IPv6 on Cable

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Note Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

Support for the IPv6 on Cable feature is introduced in Cisco IOS Release 12.2(33)SCA for the Cisco uBR7225VXR, Cisco uBR7246VXR, and Cisco uBR10012 universal broadband routers to extend IP addressing functionality on these Cisco cable modem termination system (CMTS) routers to include support for both IPv4 and IPv6 protocol stacks.

Note Starting with Cisco IOS Release 12.2(33)SCC and later releases, Cisco CMTS routers also support dual stack on the customer premises equipment (CPE) and IPv6 over subinterfaces.

The IPv6 feature support available in the Cisco IOS software and for Cisco CMTS routers is extensive. This document provides a comprehensive overview of all of the IPv6 features supported on the Cisco CMTS routers, and their restrictions.

However, the details of every feature are not covered in this document. The areas of IPv6 protocol support for the Cisco CMTS routers discussed in this document are classified by platform-independence or by platform-specific feature support.

- Platform-independent IPv6 features—Describes IPv6 features that are supported in the Cisco IOS software for several other Cisco platforms, and which generally do not have any platform-specific behavior or configuration differences on the Cisco CMTS routers.
  - Documentation about the restrictions for these platform-independent features can be found in the Restrictions for IPv6 on Cable, on page 4.
  - Detailed information about these features, including conceptual and task-based configuration information, is documented outside of this feature and in the Cisco IOS software documentation. Detailed information about the location of this related documentation in the Cisco IOS software documentation is described in the Feature Information for IPv6 on Cable, on page 53.

- Platform-specific IPv6 features—Describes IPv6 features that are specific to the cable technology area and that only apply to the supported Cisco CMTS routers. The cable-specific IPv6 feature support includes new or modified cable features supporting IPv6, and any transparent support of the IPv6 protocol in existing (legacy) cable features on the CMTS router platforms.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

Contents

Prerequisites for IPv6 on Cable

- MDF capable line cards are required for DOCSIS 3.0 cable modems (CMs) to support IPv6 CPEs.

Table below shows the hardware compatibility prerequisites for the IPv6 on Cable feature.

Table 1: IPv6 on Cable Hardware Compatibility Matrix

CMTS Platform	Processor Engine	Cable Interface Cards and SPA
Cisco uBR10012 Universal Broadband Router	**Cisco IOS Release 12.2(33)SCA and later** • PRE2 **Cisco IOS Release 12.2(33)SCB and later** • PRE4 **Cisco IOS Release 12.2(33)SCH and later** • PRE5	**Cisco IOS Release 12.2(33)SCA and later** • Cisco uBR10-MC5X20S/U[1] • Cisco Wideband SPA 2 **Cisco IOS Release 12.2(33)SCC and later** • Cisco UBR-MC20X20V[2] **Cisco IOS Release 12.2(33)SCE and later** • Cisco uBR-MC3GX60V 2 **Cisco IOS Release 12.2(33)SCH and later** • Cisco Next Generation Wideband SPA
Cisco uBR7246VXR Universal Broadband Router	**Cisco IOS Release 12.2(33)SCA and later** • NPE-G1 **Cisco IOS Release 12.2(33)SCB and later** • NPE-G2[3]	**Cisco IOS Release 12.2(33)SCA and later** • Cisco uBR-MC28U/X 1 **Cisco IOS Release 12.2(33)SCD and later** • Cisco uBR-MC88V 2
Cisco uBR7225VXR Universal Broadband Router	**Cisco IOS Release 12.2(33)SCA and later** • NPE-G1 **Cisco IOS Release 12.2(33)SCB and later** • NPE-G2 3	**Cisco IOS Release 12.2(33)SCA and later** • Cisco uBR-MC28U/X 1 **Cisco IOS Release 12.2(33)SCD and later** • Cisco uBR-MC88V 2

[1] Supports only DOCSIS 2.0 and IPv6 cable modems.

[2] Supports only DOCSIS 3.0 and IPv6 cable modems.

[3] Cisco uBR-MC88V cable interface line card is compatible only with NPE-G2

Note In a typical customer configuration, the IPv6 requires an additional pass through the PRE4. For example, if a packet with a given set of configured features takes one pass through PXF for IPv4 processing, it requires two passes for IPv6 processing.

Restrictions for IPv6 on Cable

The following capabilities are not supported by IPv6 on the Cisco CMTS routers:

- IPv6 support for SCF releases—Cisco IOS SCF releases do not support IPv6 related features

> **Note** Do not enable IPv6 on Cisco IOS SCF releases.

- Access Control List (ACL) extensions for mobile IPv6
- Alternative Provisioning Mode (APM) and Dynamic Provisioning Mode (DPM) (Supported from Cisco IOS Release 12.3(33)SCB onwards)
- Cable Intercept (PacketCable Communications Assistance for Law Enforcement Act [CALEA])
- Cable monitoring based on IPv6 ACL
- Configuration file generation for Dynamic Message Integrity Check (DMIC) for IPv6 cable modems
- DOCSIS Set-top Gateway (DSG) for IPv6
- Hot Standby Router Protocol (HSRP) for IPv6
- Internet Control Message Protocol for IPv6 (ICMPv6) filtering and policing (ICMPv6 is subject to Divert Rate Limit [DRL] in PRE4 punt path.)
- IPv6 anycast addressing
- IPv6 default router preference (DRP)
- IPv6 high availability (HA)
- IPv6 Policy Based Routing (PBR)
- IPv6 VPNs
- Load balancing used with Hot Standby Connection-to-Connection Protocol (HCCP)
- Mobile IPv6 home agent
- Multiple Dynamic Host Configuration Protocol for IPv6 (DHCPv6) addresses

> **Note** Starting with Cisco IOS Release 12.2(33)SCG1, assignment of multiple IPv6 addresses and IPv6 prefixes via DHCP to a single CPE is supported.

- Multi protocol Label System-Virtual Private Network (MPLS-VPN)
- Netflow for IPv6
- Network Address Translation-Protocol Translation (NAT-PT)
- PacketCable and PacketCable Multimedia

Note Starting with Cisco IOS Release 12.2(33)SCJ, IPv6 PacketCable Multimedia Voice is supported.

- Quality of Service (QoS) for IPv6
- Scalable differential IP address assignment (DOCSIS 3.0 assignment of different prefixes to CM and CPE based on DHCPv6 MAC address)

Note Starting with Cisco IOS Release 12.2(33)SCF4, DOCSIS 3.0 assignment of different prefixes to CM and CPE is supported.

- Service Independent Intercept (SII) or Packet Intercept IPv6 address tapping

Note Starting with Cisco IOS Release 12.2(33)SCE, IPv6 HA is supported.

Other restrictions for IPv6 on cable:

DHCPv6 Restrictions for IPv6 on Cable

- Deploy IPv6 source verification only with DHCPv6 leasequery to recover lost CPE data and ensure that traffic from legitimate CPEs can continue to be forwarded.
- DHCPv6 leasequery does not support CPEs that use only prefix delegation (PD) addresses.

The following DHCPv6 areas are not supported by the Cisco CMTS routers:

- DHCP leasequeries
- The following DHCPv6 relay agent options are not supported by the Cisco CMTS routers:
    - Syslog server address option
    - CableLabs client configuration
    - DHCPv6 relay agent subscriber-ID option
    - DHCPv6 relay agent RADIUS attribute option
    - RAAN option

IPv6 Access Services Restrictions for IPv6 on Cable

The following areas of IPv6 access services are not supported by the CMTS routers:

- Authorization, authentication, and accounting (AAA) support for Cisco IPv6 vendor-specific attributes (VSA)
- AAA support for RFC 3162 IPv6 Remote Access Dial-In User Service (RADIUS) attributes
- DHCPv6 prefix delegation via AAA
- Point-to-Point Protocol (PPP) over ATM (PPPoA)
- PPP over Ethernet (PPPoE)
- Prefix pools
- Remote bridged encapsulation

IPv6 Data Link Layer Restrictions for IPv6 on Cable

The following areas of the IPv6 Data Link Layer are not supported by the Cisco CMTS routers:

- Asynchronous Transfer Mode (ATM) permanent virtual circuit (PVC) and ATM LAN emulation (LANE)
- Fiber Distributed Data Interface (FDDI)
- Frame Relay PVC13
- Cisco High-Level Data Link Control (HDLC)
- PPP service over Packet over SONET (POS)
- Integrated Services Digital Network (ISDN)
- Serial (synchronous and asynchronous)
- Virtual LANs (VLANs) using Cisco Inter-Switch Link (ISL)
- Dynamic Packet Transport (DPT)

Multicast Restrictions

IPv6 multicast has the following behavior restrictions on the Cisco CMTS routers:

- IPv6 multicast packets on the Cisco uBR10012 universal broadband router are process-switched by the Performance Routing Engines (PRE).
- IPv6 multicast support complies with DOCSIS 2.0 for Cisco uBR10-MC5X20U and Cisco uBR-MC28U cable interface line cards only.
- IPv6 multicast support complies with DOCSIS 3.0 for Cisco uBR-MC3GX60V, Cisco uBR-MC88V, Cisco UBR-MC20X20V interface line cards, and Cisco Wideband SPA only.
- ICMP redirects are not sent to the originating host if the packet is destined for another CPE behind the same CM. All CPE-to-CPE traffic is processed by the Cisco CMTS router.
- IPv6 multicast forwarding is not supported in Parallel Express Forwarding (PXF), therefore, the IPv6 multicast forwarding performance is limited by the Router Processor (RP).

The following areas of IPv6 multicast are not supported by the Cisco CMTS routers:

- Address family support for Multiprotocol Border Gateway Protocol (MBGP)
- Bidirectional Protocol Independent Multicast (PIM)
- Bootstrap router (BSR)
- DOCSIS 3.0 encrypted multicast
- Explicit tracking of receivers
- IPv6 multicast echo
- Multicast Forwarding Information Base (MFIB) display enhancements
- Multicast use authentication and profile support
- PIM embedded rendezvous point
- Protocol Independent Multicast sparse mode (PIM-SM) accept register feature
- Reverse path forwarding (RPF) flooding of bootstrap router (BSR) packets
- Routable address hello option
- Source Specific Multicast (SSM) mapping for Multicast Listener Device (MLD) version 1 SSM
- IPv6 multicast forwarding on the Cisco uBR10012 universal broadband router in Parallel Express Forwarding (PXF)

Provisioning Restrictions for IPv6 on Cable

The following areas of IPv6 provisioning are not supported on the Cisco CMTS routers:

- Preregistration downstream service ID (DSID) notification
- Bonded-Downstream Channel Descriptor (B-DCD) messages
- Multiple DHCPv6 IPv6 addresses per CM or CPE
- Static IP address assignment for CPEs
- Stateless address auto-configuration (SLAAC) address assignment

Note In Cisco IOS Release 12.2(33)SCC and later, static IPv6 addressing for CPE is supported using Source Address Verification (SAV). For more information about SAV, see the Source Address verification section in the *DOCSIS 3.0 Security Specification* guide.

Note Starting with Cisco IOS Release 12.2(33)SCG1, Multiple IAPDs in a Single Advertise feature supports assignment of multiple IPv6 addresses to a Cable Modem (CM) subscriber.

Note Due to restrictions with DSID and B-DCD messaging support in Cisco IOS Release 12.2(33)SCA, DOCSIS 3.0 CMs must operate with DOCSIS 2.0-level functionality.

QoS Restrictions

Effective with , the following fields are supported for theIPv6 downstream classification:

- IPv6 dest addr
- ipv6 src addr
- IPv6 next header
- IPv6 traffic class

Note IPv6 flow label field is not supported.

The following areas of DOCSIS QoS are not supported by the Cisco CMTS routers:

- Upstream IPv6 Type of Service (ToS) overwrite
- Downstream IPv6 classification

Note ToS overwrite, DOCSIS classification, and Modular QoS CLI (MQC) on Gigabit Ethernet are supported on PRE4 from Cisco IOS Release 12.2(33)SCE onwards.

Routing Restrictions for IPv6 on Cable

The following areas of IPv6 routing are not supported by the Cisco CMTS routers:

- Authenticate route injection via Routing Information Protocol (RIP) for IPv6 (RIPng)
- Differential address/prefix assignment for CM and the CPE behind CM

Note Starting with Cisco IOS Release 12.2(33)SCF4, differential prefix assignment for CM and the CPE behind CM is supported.

- Enhanced Interior Gateway Routing Protocol (EIGRP)
- Open Shortest Path First (OSPFv3) cannot operate with IPv6 multicast routing. To use OSPF, you must disable the **ipv6 multicast-routing** command on the Cisco CMTS routers.

Services and Management Restrictions for IPv6 on Cable

The following areas of IPv6 services and management are not supported by the Cisco CMTS routers:

- IPv6 general prefixes
- IPv6 IOS firewall, including IOS firewall and FTP application support

Switching Restrictions for IPv6 on Cable

The following areas of IPv6 switching services are not supported by the Cisco CMTS routers:

- Automatic 6to4 tunnels
- Provider edge router over Multiprotocol Label Switching (MPLS) (6PE)
- CEFv6 switched Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) tunnels
- CEFv6 switched automatic IPv4-compatible tunnels
- Parallel Express Forwarding (PXF) switching on the Cisco uBR10012 router

Note PXF switching is supported on the Cisco CMTS routers from Cisco IOS Release 12.2(33)SCE onwards.

Tunneling Restrictions for IPv6 on Cable

The following areas of IPv6 tunneling services are not supported by the Cisco CMTS routers:

- Automatic 6to4 tunnels
- Automatic IPv4-compatible tunnels
- IPv6 over Universal Transport Interface (UTI) using a Tunnel Line Card
- ISATAP tunnel support
- IPv6 over IPv6 tunnels
- IP over IPv6 Generic Routing Encapsulation (GRE) tunnels
- IPv6 GRE tunnels in Connectionless Network Service (CLNS) networks

Restrictions for IPv6 Dual Stack CPE Support on the CMTS

The IPv6 Dual Stack CPE Support on the CMTS feature in Cisco IOS Release 12.2(33)SCC has the following limitations:

Note These limitations are not applicable for Cisco IOS Release 12.2(33)SCE. PXF acceleration support is available only on PRE4 from Cisco IOS Release 12.2(33)SCE and later releases.

- The CMTS must use DHCPv4 and DHCPv6 to assign both IPv4 and IPv6 addresses to a dual stack CPE client.
- The IPv6 functionality on the Cisco uBR10012 router manages the CM and tests the infrastructure for CPE deployment. Cisco IOS Release 12.2(33)SCC does not support PXF acceleration of IPv6 data packets on the Cisco uBR10012 router platform. IPv6 data packets from CPE devices are handled by the control processor. Hence, the packets per second (pps) rate is limited to a few kpps per CMTS. IPv6

traffic of 3 kpps on PRE2 and 12 kpps on PRE4 produces an acceptable load on the Cisco uBR10012 control processor.

Restrictions for Implementing IPv6 VPN over MPLS

- The maximum number of IPv6 virtual routing and forwarding instances (VRF) that can be supported is 2038 (including the global routing instances).
- Each subinterface on the CMTS requires an address range from the ISP and from the MSO that will will be used to assign addresses for cable modems. These two address ranges must not overlap and must be extensible to support an increased number of subscribers for scalability.
- This feature does not support DHCPv6 over MPLS and IPv6 multicast.

Note Starting with Cisco IOS Release 12.2(33)SCF4, DHCPv6 over MPLS is supported.

Restrictions for Multiple IAPDs in a Single Advertise

- The cable modem can have only one Identity Association for Non-temporary Address (IA_NA). The IA_NA can either be static or assigned via the DHCP.
- The CPE can have multiple Identity Association for Prefix Delegations (IAPDs) via a DHCP.
- The CPE cannot have multiple IA_NAs and IAPDs, both static and assigned via a DHCP at the same time.
- The default maximum number of IPv6 addresses per CPE is 16.
- The router displays all IA_NA and IAPD requests when CPEs send them together in a single request, or IA_NAs are received first followed by IAPDs. If CPEs send IA_NA and IAPD requests separately to the router and IAPD requests are received first followed by IA_NAs, then only IA_NA addresses are visible on the router. All IAPD addresses are automatically cleared.

