# Cisco uBR7200 Series MPLS VPN Cable Enhancements

**First Published:** February 14, 2008

This feature module describes the Cisco uBR7200 series universal broadband router cable Multiprotocol Label Switching Virtual Private Network (MPLS VPN) and cable interface bundling features. It explains how to create a VPN using MPLS protocol, cable subinterfaces, and interface bundles. VPNs can be created in many ways using different protocols.

**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.

## 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

# Feature Overview

Using MPLS VPN technology, service providers can create scalable and efficient private networks using a shared hybrid fiber coaxial (HFC) network and Internet protocol (IP) infrastructure.

The cable MPLS VPN network consists of:

- The Multiple Service Operator (MSO) or cable company that owns the physical infrastructure and builds VPNs for the Internet Service Providers (ISPs) to move traffic over the cable and IP backbone.

- ISPs that use the HFC network and IP infrastructure to supply Internet service to cable customers.

Each ISP moves traffic to and from a subscriber's PC, through the MSO's physical network infrastructure, to the ISP's network. MPLS VPNs, created in Layer 3, provide privacy and security by constraining the distribution of a VPN's routes only to the routers that belong to its network. Thus, each ISP's VPN is insulated from other ISPs that use the same MSO infrastructure.

An MPLS VPN assigns a unique VPN Routing/Forwarding (VRF) instance to each VPN. A VRF instance consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine the contents of the forwarding table.

Each PE router maintains one or more VRF tables. It looks up a packet's IP destination address in the appropriate VRF table, only if the packet arrived directly through an interface associated with that table.

MPLS VPNs use a combination of BGP and IP address resolution to ensure security. See *Configuring Multiprotocol Label Switching.*

The table shows a cable MPLS VPN network. The routers in the network are:

- Provider (P) router—Routers in the core of the provider network. P routers run MPLS switching, and do not attach VPN labels (MPLS label in each route assigned by the PE router) to routed packets. VPN labels are used to direct data packets to the correct egress router.

- Provider Edge (PE) router— Router that adds the VPN label to incoming packets based on the interface or subinterface on which they are received. A PE router attaches directly to a CE router. In the MPLS-VPN approach, each Cisco CMTS router acts as a PE router.

- Customer (C) router—Router in the ISP or enterprise network.

- Customer Edge (CE) router—Edge router on the ISP's network that connects to the PE router on the MSO's network. A CE router must interface with a PE router.

The MPLS network has a unique VPN that exclusively manages the MSOs devices called the management VPN. It contains servers and devices that other VPNs can access. The management VPN connects the Cisco CMTS router to a PE router, which connects to management servers such as Cisco Network Registrar (CNR) and Time of Day (ToD) servers. A PE router connects to management servers and is a part of the management VPN. Regardless of the ISP they belong to, the management servers serve the Dynamic Host Configuration Protocol (DHCP), DNS (Domain Name System), and TOD requests coming from PCs or cable modems.

**Note**     When configuring MPLS VPNs, you must configure the first subinterface created as a part of the management VPN.

