Cisco uBR10012 Universal Broadband Router Software Configuration Guide

Cisco IOS® Software - 12.3 BC, 12.2 BC, 12.2 CY
November 2006

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Text Part Number: OL-1520-08

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Cisco uBR10012 Universal Broadband Router Software Configuration Guide

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Preface

This preface explains the objectives, software options, intended audience, and organization of the *Cisco uBR10012 Universal Broadband Router Software Configuration Guide*, which describes the following release trains:

- Cisco IOS Release 12.1 BC, 12.2 BC, and 12.3 BC
- Cisco IOS Release 12.2 CY

This preface also defines this document’s conventions for conveying instructions and information.

Document Revision History

The Document Revision History table below records technical changes to this document.

Table 1 Document Revision History

Document Revision	Date	Change Summary
OL-1520-06	September 30, 2005	Incorporated new features and enhancements introduced in Cisco IOS Release 12.3(13a)BC. Added Document Revision History table.

Purpose

This guide describes the procedures necessary to configure, maintain, and troubleshoot the initial software configuration for the Cisco uBR10012 universal broadband router. This guide also directs you to other closely related documentation for additional features and optimization.

The Cisco uBR10000 series CMTS solutions allow cable companies, Internet service providers (ISPs), and others to allocate channel capacity for Internet access services using a broadband radio frequency (RF) cable plant. The Cisco uBR10012 router sustains two-way downstream and upstream traffic over Data-over-Cable Service Interface Specifications (DOCSIS)-based cable modems (CMs) that support 6 MHz National Television Systems Committee (NTSC) operations.

Audience

This guide is intended for system administrators and support engineers who configure and maintain the Cisco uBR10012 router. Many different delivery models exist for Cisco uBR10000 series equipment:

- In smaller networks, a single service provider manages all equipment and infrastructure.
- In larger networks, multiple service operators (MSOs) and ISPs share responsibility for provisioning and managing the cable plant and IP network.

How the MSO and ISP divide responsibilities depends on the service model. In some cases, the MSO maintains and operates the cable plant and attached CMs and set-top boxes (STBs), and the ISP owns, operates, and maintains the regional network and IP infrastructure beyond the cable distribution hub. In other cases, the Cable Modem Termination System (CMTS) and RF customer premises equipment (CPE) are viewed as part of the networking infrastructure, and the ISP maintains control for provisioning and managing DOCSIS functionality.

Note This guide considers the MSO and ISP as a single service principle with responsibility to provision and manage DOCSIS-based cable modems and STBs. This guide assumes that administrators are familiar with Cisco uBR10000 series hardware, DOCSIS requirements, and networking.

Document Organization

This guide focuses on configuration of Cisco IOS software for the Cisco uBR10012 router. Table 2 summarizes the chapters and procedures in this guide. These chapters are presented in the general sequence used in a router installation and configuration. However, this sequence is also affected by your network configuration and other factors.

Table 2 Guide Contents and Organization

Title	Description
Chapter 1, "Overview of Cisco uBR10012 Universal Broadband Router Software"	Acquaints you with the Cisco IOS releases, hardware, and software features supported on the Cisco uBR10000 series CMTS.
Chapter 2, "Configuring the Cable Modem Termination System for the First Time"	Provides instructions to make basic configurations to the Cisco uBR10000 series Cable Modem Termination System (CMTS) using AutoInstall, the Setup facility, or manual configuration mode. Includes sample Cisco uBR10012 router software configurations. Note Complete the configurations in this chapter prior to attempting additional configurations later in this guide.
Chapter 3, "Configuring Cable Interface Features for the Cisco uBR10012 Router"	Provides instructions for required cable interface configurations for upstream and downstream interfaces.
Chapter 4, "Managing Cable Modems on the Hybrid Fiber-Coaxial Network"	Provides a number of procedures that you can implement after you have completed upstream and downstream cable interface configurations to manage operations of your cable modems in the hybrid fiber-coaxial network.

Table 2 Guide Contents and Organization (continued)

Title	Description
Chapter 5, "Configuring Basic Broadband Internet Access"	Provides a recommended basic configuration for high-speed Internet access and a basic Internet access sample configuration file.
Chapter 6, "Troubleshooting the System"	Provides troubleshooting instructions for the configuration of the Cisco uBR10000 series CMTS.
Appendix A, "DOCSIS and CMTS Architectural Overview"	Provides a brief overview of general DOCSIS architecture and enhancements.
Appendix B, "Configuration Register Information for the Cisco uBR10012 Universal Broadband Router"	Provides information about the functions and configuration of bits in the Cisco IOS Software Configuration Register.

Conventions

This guide uses the following conventions for command syntax descriptions and textual emphasis:

Table 3 Command Syntax and Emphasis Conventions

Convention	Description
boldface font	Commands and keywords are in **boldface**.
italic font	Arguments for which you supply values are in *italics*.
[ ]	Elements in square brackets are optional.
{*x* | *y* | *z*}	Alternative, mutually exclusive, keywords are grouped in braces and separated by vertical bars.
[*x* | *y* | *z*]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
`screen` font	Terminal sessions and information the system displays are in `screen` font.
`boldface screen` font	Information you must enter is in **`boldface screen`** font.
`italic screen` font	Arguments for which you supply values are in *`italic screen`* font.
^	The symbol ^ represents the key labeled Control—for example, the key combination ^D in a screen display means hold down the Control key while you press the D key.
< >	Nonprinting characters, such as passwords, are in angle brackets in contexts where italics are not available.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Note

This symbol means *reader take note*. Notes contain helpful suggestions or references to material not covered in the publication.

Tip

This symbol means *the following are useful tips.*

Timesaver

This symbol means *the described action saves time*. You can save time by performing the action described in the paragraph.

Caution

This symbol means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Terms and Acronyms

To fully understand the content of this guide, you should be familiar with the following terms and acronyms:

Note

A complete list of terms and acronyms is available in the *Internetworking Terms and Acronyms* guide on Cisco.com and the Documentation CD-ROM.