Information About IPv6 on Cable

This section includes the following topics:

Features Supported from Cisco IOS Release 12.2(33)SCE

The following features are supported on the Cisco CMTS routers from Cisco IOS Release 12.2(33)SCE onwards:

- PXF switching
- PXF acceleration of IPv6 data packets
- Source verification of IPv6 packets in PXF

- ACL support for PXF
- ToS overwrite
- DOCSIS classification
- Modular QoS CLI (MQC) on Gigabit Ethernet
- IPv6 DOCSIS RP and LC HA and DCC
- MAC tapping of IPv6 packets
- Equal cost route load balancing of IPv6 packets destined to the backhaul
- IPv6 over IPv4 GRE tunnels

Features Supported from Cisco IOS Release 12.2(33)SCF4

The following features are supported on the Cisco CMTS routers from Cisco IOS Release 12.2(33)SCF4 onwards:

- Assignment of different prefixes to CM and CPE
- DHCPv6 over MPLS-VPN
- DHCPv6 relay prefix delegation VRF awareness

Features Supported from Cisco IOS Release 12.2(33)SCG1

The following features are supported on Cisco CMTS routers from Cisco IOS Release 12.2(33)SCG1 onwards:

- Assignment of multiple IAPDs in a single advertise for each CPE.
- Assignment of multiple IA_NA and IAPD combinations to multiple CPEs behind a CM.
- The default maximum number of IA_NA and IAPD combinations for each cable modem is 16, including link-local addresses.

Features Supported from Cisco IOS Release 12.2(33)SCI1

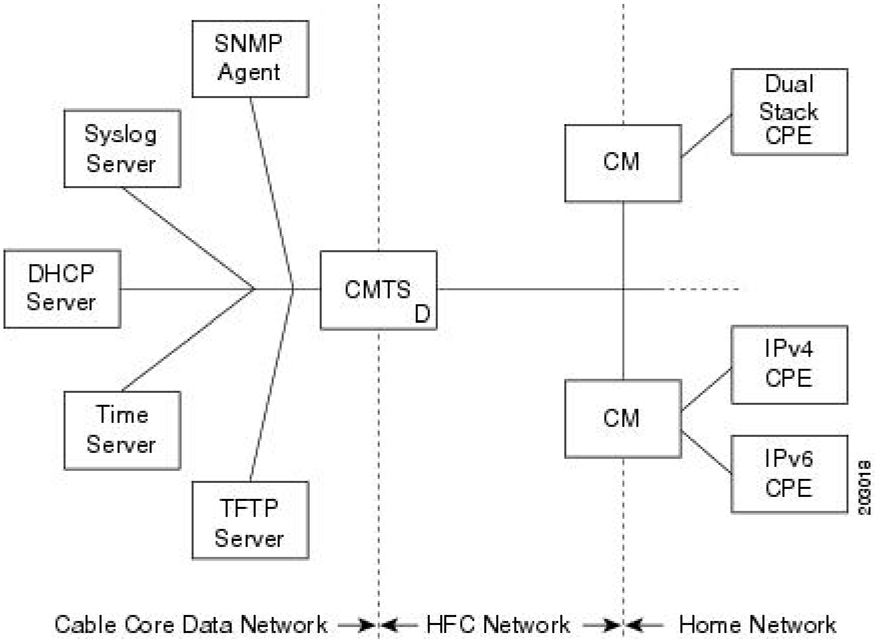
The following features are supported on Cisco CMTS routers from Cisco IOS Release 12.2(33)SCI1 onwards:

- IPv4 and IPv6 Downstream ToS overwrite.
- DHCPv6 Client Link-Layer Address Option (RFC 6939).

Overview of the DOCSIS 3.0 Network Model Supporting IPv6

Figure below illustrates the network model described by the *DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification*.

Figure 1: DOCSIS 3.0 Network Model



In this model, the different devices support the following functions and services:

- Customer premises equipment (CPE)—Supports IPv4, IPv6, or dual stack operation.

Note In Cisco IOS Release 12.2(33)SCC and later releases, Cisco CMTS routers support CPE devices provisioned for dual stack operation.

- Cable modem (CM)—Functions as a bridging device and supports IPv4, IPv6, or dual stack operation.
- Cable modem termination system (CMTS) router—Works with the CM over the hybrid fiber coaxial cable (HFC) network to provide IPv4 and IPv6 network connectivity to the provisioning servers and the core data network behind the CMTS router.

The CMTS router supports IPv6 address assignment, routing, and forwarding of IPv6 multicast and unicast packets.

Note In Cisco IOS Release 12.2(33)SCA and later releases, the Cisco CMTS router supports only a single DHCPv6 IPv6 address per client CM or CPE. This restriction also applies to DHCPv6 Prefix Delegation prefixes. The reason for blocking more than one DHCPv6 address or prefix for a client is because the end-to-end network requires Source Address Selection (SAS) and all nodes in the end-to-end network may not support the correct SAS. Moreover, the SAS specification (RFC 3484) is being revised by the IETF to define the correct SAS behavior.

- Simple Network Management Protocol (SNMP) agent—Provides management tools to configure and query devices on the network.
- Syslog server—Collects messages from the CM to support its functions.
- Dynamic Host Control Protocol (DHCP) server—The DOCSIS 3.0 network model supports both DHCPv4 and DHCPv6 servers to control the assignment of IP addresses.
- Time server—Provides the current time to the CM.
- Trivial File Transport Protocol (TFTP) server—Provides the CM configuration file.

Note In Cisco IOS Release 12.2(33)SCG1, the Cisco CMTS router supports multiple IPv6 addresses per client CPE via DHCP. The *Multiple IAPDs in a Single Advertise* feature supports assignment of multiple IA_NA and IAPD to a client CPE. This feature removes the restriction introduced in Cisco IOS Release 12.2(33)SCA to enable allocation of multiple globally-reachable IPv6 addresses to home devices of the cable modem subscriber.

Note The Cisco CMTS router supports multiple IPv6 addresses per client CPE via DHCP. The *Multiple IAPDs in a Single Advertise* feature supports assignment of multiple IA_NA and IAPD to a client CPE. This feature removes the restriction introduced in Cisco IOS Release 12.2(33)SCA to enable allocation of multiple globally-reachable IPv6 addresses to home devices of the cable modem subscriber.

Overview of Cable Modem IPv6 Address Provisioning

Prior to cable modem registration with a CMTS router, the CMTS router sends a MAC Domain Descriptor (MDD) message to provide information to the cable modem about its supported IP provisioning mode. You configure the CMTS router provisioning mode using the **cable ip-init** interface configuration command. For more information, see the Implementing IPv6 Addressing and Basic Connectivity for Cable Interfaces and Bundles, on page 24.

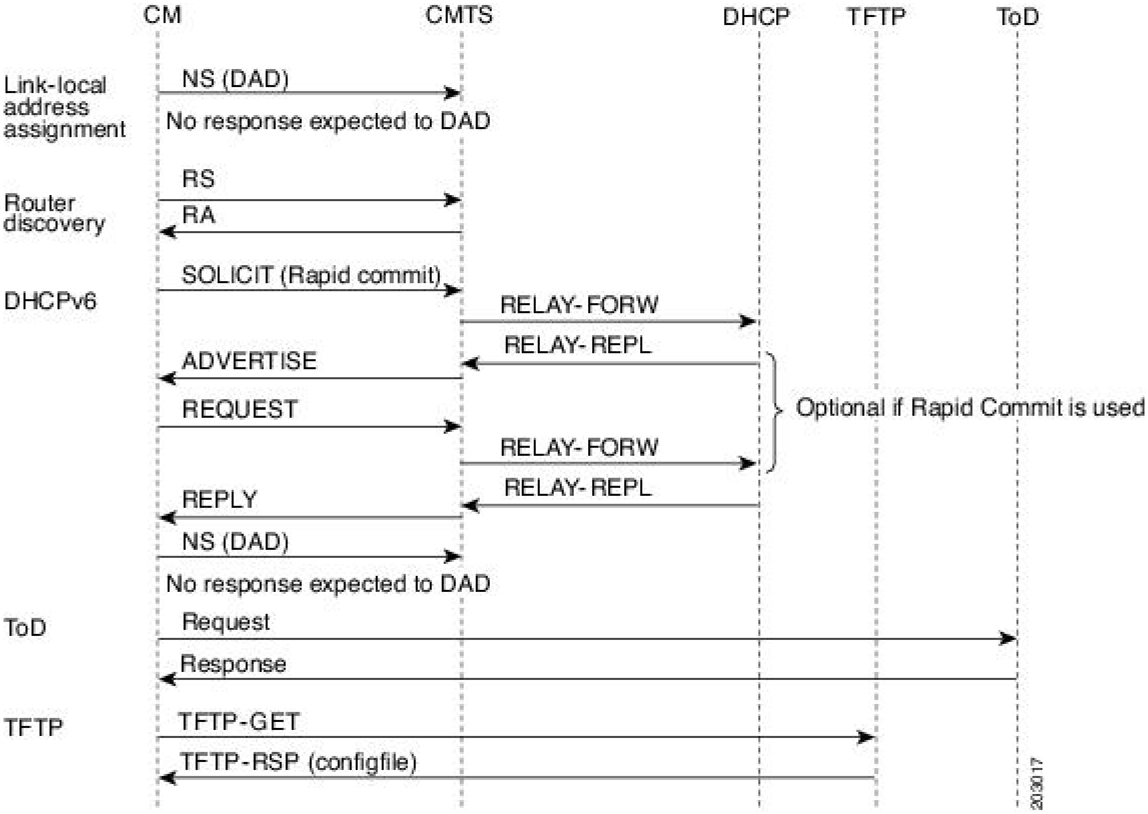
The MDD contains an IP initialization parameters type length value (TLV) that defines the IP version, management and alternate provisioning mode, and pre-registration downstream service ID (DSID) that is used by cable modems that are capable of downstream traffic filtering.

Note In Cisco IOS Release 12.2(33)SCA, the Cisco CMTS routers do not support alternate provisioning mode or pre-registration DSID.

To support the MULPIv3.0 I04 or later version of the *DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification*, the cable modem must attempt IPv6 address acquisition first.

Figure below illustrates the message flow between a cable modem, the CMTS router, and the DHCP server when the cable modem is requesting an IPv6 address.

Figure 2: Message Flow for CM Provisioning of DHCP IPv6 Address Assignment



1 Link-local address assignment—The cable modem sends a Neighbor Solicit (NS) message with its link-local address (LLA) to the CMTS router, which starts the duplicate address detection (DAD) process for that LLA. The cable modem expects no response to the NS message.

2 Router discovery—The cable modem listens to the downstream to detect periodical Router Advertise (RA) messages. When an RA message is detected, the cable modem uses the data in the RA message to configure the default route. If an RA is not detected in a specified period, the cable modem sends a Router Solicit (RS) message to find the router on the link (all nodes multicast). The CMTS router responds with a Router Advertise (RA) message with theM and O bits set to 1 to instruct the CM to perform stateful address configuration.

Note Cisco CMTS routers do not support SLAAC address assignment.

- DHCPv6—The cable modem sends a DHCPv6 Solicit message to the CMTS router to request an IPv6 address. The CMTS router relays this message to the DHCPv6 servers. The DHCPv6 servers send an Advertise message indicating the server’s availability.

If the Rapid-Commit option is not used by the cable modem, then the cable modem responds to the Advertise message of the server with a Request message to select the server that the CMTS router relays to the DHCPv6 server. If the Rapid-Commit option is used, then multiple DHCPv6 servers that could assign different addresses to the same CPE must not be used.

The cable modem starts the DAD process to verify the uniqueness of the IPv6 address that the DHCPv6 server assigns to it.

- TFTP and Time of Day (ToD)—Once the CM establishes IP connectivity, it sends a request to the TFTP server to download a configuration file and requests the current time from the ToD server to complete its boot process.

Overview of IPv6 Dual Stack CPE Support on the CMTS

In Cisco IOS Release 12.2(33)SCA and later releases, IPv6 was added to the CMTS. Most operating systems (OS) deployed at homes support dual stack operation. In Cisco IOS Release 12.2(33)SCC and later releases, CMTS also supports dual stack, which is both IPv4 and IPv6 addressing on the CPE.

Overview of IPv6 over Subinterfaces

In Cisco IOS Release 12.2(33)SCC, CMTS supports IPv6 over bundle subinterfaces. To configure IPv6 on bundle subinterfaces, see the Implementing IPv6 Addressing and Basic Connectivity for Cable Interfaces and Bundles, on page 24 section. For a CMTS bundle configuration example, see the Example: IPv6 over Subinterfaces , on page 39 section.

To enable IPv6 on subinterfaces, configure IPv6 on bundle subinterfaces and not the bundle. Reset the CMs after the subinterface is configured.

Note In Cisco IOS Release 12.2(33)SCC, MPLS VPN over subinterfaces for IPv6 is not supported.

Overview of High Availability on IPv6

In Cisco IOS Release 12.2(33)SCE, CMTS supports HA features on IPv6. IPv6 HA is supported on PRE2 with IPv6 punt path forwarding and on PRE4 with IPv6 PXF forwarding.

Note IPv6 DOCSIS HA and HCCP is supported on the Cisco CMTS routers from Cisco IOS Release 12.2(33)SCE onwards.

The IPv6 HA feature support in Cisco CMTS routers covers the following capabilities:

- DOCSIS PRE HA
- DOCSIS line card HA
- Dynamic Channel Change (DCC)

DOCSIS PRE HA

The DOCSIS PRE HA has the following behavior restrictions and prerequisites on the Cisco CMTS routers:

- The CMs and CPEs should not go offline after a PRE switchover.
- The data structures of the IPv6 CM and CPE should be synchronized to the standby PRE before the PRE switchover. Both dynamic and bulk synchronization is supported.
- Single stack, dual stack, and APM are supported for the CM.
- Single stack and dual stack provisioning modes are supported on the CPE.
- After a PRE switchover, the IPv6 neighbor entries are rebuilt by Neighbor Discovery (ND) messages on the standby PRE, and the IPv6 routes are rebuilt after converging the routing protocol.

DOCSIS Line Card HA

The DOCSIS line card HA has the following behavior restrictions and prerequisites on the Cisco CMTS routers:

- The data structures of the IPv6 CM and CPE should be synchronized to the standby line card before the line card switchover. Both dynamic and bulk synchronization is supported.
- The CMs and CPEs should not fall offline after a line card switches over and reverts; the CMs and CPEs should behave the same as before the switchover.
- The DOCSIS line card HA supports both 4+1 and 7+1 redundancy.
- Traffic outages in IPv6 may be longer because traffic recovery occurs only after converging the routing protocol.

Dynamic Channel Change

The Dynamic Channel Change (DCC) feature is supported on Cisco CMTS routers.

Note The behavior of the DCC for single stack IPv6 CM and CPE, or dual stack CM and CPE is the same as that of a single stack IPv4 CM and CPE.

The IPv6 and IPv4 DCC functionality has the following behavior restrictions and prerequisites on the Cisco CMTS routers:

Narrowband Cable Modem

- If the source and destination MAC domains of the CM are on the same line card, DCC initialization techniques 0, 1, 2, 3, and 4 are used to move the CM and its associated CPE from one upstream or downstream to another; or move the CM and CPE from one upstream and downstream combination to another.
- If the source and destination MAC domains of the CM are on different line cards, you can use only the DCC initialization technique 0 to move the CM and its associated CPE across line cards.

Wideband Cable Modem

- If the source and destination MAC domains of the CM are on the same line card, DCC initialization techniques 0, 1, 2, 3, and 4 are used to move the CM and its associated CPE from one upstream to another.
- If the primary downstream of a CM is changed after DCC, you can use only the DCC initialization technique 0 to move the CM and its associated CPE across line cards.

