The Advantages of the UPnP* Internet Gateway Device

Rafael Kolic
Technical Marketing Manager
Corporate Technology Group
Intel Corporation

Prakash Iyer
Senior Architect and Engineering Manager
Intel Labs
Intel Corporation

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Overview

Developers who are beginning to learn about Universal Plug and Play (UPnP*) architecture v1.0 should know that there is a lot to be gained by integrating the new technology into their products. Based on open IP standards, UPnP architecture leverages TCP/IP and the Web to enable seamless discovery, control, and data transfer among networked devices. It provides a consistent, interoperable framework for remote Internet Gateway Device (IGD) configuration and management and offers pervasive peer-to-peer network connectivity for PCs of any form factor, for intelligent appliances, and for wireless devices. It can be supported on virtually any operating system and works with virtually any kind of physical networking media, wired or wireless.

Moreover, UPnP architecture is easy to implement. As a result, it is playing a major role in helping to make home and small-business networking more functional and affordable for users. In this article, developers seeking to offer such benefits to their customers can learn about the basics of UPnP architecture and IGD Device Control Protocol (GCP) as well as typical usage scenarios involving UPnP-enabled Internet Gateways.

UPnP Architecture v1.0*

The UPnP Device Architecture is a framework that defines the protocols for communication between controllers, or control points, and devices. UPnP functionality involves five processes:

- Discovery—When a UPnP device is added to the network, the discovery protocol allows the device to advertise its presence to control points by using the Simple Service Discovery Protocol (SSDP). The information exchanged between the device and the control point is limited to discovery messages that provide basic information about the devices and their services (e.g., their types, identifiers, and pointers to more detailed information).
- Description—Using the URL provided in the discovery process, a control point receives XML information about the device, such as manufacturer information like make, model, serial number, and URLs to vendor-specific Web sites. In addition, the description process can also include a list of embedded devices, embedded services, and URLs used to access device features.
- Control—Given knowledge of a device and its services, control points use URLs provided during the description process to access additional XML information that describes actions to which the UPnP device services respond, along with parameters for each action. Control messages are formatted in XML and use Simple Object Access Protocol (SOAP).
- Eventing—When a control point subscribes to a service, the service publishes updates to the control point to announce changes in device status when one or more of the state variables that are evented change. Event messages are formatted in XML and use General Event Notification Architecture (GENA) protocol.
- Presentation—If a UPnP device has an URL for presentation, then the control point can retrieve a page from this URL, load the page into a browser and, depending on the capabilities of the page, allow a user to access interface control features, device, or service information, or any device-specific abilities implemented by the manufacturer.

In addition to the UPnP Architecture, specific UPnP technical working committees, such as the Internet Gateway Device Working Committee, produce additional device-specific specifications for their class of devices, each defined by a Device Control Protocol. The DCP defines variables, actions, and events that allow remote management of such devices. The DCP standardization process includes obtaining three sample implementations of the DCP to pass the UPnP Certification Test Tool, circulating the specification for a mandatory 45-day UPnP Forum member review and comment period, and obtaining the approval of the Steering Committee to become a Standardized DCP.

The UPnP Internet Gateway Device*

The UPnP architecture lends itself well to the discovery, configuration, and management of an IGD. An IGD is an IP-addressable device typically residing at the edge of a home or small-business network. An IGD interconnects at least one LAN with a WAN interface for Internet access. An IGD also provides local addressing and routing services between one or more LAN segments and to and from the Internet.

Intel is supporting IGD functionality through its residential gateways, broadband modems, network adapters, and software solutions. Recently, the company introduced the industry's first gateway product to receive the UPnP certification logo: the Intel® AnyPoint™ Networking Gateway Model 1300. Combining the functionality of a wireless access point, Internet router, and firewall, the AnyPoint Networking Gateway provides seamless discovery and configuration of UPnP-certified applications and devices. The product also extends Intel's industry leadership in UPnP implementation for Linux and UPnP Internet Gateways.

The IGD Device Control Protocol

The IGD DCP (Device Control Protocol) is a set of standardized specifications implemented by UPnP-compliant IGDs. The IGD DCP has a four-pronged focus: Configurable initiation and sharing of Internet connections, advanced connection-management features, management of host configuration services (DHCP), and support for transparent Internet access by non-UPnP-certified devices.

The DCP supports IP and PPP (Point-to-Point Protocol) connections originating at the IGD or transiting the IGD from a host on the LAN; configuration of cable, DSL, POTS, and Ethernet WAN interfaces; remote configuration of LAN DHCP services; and the delivery of both generic and connection-specific status information.