*Figure 1: MPLS VPN Network*
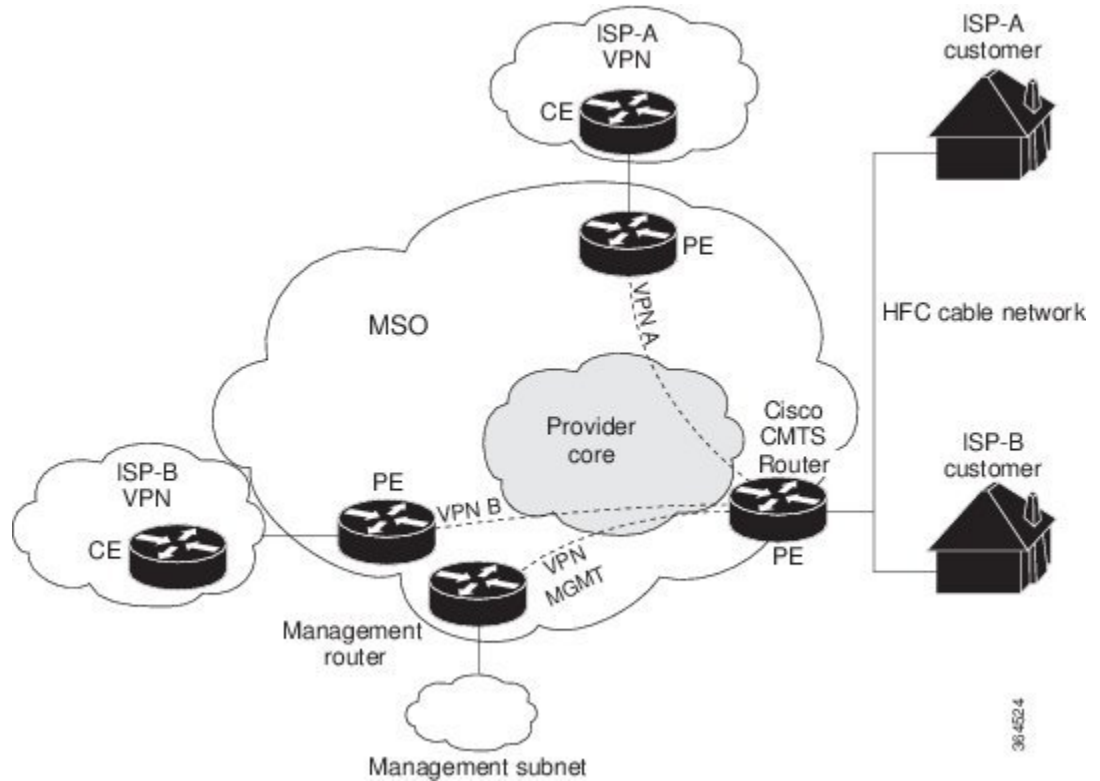


Cable VPN configuration involves an:

- MSO domain that requires a direct peering link to each enterprise network (ISP), provisioning servers for residential and commercial subscribers, and dynamic DNS for commercial users. The MSO manages cable interface IP addressing, Data-over-Cable Service Interface Specifications (DOCSIS) provisioning, CM hostnames, routing modifications, privilege levels, and usernames and passwords.

- ISP or enterprise domain that includes the DHCP server for subscriber or telecommuter host devices, enterprise gateway within the MSO address space, and static routes back to the telecommuter subnets.

**Note**     Cisco recommends that the MSO assign all addresses to the end user devices and gateway interfaces. The MSO can also use split management to let the ISP configure tunnels and security.

In an MPLS VPN configuration, the MSO must configure the following:

- CMTS

- P routers

- PE routers

- CE routers

- One VPN per ISP DOCSIS servers for all cable modem customers. The MSO must attach DOCSIS servers to the management VPN, and make them visible.

The MSO must configure the Cisco CMTS routers that serve the ISP, and remote PE routers connecting to the ISP, as PE routers in the VPN.

The MSO must determine the primary IP address range for all cable modems.

The ISP must determine the secondary IP address range for subscriber PCs.

To reduce security breaches and differentiate DHCP requests from cable modems in VPNs or under specific ISP management, MSOs can use the **cable helper-address** command in Cisco IOS software. The MSO can specify the host IP address to be accessible only in the ISP's VPN. This lets the ISP use its DHCP server to allocate IP addresses. Cable modem IP address must be accessible from the management VPN.

The MPLS VPN approach of creating VPNs for individual ISPs or customers requires subinterfaces to be configured on the virtual bundle interface. Each ISP requires one subinterface. The subinterfaces are tied to the VPN Routing/Forwarding (VRF) tables for their respective ISPs. The first subinterface must be created on the cable interface bound to the management VPN.

To route a reply from the CNR back to the cable modem, the PE router that connects to the CNR must import the routes of the ISP VPN into the management VPN. Similarly, to forward management requests (such as DHCP renewal to CNR) to the cable modems, the ISP VPN must export and import the appropriate management VPN routes.

You can group all of the cable interfaces on a Cisco CMTS router into a single bundle so that only one subnet is required for each router. When you group cable interfaces, no separate IP subnet or each individual cable interface is required. This grouping avoids the performance, memory, and security problems in using a bridging solution to manage subnets, especially for a large number of subscribers.

Subinterfaces allow traffic to be differentiated on a single physical interface, and assigned to multiple VPNs. You can configure multiple subinterfaces, and associate an MPLS VPN with each subinterface. You can split a single physical interface (the cable plant) into multiple subinterfaces, where each subinterface is associated with a specific VPN. Each ISP requires access on a physical interface and is given its own subinterface. Create a management subinterface to support cable modem initialization from an ISP.

Using each subinterface associated with a specific VPN (and therefore, ISP) subscribers connect to a logical subinterface, which reflects the ISP that provides their subscribed services. When properly configured, subscriber traffic enters the appropriate subinterface and VPN.

# Benefits

- MPLS VPNs give cable MSOs and ISPs a manageable way of supporting multiple access to a cable plant. Service providers can create scalable and efficient VPNs across the core of their networks. MPLS VPNs provide systems support scalability in cable transport infrastructure and management.