Overview of IPv6 VPN over MPLS

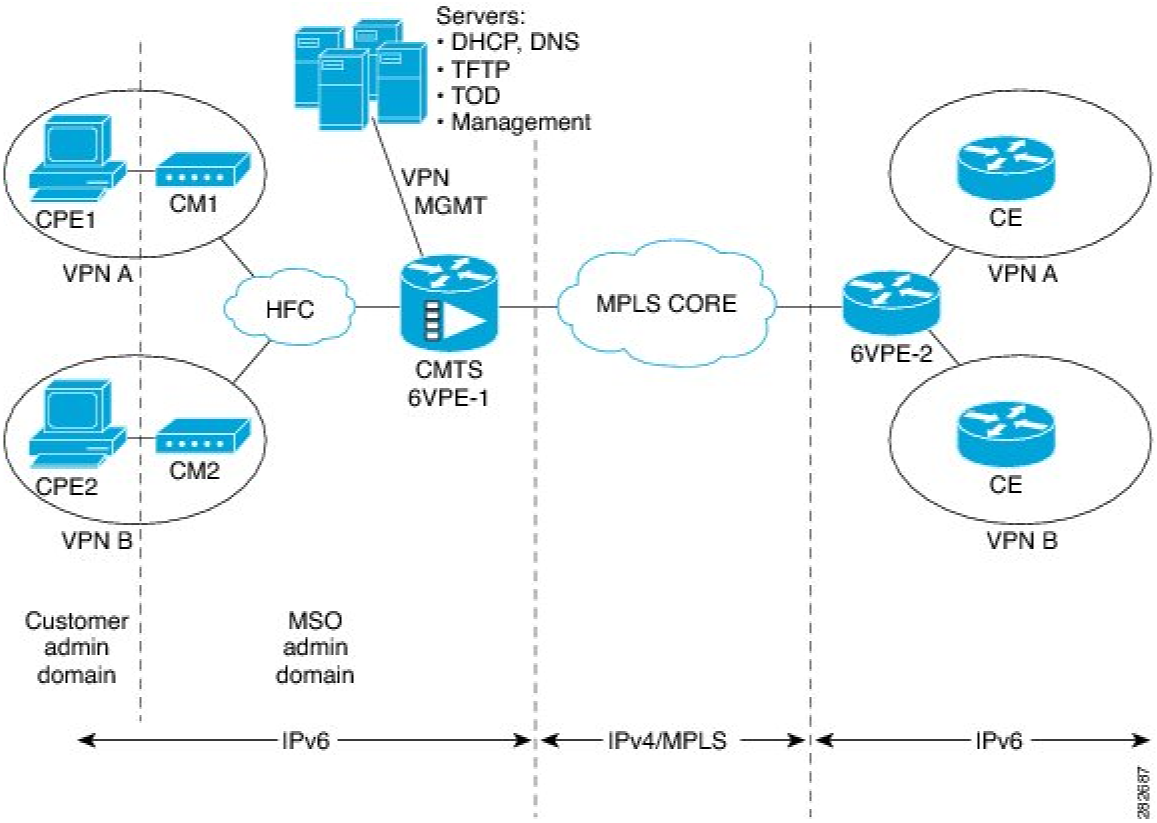
The Multiprotocol Label Switching (MPLS) VPN feature represents an implementation of the provider edge (PE) based VPN model. This document describes the IPv6 VPN over MPLS (6VPE) feature.

The 6VPE feature allows Service Providers to provide an IPv6 VPN service that does not require an upgrade or reconfiguration of the PE routers in the IPv4 MPLS Core. The resulting IPv6 VPN service has a configuration and operation which is virtually identical to the current IPv4 VPN service.

In principle, there is no difference between IPv4 and IPv6 VPNs. In both IPv4 and IPv6, the multiprotocol BGP is the core of the MPLS VPN for IPv6 (VPNv6) architecture. It is used to distribute IPv6 routes over the service provider backbone using the same procedures to work with overlapping addresses, redistribution policies, and scalability issues.

Figure below illustrates the 6PE/6VPE reference architecture diagram.

Figure 3: 6PE/6VPE Reference Architecture



For more information about these tasks, see the Implementing IPv6 VPN over MPLS chapter in the Cisco IOS IPv6 Configuration Guide, Release 12.2SR.

Cable Monitor

The Cable Monitor and Intercept features for Cisco CMTS routers provide a software solution for monitoring and intercepting traffic coming from a cable network. These features give service providers Lawful Intercept capabilities.

For more information, see Cable Monitor and Intercept Features for the Cisco CMTS Routers guide at: http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/cmts_mon_intrcpt.html

Overview of IPv6 CPE Router Support on the Cisco CMTS

In Cisco IOS Release 12.2(33)SCF and later releases, the IPv6 CPE router support is provided on the Cisco CMTS. The IPv6 CPE router is a node primarily for home or small office use that connects the end-user network to a service provider network. It is also referred to as the home router.

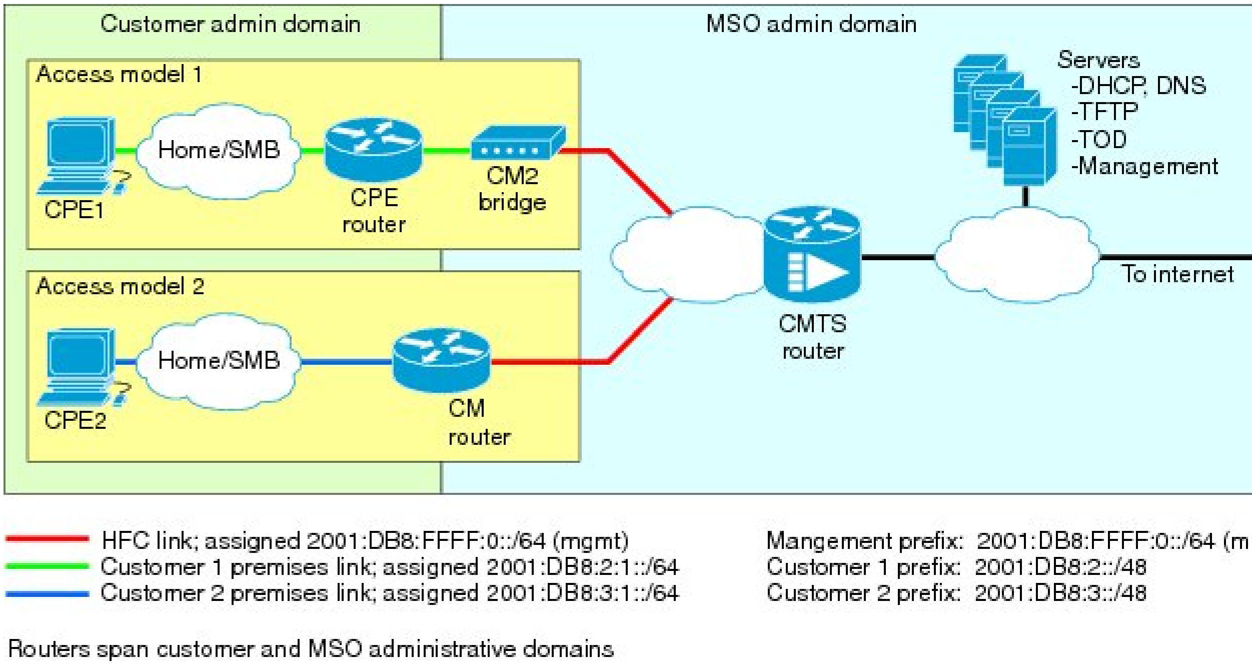
The IPv6 CPE router is responsible for implementing IPv6 routing; that is, the IPv6 CPE router looks up the IPv6 destination address in its routing table and decides to which interface the packet should be sent.

The IPv6 CPE router performs the following functions:

- Provisions its WAN interface automatically.
- Acquires IP address space for provisioning of its LAN interfaces.
- Fetches other configuration information from the service provider network.

Figure below illustrates the CPE router reference architecture diagram between the CPE router, the CMTS, and the DHCPv6 server (CNR) when the CM is requesting an IPv6 address.

Figure 4: IPv6 CPE Router Reference Architecture


Customer admin domain
MSO admin domain
Access model 1
Home/SMB
CPE1
CPE router
CM2 bridge
Servers
-DHCP, DNS
-TFTP
-TOD
-Management
To internet
CMTS router
Access model 2
Home/SMB
CPE2
CM router
HFC link; assigned 2001:DB8:FFFF:0::/64 (mgmt)
Customer 1 premises link; assigned 2001:DB8:2:1::/64
Customer 2 premises link; assigned 2001:DB8:3:1::/64
Mangement prefix: 2001:DB8:FFFF:0::/64 (m
Customer 1 prefix: 2001:DB8:2::/48
Customer 2 prefix: 2001:DB8:3::/48
Routers span customer and MSO administrative domains

As part of the IPv6 CPE Router Support feature, the following enhancements are introduced:

- Support to IPv6 router devices.
- IPv6 Prefix Delegation (PD) High Availability.
- Prefix awareness support in IPv6 cable source-verify, Cable DOCSIS filters code, and packet intercepts.

Support for IPv6 Prefix Stability on the CMTS

Cisco IOS Release 12.2(33)SCF1 supports IPv6 prefix stability on the Cisco CMTS as specified in DOCSIS 3.0 MULPI CM-SP-MULPIv3.0-I15-110210 standard. The IPv6 prefix stability allows an IPv6 home router to move from one Cisco CMTS to another while retaining the same prefix.

The multiple service operators (MSOs) can use this feature to allow their business customers (with IPv6 routers) to retain the same IPv6 prefix during a node split.

Configurable DHCPv6 Relay Address

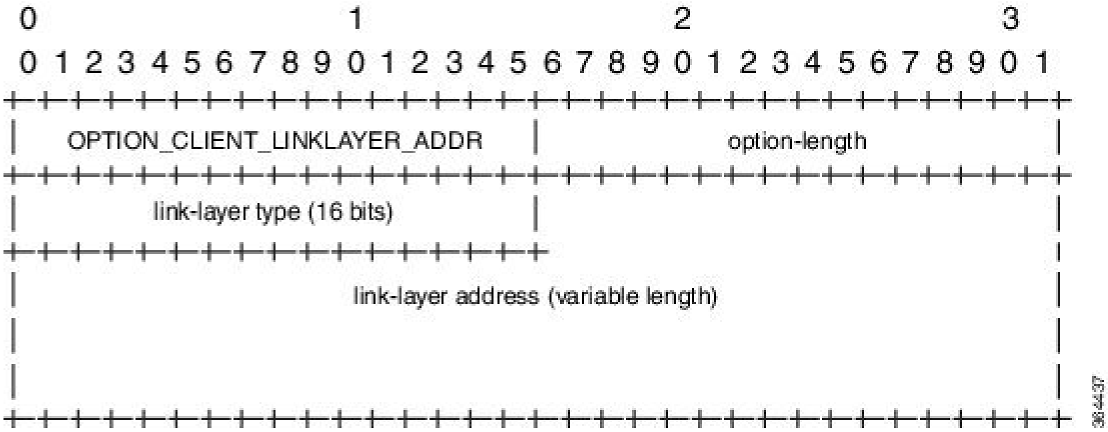
The DHCPv6 Cisco IOS relay agent on the Cisco CMTS router sends relay-forward messages from a source address to all configured relay destinations. The source address is either an IPv6 address provisioned on the network interface or a Cisco CMTS WAN IPv6 address. The relay destination can be a unicast address of a server, another relay agent, or a multicast address. The relay-forward messages contain specific DHCPv6 link-addresses.

A DHCP relay agent is used to relay messages between the client and server. A client locates a DHCP server using a reserved, link-scoped multicast address.

DHCPv6 Client Link-Layer Address Option (RFC 6939)

Cisco IOS Release 12.2(33)SCI1 supports DHCPv6 Client Link-Layer Address Option (RFC 6939). It defines an optional mechanism and the related DHCPv6 option to allow first-hop DHCPv6 relay agents (relay agents that are connected to the same link as the client) to provide the client's link-layer address in the DHCPv6 messages being sent towards the server.

