.5 Interoperability Guidelines: 10Base-T and 100Base-T Ethernet (802.3i / 802.3u) for wired connections, WiFi (802.11a /802.11b /802.11g) for wireless connections, and Bluetooth for wireless connections for mobile handheld devices such as cell phones and PDAs. Additional network connections such as 1000Base-T Ethernet (802.3ab) and faster WiFi (802.11n) will be added to the Guidelines in the future. It should also be noted that many other networking technologies such as LonWorks, CeBus, X-10, and Universal Powerline Bus (UPB) could be supported via UPnP Bridges.

Certification

In order to ensure interoperability between DLNA devices, DLNA developed and manages a comprehensive certification program. Vendor products that successfully complete certification testing are awarded the DLNA Certified Logo, which assures consumers that the product is fully DLNA compliant and interoperates with other DLNA Certified Logo products.

The initial step in gaining certification is for the products' vendor to subject the product to testing via DLNA's Conformance Test Tool (CTT). The CTT is a suite of tests that are run by the vendor against the product, and validate the devices' compliance with DLNA standards. The test harness for the CTT is a single Windows PC with the device under test connected via a DLNA defined network connection technology (Ethernet, WiFi, Bluetooth). When the device successfully passes the CTT as determined by the CTT's log file, it can begin the formal DLNA certification process.

The formal certification process entails submitting the CTT log and the product's UPnP certificate to DLNA, and scheduling a test session with one of the Independent Certification Vendors (ICV) approved by DLNA. The ICV will test the submitted product per DLNA's Certification Test Plan (CTP) against 3 reference devices of the appropriate device class. For example, the ICV would test a DMP device against 3 DMS reference devices, while a DMC would be tested against 3 DMR and 3 DMS reference devices. Any device that passes the CTP will be eligible for the DLNA Certification Logo.

In addition to its formal certification program, DLNA conducts "plugfests" (interoperability workshops) on a regular basis. The plugfests are held each calendar quarter in various locations around the world in order to allow maximum participation from device vendors across the globe. These plugfests provide DLNA member companies the opportunity to test products under development against other member's products using DLNA test tools, and are an excellent dress rehearsal for DLNA certification testing.

About Allegro

Allegro has been providing Internet solutions to systems vendors since 1996. We offer robust, standards compliant, portable implementations of all major protocols including HTTP, XML and SOAP and our customers include Agilent, Cisco, HP, Microsoft, Phillips, Siemens and Xerox.

Allegro's UPnP/DLNA technology development began more than 5 years ago, and we offer portable implementations that allow device vendors to conform to the DLNA Interoperability Guidelines. Key digital media players including Philips, Samsung, Roku, and Analog Devices have selected Allegro's UPnP/DLNA protocol stack for use in their devices. In addition Microsoft has selected Allegro as the supplier of UPnP/DLNA technology for its Media Center Extender toolkit (PIKA) and a number of upcoming products.

Allegro is a regular participant at UPnP and DLNA plugfests and Allegro's extensive experience with UPnP/DLNA can help you design and certify any DLNA device.

Questions about UPnP/DLNA? Give Allegro a call. We have the answers!