- ABR—available bit rate
- ACL—access control list
- AGC—automatic gain control
- ASIC—application specific integrated circuit
- AWG—American wire gauge
- BGP—Border Gateway Protocol
- BPI—Baseline Privacy Interface
- CM—cable modem—CPE side device in a cable network
- CMTS—cable modem termination system
- CoS—class of service
- CPE—customer premises equipment
- CRC—cyclic redundancy check
- CSU—channel service unit
- CTS—Clear To Send
- D/A—Digital to Analog (Conversion)
- DCD—Data Carrier Detect
- DCE—data communications equipment
- DHCP—Dynamic Host Configuration Protocol
- DIMM—dual in-line memory module
- DOCSIS—Data-over-Cable Service Interface Specification
- DS—downstream—data flowing from the internet backbone towards the cable network is considered to be moving in the downstream direction. Also refers to data flowing from the CMTS towards the CM is moving in the downstream direction.
- DSP—digital signal processor

- DSR—data set ready
- DSU—data service unit
- DTE—data terminal equipment
- DTR—data terminal ready
- EMC—electromagnetic compliance
- EMI—electromagnetic interference
- ESD—electrostatic discharge
- FRU—field-replaceable unit (router components that do not require replacement by a Cisco certified service provider)
- FTP—foil twisted-pair
- HCCP—Hot Standby Connection-to-Connection Protocol
- HDLC—High-Level Data Link Control
- HFC—hybrid fiber coaxial
- HWIDB—hardware interface data block
- IPSec—IP Security Protocol
- Kbps—Kilo-bits Per Second
- LC—line card
- LCN—logical channel number
- LCP—line card processor
- LLC—Logical Link Control
- Logical Interface—A group of one or more upstream and one or more downstream cable ports
- MAC—Media Access Control
- MAP—upstream bandwidth allocation map
- MB—megabyte
- Mbps—Mega-bits per second
- MM—multimode
- Modem—modulator/demodulator
- MPLS—Multiprotocol label switching
- nrt-VBR—non-real-time variable bit rate
- NTSC—National Television Standards Committee
- NVRAM—nonvolatile random-access memory
- OAM AIS—Operation, Administration, and Maintenance alarm indication signal
- OIR—online insertion and removal
- PBR—policy-based routing
- PCI—peripheral component interconnect bus
- PCMCIA—Personal Computer Memory Card International Association
- PHS—payload header suppression
- PHY—Physical Interface Chip
- PPP—Point-to-Point Protocol
- PRE—Performance Routing Engine
- QAM—Quadrature Amplitude Modulation
- QoS—quality of service
- QPSK—Quadrature Phase Shift Keying
- rcp—remote copy protocol
- RF—radio frequency
- RFI—radio frequency interference
- RIP—Routing Information Protocol
- RISC—Reduced Instruction Set Computer
- ROM—read only memory

- RP—route processor
- RPR(+)—Route Processor Redundancy (plus)
- RTS—Request To Send
- SA—spectrum analyzer
- SDRAM—synchronous dynamic random-access memory
- SFID—Service Flow Identifier
- SID—Service ID
- SIMM—single in-line memory module
- SM—subscriber modem or spectrum manager
- SMI—single-mode intermediate reach
- SNMP—Simple Network Management Protocol
- TCP/IP—Transmission Control Protocol/Internet Protocol
- TDM—time-division multiplexing
- TFTP—Trivial File Transfer Protocol
- ToD—time-of-day
- ToS—Type of Service
- UBR—unspecified bit rate
- UDP—User Datagram Protocol
- UNI—User-Network Interface
- US—upstream—Data flowing from the cable network towards the internet backbone is considered to be moving in the upstream direction. Also, data flowing from the CM towards the CMTS is moving in the upstream direction.
- UTP—unshielded twisted-pair
- VC—virtual circuit
- VPN—Virtual Private Network

Additional References

The following references provide additional information related to the Cisco uBR10012 router.

Related Topic	Document Title
Documentation Roadmap	• *Cisco uBR7200 Series Routers and Cisco uBR10012 Universal Broadband Router Documentation Roadmap* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr_rmap.htm
Cisco uBR10012 Hardware Installation	• *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/hig/
Cisco uBR10012 Field Replaceable Units (FRUs)	• *Cisco uBR10012 Field Replaceable Units (FRUs)* Documentation Web Page http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/frus/index.htm • *Cisco uBR10012 Quick Start Guides Web Page* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/qsg/index.htm

Related Topic	Document Title
Cisco uBR10012 Software, Configuration and Features	• *Cisco uBR10012 Universal Broadband Router Release Notes* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10krns/index.htm • *Cisco uBR10012 Universal Broadband Router Software Configuration Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/scg/index.htm • *Cisco uBR10012 Router Software Features* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/ub10ksw/index.htm • *Cisco Cable Modem Termination System Feature Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/index.htm
Cisco IOS Command Reference	• *Cisco Broadband Cable Command Reference Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm • *Cisco CMTS Error Messages* http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/ubrerrs.htm • *Cisco IOS Release 12.2 Web Page* http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/index.htm
Additional Cable/Broadband Information Resources	• *Cisco Cable/Broadband Software Center Web page* http://www.cisco.com/public/sw-center/sw-cable.shtml • *Cisco Cable/Broadband Technical Support Web page* http://www.cisco.com/pcgi-bin/Support/browse/index.pl?i=Technologies&f=893 • *Cisco Multiservice Broadband Cable Guide* http://www.cisco.com/en/US/products/hw/cable/prod_category_positioning_paper0900aecd8006e98b.html

Standards

Standards[1]	Title
ITU X.509 V3	*International Telecommunications Union (ITU) X.509 Version 3.0* standard
PKT-EM-I03-011221	*PacketCable™ Event Message Specification*
PKT-SP-DQOS-I03-020116	*PacketCable™ Dynamic Quality-of-Service Specification*
PKT-SP-EC-MGCP-I04-011221	*PacketCable™ Network-Based Call Signaling Protocol Specification*
PKT-SP-ESP-I01-991229	*PacketCable™ Electronic Surveillance Specification*
PKT-SP-ISTP-I02-011221	*PacketCable™ Internet Signaling Transport Protocol (ISTP) Specification*
PKT-SP-PROV-I03-011221	*PacketCable™ MTA Device Provisioning Specification*
PKT-SP-SEC-I05-020116	*PacketCable™ Security Specification*
PKT-TR-ARCH-V01-991201	*PacketCable™ 1.0 Architecture Framework Technical Report*
Note The PacketCable 1.0 specifications are available on the Packetcable website at http://packetcable.com/specifications.html.	
SP-BPI+-I08-020301	*Baseline Privacy Interface Plus Specification*
SP-RFIv1.1-I09-020830	*Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification*, version 1.1

[1] Not all supported standards are listed.

MIBs

The Cisco uBR10012 router supports the following categories of Management Information Bases (MIBs):

- **Cable-specific MIBs**—Provide information about the cable interfaces and related information on the Cisco uBR10012 router. They include both Data-over-Cable Service Interface Specifications (DOCSIS)-specific MIBs and enterprise MIBs specific to Cisco. If your network management applications have not already been configured for the Cisco uBR10012 router, these MIBs must be loaded. The Cisco uBR10012 router and CMTS supports DOCSIS 1.1 MIBs.
- The Cisco uBR10012 router supports objects related to QoS support for scheduler of DOCSIS-compliant RF interfaces in the CMTS.
- **Cisco platform and network-layer enterprise MIBs**—Common across most Cisco router platforms. If your network management applications are already configured to support other Cisco routers, such as the Cisco 2600 series router, no further configuration is needed unless the version of Cisco IOS software being used has updated these MIBs.
- **Simple Network Management Protocol (SNMP) standard MIBs**—These MIBs are required by any agent supporting SNMPv1 or SNMPv2 network management. The SNMP MIBs improve object support for SNMP traps. This aids in network management. Traps are the mechanisms used to automatically send alarms for certain network events.
- **Deprecated MIBs**—Supported in earlier releases of Cisco IOS software but have been replaced by more standardized, scalable MIBs. Network Management applications and scripts should convert to the replacement MIBs as soon as possible.