- Each ISP can support Internet access services from a subscriber's PC through an MSO's physical cable plant to their networks.

- MPLS VPNs allow MSOs to deliver value-added services through an ISP, and thus, deliver connectivity to a wider set of potential customers. MSOs can partner with ISPs to deliver multiple services from multiple ISPs and add value within the MSO's own network using VPN technology.

- Subscribers can select combinations of services from various service providers.

- The MPLS VPN cable features set build on CMTS DOCSIS 1.0 and DOCSIS 1.0 extensions to ensure services are reliably and optimally delivered over the cable plant. MPLS VPN provides systems support domain selection, authentication per subscriber, selection of QoS, policy-based routing, and ability to reach behind the cable modem to subscriber end devices for QoS and billing while preventing session spoofing.

- MPLS VPN technology ensures both secure access across the shared cable infrastructure and service integrity.

- Cable interface bundling eliminates the need for an IP subnet on each cable interface. Instead, an IP subnet is only required for each cable interface bundle. All cable interfaces in a Cisco CMTS router can be added to a single bundle.

# Restrictions

- Each subinterface on the CMTS requires an address range from the ISP and from the MSO. These two ranges must not overlap and must be extensible to support an increased number of subscribers for scalability.

**Note** This document does not address allocation and management of MSO and ISP IP addresses. See *Configuring Multiprotocol Label Switching* for this information.

- The **cable source-verify dhcp** command enables Dynamic Host Control Protocol (DHCP) Lease query protocol from the CMTS to DHCP server to verify IP addresses of upstream traffic, and prevent MSO customers from using unauthorized, spoofed, or stolen IP addresses.

- When using only MPLS VPNs, create subinterfaces on the virtual bundle, assign it an IP address, and provide VRF configuration for each ISP. When you create subinterfaces and configure only MPLS VPNs, the cable interface bundling feature is independent of the MPLS VPN.

- When using cable interface bundling:

  ◦ Define a virtual bundle interface and associate any cable physical interface to the virtual bundle.

  ◦ Specify all generic IP networking information (such as IP address, routing protocols, and switching modes) on the virtual bundle interface. Do not specify generic IP networking information on bundle slave interfaces.

  ◦ An interface that has a subinterface(s) defined over it is not allowed to be a part of the bundle.

  ◦ Specify generic (not downstream or upstream related) cable interface configurations, such as source-verify or ARP handling, on the virtual bundle interface. Do not specify generic configuration on bundle slave interfaces.

- Interface bundles can only be configured using the command line interface (including the CLI-based HTML configuration).

# Supported Platforms

- Cisco uBR7223

- Cisco uBR7246

- Cisco uBR7246 VXR

# Prerequisites

Before configuring IP-based VPNs, complete the following tasks:

- Ensure your network supports reliable broadband data transmission. Your plant must be swept, balanced, and certified based on National Television Standards Committee (NTSC) or appropriate international cable plant recommendations. Ensure your plant meets all DOCSIS or European Data-over-Cable Service Interface Specifications (EuroDOCSIS) downstream and upstream RF requirements.

- Ensure your Cisco router is installed following instructions in the Hardware Installation Guide and the Regulatory Compliance and Safety Information guide.

- Ensure your Cisco router is configured for basic operations.

- The chassis must contain at least one port adapter to provide backbone connectivity and one Cisco cable modem card to serve as the RF cable TV interface.

# Other Important Information

- Ensure all other required headend or distribution hub routing and network interface equipment is installed, configured, and operational based on the services to support. This includes all routers, servers (DHCP, TFTP, and ToD), network management systems, other configuration or billing systems and backbone, and other equipment to support VPN.

- Ensure DHCP and DOCSIS configuration files have been created and pushed to appropriate servers such that each cable modem, when initialized, can transmit a DHCP request, receive an IP address, obtain TFTP and ToD server addresses, and download a DOCSIS configuration file. Configure each subinterface to connect to the ISP's VPN.

- Ensure DOCSIS servers are visible on the management VPN.

- Be familiar with your channel plan to assign appropriate frequencies. Outline your strategies for setting up bundling or VPN solution sets if applicable to your headend or distribution hub. Obtain passwords, IP addresses, subnet masks, and device names as appropriate.

- Create subinterfaces off of a virtual bundle interface. Configure each subinterface to connect to the ISP network.

The MPLS VPN configuration steps assume the following:

- IP addressing has already been determined and there are assigned ranges in the MSO and ISP network for specific subinterfaces.