The format of the DHCPv6 Client Link-Layer Address option is shown below.



```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  OPTION_CLIENT_LINKLAYER_ADDR |          option-length        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     link-layer type (16 bits) |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                               |
|                link-layer address (variable length)           |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Name	Description
option-code	OPTION_CLIENT_LINKLAYER_ADDR (79)
option-length	2 + length of MAC address
link-layer type	CPE or CM MAC address type. The link-layer type MUST be a valid hardware type assigned by the IANA, as described in RFC0826.
link-layer address	MAC address of the CPE or CM.

Note Starting with Cisco IOS Release 12.2(33)SCI1, RFC6939 is enabled by default. It can not be enabled/disabled by any CLI command.

To configure DHCPv6 Relay Address on the Cisco CMTS bundle subinterfaces, see the Configuring DHCPv6 Relay Agent, on page 35 section.

For more information about the DHCPv6 client, server, and relay functions, see the “Implementing DHCP for IPv6” chapter in the Cisco IOS IPv6 Configuration Guide, Release 12.2SR .

Unitary DHCPv6 Leasequery

The Cisco IOS Release 12.2(33)SCF1 introduces support for unitary DHCPv6 leasequery protocol (RFC 5007) on the Cisco CMTS routers for upstream IPv6 source verification. This protocol verifies the authenticity of the IPv6 CPE behind a home or small office cable deployment.

For more information on unitary DHCPv6 leasequery, see the Unitary DHCPv6 Leasequery feature guide.

Support for Multiple IAPDs in a Single Advertise

Cisco IOS Release 12.2(33)SCG1supports assignment of multiple IA_NA and IAPD to CPEs behind a CM. This feature includes support for link-local addresses and IA_NA and IAPD. However, a CM can be assigned only one IA_NA. This IA_NA can be either static or DHCP-assigned.

The CPEs behind the CM can request for multiple DHCPv6 IA_NAs and IAPDs. Each CPE is assigned multiple IA_NAs and IAPDs in a single Advertise/Reply message. Each CPE request for IA_NA and IAPD is treated as a separate Advertise/Reply message.

IPv6 Neighbor Discovery Gleaning

The IPv6 Neighbor Discovery (ND) Gleaning feature enables Cisco CMTS routers to automatically recover lost IPv6 CPE addresses and update the CPE records in the Cisco CMTS subscriber database. The Cisco CMTS router gleans only the solicited neighbor advertise (NA) messages transmitted in the upstream direction. IPv6 ND gleaning is similar to Address Resolution Protocol (ARP) gleaning for IPv4 CPE recovery.

The IPv6 ND Gleaning feature is configured by default on Cisco CMTS routers. To disable this feature, use the **no** form of the **cable nd** command in bundle interface configuration mode. The **cable nd** command adds a CPE (host behind a cable modem) to the Cisco CMTS subscriber database. This command does not impact the IPv6 ND protocol operation on the router.

Note The IPv6 ND Gleaning feature does not support gleaning of NA messages transmitted in the downstream direction.

IPv6 Address Packet Intercept

The IPv6 Address Packet Intercept feature provides lawful intercept of cable modems and CPEs provisioned with IPv6 addresses. This feature taps all the packets received and sent from the system. The intercepted packets are sent to the MD with the content connection identifier (CCCID) specified by the tapping rule.

For more information on IPv6 Address Packet Intercept, see the IPv6 Address Packet Intercept feature guide.

How to Configure IPv6 on Cable

This section includes the following tasks:

Configuring IPv6 Switching Services

The CMTS routers support forwarding of unicast and multicast IPv6 traffic using either Cisco Express Forwarding for IPv6 (CEFv6) or distributed CEFv6 (dCEFv6):

- CEFv6—All CMTS platforms
- dCEFv6—Cisco uBR10012 universal broadband router only

The CMTS routers also support Unicast Reverse Path Forwarding (RPF), as long as you enable Cisco Express Forwarding switching or distributed Cisco Express Forwarding switching globally on the router. There is no need to configure the input interface for Cisco Express Forwarding switching. As long as Cisco Express Forwarding is running on the router, individual interfaces can be configured with other switching modes.

To configure forwarding of IPv6 traffic using Cisco Express Forwarding or distributed Cisco Express Forwarding (supported on the Cisco uBR10012 universal broadband router only) on the CMTS routers, you must configure forwarding of IPv6 unicast datagrams using the **ipv6 unicast-routing** global configuration command, and you must configure an IPv6 address on the bundle interface using the **ipv6 address** command.

The **show ipv6 cef platform** command is supported on the Cisco CMTS platform from Cisco IOS Release 12.2(33)SCE onwards. You can use the **show ipv6 cef platform** command for debugging purposes.

Before You Begin

- You must enable Cisco Express Forwarding for IPv4 globally on the router by using the **ip cef** or **ip cef distributed** command before configuring Cisco Express Forwarding v6 or distributed Cisco Express Forwarding v6.

Note The **ip cef** command is enabled by default on all Cisco CMTS routers. Therefore, you only must configure the command if it has been disabled. However, you must explicitly configure the **ip cef distributed** command on a Cisco uBR10012 universal broadband router if you want to run distributed CEF switching services for IPv4 or IPv6.

- You must configure forwarding of IPv6 unicast datagrams using the **ipv6 unicast-routing** global configuration command.
- You must configure IPv6 addressing on the cable bundle interface.
- CEF switching is required for Unicast RPF to work.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	Do one of the following:
	• **ip cef**
	• **ip cef distributed**
	Example:
	`Router(config)# ip cef`
	`or`
	`Router(config)# ip cef distributed`
		Enables Cisco Express Forwarding.
		or
		Enables distributed Cisco Express Forwarding for IPv4 datagrams.
		Note For CMTS routers, distributed Cisco Express Forwarding is supported only on a Cisco uBR10012 universal broadband router.

Step 4	Do one of the following:
	• **ipv6 cef**
	• **ipv6 cef distributed**
	Example:
	`Router(config)# ipv6 cef`
	`or`
	`Router(config)# ipv6 cef distributed`
		Enables Cisco Express Forwarding v6.
		or
		Enables distributed Cisco Express Forwarding v6 for IPv6 datagrams.
		Note For CMTS routers, distributed Cisco Express Forwarding v6 is supported only on a Cisco uBR10012 universal broadband router.

Step 5	**ipv6 unicast-routing** **Example:** `Router(config)# ipv6 unicast-routing`	Enables the forwarding of IPv6 unicast datagrams.

What to Do Next

- (Optional) Enable IPv6 multicast routing using the **ipv6 multicast-routing** command in global configuration mode and configure other multicast features.

Note In Cisco IOS Release 12.2(33)SCA, the Cisco CMTS routers do not support OSPF with IPv6 multicast routing.

Implementing IPv6 Addressing and Basic Connectivity for Cable Interfaces and Bundles

Configuring the Cable Virtual Bundle Interface

The only required IPv6 configuration on a cable line card interface is the IP provisioning mode. The remainder of the IPv6 features are configured at the virtual bundle interface, which is then associated with a particular cable line card interface to establish its configuration.

Most of the IPv6 features that are supported in interface configuration mode (both cable-specific as well as platform-independent IPv6 features) are configured at a cable bundle interface.

The Cisco CMTS routers support IPv6 routing on the bundle interface and map both IPv6 unicast and multicast addresses into the cable bundle forwarding table, for packet forwarding.

Each bundle interface has a unique link-local address (LLA) to support link-local traffic when IPv6 is enabled. Cisco CMTS routers can support a maximum of 40 active bundle interfaces, which also translates to a maximum of 40 active IPv6-enabled bundle interfaces.

Starting with Cisco IOS Release 12.3(33)SCB10, IPv6 commands can be configured on multiple bundle subinterfaces.

Before You Begin

The **cable ipv6 source-verify** and **cable nd** commands are not compatible with each other in Cisco IOS release 12.2(33)SCE and later. You must disable IPv6 ND gleaning using the **no** form of the **cable nd** command before using the **cable ipv6 source-verify** command to ensure that only DHCPv6 and SAV-based CPEs can send traffic on the router.

Restriction All multicast traffic is flooded onto bundle member interfaces.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface bundle** *n* **Example:** `Router(config)# interface bundle 1`	Specifies the cable bundle interface and enters interface configuration mode, where *n* specifies the number of the bundle interface.
Step 4	**ipv6 address***ipv6-prefix*/*prefix-length* [**eui-64**] **Example:** `Router(config-if)# ipv6 address 2001:DB8::/32 eui-64`	Specifies an IPv6 network assigned to the interface and enables IPv6 processing on the interface. The ipv6 address eui-64 command configures site-local and global IPv6 addresses with an interface identifier (ID) in the low-order 64 bits of the IPv6 address. You need to specify only the 64-bit network prefix for the address; the last 64 bits are automatically computed from the interface ID.
Step 5	**ipv6 address***ipv6-prefix* /*prefix-length* **link-local** **Example:** `Router(config-if)# ipv6 address 2001:DB8::/32 link-local`	(Optional) Specifies an IPv6 address assigned to the interface and enables IPv6 processing on the interface. The **ipv6 address link-local** command configures a link-local address on the interface that is used instead of the link-local address that is automatically configured, when IPv6 is enabled on the interface (using the **ipv6 enable** command).
Step 6	**ipv6 enable** **Example:** `Router(config-if)# ipv6 enable`	Automatically configures an IPv6 link-local address on the interface while also enabling the interface for IPv6 processing. The link-local address can be used only to communicate with nodes on the same link.
Step 7	cable ipv6 source-verify **Example:** `Router(config-if)# cable ipv6 source-verify`	(Optional) Enables source verification of MAC address-MD-SID-IPv6 address binding packets received by a cable interface upstream on Cisco CMTS routers. **Note** DHCPv6 leasequery is not supported in Cisco IOS release 12.2(33)SCE.

What to Do Next

- Configure the desired platform-independent IPv6 features on the bundle interface, such as Neighbor Discovery and DHCPv6 features.
- Configure the IP provisioning mode and bundle on the cable interface.

Configuring the IP Provisioning Mode and Bundle on the Cable Interface

The CMTS routers allow you to configure cable interfaces to support cable modems provisioned for both IPv4 and IPv6 addressing support (known as “dual stack”), only IPv4 addressing, or only IPv6 addressing. Prior to cable modem registration, the CMTS router sends its supported provisioning mode to the cable modem in the MDD message.

In addition to configuring the provisioning mode on the cable interface, you must also associate the cable interface with a cable bundle. You perform most of the other IPv6 feature configuration at the bundle interface.

Note This section describes only the commands associated with establishing IPv6 support on a CMTS router. Other cable interface commands that apply but are optional are not shown, such as to configure upstream and downstream features.

Before You Begin

Configuration of a bundle interface is required.

Restriction APM is not supported in Cisco IOS Release 12.2(33)SCA. Support for APM feature is provided from Cisco IOS Release 12.2(33)SCC onwards.

Note Starting from Cisco IOS Release 12.2(33)SCC onwards, the port parameter of the interface cable was changed to *cable-interface-index* to indicate the MAC domain index for the Cisco UBR-MC and Cisco uBR-MC3GX60V cable interface line cards.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	**interface cable** {*slot* / *port* | *slot* / *subslot* /*port* }
	Example:
	`Router(config)# interface cable 5/0/1`
		Specifies the cable interface line card, where:
		The valid values for these arguments are dependent on your CMTS router and cable interface line card. Refer to the hardware documentation for your router chassis and cable interface line card for supported slot and port numbering.

Step 4	**cable ip-init** {**apm** | **dual-stack** | **ipv4** | **ipv6**}
	Example:
	`Router(config-if)# cable ip-init ipv6`
		Specifies the IP provisioning mode supported by the cable interface, where:

Step 5	**cable bundle***n* **Example:** `Router(config)# cable bundle 1`	Associates the cable interface with a configured virtual bundle interface, where *n* specifies the number of the bundle interface.

What to Do Next

- Proceed to configuring any other cable interface features that you want to support, such as upstream and downstream features. For more information about the other cable interface features, refer to the *Cisco IOS CMTS Cable Software Configuration Guide* .
- Proceed to configure other optional IPv6 cable features.

Configuring IPv6 Cable Filter Groups

Cisco IOS Release 12.2(33)SCA extends the CMTS router IPv4 cable filter group capability to add support for IPv6 filter options.

Cable Filter Groups and the DOCSIS Subscriber Management MIB

Cable subscriber management is a DOCSIS 1.1 specification, which can be established using the following configuration methods:

- CMTS router configuration (via CLI)
- SNMP configuration
- DOCSIS 1.1 configuration file (TLVs 35, 36, and 37)

This section describes the IPv6 cable filter group feature support of the packet filtering portion of the DOCSIS Subscriber Management MIB (DOCS-SUBMGMT-MIB) using configuration commands on the CMTS routers. This IPv6 cable filter group support extends filter classifiers with IPv6 addressing options for CM and CPE traffic, but is independent of DOCSIS IPv6 classifiers, which are used to match packets to service flows.

Configuration of IPv6 cable filter groups on the CMTS routers is supported according to the following guidelines:

- A cable filter group consists of a set of **cable filter group** commands that share the same group ID.
- Separate indexes can be used to define different sets of filters for the same group ID. This can be used to define both IPv4 and IPv6 filters to the same filter group.
- CMs can be associated with one upstream and one downstream filter group.
    - Upstream traffic—All traffic coming from CMs is evaluated against the assigned upstream filter group that is configured by the **cable submgmt default filter-group cm upstream** command.
    - Downstream traffic—All traffic going to CMs is evaluated against the assigned downstream filter group that is configured by the **cable submgmt default filter-group cm downstream** command.
- CPEs can be associated with one upstream and one downstream filter group.
    - Upstream traffic—All traffic coming from CPEs is evaluated against the assigned upstream filter group that is configured by the **cable submgmt default filter-group cpe upstream** command.

- ◦ Downstream traffic—All traffic going to CPEs is evaluated against the assigned downstream filter group that is configured by the **cable submgmt default filter-group cpe downstream** command.

Note Because TLVs 35, 36, and 37 do not apply to DOCSIS 1.0 CM configuration files, the only way to enable cable subscriber management for a DOCSIS 1.0 CM is to configure it explicitly on the Cisco CMTS router and activate it by using the **cable submgmt default active** global configuration command.

Before You Begin

You must create the cable filter group before you assign it to a CM or CPE upstream or downstream.

Restriction

- Chained IPv6 headers are not supported.
- An individual filter group index cannot be configured to support both IPv4 and IPv6 versions at the same time. If you need to support IPv4 and IPv6 filters for the same filter group, then you must use a separate index number with the same filter group ID, and configure one index as **ip-version ipv4**, and the other index as **ip-version ipv6**.
- Only a single upstream and a single downstream filter group can be assigned for CM traffic.
- Only a single upstream and a single downstream filter group can be assigned to CPEs attached to a CM such that all CPEs behind a CM share a common filter group.
- For the filter group to work for CMs, a CM must re-register after the CMTS router is configured for the filter group.
- If parallel eXpress forwarding (PXF) is configured on the Cisco uBR10012 router, either the **cable filter group** commands or the interface ACL (**ip access-list**) command can be configured.
- If you do not provision TLVs 35, 36, and 37 in the DOCSIS CM configuration file, then you must activate the functionality by specifying the **cable submgmt default active** global configuration command on the CMTS router.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**cable filter group***group-id* **index***index-num***dest-port***port-num*	(Optional) Specifies the TCP/UDP destination port number that should be matched. The valid range is from 0 to 65535.

	Command or Action	Purpose
	Example: `Router(config)# cable filter group 1 index 1 dest-port 69`	The default value matches all TCP/UDP port numbers (IPv4 and IPv6 filters).
Step 4	**cable filter group** *group-id* **index** *index-num* **ip-proto** *proto-type* **Example:** `Router(config)# cable filter group 1 index 1 ip-proto 17`	(Optional) Specifies the IP protocol type number that should be matched. The valid range is from 0 to 256, with a default value of 256 that matches all protocols (IPv4 and IPv6 filters). Some commonly used values are:
Step 5	**cable filter group** *group-id* **index** *index-num* **ip-tos** *tos-mask tos-value* **Example:** `Router(config)# cable filter group 1 index 1 ip-tos 0xff 0x80`	(Optional) Specifies a ToS mask and value to be matched (IPv4 and IPv6 filters): The *tos-mask* is logically ANDed with the *tos-value* and compared to the result of ANDing the *tos-mask* with the actual ToS value of the packet. The filter considers it a match if the two values are the same. The default values for both parameters matches all ToS values.
Step 6	**cable filter group** *group-id* **index** *index-num* **ip-version ipv6** **Example:** `Router(config)# cable filter group 1 index 1 ip-version ipv6`	Specifies that this filter group is an IPv6 filter group.

Step 7	**cable filter group** *group-id* **index** *index-num* **match-action** {**accept** | **drop**}
	Example:
	`Router(config)# cable filter group 1 index 1 match-action drop`
		(Optional) Specifies the action that should be taken for packets that match this filter (IPv4 and IPv6 filters):

Step 8	**cable filter group** *group-id* **index** *index-num* **src-port** *port-num* **Example:** `Router(config)# cable filter group 1 index 1 src-port 50`	(Optional) Specifies the TCP/UDP source port number that should be matched. The valid range is from 0 to 65535. The default value matches all TCP/UDP port numbers (IPv4 and IPv6 filters).

Step 9	**cable filter group** *group-id* **index** *index-num* **status** {**active** | **inactive**}
	Example:
	`Router(config)# cable filter group 1 index 1 status inactive`
		(Optional) Enables or disables the filter (IPv4 and IPv6 filters):
		Note You must create a filter group using at least one of the other options before you can use this command to enable or disable the filter.

	Command or Action	Purpose
Step 10	**cable filter group** *group-id* **index** *index-num* **tcp-flags** *flags-mask flags-value* **Example:** `Router(config)# cable filter group 1 index 1 tcp-flags 0 0`	(Optional) Specifies the TCP flag mask and value to be matched (IPv4 and IPv6 filters):
Step 11	**cable filter group** *group-id* **index** *index-num* **v6-dest-address** *ipv6-address* **Example:** `Router(config)# cable filter group 1 index 1 v6-dest-address 2001:DB8::/32`	(Optional) Specifies the IPv6 destination address that should be matched using the format X:X:X:X::X (IPv6 filters only).
Step 12	**cable filter group** *group-id* **index** *index-num* **v6-dest-pfxlen** *prefix-length* **Example:** `Router(config)# cable filter group 1 index 1 v6-dest-pfxlen 64`	(Optional) Specifies the length of the network portion of the IPv6 destination address. The valid range is from 0 to 128.
Step 13	**cable filter group** *group-id* **index** *index-num* **v6-src-address** *ipv6-address* **Example:** `Router(config)# cable filter group 1 index 1 v6-src-address 2001:DB8::/32`	(Optional) Specifies the IPv6 source address that should be matched using the format X:X:X:X::X (IPv6 filters only).
Step 14	**cable filter group** *group-id* **index** *index-num* **v6-src-pfxlen** *prefix-length* **Example:** `Router(config)# cable filter group 1 index 1 v6-src-pfxlen 48`	(Optional) Specifies the length of the network portion of the IPv6 source address. The valid range is from 0 to 128 (IPv6 filters only).
Step 15	**cable submgmt default filter-group** {**cm** | **cpe**} {**downstream** | **upstream**} *group-id* **Example:** `Router(config)# cable submgmt default filter-group cm upstream 1`	Applies a defined filter group (by specifying its *group-id)* to either a CM or its CPE devices, for downstream or upstream traffic.
Step 16	**cable submgmt default active** **Example:** `Router(config)# cable submgmt default active`	(Required if you do not provision TLVs 35, 36, and 37 in the DOCSIS 1.1 CM configuration file) Enables filters and allows the CMTS to manage the CPE devices for a particular CM (sets the docsSubMgtCpeActiveDefault attribute to TRUE).

The following example shows how to create an IPv6 filter group with ID 254 and an index number of 128. The **ip-version ipv6** keywords must be configured to create the IPv6 filter group; otherwise, the default is an IPv4 filter group:

```
configure terminal
cable filter group 254
 index 128 v6-src-address 2001:DB8::/32
cable filter group 254
 index 128 v6-src-pfxlen 48
cable filter group 254
 index 128 v6-dest-address 2001:DB8::/32
cable filter group 254
 index 128 v6-dest-pfxlen 64
cable filter group 254
 index 128 ip-version ipv6
cable filter group 254
 index 128 match-action drop
cable submgmt default filter-group cm upstream 254
```

This group filters CM upstream traffic and drops any packets with an IPv6 source address of 2001:33::20B:BFFF:FEA9:741F (with network prefix of 128) destined for an IPv6 address of 2001:DB8::/32 (with network prefix of 128).

All of the **cable filter group** commands are associated by their group ID of 254 (and index of 128), and the **cable submgmt default filter-group** command applies the corresponding filter group ID of 254 to CM upstream traffic.

To monitor your cable filter group configuration, use forms of the **show cable filter** command as shown in the following examples. In these output examples, the output from the **show cable filter**, **show cable filter group 254**, and **show cable filter group 254 index 128** commands all display the same information because there is currently only a single filter group and index defined.

Note The “Use Verbose” string appears in the output area of the SrcAddr/mask and DestAddr/Mask fields suggesting use of the **show cable filter group verbose** form of the command to display the complete IPv6 address.