MIBs	MIBs Link
• Cisco uBR10012 MIBs supporting specific releases	• Cisco uBR10012 Release Notes Web page http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10krns/index.htm
• Selected Platforms and Feature Sets	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

Obtaining Documentation

The following sections explain how to obtain documentation from Cisco Systems.

World Wide Web

You can access the most current Cisco documentation on the World Wide Web at the following URL:

http://www.cisco.com

Translated documentation is available at the following URL:

http://www.cisco.com/public/countries_languages.shtml

Documentation CD-ROM

Cisco documentation and additional literature are available in a Cisco Documentation CD-ROM package, which is shipped with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or through an annual subscription.

Ordering Documentation

Cisco documentation is available in the following ways:

- Registered Cisco.com users (Cisco direct customers) can order Cisco product documentation from the Networking Products MarketPlace:

  http://www.cisco.com/cgi-bin/order/order_root.pl

- Registered Cisco.com users can order the Documentation CD-ROM through the online Subscription Store:

  http://www.cisco.com/go/subscription

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco corporate headquarters (California, USA) at 408 526-7208 or, elsewhere in North America, by calling 800 553-NETS (6387).

Documentation Feedback

If you are reading Cisco product documentation on Cisco.com, you can submit technical comments electronically. Click the **Fax** or **Email** option under the "Leave Feedback" at the bottom of the Cisco Documentation home page.

You can e-mail your comments to bug-doc@cisco.com.

To submit your comments by mail, use the response card behind the front cover of your document, or write to the following address:

Cisco Systems
Attn: Document Resource Connection
170 West Tasman Drive
San Jose, CA 95134-9883

We appreciate your comments.

Obtaining Technical Assistance

Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools by using the Cisco Technical Assistance Center (TAC) Web site. Cisco.com registered users have complete access to the technical support resources on the Cisco TAC Web site.

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Cisco.com is the foundation of a suite of interactive, networked services that provides immediate, open access to Cisco information, networking solutions, services, programs, and resources at any time, from anywhere in the world.

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- Download and test software packages

- Order Cisco learning materials and merchandise
- Register for online skill assessment, training, and certification programs

You can self-register on Cisco.com to obtain customized information and service. To access Cisco.com, go to the following URL:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC is available to all customers who need technical assistance with a Cisco product, technology, or solution. Two types of support are available through the Cisco TAC:

- the Cisco TAC Web site

Note In addition, be sure to familiarize yourself with TAC's *Cisco uBR10012 Product Support Page* at http://www.cisco.com/pcgi-bin/Support/PSP/psp_view.pl?p=Hardware:ubr10012.

- the Cisco TAC Escalation Center

Inquiries to Cisco TAC are categorized according to the urgency of the issue:

- Priority level 4 (P4)—You need information or assistance concerning Cisco product capabilities, product installation, or basic product configuration.
- Priority level 3 (P3)—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- Priority level 2 (P2)—Your production network is severely degraded, affecting significant aspects of business operations. No workaround is available.
- Priority level 1 (P1)—Your production network is down, and a critical impact to business operations will occur if service is not restored quickly. No workaround is available.

Which Cisco TAC resource you choose is based on the priority of the problem and the conditions of service contracts, when applicable.

Cisco TAC Web Site

The Cisco TAC Web site allows you to resolve P3 and P4 issues yourself, saving both cost and time. The site provides around-the-clock access to online tools, knowledge bases, and software. To access the Cisco TAC Web site, go to the following URL:

http://www.cisco.com/tac

All customers, partners, and resellers who have a valid Cisco services contract have complete access to the technical support resources on the Cisco TAC Web site. The Cisco TAC Web site requires a Cisco.com login ID and password. If you have a valid service contract but do not have a login ID or password, go to the following URL to register:

http://www.cisco.com/register/

If you cannot resolve your technical issues by using the Cisco TAC Web site, and you are a Cisco.com registered user, you can open a case online by using the TAC Case Open tool at the following URL:

http://www.cisco.com/tac/caseopen

If you have Internet access, it is recommended that you open P3 and P4 cases through the Cisco TAC Web site.

Cisco TAC Escalation Center

The Cisco TAC Escalation Center addresses issues that are classified as priority level 1 or priority level 2; these classifications are assigned when severe network degradation significantly impacts business operations. When you contact the TAC Escalation Center with a P1 or P2 problem, a Cisco TAC engineer will automatically open a case.

To obtain a directory of toll-free Cisco TAC telephone numbers for your country, go to the following URL:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

Before calling, please check with your network operations center to determine the level of Cisco support services to which your company is entitled; for example, SMARTnet, SMARTnet Onsite, or Network Supported Accounts (NSA). In addition, please have available your service agreement number and your product serial number.

Overview of Cisco uBR10012 Universal Broadband Router Software

This chapter describes the Cisco uBR10012 Universal Broadband Router Cable Modem Termination System (CMTS), supported service offerings, software, and related hardware features. This chapter contains the following sections:

Section	Purpose
Cisco IOS Releases and Images for the Cisco uBR10012 Router, page 2	Describes the supported Cisco IOS release trains, associated features, and latest Cisco IOS images for each recently supported train. One early step in CMTS feature configuration is to verify your Cisco IOS release train, the associated image and feature set. This section guides you in determining such information.
Cisco uBR10012 Universal Broadband Router Chassis Overview, page 5	Describes the Cisco uBR10012 router, and supported hardware features and interoperability.
Supported Software Features for the Cisco uBR10012 Router, page 10	Describes the features and configuration utilities that are available on the Cisco uBR10012 router.

The remaining chapters in this guide provide basic software configuration and troubleshooting procedures.

Cisco IOS Releases and Images for the Cisco uBR10012 Router

The Cisco uBR10012 router supports the following Cisco IOS methods and release trains:

- Operational Overview
- Cisco IOS Software Location
- Determining Your Cisco IOS Software Release
- Upgrading to a New Software Release
- 12.3 BC Release Train and Images
- 12.2 BC Release Train and Images
- 12.2 CY Release Train and Images

Operational Overview

The Cisco uBR10012 router runs the IOS image that is located on the Type II Personal Computer Memory Card International Association (PCMCIA) Flash memory disks. These disks are located in the two PCMCIA slots in the primary Performance Routing Engine 1 (PRE1). A PCMCIA disk in either slot can store a Cisco IOS image or configuration file.