- The MSO is using CNR and has configured it (using the **cable helper-address** command) to serve appropriate IP addresses to cable modems based on the cable modem MAC address. The CMTS forwards DHCP requests to the CNR based on the **cable helper-address** settings. The CNR server determines the IP address to assign the cable modem using the client-classes feature, which let the CNR assign specific parameters to devices based on MAC addresses.

- ISP CE routers are configured (using the **cable helper-address** command) to appropriately route relevant IP address ranges into the VPN.

- P and PE routers are already running Cisco Express Forwarding (CEF).

- MPLS is configured on the outbound VPN using the **tag switching ip** command in interface configuration mode.

# Configuration Tasks

To configure MPLS VPNs, perform the following tasks:

## Creating VRFs for each VPN

To create VRFs for each VPN, perform the following steps beginning in the router configuration mode.

**Note** Since only the CMTS has logical subinterfaces, assignments of VRFs on the other PE devices will be to specific physical interfaces.

**DETAILED STEPS**

|        | Command or Action | Purpose |
|--------|-------------------|---------|
| Step 1 | Router(config)# **ip vrf** *mgmt-vpn* | Enters VRF configuration mode (config-vrf)# and maps a VRF table to the VPN (specified by *mgmt-vpn* ). The management VPN is the first VPN configured. |
| Step 2 | Router(config-vrf)# **rd** *mgmt-rd* | Creates a routing and forwarding table by assigning a route distinguisher to the management VPN. |
| Step 3 | Router(config-vrf)# **route-target** {**export**\| **import**\| **both**} *mgmt-rd* | Exports and/or imports all routes for the management VPNs route distinguisher. This determines which routes will be shared within VRFs. |
| Step 4 | Router(config-vrf)# **route-target import** isp1-vpn-rd | Imports all routes for the VPNs (*isp1-vpn)* route distinguisher. |
| Step 5 | Router(config-vrf)# **route-target import** isp2-vpn-rd | Imports all routes for the VPNs (*isp2-vpn)* route distinguisher. |
| Step 6 | Router(config-vrf)# **ip vrf** isp1-vpn | Creates a routing and forwarding table by assigning a route distinguisher to *isp1-vpn* . |

|         | **Command or Action** | **Purpose** |
|---------|----------------------|-------------|
| **Step 7** | Router(config-vrf)# **rd** *mgmt-rd* | Creates a routing and forwarding table by assigning a route distinguisher (mgmt-rd) to the management VPN (mgmt-vpn). |
| **Step 8** | Router(config-vrf)# **route-target export** isp1-vpn-rd | Exports all routes for the VPNs (*isp1-vpn*) route distinguisher. |
| **Step 9** | Router(config-vrf)# **route-target import** isp1-vpn-rd | Imports all routes for the VPNs (*isp1-vpn*) route distinguisher. |
| **Step 10** | Router(config-vrf)# **route-target import** mgmt-vpn-rd | Exports all routes for the VPNs (*mgmt-vpn*) route distinguisher. |
| **Step 11** | Router(config-vrf)# **ip vrf** isp2-vpn | Creates a routing and forwarding table by assigning a route distinguisher to *isp2-vpn* . |
| **Step 12** | Router(config-vrf)# **route-target export** isp2-vpn-rd | Exports all routes for the VPNs (*isp2-vpn*) route distinguisher. |
| **Step 13** | Router(config-vrf)# **route-target import** isp2-vpn-rd | Imports all routes for the VPNs (*isp2-vpn*) route distinguisher. |
| **Step 14** | Router(config-vrf)# **route-target import** mgmt-vpn-rd | Imports all routes for the VPNs (*mgmt-vpn*) route distinguisher. |

# Defining Subinterfaces on a Virtual Bundle Interface and Assigning VRFs

To create a logical cable subinterface, perform the following steps beginning in the global configuration mode. Create one subinterface for each VPN (one per ISP). The first subinterface created must be configured as part of the management VPN (with the lowest subinterface number).