```
Router# show cable filter
Filter    SrcAddr/Mask       DestAddr/Mask      Prot ToS  SPort DPort TCP   Action Status
Grp Id v6                                                             Flags
254 128Y  Use Verbose
        Use Verbose
                                    drop   active
Router# show cable filter group 254
Filter    SrcAddr/Mask       DestAddr/Mask      Prot ToS  SPort DPort TCP   Action Status
Grp Id v6                                                             Flags
254 128Y  Use Verbose        Use Verbose                                    drop   active
Router# show cable filter group 254 index 128
Filter    SrcAddr/Mask       DestAddr/Mask      Prot ToS  SPort DPort TCP   Action Status
Grp Id v6                                                             Flags
254 128Y  Use Verbose        Use Verbose                                    drop   active
Router# show cable filter group 254 index 128 verbose
Filter Group                         : 254
Filter Index                         : 128
Filter Version                       : IPv6
Matches                              : 0
    Source IPv6 address              : 2001:DB8::/32
    Destination IPv6 address         : 2001:DB8::/32
    Match action                     : drop
    Status                           : active
```

Troubleshooting Tips

You should configure the **cable filter group** commands prior to applying a filter group using the **cable submgmt default filter-group** command. Failure to do so results in the following message, and an association to a filter group that is undefined:

```
Router(config)# cable submgmt default filter-group cm upstream 100
Default value set to a nonexistent filter-group 100.
```

Configuring IPv6 Domain Name Service

Cisco IOS Release 12.2(33)SCA introduces the domain name service (DNS) capability for devices using IPv6 addressing on the Cisco CMTS routers.

Cisco IOS Release 12.2(33)SCA introduces the domain name service (DNS) capability for devices using IPv6 addressing on the Cisco CMTS routers.

DNS simplifies the identification of cable devices by associating a hostname with what can often be a complex 128-bit IPv6 address. The hostname can then be used in place of the IPv6 address within the CMTS router CLI that supports use of hostnames.

There are two separate DNS caches supported on a CMTS router—an IOS DNS cache and a cable-specific DNS cache that stores IPv6 addresses learned by the CMTS router for CMs and CPEs.

In this phase of the IPv6 DNS service on cable, the DNS server is queried for domain name information as needed when you use the **show cable modem domain-name** command. When you use this command, the following actions take place:

1. The CMTS router checks whether CMs are online. If a CM is online, the CMTS router uses the corresponding IPv6 address assigned to the CM and looks up its domain name from the IOS DNS cache.
2. If no match is found, the CMTS router sends a DNS-QUERY message with the IPv6 address of the CM to the DNS server, which tries to resolve the domain name.
3. When the DNS reply is received, the CMTS router stores the domain name in the IOS DNS cache for each IPv6 address.
4. The CMTS router also stores the fully-qualified domain name (FQDN) that is replied by the DNS server in the cable-specific DNS cache.

Note Running the **no ip domain lookup** command turns off the DNS resolution.

The following platform-independent Cisco IOS software commands are supported using host names by the CMTS router for IPv6 DNS on cable:

- **connect**
- **ping ipv6**
- **show hosts**
- **telnet**
- **traceroute**

Before You Begin

- A DNS server must be configured.
- You must identify and assign the host names to the IPv6 addresses. If you are using the Cisco DNS server, use the **ip host** global configuration command to map hostnames to IP addresses.
- You must configure the DNS server using the **ip name-server** global configuration command before use of DNS host names (or domains) are available in the supported commands.
- The **show cable modem domain-name** command must be run first on the Route Processor (RP) of the CMTS router before any domain name can be used as part of a cable command.

For more information about configuring these prerequisites and related IP domain configuration options, refer to the *Mapping Host Names to IP Addresses* section in the *Cisco IOS IP Configuration Guide* at: http://www.cisco.com/c/en/us/td/docs/ios/12_2/ip/configuration/guide/fipr_c/1cfipadr.html#wp1001317

Restriction

- DNS for cable devices using IPv4 addressing is not supported.
- Due to column size limitations within the command-line interface (CLI), the domain name display is limited to 32 characters. Therefore, the entire domain name cannot always be seen in CMTS router command output.
- Only those cable devices where IPv6 address learning takes place are supported, such as acquiring an IPv6 address through DHCPv6 or the IPv6 (ND) process.
- The cable-specific DNS cache is only updated when you use the **show cable modem domain-name** command on the Route Processor (RP). A DNS-QUERY can only be sent on the RP using this command, therefore the DNS cache cannot update if you use the **show cable modem domain-name** command on a line card console. The output is displayed on the RP only.
- The cable-specific DNS cache does not store partially qualified domain names, only FQDNs are stored.
- The cable-specific DNS cache is not associated with the timeouts that apply to the IOS DNS cache. Therefore, a cable-specific DNS cache entry is not removed when an IOS DNS cache timeout occurs for that device. The cable-specific DNS cache is only updated when you use the **show cable modem domain-name** command.
- The CMTS router supports storage of only one domain name per IPv6 address in the cable-specific DNS cache.
- Domain names for the link local address are not supported.
- The **no ip domain-name** command disables DNS lookup.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip name-server** [**vrf** *vrf-name*] *server-address1* [*server-address2...server-address6*] **Example:** `Router(config)# ip name-server 2001:DB8::/32`	Specifies the address of one or more name servers to use for name and address resolution.
Step 4	**exit** **Example:** `Router(config)# exit`	Leaves global configuration mode and enters privileged EXEC mode.
Step 5	**show cable modem domain-name** **Example:** `Router# show cable modem domain-name`	Updates the cable-specific DNS cache and displays the domain name for all CMs and the CPE devices behind a CM.

Configuring IPv6 Source Verification

Typically, the IPv6 source verification feature is enabled on a cable bundle interface. From there, the cable interface is associated with the virtual bundle interface to acquire its configuration.

When you enable IPv6 source verification on a cable line card interface, the source verification routine verifies the MAC address-MD-SID-IP binding of the packet. If the source verification succeeds, the packet is forwarded. If the verification fails, the packet is dropped.

When a CM is operating as a bridge modem device, then the CMTS router verifies all the IPv6 addresses related to that CM and the CPEs behind that CM.

The **cable ipv6 source-verify** command controls only the source verification of IPv6 packets. For IPv4-based source verification, use the **cable source-verify** command, which also supports different options.

For more information about how to configure IPv6 source verification on a bundle interface, see the Configuring the Cable Virtual Bundle Interface, on page 24.

Restrictions

Source verification of IPv6 packets occurs only on packets in the process-switched path of the Route Processor (RP).

Note Source verification of IPv6 packets in PXF is supported on the Cisco CMTS routers from Cisco IOS Release 12.2(33)SCE onwards.

Configuring IPv6 VPN over MPLS

Starting with Cisco IOS Release 12.2(33)SCF, the Cisco CMTS routers support the IPv6 VPN over MPLS (6VPE) feature. Implementing this feature includes the following configuration tasks.

- Configuring a VRF instance for IPv6
- Binding a VRF to an interface
- Creating a subinterface
- Configuring a static route for PE-to-CE-routing
- Configuring eBGP PE-to-CE routing sessions
- Configuring the IPv6 VPN address family for iBGP
- Configuring route reflectors for improved scalability
- Configuring Internet access

For detailed information about these tasks, see the Implementing IPv6 VPN over MPLS chapter in the Cisco IOS IPv6 Configuration Guide, Release 12.2SR at: http://www.cisco.com/en/US/docs/ios-xml/ios/ipv6/configuration/12-2sr/ip6-ov-mpls-6vpe.html.

For detailed information about the configuration examples, see Configuration Examples for IPv6 on Cable, on page 39.

Note Starting from Cisco IOS Release 12.2(33)SCF2, the IPv6 address of the sub-bundle interface (to which the CM is connected) is used in the DHCPv6 relay packet of the CPE DHCPv6 request. If the DHCPv6 packet has to go from one VRF interface to another, the IPv6 address of each VRF interface should be configured on the Cisco CMTS to establish connectivity.

Configuring DHCPv6 Relay Agent

Starting with Cisco IOS Release 12.2(33)SCE5, the Cisco CMTS router supports DHCPv6 relay agent to forward relay-forward messages from a specific source address to client relay destinations.

Perform the steps given below to enable the DHCPv6 relay agent function and specify relay destination addresses on an interface.

Before You Begin

The relay-forward messages should contain specific source IPv6 address. This is required because the firewall deployed between the Cisco CMTS DHCPv6 relay agent and the DHCPv6 server expects only one source address for one Cisco CMTS bundle interface.

Restriction If you change one or more parameters of the **ipv6 dhcp relay destination** command, you have to disable the command using the **no** form, and execute the command again with changed parameters.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface type** *number* **Example:** `Router(config)# interface ethernet 4/2`	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	**ipv6 dhcp relay destination** *ipv6-address*[*interface*] [**link-address** *link-address*] [**source-address** *source-address*] **Example:** `Router(config-if) ipv6 dhcp relay destination 2001:db8:1234::1 ethernet 4/2 link-address 2001:db8::1 source-address 2001:db8::2`	Specifies a destination address to which client packets are forwarded and enables DHCPv6 relay service on the interface.

Step 5	**end**
	Example:
	`Router(config-if) end`
		Exits interface configuration mode and enters privileged EXEC mode.

Disabling IPv6 ND Gleaning

You must disable IPv6 ND gleaning before configuring IPv6 source verification using DHCPv6 leasequery.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interfacebundle** *bundle-no* **Example:** `Router(config)# interface bundle 1`	Specifies a bundle interface number and enters bundle interface configuration mode. • *bundle-no* —Bundle interface number. The valid range is from 1 to 255.
Step 4	**no cable nd** **Example:** `Router(config-if) no cable nd`	Disables IPv6 ND gleaning on the Cisco CMTS router.

Step 5	**end**
	Example:
	`Router(config-if) end`
		Returns to privileged EXEC mode.

How to Verify IPv6 Dual Stack CPE Support

This section describes how to use **show** commands to verify the configuration of the IPv6 Dual Stack CPE Support on the CMTS feature in Cisco IOS Release 12.2(33)SCC.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	**show cable modem** [*ip-address* | *mac-address*] **ipv6**[**cpe** | **prefix** | **registered** | **unregistered]** **Example:** `Router#` **`show cable modem ipv6 registered`** **Example:** `Router#` **`show cable modem 0019.474a.c14a ipv6 cpe`**	Displays IPv6 information for specified CMs and CPEs behind a CM on a Cisco CMTS router. You can specify the following options:
Step 3	**show cable modem** [ip-address | mac-address] **registered** **Example:** `Router#` **`show cable modem 0019.474e.e4DF registered`**	Displays a list of the CMs that have registered with the Cisco CMTS. You can specify the following options:
Step 4	**show cable modem** {ip-address | mac-address} **cpe** **Example:** `Router#` **`show cable modem 0019.474a.c14a cpe`**	Displays the CPE devices accessing the cable interface through a particular CM. You can specify the following options:

Examples

Use the **show cable modem ipv6** command to display the IPv6 portion of a dual stack CPE and use the **show cable modem cpe** command to display the IPv4 mode of a dual stack CPE. Both **show cable modem ipv6 registered** and **show cable modem registered** commands display CPE count as one for a dual stack CPE.

The following example shows the output of the **show cable modem ipv6** command:

```
Router# show cable modem ipv6 registered
Interface   Prim Online       CPE IP Address                             MAC Address
            Sid  State
C4/0/U2     1    online       0   ---                                    0019.474a.c18c
C4/0/U2     3    online(pt)   1   2001:420:3800:809:EDA4:350C:2F75:4779   0019.474a.c14a
Router# show cable modem 0019.474a.c14a ipv6 cpe
MAC Address    IP Address                             Domain Name
0005.0052.2c1d 2001:420:3800:809:48F7:3C33:B774:9185
```

Starting from Cisco IOS Release 12.2(33)SCG1, the output of the show cable modem ipv6 command for keyword cpe is changed.

The following example shows the output of the **show cable modem ipv6** command:

```
Router# show cable modem
 0023.bed9.4c8e ipv6 cpe
Load for five secs: 0%/0%; one minute: 1%; five minutes: 1%
Time source is hardware calendar, *06:37:20.439 UTC Thu Aug 2 2012
MAC Address    IP Address
0023.bed9.4c91 2001:40:3:4:200:5EB7:BB6:C759
2001:40:3:4:210:D73B:7A50:2D05
```

The following example shows the output of the **show cable modem registered** command:

```
Router# show cable modem registered
```

```
Interface   Prim Online      Timing Rec    QoS CPE IP address      MAC address
            Sid  State       Offset Power
C4/0/U2     3    online      1022   0.00  2   1   50.3.37.12      0019.474a.c14a
```

The following example shows the output of the **show cable modem cpe** command:

```
Router# show cable modem 0019.474a.c14a cpe

IP address        MAC address      Dual IP
```

50.3.37.3 0005.0052.2c1d Y

Configuration Examples for IPv6 on Cable

This section includes the following examples:

Example: IPv6 over Subinterfaces

The following example shows the CMTS bundle configuration that can be used with subinterfaces:

```
Router# show cable modem ipv6
Device Type: B - CM Bridge, R - CM Router
IP Assignment Method: D - DHCP
MAC Address    Type Interface    Mac State    D/IP IP Address
0019.474a.c18c B/D  C4/0/U2      online        Y  2001:420:3800:809:4C7A:D518:91
C6:8A18
Router# show run interface bundle2
Building configuration...
Current configuration : 138 bytes
!
interface Bundle2
 no ip address
 cable arp filter request-send 3 2
 cable arp filter reply-accept 3 2
 no cable ip-multicast-echo
end
Router#

show run interface bundle2.1
Building configuration...
Current configuration : 382 bytes
!
interface Bundle2.1
 ip address 50.3.37.1 255.255.255.0
 no cable ip-multicast-echo
 cable helper-address 10.10.0.12
 ipv6 address 2001:DB8::/32
 ipv6 enable
 ipv6 nd prefix default no-advertise
 ipv6 nd managed-config-flag
 ipv6 nd other-config-flag
 ipv6 nd ra interval msec 2000
 ipv6 dhcp relay destination 2001:420:3800:800:203:BAFF:FE11:B644
 arp timeout 240
end
```

Example: Basic IPv6 Cable Filter Groups

The following example shows the configuration of an IPv6 filter group that drops traffic from a specific IPv6 host (with source address 2001:DB8::1/48) behind a cable router to an IPv6 host on the network (with destination address 2001:DB8::5/64):

```
configure terminal
!
! Specify the filter group criteria using a common group ID
!
cable filter group 254 index 128 v6-src-address 2001:DB8::1
cable filter group 254 index 128 v6-src-pfxlen 128
cable filter group 254 index 128 v6-dest-address 2001:DB8::5
cable filter group 254 index 128 v6-dest-pfxlen 128
!
! Specify that the filter group is IP version 6
!
cable filter group 254 index 128 ip-version ipv6
!
! Specify the drop action for matching packets
!
cable filter group 254 index 128 match-action drop
!
! Apply the filter group with ID 254 to all CM upstream traffic
!
cable submgmt default filter-group cm upstream 254
```

Example: Complete Cable Configuration with IPv6

The following example shows a complete cable configuration example; it also displays the configuration of multiple cable filter groups using both IPv4 and IPv6 and separate indexes to associate the filter definitions with the same group ID.