Also included in the IGD specification is a solution for NAT (Network Address Translation) traversal. NAT can "break" many of the compelling new PC and home networking experiences such as multi-player games, real-time communications, and other peer-to-peer services that people increasingly want to use in their homes or small businesses. As IP packets from the private LAN traverse the gateway, NAT translates a private IP address and port number to a public IP address and port number, tracking those translations to keep individual sessions intact.

IGD v1.0: User

Developers considering integrating UPnP architecture in an IGD or other device or application targeting the home or small-business market can think of usage benefits in terms of three functional categories: configuring and querying the state of the IGD, enhancing the ability of applications and devices on the network to access services outside it, and enhancing the ability of services outside the network to access applications and devices on it.

Configuring and querying the state of the IGD:

- Users can access information on the IGD status, the load on any active Internet connection(s), and the available options for installing drivers and/or selected application software without having to remember IP addresses or install custom software.
- Users who are preparing to be away from the network can disable a WAN connection directly from the IGD presentation page and without having to physically disconnect cables.
- Users concerned about line noise or malfunction of their ISP connection can be notified in advance when a connection is in jeopardy of being dropped and when a dropped connection is re-established.
- Users can determine why an Internet connection is malfunctioning, or assist support professionals in doing the same, by accessing connection-debug information that is far more detailed than that traditionally available through operating-system status indicators.

Ensuring that applications and devices on the network can access services outside it:

- Users can launch a UPnP-aware media player that can configure an IGD proxy without requiring user intervention. Similarly, the media player can send IGD bandwidth and other attributes to a media-delivery Web site so the site can select the appropriate presentation stream speed, also without the need for user intervention.
- Users can have their UPnP-enabled Internet telephony application automatically detect and configure the port mapping for Network Address Translation (NAT) on the IGD to enable inbound audio streams, without having to manually configure the IGD.

Ensuring that services outside the network can access applications and devices on it:

- A UPnP-certified video-recorder application can automatically update its program guide nightly with information from a selected Web site by using UPnP to determine the IGD connection status. This capability eliminates the need for such applications to use a private ISP over an analog modem, saving manufacturers and users money and ensuring a higher level of service.
- Users can set up a Web server with UPnP-enabled software that automatically configures the IGD with the necessary port mapping to properly forward all Web requests going through the gateway. UPnP enables the NAT port mapping to take place transparently, without requiring users to manually configure the gateway.

Note the importance of NAT in a few of these usage scenarios. Developers should know that consumers purchasing or leasing an IGD from their ISP are being strongly encouraged to consider only devices that support UPnP for NAT traversal. This capability is essential for lowering support costs and enabling the deployment and use of the most innovative services and applications.

Summary

Incorporating Universal Plug and Play (UPnP) architecture and the new Internet Gateway specification into an Internet gateway device is relatively easy and inexpensive for the device manufacturer. UPnP and the IGD DCP address the problems of NAT traversal and extend the benefit of easier control and accessibility for home and small-business users to almost any application that traverses their network. This improves the user experience for rich broadband applications such as real-time communications, Internet games, and digital entertainment.

More Info

To learn more about UPnP, the IGD DCP, and related specifications, consider joining the UPnP Forum. The UPnP Forum currently has over 400 member companies, many of which are in the process of releasing new UPnP-certified products. More information is available at the Forum's Web site and at the Intel® UPnP Web site.

Author Bios

Rafael Kolic is a technical marketing manager in the Corporate Technology Group's Intel Labs. Since joining Intel in 2000, he has worked on a number of projects involving Universal Plug and Play technology as well as others involving residential gateways, second-screen interactivity, and information management. Rafael has also designed DSP variable speed controllers and performed research in the area of power electronics. Rafael holds an M.E. in electrical and computer engineering and a B.S. in electrical engineering from the University of Florida.

Prakash Iyer is a senior architect and engineering manager in the Network Architecture Lab in Intel Labs. With Intel for over 10 years, he leads a group that develops technologies related to IPv6 routing and transition mechanisms, consumer networking, and seamless, secure IP mobility. Prakash also chairs the Internet Gateway working committee in the Universal Plug and Play Forum. He has previously worked on LAN networking products, IP telephony, and conferencing and VPN technologies. Prakash holds B.S. degrees in physics and electrical engineering and an M.S. in computer science.

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