In addition to the Flash memory disks, each PRE1 module contains onboard Flash memory that is used to store a boot loader. The loader executes following a system reset to reload and execute the Cisco IOS software on the Flash memory disks.

The PRE1 module also stores the system configuration in the onboard Flash memory. The configuration information read from the Flash memory is buffered in operational memory following initialization, and is written to the Flash memory device when you save the configuration.

Each line card also contains onboard Flash memory that is used to store a boot loader, similar in function to that used on the PRE1 module. However, the line card loader executes following a system reset, line card reset, or line card insertion to reload and execute any code that must run on the line card for it to operate properly. Software images may also be stored on an external TFTP server. If the Cisco uBR10012 router is so configured, it then downloads the proper image from the TFTP server and executes it.

Cisco IOS Software Location

Cisco IOS software is stored on the PRE1 module, which includes two PCMCIA slots that are accessible from the front panel. Either slot can store an IOS image or configuration file.

The Flash memory on the PRE1 module is used to store a simple ROM monitor or boot loader. The loader executes following a system reset, line card reset, or line card insertion.

Line card images may also be stored in PRE1 module Flash memory or on an external TFTP server.

The PRE1 module stores the system configuration in a 512 KB NVRAM device. Configuration information read from NVRAM is buffered in RAM following initialization and is written to the device when you save the configuration.

Determining Your Cisco IOS Software Release

To determine the version of Cisco IOS software running on the Cisco uBR10012 router, log in to the router and enter the **show version** command in privileged EXEC mode. For example:

```
Router> show version
Cisco Internetwork Operating System Software
IOS (tm) 12.2 XF Software (ubr10k-k8p6-mz), Version 12.2 XF, RELEASE SOFTWARE
```

Upgrading to a New Software Release

An upgrade is an order placed for a Cisco IOS® feature set that contains more functionality than the one that you are replacing. And upgrade is not an update. An update consists of installing a more recent version of the SAME feature set. Exception— If a feature set has been made obsolete, the next, closest feature set, on a more recent release, will be considered an update.

For general information about upgrading to a new software release, refer to the *Cisco IOS Upgrade Ordering Instructions* on Cisco.com.

12.3 BC Release Train and Images

The 12.3 Release Train is the first Cisco IOS Release to support the Performance Routing Engine 2 (PRE2) modules on the Cisco uBR10012 universal broadband router. This release adds a substantial number of additional features while continuing to support earlier supported features from the 12.2 Release Train. These features are introduced in the "Supported Software Features for the Cisco uBR10012 Router" section on page 10, with additional links for configuration documentation.

Table 1 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR10012 universal broadband router for Cisco IOS Release 12.3(9a)BC.

Table 1 Memory Recommendations for the Cisco uBR10012 Routers, Cisco IOS Release 12.3(9a)BC Feature Sets

Feature Set	Cisco uBR10012 Route Processor	Software Image	Recommended Flash Memory	Recommended DRAM Memory[1]	Runs From
DOCSIS BPI IP Plus	PRE1	ubr10k-k8p6-mz	48MB	512 MB	RAM
	PRE2	ubr10k2-k8p6-mz	48MB	1.0 GB	RAM
DOCSIS Base 3 DES	PRE1	ubr10k-k9p6-mz	48MB	512 MB	RAM
	PRE2	ubr10k2-k9p6-mz	48MB	1.0 GB	RAM

[1] DRAM memory is not configurable on the Cisco uBR10012 router.

12.2 BC Release Train and Images

The 12.2 BC train is an interim release train that provides DOCSIS 1.1 two-way support, along with support for selected new features.

Cisco IOS Release 12.2(4)BC1b, provides a migration path from the earlier 12.2 XF releases. Cisco IOS Release 12.2(4)BC1b supports the Cisco uBR10012 universal broadband router, which provides a high-capacity, high-throughput cable modem termination system (CMTS), optimized for aggregating traffic at the edge of the cable network. Designed for cable operators and service providers, the platform connects residential subscribers via cable modems, digital set-top boxes, or IP telephony cable modems for high-speed data, broadband entertainment, and IP telephony solutions.

Note Cisco IOS Release 12.2(4)BC1b does not include support for telco-return images.

Table 2 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR10012 universal broadband router for Cisco IOS Release 12.2(4)BC1b. Cisco uBR10012 universal broadband routers are available with a 48-MB or 120-MB Type II PCMCIA Flash memory card.

Table 2 Memory Recommendations for the Cisco uBR10012 Routers, Cisco Release 12.2 BC Feature Sets

Feature Set	Software Image	Recommended Flash Memory	Recommended DRAM Memory	Runs From
DOCSIS BPI IP Plus	ubr10k-k8p6-mz[1]	40 MB Flash	128 MB DRAM	RAM

[1] The Cisco IOS 12.2(11)BC3 image cannot be loaded from a 128 MB Flask Disk. This image is not available in the Cisco IOS 12.2(11)BC2a rebuild release.

Note In Cisco IOS Release 12.2(11)BC3 only, the ubr10k-k8p6-mz software image could not be loaded from a 128 MB Flash Disk card. See caveat CSCea65301 in Bug Toolkit for more information. This caveat was fixed, and this limitation removed, in Cisco ISO 12.2(11)BC3a and later Release 12.2 BC releases.

12.2 CY Release Train and Images

The Cisco IOS 12.2 CY release train is based on Cisco IOS Release 12.2(11)BC1b, which in turn is based on Cisco IOS Release 12.2(11)T. The Cisco IOS Release 12.2(11)BC1b train is an interim release train that provides DOCSIS 1.1 two-way support, along with support for selected new features. Cisco IOS Release 12.2(11)BC1b provides a migration path from the earlier 12.2 XF releases.

The Cisco IOS 12.2 CY release train provides the following additional software features:

- PBR support for Cisco uBR10012
- VLAN support for Cisco uBR10012

Note Cisco IOS Release 12.2(11)CY does not include support for telco-return images.

Table 2 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR10012 universal broadband router for Cisco IOS Release 12.2(11)CY. Cisco uBR10012 universal broadband routers are available with a 48-MB or 120-MB Type II PCMCIA Flash memory card.

Table 3 Memory Recommendations for the Cisco uBR10012 Routers, Cisco Release 12.2 CY Feature Sets

Feature Set	Software Image	Recommended Flash Memory	Recommended DRAM Memory	Runs From
DOCSIS IP Plus	ubr10k-p6-mz	40 MB Flash	128 MB DRAM	RAM
DOCSIS BPI IP Plus	ubr10k-k8p6-mz	40 MB Flash	128 MB DRAM	RAM

Cisco uBR10012 Universal Broadband Router Chassis Overview

The Cisco uBR10012 router provides a cost-effective, scalable, and industry-proven CMTS, optimized for aggregating traffic at the edge of the cable network. It has eight broadband aggregation slots and four WAN backhaul slots. The broadband slots can support Cisco uBR7200 series broadband cards through an adapter card (line card processor).