```
Router# show running-config
Building configuration...
Current configuration : 15010 bytes
!
! Last configuration change at 08:32:14 PST Thu Nov 8 2007
!
version 12.2
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service internal
service compress-config
!
hostname router
!
boot-start-marker
boot-end-marker
!
enable password password1
!
no aaa new-model
clock timezone PST -9
clock summer-time PDT recurring
clock calendar-valid
facility-alarm core-temperature major 53
facility-alarm core-temperature minor 45
facility-alarm core-temperature critical 85
facility-alarm intake-temperature major 49
facility-alarm intake-temperature minor 40
facility-alarm intake-temperature critical 67
```

```
!
!
card 1/0 2jacket-1
card 1/0/0 24rfchannel-spa-1
card 5/0 5cable-mc520h-d
cable admission-control preempt priority-voice
cable modem vendor 00.18.68 SA-DPC2203
cable modem vendor 00.19.47 SA-DPC2505
no cable qos permission create
no cable qos permission update
cable qos permission modems
!
cable filter group 1 index 1 src-ip 0.0.0.0
cable filter group 1 index 1 src-mask 0.0.0.0
cable filter group 1 index 1 dest-ip 0.0.0.0
cable filter group 1 index 1 dest-mask 0.0.0.0
cable filter group 2 index 1 src-ip 0.0.0.0
cable filter group 2 index 1 src-mask 0.0.0.0
cable filter group 2 index 1 dest-ip 0.0.0.0
cable filter group 2 index 1 dest-mask 0.0.0.0
cable filter group 3 index 1 src-ip 0.0.0.0
cable filter group 3 index 1 src-mask 0.0.0.0
cable filter group 3 index 1 dest-ip 0.0.0.0
cable filter group 3 index 1 dest-mask 0.0.0.0
cable filter group 4 index 1 src-ip 0.0.0.0
cable filter group 4 index 1 src-mask 0.0.0.0
cable filter group 4 index 1 dest-ip 0.0.0.0
cable filter group 4 index 1 dest-mask 0.0.0.0
cable filter group 5 index 1 src-ip 0.0.0.0
cable filter group 5 index 1 src-mask 0.0.0.0
cable filter group 5 index 1 dest-ip 0.0.0.0
cable filter group 5 index 1 dest-mask 0.0.0.0
cable filter group 6 index 1 src-ip 0.0.0.0
cable filter group 6 index 1 src-mask 0.0.0.0
cable filter group 6 index 1 dest-ip 0.0.0.0
cable filter group 6 index 1 dest-mask 0.0.0.0
cable filter group 7 index 1 src-ip 0.0.0.0
cable filter group 7 index 1 src-mask 0.0.0.0
cable filter group 7 index 1 dest-ip 0.0.0.0
cable filter group 7 index 1 dest-mask 0.0.0.0
cable filter group 8 index 1 src-ip 0.0.0.0
cable filter group 8 index 1 src-mask 0.0.0.0
cable filter group 8 index 1 dest-ip 0.0.0.0
cable filter group 8 index 1 dest-mask 0.0.0.0
cable filter group 9 index 1 src-ip 0.0.0.0
cable filter group 9 index 1 src-mask 0.0.0.0
cable filter group 9 index 1 dest-ip 0.0.0.0
cable filter group 9 index 1 dest-mask 0.0.0.0
cable filter group 10 index 1 src-ip 0.0.0.0
cable filter group 10 index 1 src-mask 0.0.0.0
cable filter group 10 index 1 dest-ip 0.0.0.0
cable filter group 10 index 1 dest-mask 0.0.0.0
cable filter group 12 index 1 src-ip 0.0.0.0
cable filter group 12 index 1 src-mask 0.0.0.0
cable filter group 12 index 1 dest-ip 0.0.0.0
cable filter group 12 index 1 dest-mask 0.0.0.0
cable filter group 16 index 1 src-ip 0.0.0.0
cable filter group 16 index 1 src-mask 0.0.0.0
cable filter group 16 index 1 dest-ip 0.0.0.0
cable filter group 16 index 1 dest-mask 0.0.0.0
ip subnet-zero
ip domain name cisco.com
ip host host1 239.192.254.254
ip host host2 239.192.254.253
ip name-server 10.39.26.7
ip name-server 2001:0DB8:4321:FFFF:0:800:20CA:D8BA
!
!
!
!
ipv6 unicast-routing
ipv6 cef
packetcable multimedia
```

```
packetcable
!
!
!
redundancy
 mode sso
!
!
controller Modular-Cable 1/0/0
 annex B modulation 64qam 0 23
 ip-address 10.30.4.175
 modular-host subslot 5/0
 rf-channel 0 cable downstream channel-id 24
 rf-channel 1 cable downstream channel-id 25
 rf-channel 2 cable downstream channel-id 26
 rf-channel 3 cable downstream channel-id 27
 rf-channel 4 cable downstream channel-id 28
 rf-channel 5 cable downstream channel-id 29
 rf-channel 6 cable downstream channel-id 30
 rf-channel 7 cable downstream channel-id 31
 rf-channel 8 cable downstream channel-id 32
 rf-channel 9 cable downstream channel-id 33
 rf-channel 10 cable downstream channel-id 34
 rf-channel 11 cable downstream channel-id 35
 rf-channel 12 cable downstream channel-id 36
 rf-channel 13 cable downstream channel-id 37
 rf-channel 14 cable downstream channel-id 38
 rf-channel 15 cable downstream channel-id 39
 rf-channel 16 cable downstream channel-id 40
 rf-channel 17 cable downstream channel-id 41
 rf-channel 18 cable downstream channel-id 42
 rf-channel 19 cable downstream channel-id 43
 rf-channel 20 cable downstream channel-id 44
 rf-channel 21 cable downstream channel-id 45
 rf-channel 22 cable downstream channel-id 46
 rf-channel 23 cable downstream channel-id 47
!
!
policy-map foo
policy-map 1
policy-map cos
policy-map qpolicy
policy-map shape
policy-map dscp
!
!
!
!
!
!
interface Loopback0
 ip address 127.0.0.1 255.255.255.255
!
interface FastEthernet0/0/0
 ip address 10.39.21.10 255.255.0.0
 speed 100
 half-duplex
 ipv6 address 2001:DB8::/32
 ipv6 enable
!
interface Wideband-Cable1/0/0:0
 no cable packet-cache
 cable bonding-group-id 1
!
interface Wideband-Cable1/0/0:1
 no cable packet-cache
 cable bonding-group-id 2
!
interface Wideband-Cable1/0/0:2
 no cable packet-cache
 cable bonding-group-id 3
!
interface Wideband-Cable1/0/0:3
```

```
 no cable packet-cache
 cable bonding-group-id 4
!
interface Wideband-Cable1/0/0:4
 no cable packet-cache
 cable bundle 1
 cable bonding-group-id 5
 cable rf-channel 1 bandwidth-percent 60
!
interface Wideband-Cable1/0/0:5
 no cable packet-cache
 cable bundle 1
 cable bonding-group-id 6
 cable rf-channel 0 bandwidth-percent 40
 cable rf-channel 2
 cable rf-channel 3
!
interface Wideband-Cable1/0/0:6
 no cable packet-cache
 cable bonding-group-id 7
!
interface Wideband-Cable1/0/0:7
 no cable packet-cache
 cable bonding-group-id 8
!
interface Wideband-Cable1/0/0:8
 no cable packet-cache
 cable bonding-group-id 9
!
interface Wideband-Cable1/0/0:9
 no cable packet-cache
 cable bonding-group-id 33
!
interface Wideband-Cable1/0/0:10
 no cable packet-cache
 cable bonding-group-id 34
!
interface Wideband-Cable1/0/0:11
 no cable packet-cache
 cable bonding-group-id 35
!
interface Cable5/0/0
 no cable packet-cache
 cable bundle 1
 cable downstream channel-id 119
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream frequency 99000000
 no cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream 0 connector 0
 cable upstream 0 frequency 6000000
 cable upstream 0 ingress-noise-cancellation 200
 cable upstream 0 docsis-mode tdma
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 21
 no cable upstream 0 shutdown
 cable upstream 1 connector 1
 cable upstream 1 ingress-noise-cancellation 200
 cable upstream 1 docsis-mode tdma
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 2
 cable upstream 2 ingress-noise-cancellation 200
 cable upstream 2 docsis-mode tdma
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 3
 cable upstream 3 ingress-noise-cancellation 200
 cable upstream 3 docsis-mode tdma
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
!
interface Cable5/0/1
 cable ip-init ipv6
 no cable packet-cache
 cable bundle 1
 cable downstream channel-id 120
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 705000000
 no cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream 0 connector 4
 cable upstream 0 frequency 6000000
 cable upstream 0 ingress-noise-cancellation 200
 cable upstream 0 docsis-mode tdma
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 21
 no cable upstream 0 shutdown
 cable upstream 1 connector 5
 cable upstream 1 ingress-noise-cancellation 200
 cable upstream 1 docsis-mode tdma
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 6
 cable upstream 2 ingress-noise-cancellation 200
 cable upstream 2 docsis-mode tdma
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 7
 cable upstream 3 ingress-noise-cancellation 200
 cable upstream 3 docsis-mode tdma
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
!
interface Cable5/0/2
 no cable packet-cache
 cable downstream channel-id 121
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream 0 connector 8
 cable upstream 0 ingress-noise-cancellation 200
 cable upstream 0 docsis-mode tdma
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 21
 cable upstream 0 shutdown
 cable upstream 1 connector 9
 cable upstream 1 ingress-noise-cancellation 200
 cable upstream 1 docsis-mode tdma
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 10
 cable upstream 2 ingress-noise-cancellation 200
 cable upstream 2 docsis-mode tdma
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 11
 cable upstream 3 ingress-noise-cancellation 200
 cable upstream 3 docsis-mode tdma
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
!
interface Cable5/0/3
 no cable packet-cache
 cable downstream channel-id 122
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream 0 connector 12
 cable upstream 0 ingress-noise-cancellation 200
 cable upstream 0 docsis-mode tdma
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 21
 cable upstream 0 shutdown
 cable upstream 1 connector 13
 cable upstream 1 ingress-noise-cancellation 200
 cable upstream 1 docsis-mode tdma
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 14
 cable upstream 2 ingress-noise-cancellation 200
 cable upstream 2 docsis-mode tdma
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 15
 cable upstream 3 ingress-noise-cancellation 200
 cable upstream 3 docsis-mode tdma
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
!
interface Cable5/0/4
 no cable packet-cache
 cable downstream channel-id 123
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream max-ports 4
 cable upstream 0 connector 16
 cable upstream 0 ingress-noise-cancellation 200
 cable upstream 0 docsis-mode tdma
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 21
 cable upstream 0 shutdown
 cable upstream 1 connector 17
 cable upstream 1 ingress-noise-cancellation 200
 cable upstream 1 docsis-mode tdma
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 18
 cable upstream 2 ingress-noise-cancellation 200
 cable upstream 2 docsis-mode tdma
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 19
 cable upstream 3 ingress-noise-cancellation 200
 cable upstream 3 docsis-mode tdma
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
!
interface Bundle1
 ip address 10.46.2.1 255.255.0.0 secondary
 ip address 10.46.1.1 255.255.0.0
 cable arp filter request-send 3 2
 cable arp filter reply-accept 3 2
 cable dhcp-giaddr policy strict
 cable helper-address 10.39.26.8
 ipv6 address 2001:DB8::/32
 ipv6 enable
 ipv6 nd managed-config-flag
 ipv6 nd other-config-flag
 ipv6 nd ra interval 5
 ipv6 dhcp relay destination 2001:0DB8:4321:FFFF:0:800:20CA:D8BA
!
ip default-gateway 10.39.0.1
ip classless
ip route 0.0.0.0 0.0.0.0 10.39.26.12
ip route 192.168.254.253 255.255.255.255 10.39.0.1
ip route 192.168.254.254 255.255.255.255 10.39.0.1
!
!
no ip http server
no ip http secure-server
!
logging cmts cr10k log-level errors
cpd cr-id 1
nls resp-timeout 1
cdp run
!
tftp-server bootflash:docs10.cm alias docs10.cm
tftp-server bootflash:rfsw_x373.bin alias rfsw_x373.bin
snmp-server community private RW
snmp-server enable traps cable
snmp-server manager
!
!
control-plane
!
!
```

```
line con 0
 logging synchronous
 stopbits 1
line aux 0
line vty 0 4
 password lab
 login
!
!
cable fiber-node 1
  downstream Modular-Cable 1/0/0 rf-channel 1
  upstream Cable 5/0 connector 0
!
cable fiber-node 2
  downstream Modular-Cable 1/0/0 rf-channel 0 2-3
  upstream Cable 5/0 connector 4
!
end
```

Example: BGP Configuration for 6VPE

The following example shows a sample BGP configuration on CMTS 6VPE.

```
Router# router bgp 1
 no synchronization
 bgp log-neighbor-changes
 neighbor 11.1.1.5 remote-as 1
 neighbor 11.1.1.5 update-source Loopback1
 no auto-summary
 !
 address-family vpnv6              --- Enable vpnv6 AF
  neighbor 11.1.1.5 activate      --- Activate neighbor 6VPE-2
  neighbor 11.1.1.5 send-community extended
 exit-address-family
 !
 address-family ipv6 vrf vrf_mgmt
  redistribute connected            ---- Publish directly connected route
  redistribute static
  no synchronization
 exit-address-family
!
 address-family ipv6 vrf vrfa   --- Enable IPv6 vrf AF for each VRF
  redistribute connected
  no synchronization
 exit-address-family
 !
 address-family ipv6 vrf vrfb --- Enable IPv6 vrf AF for each VRF
  redistribute connected
  no synchronization
 exit-address-family
!
```

Example: Subinterface Configuration for 6VPE

The following example shows how to define a subinterface on virtual bundle interface 1.

When configuring IPv6 VPNs, you must configure the first subinterface created as a part of the management VRF. In the following example, Bundle 1.10 is the first sub-interface, which is configured into management VRF. Make sure the CNR server is reachable in management VRF.

```
interface Bundle1.10                --- Management VRF
 vrf forwarding vrf_mgmt
 cable dhcp-giaddr primary
 ipv6 address 2001:40:3:110::1/64
 ipv6 enable
 ipv6 nd managed-config-flag
 ipv6 nd other-config-flag
 ipv6 dhcp relay destination 2001:10:74:129::2
interface Bundle1.11          --- VRF A
 vrf forwarding vrfa
 cable dhcp-giaddr primary
 ipv6 address 2001:40:3:111::1/64
 ipv6 enable
 ipv6 dhcp relay destination 2001:10:74:129::2
interface Bundle1.12          --- VRFB
 vrf forwarding vrfb
 cable dhcp-giaddr primary
 ipv6 address 2001:40:3:112::1/64
 ipv6 enable
 ipv6 dhcp relay destination 2001:10:74:129::2
```

Example: Cable Interface Bundling

The following example shows how to bundle a group of physical interfaces.

```
int C5/0/4 and int c5/0/3 are bundled.
int c5/0/4
cable bundle 1
int c5/0/3
cable bundle 1
```

Example: VRF Configuration for 6VPE

The following example shows how to create VRFs for each VPN.

```
vrf definition vrf_mgmt
 rd 1:1
 !
 address-family ipv4
 route-target export 1:1
 route-target import 1:1
 route-target import 2:2
 route-target import 2:1
 exit-address-family
 !
 address-family ipv6
 route-target export 1:1
 route-target import 1:1
 route-target import 2:1  -- import route of vrfa
 route-target import 2:2  -- import route of vrfb
 exit-address-family
```

Verifying IPv6 on Cable

This section explains how to verify IPv6 on cable configuration and it contains the following topics:

Verifying IPv6 VRF Configuration

To verify the IPv6 VRF configuration, use the show vrf ipv6 command in privileged EXEC mode.

```
Router# show vrf ipv6 vrfa
  Name                             Default RD          Protocols   Interfaces
  vrfa                                2:1                ipv4,ipv6   Bu1.11
Router# show vrf ipv6 interfaces
Interface              VRF                                Protocol   Address

Bu1.10                 vrf_mgmt                           up         2001:40:3:110::1

Fa0/0/0                vrf_mgmt                           up         2001:20:4:1::38

Bu1.11                 vrfa                               up         2001:40:3:111::1

Bu1.12                 vrfb                               up         2001:40:3:112::1

CMTS#
```

Verifying IPv6 BGP Status

To verify the IPv6 BGP status, use the show ip bgp command in privileged EXEC mode.

```
Router# show ip bgp vpnv6 unicast all neighbors

BGP neighbor is 11.1.1.5,  remote AS 1, internal link
  BGP version 4, remote router ID 11.1.1.5
  Session state = Established, up for 00:35:52
  Last read 00:00:37, last write 00:00:14, hold time is 180, keepalive interval is 60 seconds

  BGP multisession with 2 sessions (2 established), first up for 00:40:07
  Neighbor sessions:
    2 active, is multisession capable
  Neighbor capabilities:
    Route refresh: advertised and received(new) on session 1, 2
    Address family IPv4 Unicast: advertised and received
    Address family VPNv6 Unicast: advertised and received
......
```

Verifying MPLS Forwarding Table

To verify the output of the MPLS forwarding table, use the show mpls forwarding-table command in the privileged EXEC mode.