**DETAILED STEPS**

|         | **Command or Action** | **Purpose** |
|---------|----------------------|-------------|
| **Step 1** | Router# **configure terminal** | Enters configuration mode. |
| **Step 2** | Router(config)# **interface bundle n** | Enters virtual bundle interface configuration mode and defines the first (management) subinterface with the lowest subinterface number. Valid range for the bundle number n is from 1 to 255. |
| **Step 3** | Router(config-subif)# **description** *string* | Identifies the subinterface as the management subinterface. |
| **Step 4** | Router(config-subif)# **ip vrf forwarding** *mgmt-vpn* | Assigns the subinterface to the management VPN (the MPLS VPN used by the MSO to supply service to customers). |
| **Step 5** | Router(config-subif)# **ip address** *ipaddress mask* | Assigns the subinterface an IP address and a subnet mask. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 6** | Router(config-subif)# **cable helper-address** *ip-address* **cable-modem** | Forwards DHCP requests from cable modems to the IP address listed. |
| **Step 7** | Router(config-subif)# **cable helper-address** *ip-address* **host** | Forwards DHCP requests from hosts to the IP address listed. |
| **Step 8** | Router(config-if)# **interface bundle n** | Defines an additional subinterface for the ISP (such as isp1). |
| **Step 9** | Router(config-subif)# **description** *string* | Identifies the subinterface (such as subinterface for *isp1-vpn*) . |
| **Step 10** | Router(config-subif)# **ip vrf forwarding** *isp1-vpn* | Assigns the subinterface to *isp1-vpn* VPN. |
| **Step 11** | Router(config-subif)# **ip address** *ipaddress mask* | Assigns the subinterface an IP address and a subnet mask. |
| **Step 12** | Router(config-subif)# **cable helper-address** *ip-address* **cable-modem** | Forwards DHCP requests from cable modems to the IP address listed. |
| **Step 13** | Router(config-subif)# **cable helper-address** *ip-address* **host** | Forwards DHCP requests from hosts to the IP address listed. |
| **Step 14** | Router(config-if)# **interface cable** *slot/port.n* | Defines an additional subinterface for the ISP (such as isp2). |
| **Step 15** | Router(config-subif)# **description** *string* | Identifies the subinterface (such as subinterface for *isp2-vpn*) . |
| **Step 16** | Router(config-subif)# **ip vrf forwarding** *isp2-vpn* | Assigns the subinterface to *isp2-vpn*  VPN. |
| **Step 17** | Router(config-subif)# **ip address** *ipaddress mask* | Assigns the subinterface an IP address and a subnet mask. |
| **Step 18** | Router(config-subif)# **cable helper-address** *ip-address* **cable-modem** | Forwards DHCP requests from cable modems to the IP address listed. |
| **Step 19** | Router(config-subif)# **cable helper-address** *ip-address* **host** | Forwards DHCP requests from hosts to the IP address listed. |
| **Step 20** | Router(config)# **exit** | Returns to configuration mode. |

# Configuring Cable Interface Bundles

To assign a cable interface to a bundle, perform the following steps beginning in the interface configuration mode.

**DETAILED STEPS**

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | Router(config)# **interface cable** *slot/port* | Enters the cable interface configuration mode. |

| | Command or Action | Purpose |
|---|---|---|
| | | IP addresses are not assigned to this interface. They are assigned to the logical subinterfaces created within this interface. |
| Step 2 | Router(config-if)# **cable bundle** *bundle-number* **[master]** | Defines the interface as the bundle's master interface. |
| Step 3 | Router(config)# **interface cable** *slot/port* | Enters the cable interface configuration mode for another cable interface. |
| | | IP addresses are not assigned to this interface. They are assigned to the logical subinterfaces created within this interface. |
| Step 4 | Router(config-if)# **cable bundle** *bundle-number* | Adds the interface to the bundle specified by *bundle-number* . |

# Configuring Subinterfaces and MPLS VPNs on a Virtual Bundle Interface

To configure subinterfaces on a virtual bundle interface and assign each subinterface a Layer 3 configuration:

Configure cable interface bundles.

Define subinterfaces on the virtual bundle interface and assign a Layer 3 configuration to each subinterface.

Create one subinterface for each customer VPN (one per ISP).

# Configuring MPLS in the P Routers in the Provider Core

To configure MPLS in the P routers in the provider core, perform the following steps.

**DETAILED STEPS**

| | Command or Action | Purpose |
|---|---|---|
| Step 1 | Router# **configure terminal** | Enters configuration mode. |
| Step 2 | Router(config)#**ip cef** | Enables Cisco Express Forwarding (CEF) operation. |
| | | For information about CEF configuration and command syntax, see Cisco Express Forwarding Overview and Configuring Cisco Express Forwarding. |
| Step 3 | Router(config)#**interface FastEthernet** *slot/port* | Enters FastEthernet interface configuration mode. |
| Step 4 | Router(config-if)#**ip address** *ip-address mask* | Defines the primary IP address range for the interface. |
| Step 5 | Router(config-if)#**mpls ip** | Enables the interface to be forwarded to an MPLS packet. |

|  | **Command or Action** | **Purpose** |
|---|---|---|
| **Step 6** | Router(config-if)#**exit** | Returns to global configuration mode. |
| **Step 7** | Router(config)#**mpls label-protocol ldp** | Enables Label Distribution Protocol (LDP). For information about LDP and MPLS, see Configuring Multiprotocol Label Switching. |
| **Step 8** | Router(config)# **exit** | Returns to the configuration mode. |

## Verifying the MPLS VPN Configuration

Use the following commands to verify MPLS VPN operations on PE routers. For more MPLS VPN verification commands, see Configuring Multiprotocol Label Switching.