Designed for cable operators and service providers, the Cisco uBR10012 router CMTS platform connects residential subscribers via CMs, digital set-top boxes, or IP telephony CMs for high-speed data, broadband entertainment, and IP telephony solutions.

Note This guide focuses on Cisco uBR10012 router software and related hardware. For detailed descriptions of the Cisco uBR10012 router chassis and components, refer to these resources:

- *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide*
- *Cisco uBR10012 Field Replaceable Units (FRUs)* web page on Cisco.com

The Cisco uBR10012 router chassis is designed for front and rear access. The front of the chassis provides access to these components, shown in Figure 1:

- Two Performance Routing Engine 1 (PRE1) or PRE2 processor modules
- LCD Display
- Two DC Power Entry Modules (DC PEMs)
- Fan Assembly Module

The rear of the chassis provides access to these components, shown in Figure 2:

- Eight Cable Interface Line Cards (single-slot)
- Four High-Speed, High-Performance Network Uplink Interface Line Cards
- Two Timing, Communication, and Control Plus (TCC+) Cards

The Cisco uBR10012 router uses redundant PEMs using –48–60 VDC input power. An optional AC-input power shelf can be used to provide the DC-output power for the Cisco uBR10012 router.

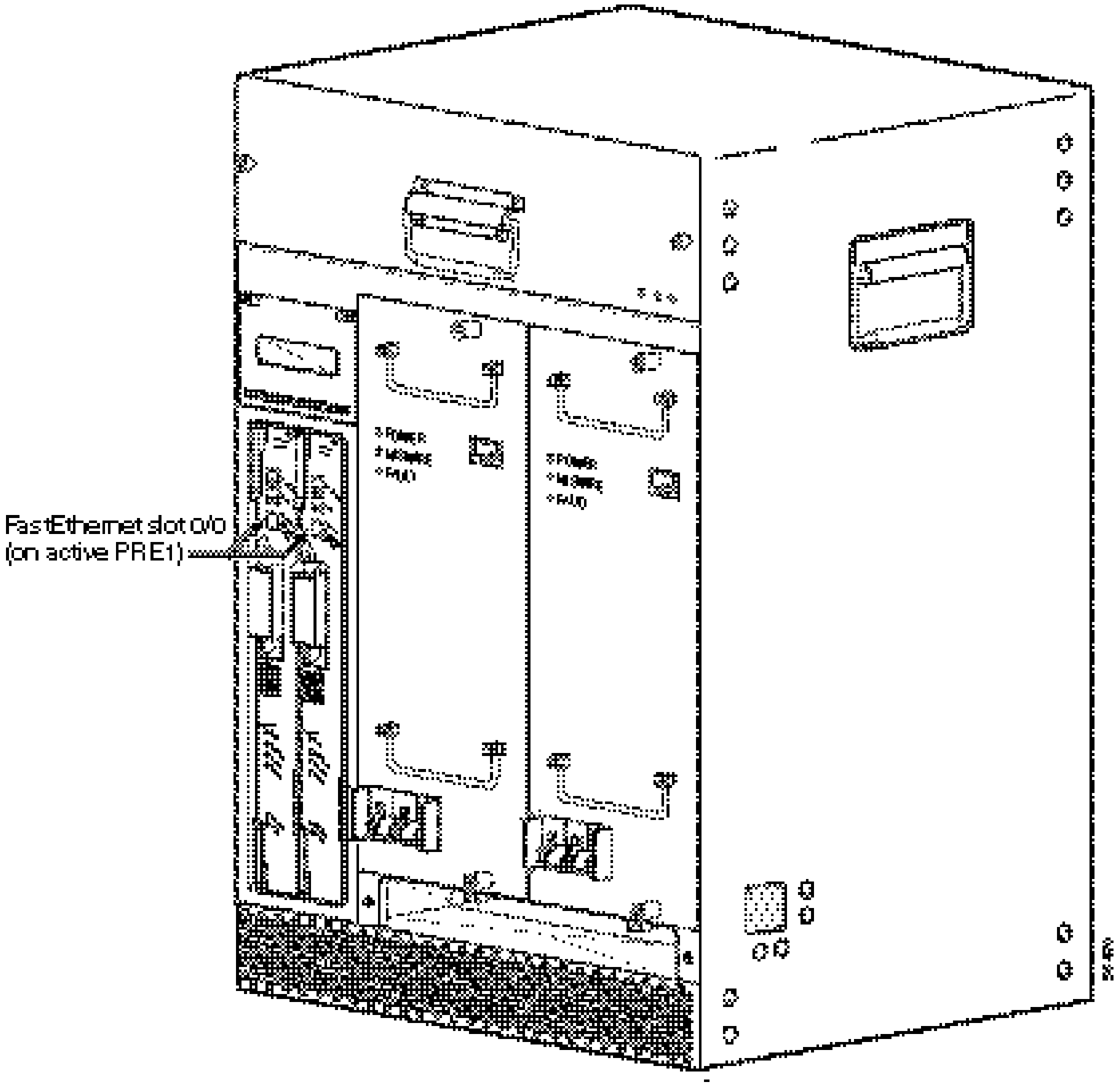
Cisco uBR10012 Router Slot Numbering

The Cisco uBR10012 router contains 16 card slots total for the following cards:

- Front Access (refer to Figure 1):
  - One or two PRE1 or PRE2 modules (two modules for redundant configuration)
- Rear Access (refer to Figure 2):
  - Eight cable interface line cards
  - Four network uplink line cards (either OC-12 POS or GigE)
  - One or two TCC+ cards (two TCC+ cards for redundant configuration)—each TCC+ card also provides a connector for an external clock reference source, with a second connector for a backup clock source

Figure 1 shows the slot numbering for the front view components of a fully loaded Cisco uBR10012 router with the corresponding slot numbering (without bezel).

