CISCO IOS IPv6 MULTICAST INTRODUCTION

INTRODUCTION

IPv6 offers solutions to the limitations of IPv4 (RFC 791), which has been, and continues to be successful, but was never designed for the type of Internet-work that the Internet has become.

IPv6 offers significantly more address space than IPv4: 340 undecillion (sextillion for the United Kingdom) versus four billion for IPv4. It also simplifies the deployment process with features such as auto-configuration and embedded security via IPsec.

Additional predictors of future IPv6 success include the addressing needs of certain geographies (ie: Asia) and new government mandates regarding IPv6 deployment in the future.

Several Unicast IGPs, including Routing Information Protocol (RIP), Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), Enhanced Interior Gateway Routing Protocol (EIGRP), and Multi-Protocol Border Gateway Protocol (MP-BGP) can already support IPv6.

Many applications currently support IPv6, including a number of operating systems (ie: Linux, FreeBSD, Solaris and Microsoft Windows XP).

This document will introduce IPv6 Multicast to engineers who are already familiar with IPv4 Multicast. It highlights key topics that will distinguish IPv4 and IPv6. It provides a complement for Cisco IOS Software Technical Documentation, and does not include command references.

Note that work is still in progress; the information in this document is current as of December 2003.

IPv6 MULTICAST ADDRESSING

This section discusses Layer 3 addressing, reorganization of a multicast address, and the meaning of the various portions of the address.

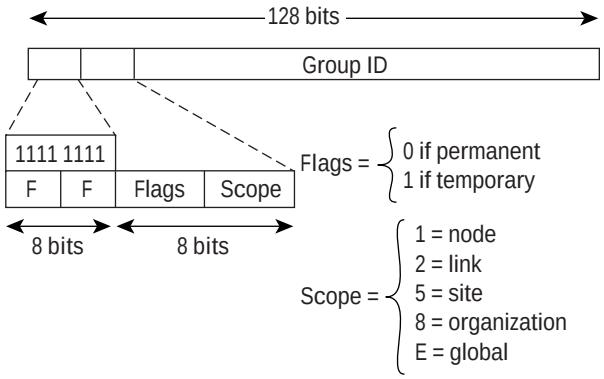
All Multicast addresses begin with the format prefix 1111 1111, which can be more easily written as FF.

The Addressing structure of IPv6 is 128bits, while IPv4 is only 32 bits long, so IPv6 offers a significantly greater number of digits to manipulate. Due to the address length, there may be a sequence that includes a long series of zeros. Users often compress the zeros as follows, in order to more easily understand of the sequence:

FF05:0:0:0:0:0:0:2 will be written as FF05::2

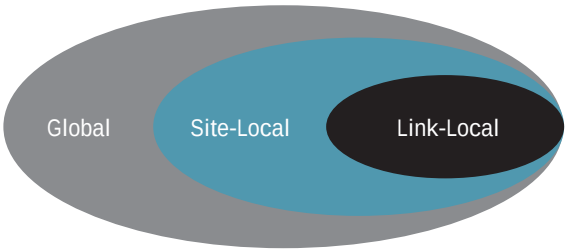
The format prefix, FF, is followed by 2 fields Flags and Scope. These 2 fields are each 4 bits. The remaining 112 bits are the Group ID

Figure 1
IPv6 Multicast Addressing



The flags field initially indicated whether the address was permanent or transient; the latter is scope relevant. A scope is a subset of the network, and multiple scopes are defined within IPv6. Figure 1 illustrates how a scope fits into hierarchy:

Figure 2
Scope in the Network Hierarchy



IPv6 actually has possible 15 scopes, from 0–F in hexadecimal, some of which are unused.

For example of an address with the scope set is the 'all' routers addresses below:

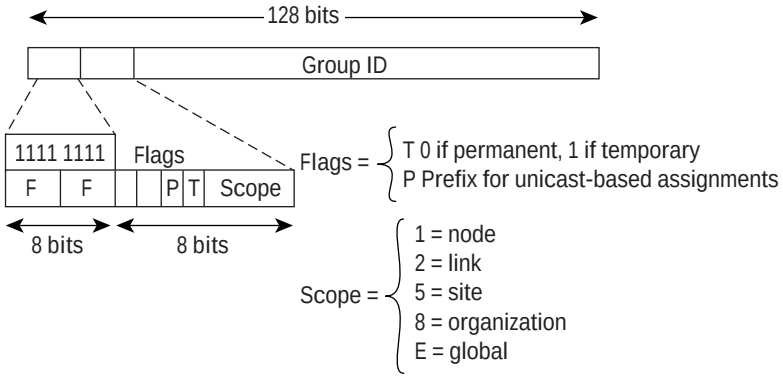
FF01:0:0:0:0:0:0:2 with a scope of the local node.