**DETAILED STEPS**

|  | **Command or Action** | **Purpose** |
|---|---|---|
| **Step 1** | Router# **show ip vrf** | Displays the set of VRFs and interfaces. |
| **Step 2** | Router# **show ip route vrf [vrf-name]** | Displays the IP routing table for a VRF. |
| **Step 3** | Router# **show ip protocols vrf [vrf-name]** | Displays the routing protocol information for a VRF. |
| **Step 4** | Router# **show ip route vrf** *vrf-name* | Displays the Local and Remote CE devices that are in the PE routing table. |
| **Step 5** | Router# **show mpls forwarding-table** | Displays entries for a VPN Routing/Forwarding instance. |

**What to Do Next**

For more verification instructions, see the MPLS: Layer 3 VPNs Configuration Guide.

# Configuration Examples

This section provides the following configuration examples:

## Subinterface Configuration Example

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

```
interface cable3/0
! No IP address
```

```
! MAC level configuration only
! first subinterface
interface bundle1.1
description Management Subinterface
ip address 10.255.1.1 255.255.255.0
cable helper-address 10.151.129.2
! second subinterface
interface bundle1.2
ip address 10.279.4.2 255.255.255.0
cable helper-address 10.151.129.2
! third subinterface
interface bundle1.3
ip address 10.254.5.2 255.255.255.0
cable helper-address 10.151.129.2
```

# Cable Interface Bundling Example

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

interface cable 3/0 and interface cable 4/0 are bundled.

```
interface cable 3/0
 cable bundle 1
interface cable 4/0
 cable bundle 1
interface Bundle 1
 ip address 209.165.200.225 255.255.255.0
 ip address 209.165.201.1 255.255.255.0 secondary
```

# Subinterface Definition on Virtual Bundle Example

The following example shows how to define subinterfaces on a virtual bundle and define Layer 3 configurations for each subinterface.

interface cable 3/0 and interface cable 4/0 are bundled.

```
interface cable 3/0
! No IP address
! MAC level configuration only
cable bundle 1
interface cable 4/0
! No IP address
! MAC layer configuration
cable bundle 1
! first subinterface
interface bundle1.1
ip address 10.22.64.1 255.255.255.0
cable helper-address 10.4.1.2
! second subinterface
interface bundle1.2
ip address 10.12.39.1 255.255.255.0
cable helper-address 10.4.1.2
! third subinterface
interface bundle1.3
ip address 10.96.3.1 255.255.255.0
cable helper-address 10.4.1.2
```

# Cable Interface Bundle Master Configuration Example

The following examples show how to configure cable interface bundles:

```
Displaying the contents of the bundle
Router(config-if)#cable bundle ?
  <1-255>  Bundle number
Router(config-if)#cable bundle 25 master
Router(config-if)#
07:28:17: %UBR7200-5-UPDOWN: Interface Cable3/0 Port U0, changed state to down
07:28:18: %UBR7200-5-UPDOWN: Interface Cable3/0 Port U0, changed state to up
```