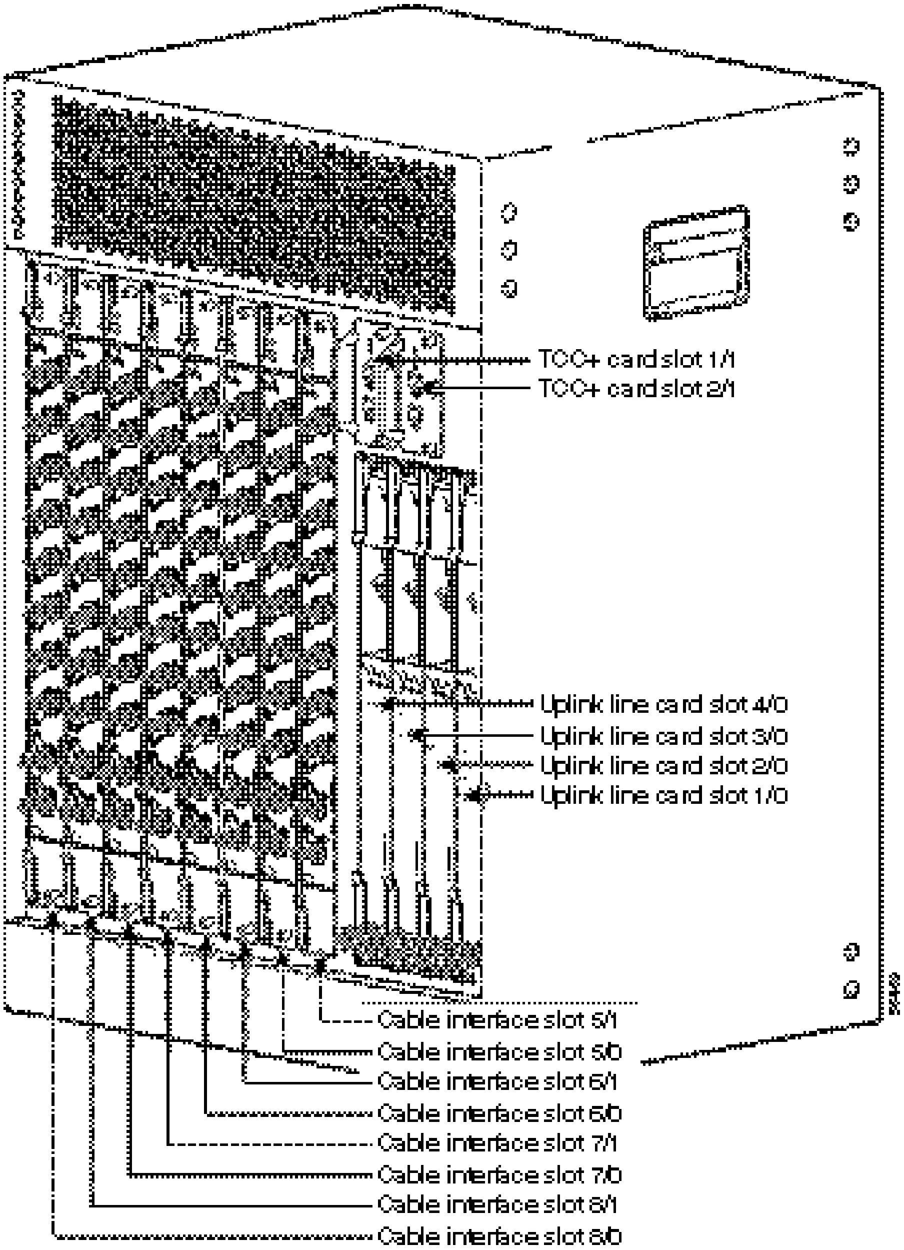
Figure 1 Cisco uBR10012 Router Slot Numbering—Front View (without bezel)



Tip The Fast Ethernet interface on the backup PRE module is not used unless the primary PRE module fails and the backup PRE module is activated. When the backup PRE module becomes the active PRE module, its FastEthernet interface automatically becomes the active FastEthernet interface at slot 0/0.

Figure 2 shows the rear view components of a fully loaded Cisco uBR10012 router with the corresponding slot numbering.

Figure 2 Cisco uBR10012 Router Slot Numbering—Rear View



Hardware Supported on the Cisco uBR10012 Router

Cisco IOS Release 12.3(9a)BC supports the following hardware on the Cisco uBR10012 router. This and earlier descriptions of supported hardware are available in the release notes for your respective Cisco IOS release.

Table 4 Cisco uBR10012 Universal Broadband Router Supported Hardware

Cable Interface Line cards	Up to eight of the following broadband processing engines and cable interface line cards can be housed in a chassis in any combination: • Cisco uBR10-MC5X20S/U broadband processing engines • Cisco uBR10-LCP2-MC16C/MC16E/MC16S cable interface line cards • Cisco uBR10-LCP2-MC28C cable interface line cards Note The Cisco uBR7200 Series MC28U BPE does not support the Cisco uBR10012 router, though the Cisco MC28U BPE physically fits into the Cisco uBR10012 router chassis.
Network Uplink Line Cards	Up to four line cards with any combination of the following WAN choices: • Cisco uBR10-SRP-OC12SML DPT WAN Line Card for the Cisco uBR10012 Router • Cisco uBR10012 OC-48 DPT/POS interface module • Cisco uBR10-1GE Gigabit Ethernet (GigE) uplink line card • Cisco uBR10-1OC12/P-SMI OC-12 POS uplink line card • Cisco uBR10-SRP-OC12SML Dynamic Packet Transport (DPT) WAN card
Timing, Communication and Control Plus (TCC+) card	The TCC+ card can connect to an external reference Stratum 3 clock source that is traceable to a Stratum 1 source. Two such sources can be connected for redundancy. The TCC+ card also monitors the cable line cards and power supply use, as well as control the LCD display screen on the chassis. Two cards can be installed for redundancy.
Performance Routing Engine 2 (PRE2)	The new Cisco uBR10012 Series PRE2 effectively doubles the bandwidth available to each slot on the router as supported by cable interface line cards or Cisco Broadband Processing Engines. The PRE2 module introduces support for full-duplex Gigabit Ethernet ports, and increases the supported connections to 1.6 Gbps in full duplex (each direction per half-slot). Full-slot modules can now have up to 3.2 Gbps to and from the PRE2 module. This is twice the connection rate of the Cisco uBR10012 PRE1 route processor module.

Table 4 Cisco uBR10012 Universal Broadband Router Supported Hardware

Performance Routing Engine (PRE1 or PRE2)	One PRE1 or PRE2 module performs layer 2 and layer 3 packet processing, as well as routing and system management functions. Two PRE modules can be installed for redundancy. Note The PRE1 module is functionally identical to the PRE module except that it adds support for the Error Checking and Correction (ECC) feature, which can automatically correct single-bit memory errors. Note The Cisco uBR10012 PRE1 module supports an Ethernet port to a LAN for a 10BASE-T or 100BASE-T connection for network management. The PRE1 module supports connections of 800 Mbps in full duplex (each direction) per half-slot.
AC-input Power Entry Module (PEM)	The Cisco uBR10012 router ships with two AC power entry modules (AC PEMs) that provide a redundant power supply to the system. One AC PEM can provide sufficient power for a fully configured chassis, so that if one AC PEM fails, the other automatically begins providing power for the entire router, without impacting system operations. The AC PEMs use standard 200–240 VAC (50/60 Hz) input power obtained through power receptacles on the front panel of each PEM. The two AC PEMs convert the AC power to provide filtered, redundant, and load shared DC power to the Cisco uBR10012 chassis. ⚠ Caution The Cisco uBR10012 router does not support mixing AC and DC PEMs. Both PEMs must be either AC PEMs or DC PEMs.
DC-input Power Entry Module (PEM)	The Cisco uBR10012 router may ship with two DC PEMs to provide power to the chassis. The use of two PEMs provide power balancing and redundancy, as well as the ability to hot-swap a single power supply when needed. ⚠ Caution The Cisco uBR10012 router does not support mixing AC and DC PEMs. Both PEMs must be either AC PEMs or DC PEMs.
Fan assembly module	The fan assembly module contains four fans that are capable of cooling the chassis even with the failure of a single fan. The fan assembly is dual-speed, providing additional cooling when the chassis temperature exceeds the nominal operating range.