FF02:0:0:0:0:0:0:2 with a scope of the local link.

The flags field originally included the T flag to indicate a transient address, but it has evolved. RFC 3306 Unicast-Prefix-based IPv6 Multicast added a P flag.

The P flag indicates a prefix. Within IPv6 multicast, this flag allows part of the group address to include the source' networks Unicast prefix, which creates a globally unique Group Address.

Figure 3
IPv6 Multicast Addressing



This document will offer additional details about this method.

IPv6 MULTICAST AND LAYER 2

Media Access Control (MAC) layer addresses within Ethernet are 48 bit addresses. These 48 bits comprise 24 bits for the Organizational Unit Identifier (OUI) and 24 bits for serial number of the card, which becomes the remainder of the unique address.

The address of a multicast group does not relate to a physical device, but rather to a transient group of devices; therefore, the MAC address format uses a special OUI.

The OUI for IPv4 Multicast is 00:00:5E with the Least Significant Bit Most Significant Byte set. Only half of this address space was allocated for IP Multicast. This means that 23 bits were available for the group address when using the historical OUI 01:00:5E. This prompted a 32-1 possible address overlap at Layer 2.

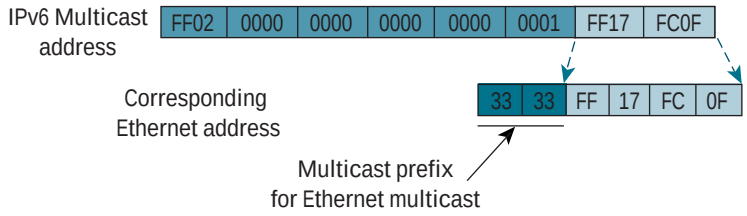
There is a new OUI format for IPv6 Multicast. The leading two Bytes are set to 33-33, while the following 4 bytes/ 32bits are available for address mapping from the last 32 bits of the 128 bit Multicast address.

According to this model, all routers would have the following address:

33:33:xx:xx:xx:xx: where X is the last 32 bits of the address

33:33:00:00:00:02

Figure 4
IPv6 Multicast Mapping over Ethernet



HOST TO ROUTER SIGNALLING

IPv6 Multicast does not use the IGMP protocol when a Host signals a router with its desire to receive data from a specific group. IPv6 now uses a new protocol: Multicast Lister Discovery (MLD), which is a sub protocol of ICMP.

MLD version 1 was an similar to IGMPv2, while MLDv2 is similar to IGMPv3. MLDv2 therefore enables IPv6 to use the Source Specific Multicast (SSM) operation.

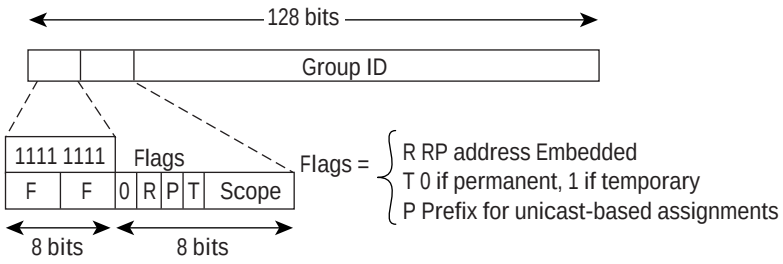
RP METHODOLOGIES

Auto-RP is not currently available; however, there is a BSR for IPv6. As well as static configuration of an RP or Embedded RP

PIM SM has an inter-domain deployment problem with regard to IPv6 multicast, as there is no MSDP like protocol. Static use is acceptable in the intra-domain, but not within the inter-domain. SSM deployment may work for the inter-domain. Embedded RP is a viable solution for those applications/customers who cannot leverage SSM and who require a PIM SM model to interoperate across multiple domains then.

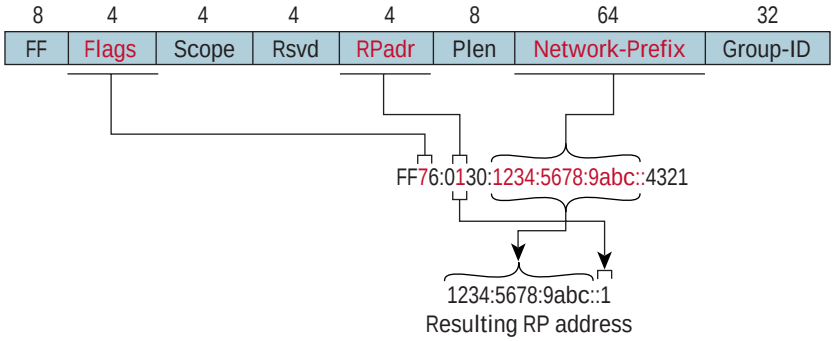
Embedded RP uses the P flag discussed above in the Unicast prefix

Figure 5
Embedded RP



With Embedded RP, the flags RP&T are set to 1. This indicates that the RP address is embedded in the group address.