# PE Router Configuration Example

```
!
! Identifies the version of Cisco IOS software installed.
version 12.0
! Defines the hostname of the Cisco uBR7246
hostname region-1-ubr
!
! Describes where the system is getting the software image it is running. In
! this configuration example, the system is loading a Cisco uBR7246 image named
! AdamSpecial from slot 0.
boot system flash slot0:ubr7200-p-mz.AdamSpecial
!
! Creates the enable secret password.
enable secret xxxx
enable password xxxx
!
! Sets QoS per modem for the cable plant.
no cable qos permission create
no cable qos permission update
cable qos permission modems
!
! Allows the system to use a full range of IP addresses, including subnet zero, for
! interface addresses and routing updates.
ip subnet-zero
!
! Enables Cisco Express Forwarding.
ip cef
!
! Configures a Cisco IOS Dynamic Host Configuration Protocol (DHCP) server to insert the
! DHCP relay agent information option in forwarded BOOTREQUEST messages.
ip dhcp relay information option
!
! Enters the virtual routing forwarding (VRF) configuration mode and maps a VRF table to
! the virtual private network (VPN) called MGMT-VPN. The VRF table contains the set of
! routes that points to or gives routes to the CNR device, which provisions the cable
! modem devices. Each VRF table defines a path through the MPLS cloud.
ip vrf MGMT-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
 rd 100:1
!
! Creates a list of import and/or export route target communities for the VPN.
 route-target export 100:2
 route-target export 100:3
!
! Maps a VRF table to the VPN called ISP1-VPN.
ip vrf ISP1-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
 rd 100:2
```

```
!
! Creates a list of import and/or export route target communities for the VPN.
 route-target import 100:1
!
! Maps a VRF table to the VPN called ISP2-VPN.
ip vrf ISP2-VPN
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
 rd 100:3
!
! Creates a list of import and/or export route target communities for the VPN.
 route-target import 100:1
!
! Maps a VRF table to the VPN called MSO-isp. Note: MSO-isp could be considered ISP-3; in
! this case, the MSO is competing with other ISPs for other ISP services.
ip vrf MSO-isp
!
! Creates the route distinguisher and creates the routing and forwarding table of the
! router itself.
 rd 100:4
!
! Creates a list of import and/or export route target communities for the VPN.
  route-target import 100:1
!
! Builds a loopback interface to be used with MPLS and BGP; creating a loopback interface
! eliminates unnecessary updates (caused by physical interfaces going up and down) from
! flooding the network.
interface Loopback0
 ip address 10.2.2.1 255.255.255.0
 no ip directed-broadcast
!
! Assigns an IP address to this Fast Ethernet interface. MPLS lable protocol must be
! enabled on this interface.
interface FastEthernet0/0
 description Connection to MSO core.
 ip address 10.0.1.1 255.255.255.0
 no ip directed-broadcast
 full-duplex
 mpls ip
 mpls label protocol ldp
!
! Enters cable interface configuration mode and configures the physical aspects of the
! 3/0 cable interface. Please note that no IP addresses are assigned to this interface;
! they will be assigned instead to the logical subinterfaces. All other commands for
! this cable interface should be configured to meet the specific needs of your cable RF
! plant and cable network.
interface Cable3/0
 no ip address
 cable bundle 1
 ip directed-broadcast
 no ip mroute-cache
 load-interval 30
 no keepalive
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 855000000
 cable upstream 0 frequency 30000000
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable upstream 4 shutdown
 cable upstream 5 shutdown
!
! Configures bundle 1.1 subinterface. If cable modems have
! not been assigned IP addresses, they will automatically come on-line using the settings
! for subinterface bundle1.1.
interface bundle1.1
 description Cable Administration Network
!
```

```
! Associates this interface with the VRF and MPLS VPNs that connect to the MSO cable
! network registrar (CNR). The CNR provides cable modems with IP addresses and other
! initialization parameters.
 ip vrf forwarding MSO
!
! Defines a range of IP addresses and masks to be assigned to cable modems not yet associated
 with an ISP.
 ip address 10.0.0.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
 no ip directed-broadcast
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
 cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PCs that are not yet associated with an ISP.
 cable helper-address 10.4.1.2 host
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
 no cable proxy-arp
 no cable ip-multicast-echo
!
! Configures bundle1.2 subinterface.
interface bundle1.2
 description MSO as ISP Network
!
! Assigns this subinterface to the MPLS VPN used by the MSO to supply service to
! customers—in this case, MSO-isp.
 ip vrf forwarding MSO-isp
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
 ip address 10.1.1.1 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
 ip address 10.1.0.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
 no ip directed-broadcast
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
 cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
 cable helper-address 10.4.1.2 host
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
 no cable proxy-arp
 no cable ip-multicast-echo
!
! Configures bundle1.3 subinterface
interface bundle1.3
 description ISP1's Network
!
! Makes this subinterface a member of the MPLS VPN.
 ip vrf forwarding isp1
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
 ip address 10.1.1.1 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
 ip address 10.0.1.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
 no ip directed-broadcast
!
```

```
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! cable interface.
 no cable proxy-arp
 no cable ip-multicast-echo
!
! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
 cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
 cable helper-address 10.4.1.2 host
!
! Configures bundle1.4 subinterface
interface bundle1.4
 description ISP2's Network
!
! Makes this subinterface a member of the MPLS VPN.
 ip vrf forwarding isp2
!
! Defines a range of IP addresses and masks to be assigned to cable modems associated
! with the MSO as ISP network.
 ip address 10.1.2.1 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
 ip address 10.0.1.1 255.255.255.0
!
! Disables the translation of directed broadcasts to physical broadcasts.
 no ip directed-broadcast
!
! Disables cable proxy Address Resolution Protocol (ARP) and IP multicast echo on this
! interface.
 no cable proxy-arp
 no cable ip-multicast-echo
!
!
 cable dhcp-giaddr policy
!
!! Defines the DHCP server for cable modems whether they are associated with an ISP or
! with the MSO acting as ISP.
 cable helper-address 10.4.1.2 cable-modem
!
! Defines the DHCP server for PC host devices.
 cable helper-address 10.4.1.2 host
!
end
```

