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MOTOROLA

IP Addressing in the Consumer Domain

Network Attachment of Devices in the Home Environment

WHITE PAPER

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Introduction

The home environment is evolving from a collection of isolated devices in the home to a network of connected and well-managed devices. Many industry standards bodies, including ITU-T, ATIS[1] IPTV Interoperability Forum (IIF), DSL Forum, DLNA, and others, are actively working on writing specifications for the home network and the different end devices operating in the home environment.

Some standard bodies expanded the physical notion of a "home network" to a logical notion of "consumer domain" that can encompass multiple home networks, multiple networking topologies, and even mobile devices. One common denominator for all is the use of IP as the layer of convergence for all communication across the home network. Consequently, IP addressing has emerged as one of the key topics in multiple standard bodies since obtaining an IP address is a prerequisite to any subsequent interaction between the end device and the network.

Netopia/Motorola has been a driving force in writing many of these standard specifications, taking into account the evolution from current hybrid network architecture to a converged IP-based Next-Generation Network (NGN) architecture.

This white paper briefly presents our views on the home network environment, device attachment to the network, IP address assignment procedure, and future plans toward IPv6.

The Home Network and the Consumer Domain

The home network is the first segment of the overall network and may be one of the most cost sensitive to the service provider. The home network can be a heterogeneous collection of network types that can consist of multiple physical segments and a variety of devices and networking technologies. While many network elements in the core/transport network deal only with the transport layers (L1-L3), the elements in the home network deal with all ISO layers including upper layers (L4-L7) and support a variety of IP-based services.

The IPTV Interoperability Forum (IIF), working closely with ITU-T, is taking the lead in the industry in defining a rich home network environment. While the focus of the IIF standard specification [1] is IPTV network architecture and services, it does provide a good insight into how the industry leaders are envisioning the future of the home network.

The Residential Gateway is at the Center of the Home

From a Telco perspective, the Residential Gateway (RGW) resides at the center of house. It terminates the WAN side of the network and provides layer 3 functions for the end devices that are attached to the home network (for both wired and wireless home networks). This includes IP routing function, Network Address Translation (NAT) function, Firewall function, and local resource management function.

One of the key functions of the RGW is to protect the home network and the end users from the outside world. It achieves this task by performing the following tasks:

- It represents a single point of entry to the house, from an IP addressing perspective. That is, the RGW is effectively the only network element that is publicly known to the network at large. This public address is known as the RGW WAN IP address.
- It performs the function of a DHCP server for all the devices on the home network. That is, it assigns local/private IP addresses to all the connected devices in the home. These local IP addresses are hidden from behind the RGW Firewall.
- It performs address translation between the single public WAN IP address and the multiple local/private addresses in the home.

1. The Alliance for Telecommunications Industry Solutions (ATIS) is a U.S.-based organization that develops and promotes technical and operations standards for the communications and related information technologies industry worldwide.

- It performs Firewall operation to protect the network and its resources from potentially harmful traffic.

There are two methods by which the RGW can obtain its WAN IP address from the network: PPP and DHCP. Initial DSL deployments were based on having a BRAS system in the edge/metro network that uses the PPP protocol to allocate an IP address to the RGW, however the industry is moving fast to the more powerful DHCP method.

Netopia/Motorola supports both approaches. Upon power up or initialization, the RGW interacts with a BRAS or DHCP server across the network to acquire its WAN IP address.[2]

2. Other information acquired via DHCP includes subnet mask and DNS IP address.

IP Address Assignment for End Devices

The RGW is the entity that assigns IP addresses to all the devices in the home. When an end device is powered up or initialized, the following sequence takes place:

- The end device establishes L1 and L2 connectivity with the RGW across the home network, which could be over a copper network, a coaxial network, fiber/plastic network, or wireless network.
- The end device issues a DHCP DISCOVER message toward the RGW that must include all the mandatory DHCP options, per RFC 2131. The IIF specifications further require that the end device includes option 60 to allow it to identify itself to the RGW.

The RGW, as a DHCP server, replies to the end device with a DHCP OFFER message that must include all the DHCP mandatory options, per 2131. The RGW must provide the following information to the ITF device:

- End device local IP address
- End device local network mask
- Remote auto-configuration server (ACS) IP address
- DNS IP address

The DHCP protocol sequence completes with the standard DHCP REQUEST and DHCP ACK messages.

This sequence clearly shows that IP address assignment within the home environment is under the complete control of the RGW. The end device then communicates with the ACS, through the RGW, to complete the remote configuration process.

Rules for IP Address Assignment

The RGW can be provisioned by the Network Provider to allocate IP addresses from a specific pool of IP addresses, or can leave local address allocation scheme to the default setting of the RGW. The Netopia/Motorola RGW product offers a great deal of flexibility for the Network Provider.

Migration to IPv6

Netopia/Motorola is following standard and development activities related to the definition and implementation of an IPv6 network and technology. Some of the latest development in this area includes:

- Many BRAS vendors currently support both IPv4 and IPv6 address assignment
- Many software vendors upgraded their DHCP server functionality to support both IPv4 and IPv6 address assignment
- Microsoft Windows Vista OS, which was recently launched, supports IPv6 native addressing (in addition to legacy IPv4)

- The ATIS Technical Committee published a notable recommendations [2] on the best practices to support the migration from IPv4 to IPv6

Netopia/Motorola is well prepared for the IPv4 to IPv6 migration. Specifically,

- Netopia/Motorola is working diligently on providing full IPv6 support in its RGW product, and is planning to offer a firmware upgrade for installed units in the field.
- Netopia/Motorola is well aware that the migration will be gradual, and will happen over a number of years. Therefore Netopia/Motorola is evaluating the two approaches stated in the ATIS IPv6 recommendation report, namely, the dual stack approach and the tunneling approach, to facilitate the migration from IPv4 to IPv6.

It should be noted, however, that with the deployment of the RGW as an intelligent L3 device in the home, and with a network architecture that requires only a single public IP address for the home, the concern about running out of IP addresses, which was one of the driving forces behind the push for IPv6, has been alleviated somewhat.

Conclusion

Netopia offers a complete line of RGW products. These CPE devices are intelligent L3-capable routing systems with standard DHCP server functionality for the allocation of local IP addresses within the home environment.

As the industry migrates from IPv4 to IPv6, Netopia/Motorola is planning carefully for this evolution by providing the necessary hardware and firmware hooks to support a smooth and painless migration, and to upgrade installed units in the field.

References

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ATIS Internet Protocol Version 6 (IPv6) Report & Recommendation, May 2006

About the Author

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