Figure 6
Multicast Address with Embedded RP address



SSM has an IPv6 reserved range FF3x/96

Here the flags will be set with Pbit set =1 in the flag field,. but the Prefix length Plen set to 0 and the prefix set at 0.

SEPARATION OF STATE AND FORWARDING

Within IPv6 Multicast, the PIM topology and the Forwarding tables used by the router can be separated.

Two areas of the router must be considered:

- Multicast Forwarding Information Base: holds information on interfaces regarding which interfaces can receive forwarding data
- Multicast Routing Information Base: holds information from the control plane (ie: is the outgoing interface populated by a PIM message or via a MLD message?)

IPv6 BOUNDARIES/SCOPING

Cisco IOS Software does not currently support IPv6 scoping of multicast address.

TRANSITION/COEXISTENCE TECHNOLOGIES

Cisco expects an incremental transition to IPv6 in most cases. Three primary methods will help achieve this:

1. Dual-stack techniques

   IPv4 and IPv6 protocol stacks on each device enable IPv4 and IPv6 to co-exist in the network.

2. Tunneling

   A tunnel from an IPv6 network connects islands of IPv4 to the remote IPv6 network, allowing areas of the network to be deployed independently of the whole. While ISATAP is an example of tunnelling, it does not support Multicast, so IPv6/IPv4or configured tunnels are a preferable solution for IP multicast enabled networks.

3. Translation techniques

   Allows IPv6-only devices to communicate with IPv4-only devices.

SUMMARY

IPv6 multicast will see significant deployment within certain geographic areas, including Japan, and within certain government organizations (ie: United States Department of Defense).

Significant differences between IPv6 Multicast and IPv4 Multicast:

- IPv6 Multicast has significantly more address space, so overlapping addresses are less likely
- IGMP has been replaced with MLD in IPv6 Multicast
- NO MSDP protocol in IPv6 Multicast, which does have alternative options such as Embedded RP and SSM
- IPv6 Multicast does not support Dense mode multicast
- FF:FF is MAC layer prefix for use on Ethernet.

IPv6 REFERENCES

- http://www.cisco.com/warp/public/732/Tech/ipv6/
- http://www.ipv6forum.com/
- http://www.ipv6-taskforce.org/
- http://www.ietf.org/

MULTICAST REFERENCES

- http://www.cisco.com/warp/public/732/Tech/multicast/multicast_techdoc.shtmlftp://ftpeng.cisco.com/ipmulticast/index.html
- http://www.ietf.org/

ADDITIONAL REFERENCES

- IPv6 Addressing Architecture

  http://www.ietf.org/rfc/rfc3513.txt
- IPv6 Multicast Addresses registered with IANA

  http://www.iana.org/assignments/ipv6-multicast-addresses
- Unicast-Prefix-based IPv6 Multicast Addresses

  http://www.ietf.org/rfc/rfc3306.txt
- Multicast Listener Discovery

  http://www.ietf.org/rfc/rfc2710.txt
- IPv6 Packets over Ethernet Networks

  http://www.ietf.org/rfc/rfc2464.txt
- Multicast Listener Discovery v2

  http://www.ietf.org/internet-drafts/draft-vida-mld-v2-07.txt
- IGMP/MLD snooping

  http://www.ietf.org/internet-drafts/draft-ietf-magma-snoop-10.txt
- Embedded RP addressing drafts

  http://www.ietf.org/internet-drafts/draft-savola-mboned-mcast-rpaddr-03.txt

  http://www.ietf.org/internet-drafts/draft-ietf-mboned-embeddedrp-00.txt
- Cisco IOS IPv6 Command Reference

  http://www.cisco.com/application/pdf/en/us/guest/products/ps5187/c1051/ccmigration_09186a00801d662f.pdf

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: 31 0 20 357 1000
Fax: 31 0 20 357 1100

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on the Cisco Web site at www.cisco.com/go/offices

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia Czech Republic • Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland Israel • Italy • Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland Portugal • Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden Switzerland • Taiwan • Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

203152_ETMG_SH 03.04