# P Router Configuration Example

```
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname R7460-7206-02
!
enable password xxxx
!
ip subnet-zero
ip cef
ip host brios 223.255.254.253
!
interface Loopback0
 ip address 10.2.1.3 255.255.255.0
 no ip directed-broadcast
```

```
!
interface Loopback1
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
!
interface FastEthernet0/0
 ip address 1.7.108.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 shutdown
 full-duplex
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/0
 ip address 10.0.5.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache cef
 no ip mroute-cache
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/1
 ip address 10.0.1.17 255.255.255.0
 no ip directed-broadcast
 no ip route-cache cef
 no ip mroute-cache
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/2
 ip address 10.0.2.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache cef
 no ip mroute-cache
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/3
 ip address 10.0.3.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache cef
 no ip mroute-cache
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/4
 ip address 10.0.4.2 255.255.255.0
 no ip directed-broadcast
 no ip route-cache cef
 no ip mroute-cache
 mpls ip
 mpls label protocol ldp
 no cdp enable
!
interface Ethernet1/5
 no ip address
 no ip directed-broadcast
 no ip route-cache cef
 shutdown
 no cdp enable
!
interface Ethernet1/6
 no ip address
 no ip directed-broadcast
 no ip route-cache cef
 shutdown
```

```
 no cdp enable
!
interface Ethernet1/7
 no ip address
 no ip directed-broadcast
 no ip route-cache cef
 shutdown
 no cdp enable
!
router ospf 222
 network 10.0.5.0 255.255.255.0 area 0
 network 10.0.2.0 255.255.255.0 area 0
 network 10.0.3.0 255.255.255.0 area 0
 network 10.0.4.0 255.255.255.0 area 0
 network 20.2.1.3 255.255.255.0 area 0
!
ip classless
no ip http server
!
!
map-list test-b
no cdp run
!
tftp-server slot0:master/120/c7200-p-mz.120-1.4
!
line con 0
 exec-timeout 0 0
 password xxxx
 login
 transport input none
line aux 0
line vty 0 4
 password xxxx
 login
!
no scheduler max-task-time
end
```

# Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS Cable Command Reference* at http://www.cisco.com/c/en/us/td/docs/cable/cmts/cmd_ref/b_cmts_cable_cmd_ref.html For information about all Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the *Cisco IOS Master Commands List* .

- **cable bundle**

- **cable helper-address**

- **ip dhcp relay information option**

- **show cable bundle**

# Additional References

### Related Documents

For additional information on the Cisco uBR7200 series and MPLS VPN, see:

- Cisco uBR7200 Series Universal Broadband Router Software Configuration Guide

- Cisco uBR7200 Series Universal Broadband Router Hardware Installation Guide
- Cisco uBR7200 Series Software Release Notes and Features
- Cisco uBR7200 Series Configuration Notes
- Cisco Network Registrar for the Cisco uBR7200 Series Universal Broadband Routers
- Regulatory Compliance and Safety Information for the Cisco uBR7200 Series Universal Broadband Router
- Configuring Multiprotocol Label Switching
- MPLS Label Switching on Cisco Routers
- Cisco IOS Release 12.1 Documents

### Standards

DOCSIS 1.0.

### MIBs

- CISCO-DOCS-REMOTE-QUERY.my

No new or modified MIB objects are supported by the cable interface bundling feature.

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

### RFCs

- RFC 1163, A Border Gateway Protocol
- RFC 1164, Application of the Border Gateway Protocol in the Internet
- RFC 2283, Multiprotocol Extensions for BGP-4
- RFC 2547, BGP/MPLS VPNs
- RFC 2233, DOCSIS OSSI Objects Support
- RFC 2669, Cable Device MIB
- RFC 2665, DOCSIS Ethernet MIB Objects Support

# Feature Information for Cisco uBR7200 Series MPLS VPN Cable Enhancements

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.

| Feature Name | Releases | Feature Information |
|---|---|---|
| Support for Multiprotocol Label Switching Virtual Private Network (MPLS VPN) and Cable Interface Bundling | 12.2(33)SCA | Cisco IOS Release 12.2(33)SCA integrates support for this feature on the Cisco CMTS routers |