Supported Software Features for the Cisco uBR10012 Router

This section summarizes Cisco uBR10012 router software features for all supported Cisco IOS Release trains, and directs you to additional configuration information for each feature.

Cisco uBR10012 Router Features and Cisco IOS Releases

Table 5 summarizes the software-related features and related Cisco IOS releases that support the Cisco uBR10012 router. Cisco IOS features indicate the first release in which the feature was introduced. Unless otherwise noted, feature support continues in later releases of the same or related Cisco IOS release train.

Table 5 Cisco uBR10012 Router Features by Cisco IOS Release

Feature	Supporting Cisco IOS Releases
Cisco uBR10012 Router Configuration Tools	
AutoInstall	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Cable Interface Setup Facility	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Cisco Network Registrar	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Configuration Mode (Command Line Interface Configuration)	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Extended Setup Facility	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Cisco IOS Release 12.3 BC Command-line Enhancements	
Cisco IOS Release 12.3(9a)BC Command-Line Interface (CLI) Enhancements	12.3(9a)BC and later 12.3 BC releases
DHCP Servers and Feature Support	
DHCP MAC Address Exclusion List for cable-source verify dhcp Command	Cisco IOS Release 12.3(13a)BC and later 12.3 BC releases.
Integrated DHCP Server	Multiple Cisco IOS releases and trains.
DOCSIS 1.0 Feature Support	
DOCSIS 1.0 Baseline Privacy Interface	DOCSIS 1.0 BPI encryption and authentication supported in Cisco IOS 12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 Concatenation Override	12.3(13a)BC and later 12.3 BC releases
DOCSIS 1.0 Configuration File Settings	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 Constant Bit Rate Extension	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 MAC Driver	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 Quality of Service Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 Payload Header Suppression	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 per SID Bandwidth Request and Grant Counters	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.0 ToS Overwrite	12.3(17a)BC2 and later 12.3 BC releases.
Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems	12.3(13a)BC and later 12.3 BC releases
DOCSIS 1.0+ Feature Support	

Table 5 Cisco uBR10012 Router Features by Cisco IOS Release (continued)

Feature	Supporting Cisco IOS Releases
DOCSIS 1.1 CM Compatibility	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Feature Support	
DOCSIS 1.1 Baseline Privacy Interface Plus Features	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS BPI+ Multiple Root Certificate Support	12.3(13a)BC and later 12.3 BC releases
DOCSIS 1.1 CM Compatibility	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 CM Database Manager	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Concatenation Support See also DOCSIS 1.0 Concatenation Override	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Customer Premises Equipment Configurator	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Downstream Packet Classifier	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Downstream Packet Scheduler	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Dynamic MAC Messages	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Enhanced Registration	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Fragmentation and Reassembly	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Layer 2 Fragmentation	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 MAC Scheduler	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Payload Header Suppression and Restoration	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Quality of Service Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Rate Limiting and Traffic Shaping	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Service Flow Manager	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Service Template and Class Manager	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Software Infrastructure	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Subscriber Management	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Time Slot Scheduling	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 TLV Parser and Encoder	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Token-Bucket Rate Shaping	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 1.1 Two-Way Interoperability	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Optional Upstream Scheduler Modes	12.3(13a)BC and later 12.3 BC releases
High Availability Features	
Automatic Revert Feature for HCCP N+1 Redundancy Switchover Events	12.3(13a)BC and later 12.3 BC releases
Backup Path Testing for the Cisco RF Switch	12.3(13a)BC and later 12.3 BC releases
DSX Messages and Synchronized PHS Information	12.3(17a)BC and later 12.3 BC releases
Factory-Configured HCCP N+1 Redundancy	12.3(13a)BC and later 12.3 BC releases
Globally Configured HCCP 4+1 and 7+1 Redundancy on the Cisco uBR10012 Router	12.3(17a)BC and later 12.3 BC releases

Table 5 Cisco uBR10012 Router Features by Cisco IOS Release (continued)

Feature	Supporting Cisco IOS Releases
HCCP N+1 Redundancy Supporting DOCSIS 1.1 for the Cisco CMTS	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
HCCP Timing and Error Enhancements in HCCP Redundancy Show Commands	12.3(13a)BC and later 12.3 BC releases
High Availability Support for Encrypted IP Multicast	12.3(17a)BC and later 12.3 BC releases
Shutdown and No Shutdown Enhancement for Cable Interfaces	12.3(13a)BC and later 12.3 BC releases
Intercept Features	
Access Control List Support for COPS Intercept	12.3(13a)BC and later 12.3 BC releases
Basic Wiretap Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Cable Monitor Enhancements	12.3(17a)BC and later 12.3 BC releases
Cable Monitor Support for Cisco MC5x20U-D and Cisco MC28U Broadband Processing Engines	12.3(13a)BC and later 12.3 BC releases
cable monitor Command	12.2(4)XF and later 12.2 XF, 12.2 BC and 12.3 BC releases
COPS TCP Support for the Cisco Cable Modem Termination System	12.3(13a)BC and later 12.3 BC releases
Packet Intercept	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
PXF ARP Filter	12.3(17a)BC and later 12.3 BC releases
PXF Divert Rate Limiting	12.3(17a)BC and later 12.3 BC releases
Service Independent Intercept (SII) Support	12.3(13a)BC and later 12.3 BC releases
IP Broadcast and Multicast Features	
IP Broadcast Echo	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
IP Multicast Echo	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Multicast QoS Support on the Cisco uBR10012 CMTS	12.3(13a)BC and later 12.3 BC releases
SSM Mapping	12.3(17a)BC and later 12.3 BC releases
IP Routing Features	
Cable ARP Filter Enhancement	12.3(9a)BC and later 12.3BC releases
Configurable Registration Timeout	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DHCP MAC Address Exclusion List for cable-source verify dhcp Command	12.3(13a)BC and later 12.3 BC releases
Host-to-Host Communication (Proxy Address Resolution Protocol)	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Integrated DHCP Server	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Integrated Time-of-Day Server	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
PBR support for the Cisco uBR10012	12.2(11) CY and later CY releases
Supported Protocols	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Management Features	
Admission Control for the Cisco CMTS	12.3(13a)BC and later 12.3 BC releases