```
Router# show mpls forwarding-table

Local  Outgoing      Prefix            Bytes Label   Outgoing   Next Hop
Label  Label or VC   or Tunnel Id      Switched      interface
......
19     No Label      2001:40:3:110::/64[V]   \                             ---Route in
vrf_mgmt
                                       0             aggregate/vrf_mgmt
21     No Label      2001:40:3:111::/64[V]   \                             ---Route in
vrfa
                                       0             aggregate/vrfa
22     No Label      2001:40:3:112::/64[V]   \                             ---Route in
vrfb
                                       0             aggregate/vrfb
......
```

Verifying IPv6 Cable Modem and its Host State

To verify IPv6 addresses and connected host states of cable modems and CPEs, use the **show interface cable modem** command in the privileged EXEC mode:

```
Router# show interface cable 7/0/0 modem ipv6
SID  Type State        IPv6 Address                            M MAC address
11   CM  online        2001:420:3800:809:3519:5F9C:B96A:D31    D 0025.2e2d.743a
11   CPE unknown       2001:420:3800:809:3DB2:8A6C:115F:41D8   D 0011.2544.f33b
```

Verifying Multiple IAPDs in a Single Advertise

To verify the multiple IPv6 prefixes assigned to devices on a network, use the show cable modem ipv6 prefix command in privileged EXEC mode:

```
Router# show cable modem ipv6 prefix
Load for five secs: 1%/0%; one minute: 1%; five minutes: 1%
Time source is hardware calendar, *06:36:53.075 UTC Thu Aug 2 2012
Device Type: B - CM Bridge, R - CM Router
IP Assignment Method: D - DHCP
MAC Address    Type IPv6 prefix
0023.bed9.4c91 R/D  2001:40:1012::/64
               R/D  2001:40:2012:1::/64
0000.002e.074c R/D  2001:40:1012:8::/64
               R/D  2001:40:2012:1D::/64
0000.002e.074b R/D  2001:40:1012:23::/64
               R/D  2001:40:2012:1C::/64
0000.002e.074a R/D  2001:40:1012:22::/64
               R/D  2001:40:2012:1B::/64
```

To verify the multiple IPv6 prefixes assigned to CPEs behind a CM with a specific MAC address, use the **show cable modem** *mac-address* **ipv6 prefix** command in privileged EXEC mode:

```
Router# show cable modem 0023.bed9.4c8e ipv6 prefix
Load for five secs: 0%/0%; one minute: 1%; five minutes: 1%
Time source is hardware calendar, *06:37:22.335 UTC Thu Aug 2 2012
Device Type: B - CM Bridge, R - CM Router
IP Assignment Method: D - DHCP
MAC Address    Type IPv6 prefix
0023.bed9.4c91 R/D  2001:40:1012::/64
               R/D  2001:40:2012:1::/64
```

To verify the IPv6 information of CPEs behind a CM with a specific MAC address, use the show cable modem *mac-address* ipv6 **cpe** command in privileged EXEC mode:

```
Router# show cable modem 0023.bed9.4c8e ipv6 cpe
Load for five secs: 0%/0%; one minute: 1%; five minutes: 1%
Time source is hardware calendar, *06:37:20.439 UTC Thu Aug 2 2012
MAC Address    IP Address
0023.bed9.4c91 2001:40:3:4:200:5EB7:BB6:C759
               2001:40:3:4:210:D73B:7A50:2D05
```

Additional References

The following sections provide references related to the IPv6 on Cable feature.

Related Documents

Related Topic	Document Title
Commands on the Cisco CMTS (universal broadband) routers	Cisco IOS CMTS Cable Command Reference
Platform-independent IPv6 configuration guide	Cisco IOS IPv6 Configuration Guide, Release 12.2SR
Platform-independent IPv6 commands	Cisco IOS IPv6 Command Reference
Platform-independent IPv6 concepts and feature configuration	Cisco IOS IPv6 Configuration Library

Standards

Standard	Title
CM-SP-MULPIv3.0-I04-070518	*DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification*
CM-SP-MULPIv3.0-I15-110210	*DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification*

MIBs

MIB	MIBs Link
CISCO-IP-FORWARD-MIB CISCO-IP-MIB CISCO-DOCS-EXT-MIB DOCS-CABLE-DEVICE-MIB DOCS-IF-MIB DOCS-SUBMGT-MIB DOCS-SUBMGT3-MIB IF-MIB (Interface counters) TCP-MIB UDP-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
draft-ietf-isis-ipv6-06.txt	*Routing IPv6 with IS-IS*

RFC	Title
RFC 2460	*Internet Protocol, Version 6 (IPv6) Specification*
RFC 2461	*Neighbor Discovery for IP version 6 (IPv6)*
RFC 2462	*IPv6 Stateless Address Autoconfiguration*
RFC 2463	*Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification*
RFC 2464	*Transmission of IPv6 Packets over Ethernet Networks*
RFC 2710	*Multicast Listener Discovery (MLD) for IPv6*
RFC 2740	*OSPF for IPv6*
RFC 2893 (Dual stack mode of operation)	*Transition Mechanisms for IPv6 Hosts and Routers*
RFC 3315 (Relay Agent)	*Dynamic Host Configuration Protocol for IPv6 (DHCPv6)*
RFC 3513	*Internet Protocol Version 6 (IPv6) Addressing Architecture*
RFC 3587	*IPv6 Global Unicast Address Format*
RFC 3596 (AAAA records)	*DNS Extensions to Support IP Version 6*
RFC 3810	*Multicast Listener Discovery Version 2 (MLDv2) for IPv6*
RFC 4022	*Management Information Base for the Transmission Control Protocol (TCP)*
RFC 4113	*Management Information Base for the User Datagram Protocol (UDP)*
RFC 4659	BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 VPN
RFC 4861	*Neighbor Discovery for IP version 6 (IPv6)*
RFC 4862	*IPv6 Stateless Address Autoconfiguration*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for IPv6 on Cable

Table below lists the features in this module and provides links to specific configuration information.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

Note The below table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 2: Feature Information for IPv6 on Cable

Feature Name	Releases	Feature Information
IPv6 on Cable	12.2(33)SCA	This feature is introduced on the Cisco uBR7225VXR, Cisco uBR7246VXR, and Cisco uBR10012 Universal Broadband Routers. The following new commands are supported: • **cable ip-init** • **cable ipv6 source-verify** • **clear cable modem name** • **debug cable ipv6** • **show cable modem classifiers** • **show cable modem domain-name** • **show cable modem ipv6** • **show cable modem type**
	12.2(33)SCA	The following modified commands are supported: • **cable event syslog-server** • **cable filter group** • **clear cable host** • **clear cable modem reset** • **ping docsis** • **show cable filter** • **show cable modem** • **show cable modem access-group**

Feature Name	Releases	Feature Information
IPv6 on Cable (continued)	12.2(33)SCA	• **show cable modem calls** • **show cable modem classifiers** • **show cable modem cnr** • **show cable modem connectivity** • **show cable modem counters** • **show cable modem cpe** • **show cable modem errors** • **show cable modem flap** • **show cable modem mac** • **show cable modem maintenance** • **show cable modem offline** • **show cable modem phy** • **show cable modem qos** • **show cable modem registered** • **show cable modem rogue** • **show cable modem unregistered** • **show interface cable modem** • **show interface cable sid**

Feature Name	Releases	Feature Information
	12.2(33)SCA	The following existing cable features support the IPv6 protocol stack without any other modification to the configuration of the cable feature on the Cisco CMTS routers: • Baseline Privacy Plus (BPI+) • Cable Monitor (Except cable monitoring based on IPv6 ACL) • Cable Transport LAN Service (TLS) • CM configuration files • DHCP Relay Agent option for DOCSIS 3.0, Annex J (See also DHCPv6 Restrictions for IPv6 on Cable, on page 5)
IPv6 on Cable	12.2(33)SCA	• DMIC (except configuration file generation for DMIC IPv6 CMs) • Dynamic Channel Change (DCC) • DOCSIS Dynamic Service Addition (DSA) and Dynamic Service Change (DSC) operations • DOCSIS load balancing (except load balancing with HCCP) • Flap list • IPv6 L2VPN • Spectrum management • Virtual bundles (See the Configuring the Cable Virtual Bundle Interface, on page 24)
IPv6 Access Services		

Feature Name	Releases	Feature Information
IPv6 Access Services: DHCP for IPv6 Relay Agent	12.2(33)SCA	A DHCP relay agent, which may reside on the client's link, is used to relay messages between the client and server. **Platform-Independent Cisco IOS Software Documentation** The " http://www.cisco.com/en/US/docs/ios/ipv6/configuration/guide/ip6-dhcp.html " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature.
IPv6 Access Services: Source Verification	12.2(33)SCA	Enabling IPv6 source verification on a cable line card interface allows the source verification routine to verify the MAC address-MD-SID-IP binding of the packet. If the source verification succeeds, the packet is forwarded. If the verification fails, then the packet is dropped. **Platform-Specific Documentation for the Cisco CMTS Routers** For information about configuring IPv6 source verification, see the Configuring IPv6 Source Verification, on page 34.

Feature Name	Releases	Feature Information
IPv6 Access Services: Stateless DHCPv6	12.2(33)SCA	Stateless DHCP for IPv6 allows DHCP for IPv6 to be used for configuring a node with parameters that do not require a server to maintain any dynamic state for the node. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing DHCP for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Configuring the Stateless DHCPv6 Function • Configuring the Stateless DHCPv6 Function: Example
IPv6 Basic Connectivity		
Syslog over IPv6	12.2(33)SCA	The Cisco IOS syslog process in IPv6 allows users to log syslog messages to external syslog servers and hosts with IPv6 addresses. **Platform-Independent Cisco IOS Software Documentation** The Simplified IPv6 Packet Header section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter and the Configuring Syslog over IPv6 section of the " Implementing IPv6 for Network Management " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature.

Feature Name	Releases	Feature Information
IPv6 Unicast	12.2(33)SCA	An IPv6 unicast address is an identifier for a single interface, on a single node. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IPv6 Address Formats • IPv6 Address Type: Unicast • IPv6 Address Type: Multicast • IPv6 Neighbor Solicitation Message • IPv6 Router Advertisement Message • Configuring IPv6 Addressing and Enabling IPv6 Routing

Feature Name	Releases	Feature Information
IPv6 Unicast Reverse Path Forwarding (uRPF)	12.2(33)SCA	The Unicast RPF feature mitigates problems caused by malformed or forged (spoofed) IPv6 source addresses that pass through an IPv6 router. Malformed or forged source addresses can indicate denial-of-service (DoS) attacks based on source IPv6 address spoofing. **Platform-Independent Cisco IOS Software Documentation** The following sections of the “ Implementing IPv6 Addressing and Basic Connectivity ” chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Prerequisites for Implementing IPv6 Addressing and Basic Connectivity • Cisco Express Forwarding and distributed Cisco Express Forwarding Switching for IPv6
IPv6 Cable Filter Groups		

Feature Name	Releases	Feature Information
IPv6 Cable Filter Groups: IPv6 Filter Classifiers for CM and CPE traffic	12.2(33)SCA	The IPv6 cable filter group feature support of the packet filtering portion of the DOCSIS Subscriber Management MIB (DOCS-SUBMGMT-MIB) using configuration commands on the CMTS routers. This IPv6 cable filter group support extends filter classifiers with IPv6 addressing options for CM and CPE traffic, but is independent of DOCSIS IPv6 classifiers which are used to match packets to service flows. **Platform-Specific Documentation for the Cisco CMTS Routers** For information about configuring IPv6 cable filter groups, see the Configuring IPv6 Cable Filter Groups, on page 27.
IPv6 Data Link Layer		
IPv6 Data Link: Ethernet, Fast Ethernet, Gigabit Ethernet, 10-Gigabit Ethernet	12.2(33)SCA	In IPv6 networks, a data link is a network sharing a particular link-local prefix. Ethernet, Fast Ethernet, Gigabit Ethernet, and 10-Gigabit Ethernet are data links supported for IPv6. **Platform-Independent Cisco IOS Software Documentation** The following section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature: • IPv6 Data Links

Feature Name	Releases	Feature Information
IPv6 Data Link: VLANs Using IEEE 802.1q Encapsulation	12.2(33)SCA	In IPv6 networks, a data link is a network sharing a particular link-local prefix. VLANs using IEEE 802.1Q encapsulation is a type of data link supported for IPv6. **Platform-Independent Cisco IOS Software Documentation** The "IPv6 Data Links" section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 ICMPv6		
ICMPv6	12.2(33)SCA	ICMP for IPv6 generates error messages, such as ICMP destination unreachable messages, and informational messages, such as ICMP echo request and reply messages. Additionally, ICMP packets in IPv6 are used in the IPv6 neighbor discovery process, path MTU discovery, and the MLD protocol for IPv6. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • ICMP for IPv6 • IPv6 Neighbor Discovery • IPv6 Neighbor Solicitation Message • IPv6 Router Advertisement MessageConfiguring IPv6 ICMP Rate Limiting • IPv6 ICMP Rate Limiting Configuration: Example

Feature Name	Releases	Feature Information
ICMPv6 Redirect	12.2(33)SCA	A value of 137 in the Type field of the ICMP packet header identifies an IPv6 neighbor redirect message. Routers send neighbor redirect messages to inform hosts of better first-hop nodes on the path to a destination. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IPv6 Neighbor Redirect Message • IPv6 Redirect Messages
IPv6 Multicast		

Feature Name	Releases	Feature Information
IPv6 Multicast	12.2(33)SCA	An IPv6 multicast address is an identifier for a set of interfaces that typically belong to different nodes. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about the supported IPv6 multicast features on the Cisco CMTS routers: • Prerequisites for Implementing IPv6 Multicast • Restrictions for Implementing IPv6 Multicast • Information about Implementing IPv6 Multicast • Enabling IPv6 Multicast Routing • Configuring the MLD Protocol • Configuring PIM • Configuring Static Mroutes • Disabling Default Features in IPv6 Multicast • Configuration Examples for Implementing IPv6 Multicast • Additional References

Feature Name	Releases	Feature Information
IPv6 Multicast: MLD Access Group	12.2(33)SCA	The MLD access group provides receiver access control in Cisco IOS IPv6 multicast routers. The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • MLD Access Group • Customizing and Verifying MLD on an Interface
IPv6 Multicast: MLD Group Limits	12.2(33)SCA	The MLD group limits feature provides protection against denial of service (DoS) attacks caused by MLD packets. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Multicast Listener Discovery Protocol for IPv6 • Implementing MLD Group Limits

Feature Name	Releases	Feature Information
IPv6 Multicast: PIM Sparse Mode (PIM-SM)	12.2(33)SCA	PIM-SM uses unicast routing to provide reverse-path information for multicast tree building. PIM-SM is used in a multicast network when relatively few routers are involved in each multicast and these routers do not forward multicast packets for a group, unless there is an explicit request for the traffic. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Restrictions for Implementing IPv6 Multicast • IPv6 Multicast Routing Implementation • Protocol Independent Multicast

Feature Name	Releases	Feature Information
IPv6 Multicast: PIM Source Specific Multicast (PIM-SSM)	12.2(33)SCA	PIM-SSM supports the implementation of SSM and is derived from PIM-SM. The SSM feature forwards datagram traffic to receivers from only those multicast sources that the receivers have explicitly joined, optimizing bandwidth utilization and denying unwanted Internet broadcast traffic. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IPv6 Multicast Routing Implementation • Protocol Independent Multicast • PIM-Source Specific Multicast • IPv6 Multicast Process Switching and Fast Switching • Configuring PIM
IPv6 Multicast: Scope Boundaries	12.2(33)SCA	IPv6 includes support for global and nonglobal addresses. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IPv6 Multicast Addressing • Scoped Address Architecture • IPv6 BSR • Configuring a BSR

Feature Name	Releases	Feature Information
IPv6 Multicast: Static Multicast Routing (Mroute)	12.2(33)SCA	IPv6 static mroutes share the same database as IPv6 static routes and are implemented by extending static route support. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Multicast " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Restrictions for Implementing IPv6 Multicast • Static Mroutes • Configuring Static Mroutes
IPv6 Neighbor Discovery		
IPv6 Neighbor Discovery	12.2(33)SCA	The IPv6 neighbor discovery process uses ICMP messages and solicited-node multicast addresses to determine the link-layer address of a neighbor on the same network (local link), verify the reachability of a neighbor, and track neighboring routers. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Link-Local Address • ICMP for IPv6 • IPv6 Neighbor Discovery • IPv6 Multicast Groups

Feature Name	Releases	Feature Information
IPv6 Neighbor Discovery Duplicate Address Detection	12.2(33)SCA	IPv6 neighbor discovery duplicate address detection is performed first on a new, link-local IPv6 address before the address is assigned to an interface (the new address remains in a tentative state while duplicate address detection is performed). **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IPv6 Neighbor Solicitation Message • IPv6 Stateless Autoconfiguration
IPv6 Neighbor Discovery Static Cache Entry	12.2(33)SCA	The IPv6 static cache entry for neighbor discovery feature allows static entries to be made in the IPv6 neighbor cache. **Platform-Independent Cisco IOS Software Documentation** The following section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature: • IPv6 Neighbor Discovery
IPv6 Routing		

Feature Name	Releases	Feature Information
IPv6 Routing: IS-IS Support for IPv6	12.2(33)SCA	IPv6 enhancements to IS-IS allow IS-IS to advertise IPv6 prefixes in addition to IPv4 and OSI routes. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IS-IS for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IS-IS Enhancements for IPv6 • Configuring Single-Topology IS-IS for IPv6 • Customizing IPv6 IS-IS • Redistributing Routes into an IS-IS Routing Process • Redistributing IPv6 IS-IS Routes Between IS-IS Levels
IPv6 Routing: IS-IS Multitopology Support for IPv6	12.2(33)SCA	IS-IS multitopology support for IPv6 allows IS-IS to maintain a set of independent topologies within a single area or domain. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IS-IS for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • IS-IS Enhancements for IPv6 • IS-IS Multitopology Support for IPv6 • Transition from Single-Topology to Multitopology Support for IPv6 • Configuring Multitopology IS-IS for IPv6

Feature Name	Releases	Feature Information
IPv6 Routing: Multiprotocol BGP Extensions for IPv6	12.2(33)SCA	Multiprotocol BGP extensions for IPv6 supports the same features and functionality as IPv4 BGP. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Multiprotocol BGP for IPv6" chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Multiprotocol BGP Extensions for IPv6 • How to Implement Multiprotocol BGP for IPv6
IPv6 Routing: Multiprotocol BGP Link-local Address Peering	12.2(33)SCA	IPv6 on Cable supports multiprotocol BGP link-local address peering. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Multiprotocol BGP for IPv6" chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Configuring an IPv6 Multiprotocol BGP Peer Using a Link-Local Address • Multiprotocol BGP Peering Using Link-Local Addresses

Feature Name	Releases	Feature Information
IPv6 Routing: OSPF for IPv6 (OSPFv3)	12.2(33)SCA	OSPF version 3 for IPv6 expands on OSPF version 2 to provide support for IPv6 routing prefixes and the larger size of IPv6 addresses. **Platform-Independent Cisco IOS Software Documentation** The “ Implementing OSPF for IPv6” chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 Routing: OSPF for IPv6 Authentication Support with IPSec	12.2(33)SCA	OSPF for IPv6 uses the IPSec secure socket API to add authentication to OSPF for IPv6 packets. **Note** In Cisco IOS Release 12.2(33)SCA, the Cisco CMTS routers do not support OSPF with IPv6 multicast routing. **Platform-Independent Cisco IOS Software Documentation** The following sections of the “ Implementing OSPF for IPv6” chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • OSPF for IPv6 Authentication Support with IPSec • Configuring IPSec on OSPF for IPv6 • Defining Authentication on an Interface • Defining Authentication in an OSPF Area

Feature Name	Releases	Feature Information
IPv6 Routing: RIP for IPv6 (RIPng)	12.2(33)SCA	RIP enhancements for IPv6 include support for IPv6 addresses and prefixes, and the use of the all-RIP-routers multicast group address FF02::9 as the destination address for RIP update messages. **Platform-Independent Cisco IOS Software Documentation** The " Implementing RIP for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 Routing: Route Redistribution for RIPng	12.2(33)SCA	Routes may be specified by prefix, using a route-map prefix list, or by tag, using the route-map "match tag" function. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing RIP for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Redistributing Routes into an IPv6 RIP Routing Process • Configuring Tags for RIP Routes • IPv6 RIP Configuration: Example

Feature Name	Releases	Feature Information
IPv6 Routing: Route Redistribution for IS-IS	12.2(33)SCA	IS-IS for IPv6 supports redistributing routes into an IPv6 IS-IS routing process and redistributing IPv6 IS-IS routes between IS-IS levels. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IS-IS for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Information about Implementing IS-IS for IPv6 • Redistributing Routes into an IS-IS Routing Process • Redistributing IPv6 IS-IS Routes Between IS-IS Levels
IPv6 Routing: Static Routes	12.2(33)SCA	Static routes are manually configured and define an explicit path between two networking devices. **Platform-Independent Cisco IOS Software Documentation** The " Implementing Static Routes for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 Services and Management		

Feature Name	Releases	Feature Information
IPv6 Services: AAAA DNS Lookups over an IPv4 Transport	12.2(33)SCA	IPv6 basic connectivity can be enhanced by configuring support for AAAA record types in the DNS name-to-address and address-to-name lookup processes. **Platform-Independent Cisco IOS Software Documentation** The " DNS for IPv6 " section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 Services: Cisco Discovery Protocol—IPv6 Address Family Support for Neighbor Information	12.2(33)SCA	The Cisco Discovery Protocol IPv6 address support for neighbor information feature adds the ability to transfer IPv6 addressing information between two Cisco devices. **Platform-Independent Cisco IOS Software Documentation** The " Cisco Discovery Protocol IPv6 Address Support " section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature.
IPv6 Services: CISCO-IP-FORWARD-MIB	12.2(33)SCA	A MIB is a database of the objects that can be managed on a device. The managed objects, or variables, can be set or read to provide information on the network devices and interfaces. **Platform-Independent Cisco IOS Software Documentation** The " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature.

Feature Name	Releases	Feature Information
IPv6 Services: CISCO-IP-MIB Support	12.2(33)SCA	A MIB is a database of the objects that can be managed on a device. The managed objects, or variables, can be set or read to provide information on the network devices and interfaces. **Platform-Independent Cisco IOS Software Documentation** The " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature.
IPv6 Services: DNS Lookups over an IPv6 Transport	12.2(33)SCA	IPv6 supports DNS record types that are supported in the DNS name-to-address and address-to-name lookup processes. **Platform-Independent Cisco IOS Software Documentation** The " DNS for IPv6 " section of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provides information about this feature. **Platform-Specific Documentation for the Cisco CMTS Routers** For information about configuring DNS for IPv6 on the Cisco CMTS routers, see the Configuring IPv6 Domain Name Service, on page 32.

Feature Name	Releases	Feature Information
IPv6 Services: IPv6 IPSec VPN	12.2(33)SCA	**Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPSec in IPv6 Security " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Information About Implementing IPSec for IPv6 Security • How to Implement IPSec for IPv6 Security
IPv6 Services: Secure Shell (SSH) Support over IPv6	12.2(33)SCA	SSH in IPv6 functions the same and offers the same benefits as SSH in IPv4—the SSH Server feature enables an SSH client to make a secure, encrypted connection to a Cisco router and the SSH Client feature enables a Cisco router to make a secure, encrypted connection to another Cisco router or to any other device running an SSH server. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 for Network Management " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • SSH over an IPv6 Transport • Enabling SSH on an IPv6 Router

Feature Name	Releases	Feature Information
IPv6 Services: SNMP over IPv6	12.2(33)SCA	SNMP can be configured over IPv6 transport so that an IPv6 host can perform SNMP queries and receive SNMP notifications from a device running Cisco IOS IPv6. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 for Network Management " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • SNMP over an IPv6 Transport • Configuring an SNMP Notification Server over IPv6 • Configuring an SNMP Notification Server over IPv6: Examples

Feature Name	Releases	Feature Information
IPv6 Services: Standard Access Control Lists	12.2(33)SCA	Access lists determine what traffic is blocked and what traffic is forwarded at router interfaces and allow filtering based on source and destination addresses, inbound and outbound to a specific interface. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Traffic Filters and Firewalls for IPv6 Security " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Restrictions for Implementing Traffic Filters and Firewalls for IPv6 Security • Access Control Lists for IPv6 Traffic Filtering • PAM in Cisco IOS Firewall for IPv6 • How to Implement Traffic Filters and Firewalls for IPv6 Security • Configuration Examples for Implementing Traffic Filters and Firewalls for IPv6 Security
IPv6 Switching		

Feature Name	Releases	Feature Information
IPv6 Switching: CEF/dCEF Support	12.2(33)SCA	Cisco Express Forwarding for IPv6 is advanced, Layer 3 IP switching technology for the forwarding of IPv6 packets. Distributed Cisco Express Forwarding for IPv6 performs the same functions as CEFv6 but for distributed architecture platforms. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing IPv6 Addressing and Basic Connectivity " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Cisco Express Forwarding and distributed Cisco Express Forwarding Switching for IPv6 • Configuring Cisco Express Forwarding and distributed Cisco Express Forwarding Switching for IPv6 **Platform-Specific Documentation for the Cisco CMTS Routers** For information about configuring IPv6 switching on the Cisco CMTS routers, see the Configuring DHCPv6 Relay Agent, on page 35.
IPv6 Tunneling		

Feature Name	Releases	Feature Information
IPv6 Tunneling: Manually Configured IPv6 over IPv4 Tunnels	12.2(33)SCA	A manually configured tunnel is equivalent to a permanent link between two IPv6 domains over an IPv4 backbone. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Tunneling for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Overlay Tunnels for IPv6 • IPv6 Manually Configured Tunnels • Configuring Manual IPv6 Tunnels • Configuring Manual IPv6 Tunnels: Example
IPv6 Tunneling: IPv6 over IPv4 GRE Tunnels	12.2(33)SCA	GRE tunnels are links between two points, with a separate tunnel for each link. The tunnels are not tied to a specific passenger or transport protocol, but in this case carry IPv6 as the passenger protocol with the GRE as the carrier protocol and IPv4 or IPv6 as the transport protocol. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Tunneling for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Library* provide information about this feature: • Overlay Tunnels for IPv6 • GRE/IPv4 Tunnel Support for IPv6 Traffic • Configuring GRE IPv6 Tunnels • Configure GRE Tunnels: Examples

Feature Name	Releases	Feature Information
IPv6 Tunneling: IPv4 over IPv6 Tunnels	12.2(33)SCA	**Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing Tunneling for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Guide* provide information about this feature: • IPv6 Manually Configured Tunnels • Configuring Manual IPv6 Tunnels
IPv6 Dual Stack CPE Support on the CMTS	12.2(33)SCC	Cisco IOS Release 12.2(33)SCC introduced this feature on the Cisco CMTS routers. The following sections provide information about this feature: • Restrictions for IPv6 Dual Stack CPE Support on the CMTS, on page 9 • Overview of IPv6 Dual Stack CPE Support on the CMTS, on page 15 • How to Verify IPv6 Dual Stack CPE Support , on page 37
IPv6 over Subinterfaces	12.2(33)SCC	Cisco IOS Release 12.2(33)SCC introduced this feature on the Cisco CMTS routers. The following sections provide information about this feature: • Overview of IPv6 over Subinterfaces , on page 15 • Example: IPv6 over Subinterfaces , on page 39

Feature Name	Releases	Feature Information
IPv6 ND Gleaning	12.2(33)SCC	The IPv6 ND Gleaning feature enables Cisco CMTS routers to automatically recover lost IPv6 CPE addresses. This feature is configured by default on routers. The **cable nd** command was introduced to support this feature. The following sections provide information about this feature: • IPv6 Neighbor Discovery Gleaning, on page 21 • Disabling IPv6 ND Gleaning, on page 36
IPv6 Support on Multiple Subinterfaces	12.2(33)SCB10	Starting with Cisco IOS Release 12.2(33)SCB10, IPv6 commands are supported on multiple CMTS bundle subinterfaces.
IPv6 HA	12.2(33)SCE	Cisco IOS Release 12.2(33)SCE introduced this feature on the Cisco CMTS routers.

Feature Name	Releases	Feature Information
IPv6 Access Services: DHCPv6 Prefix Delegation	12.2(33)SCE3	The DHCP for IPv6 prefix delegation feature can be used to manage link, subnet, and site addressing changes. DHCP for IPv6 can be used in environments to deliver stateful and stateless information. **Platform-Independent Cisco IOS Software Documentation** The following sections of the " Implementing DHCP for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Guide* provide information about this feature: • DHCPv6 Prefix Delegation • Configuring the DHCP for IPv6 Server Function • Configuring the DHCP for IPv6 Client Function • Configuring the DHCP for IPv6 Server Function: Example • Configuring the DHCP for IPv6 Client Function: Example
IPv6: 6PE & 6VPE	12.2(33)SCF	The Multiprotocol Label Switching (MPLS) virtual private network (VPN) feature represents an implementation of the provider edge (PE)-based VPN model. The 6VPE feature allows Service Providers to provide an IPv6 VPN service that does not require an upgrade or reconfiguration of the PE routers in the IPv4 MPLS core. The following sections provide information about this feature: • Overview of IPv6 VPN over MPLS, on page 17 • Services and Management Restrictions for IPv6 on Cable, on page 8

Feature Name	Releases	Feature Information
IPv6 CPE Router Support on the Cisco CMTS	12.2(33)SCF	The IPv6 CPE router is a node for home or small office use that connects the end-user network to a service provider network. The following section provides information about this feature: • Overview of IPv6 CPE Router Support on the Cisco CMTS, on page 18 The following commands were introduced or modified: • show ipv6 route • **show ipv6 cef platform**
Support for IPv6 Prefix Stability on the Cisco CMTS	12.2(33)SCF1	The IPv6 prefix stability on the Cisco CMTS allows an IPv6 home router to move from one Cisco CMTS to another while retaining the same prefix. The following section provides information about this feature: • Overview of IPv6 CPE Router Support on the Cisco CMTS, on page 18
Unitary DHCPv6 Leasequery protocol (RFC 5007)	12.2(33)SCF1	Added support for RFC 5007 compliant DHCPv6 leasequery protocol. The following commands were introduced or modified: **cable ipv6 source-verify, cable ipv6 source-verify leasequery-filter downstream, show cable leasequery-filter, and debug cable ipv6 lq**.

Feature Name	Releases	Feature Information
Configurable DHCPv6 Relay Address	12.2(33)SCE5	The Cisco CMTS router supports the DHCPv6 relay agent to send relay-forward messages from a specific source address to client relay destinations. The following sections provide information about this feature: **Platform-Specific Documentation for the Cisco CMTS Routers** • Configurable DHCPv6 Relay Address, on page 19 • Configuring DHCPv6 Relay Agent, on page 35 The ipv6 dhcp relay destination command was modified for this feature. **Platform-Independent Cisco IOS Software Documentation** The following section of the " Implementing DHCP for IPv6 " chapter of the *Cisco IOS IPv6 Configuration Guide* provides more information about this feature. • DHCPv6 Client, Server, and Relay Functions

Feature Name	Releases	Feature Information
DHCPv6 with Full 6VPE Support	12.2(33)SCF4	Starting with Cisco IOS Release 12.2(33)SCF4, the following capabilities are supported by IPv6 on the Cisco CMTS routers: • Assignment of different prefixes to CM and CPE • DHCPv6 over MPLS-VPN • DHCPv6 relay Prefix Delegation (PD) VRF awareness The following commands were modified: • **clear ipv6 dhcp relay binding** • **show ipv6 dhcp relay binding** **Platform-Independent Cisco IOS Software Documentation** For more information on the modified commands, see Cisco IOS IPv6 Command Reference .
IPv6 Address Packet Intercept	12.2(33)SCG	The IPv6 Address Packet Intercept feature supports lawful intercept of CMs and CPEs provisioned with IPv6 addresses. The following sections provide information about this feature: • IPv6 Address Packet Intercept • Provisioning IPv6 Taps Using SNMPv3.

Feature Name	Releases	Feature Information
Multiple IAPDs in a Single Advertise	12.2(33)SCG1	The Multiple IAPDs in a Single Advertise feature supports assignment of multiple IA_NAs and IAPDs for a CPE in a single advertise. The output of the **show cable modem ipv6** command was modified to support this feature. The following sections provide more information about this feature: • Restrictions for Multiple IAPDs in a Single Advertise, on page 10 • Support for Multiple IAPDs in a Single Advertise, on page 21 • Verifying Multiple IAPDs in a Single Advertise, on page 50