Table 5 Cisco uBR10012 Router Features by Cisco IOS Release (continued)

Feature	Supporting Cisco IOS Releases
Broadband Internet Access	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Cable Interface Bundling	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
CNEM Compliance	12.3(17a)BC and later 12.3 BC releases
Customer Premises Equipment Limitation and Override	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
DOCSIS 2.0 SAMIS ECR Data Set	12.3(17a)BC and later 12.3 BC releases
DOCSIS Set-Top Gateway Issue 1.0 Advanced-mode DOCSIS Set-Top Gateway Issue 1.1 Advanced-mode DOCSIS Set-Top Gateway Issue 1.2	12.3(9a)BC and later 12.3 BC releases 12.3(13a)BC and later 12.3 BC releases 12.3(17a)BC2 and later 12.3 BC releases
Downstream Channel ID Configuration	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Downstream Frequency Override	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Downstream Load Balancing Distribution with Upstream Load Balancing	12.3(17b)BC and later 12.3 BC releases
Dynamic Channel Change (DCC) for Loadbalancing	12.3(17a)BC and later 12.3 BC releases
Dynamic Modulation Profiles	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Dynamic Upstream Modulation	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
EtherChannel Support on the Cisco uBR10012 Universal Broadband Router	12.3(9a)BC and later 12.3 BC releases
Management Information Base (MIB) Changes and Enhancements	12.3(17a)BC and later 12.3 BC releases
MIBs Changes and Updates in Cisco IOS Release 12.3(9a)BC	12.3(9a)BC and later 12.3 BC releases
Pre-equalization Control for Cable Modems	12.3(17a)BC and later 12.3 BC releases
Route Processor Redundancy Support	12.2(4)XF 12.2 XF , 12.2 BC and 12.3 BC releases
Secure Socket Layer Server for Usage-Based Billing	12.3(17a)BC and later 12.3 BC releases
SFID Support for Multicast and Cable Interface Bundling	12.3(9a)BC and later 12.3 BC releases
Simple Network Management Protocol Cable Modem Remote Query	12.2(4)BC1b and later 12.2 BC and 12.3 BC releases
Simple Network Management Protocol v3	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Spectrum Management Advanced Spectrum Management Support on the Cisco uBR10012 CMTS	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases 12.3(13a)BC and later 12.3 BC releases
Static CPE Override (cable submgmt default Command)	12.3(9a)BC and later 12.3 BC releases
Statistical Counters	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Subscriber Traffic Management (STM) Version 1.1	12.3(9a)BC and later 12.3 BC releases
Usage Based Billing (SAMIS)	12.3(9a)BC and later 12.3 BC releases
PacketCable and Voice Support Features	
PacketCable 1.0 With CALEA	12.3(9a)BC and later 12.3 BC releases

Table 5 Cisco uBR10012 Router Features by Cisco IOS Release (continued)

Feature	Supporting Cisco IOS Releases
PacketCable Emergency 911 Cable Interface Line Card Prioritization	12.3(13a)BC and later 12.3 BC releases
PacketCable Emergency 911 Services Listing and History	12.3(13a)BC and later 12.3 BC releases
Packetcable Multimedia for the Cisco CMTS	12.3(13a)BC and later 12.3 BC releases
Security Features	
Address Verification	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
CM Transmission Burst Size	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Dynamic or Mobile Host Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Dynamic Shared Secret (DMIC) with OUI Exclusion	12.3(9a)BC and later 12.3 BC releases
Testing, Troubleshooting and Diagnostic Features	
Cisco Broadband Troubleshooter 3.2	12.3(9a)BC and later 12.3 BC releases
CBT 3.2 Spectrum Management Support with the Cisco uBR10-MC5X20S/U BPE	12.3(9a)BC and later 12.3 BC releases
Dynamic Ranging	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Flap List Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
Online Offline Diagnostics (OOD) Support for the Cisco uBR10012 Universal Broadband Router	12.3(13a)BC and later 12.3 BC releases
Virtual Interfaces	
Virtual Interface and Frequency Stacking Support on the Cisco uBR10-MC5X20S/U BPE	12.3(9a)BC and later 12.3 BC releases
Virtual Interface Support for HCCP N+1 Redundancy	12.3(9a)BC and later 12.3 BC releases
Virtual Interface Bundling on the Cisco uBR10-MC5X20S/U BPE	12.3(13a)BC and later 12.3 BC releases
VLAN Features	12.2(11)CY and later 12.2 CY releases
VPN and Layer 2 Tunneling Features	
Dynamic SID/VRF Mapping Support	12.3(13a)BC and later 12.3 BC releases
Generic Routing Encapsulation (GRE) Tunneling on the Cisco uBR10012	12.3(17a)BC and later 12.3 BC releases
IPv6 over L2VPN	12.3(17a)BC and later 12.3 BC releases
MPLS-VPN Network Support	12.2(1)XF1 and later 12.2 XF, 12.2 BC and 12.3 BC releases
NetFlow Accounting Versions 5 and 8 Support	12.3(9a)BC and later 12.3 BC releases
Transparent LAN Service (TLS) on the Cisco uBR10012 Router with IEEE 802.1Q	12.3(9a)BC and later 12.3 BC releases
Transparent LAN Service and Layer 2 Virtual Private Networks	12.3(13a)BC and later 12.3 BC releases

Cisco uBR10012 Router Configuration Tools

The Cisco uBR10012 Universal Broadband Router provides you with the following configuration tools, allowing you flexibility in choosing your configuration method:

- AutoInstall
- Cable Interface Setup Facility
- Cisco Network Registrar
- Configuration Mode (Command Line Interface Configuration)
- Extended Setup Facility

AutoInstall

The AutoInstall process configures the Cisco uBR10012 router automatically ***after*** connection to your WAN. For additional information, refer to the "Configuring the Cisco uBR10012 Router Using AutoInstall" section on page 7.

Cable Interface Setup Facility

The Cisco uBR10012 router Setup facility (also called the System Configuration dialog) is a useful and efficient tool for configuring your CMTS. The Setup facility supports the a number of functions so that cable interfaces and cable interface line cards are fully operational (after initial setup). Refer to the "Configuring the Cisco uBR10012 Router Using the Setup Facility" section on page 8.

Configuration Mode (Command Line Interface Configuration)

The Configuration mode allows you to configure the Cisco uBR10012 router manually if you prefer not to use Autoinstall or the Cable Interface Setup facility. For additional information, refer to the "Configuring the Cisco uBR10012 Router Manually Using Configuration Mode" section on page 13.

Cisco Network Registrar

Cisco provides the Cisco Network Registrar with each Cisco uBR10012 router.
Cisco Network Registrar dramatically improves the reliability of naming and addressing services for enterprise and service provider networks. Cisco Network Registrar provides scalable Domain Name System (DNS) and Dynamic Host Configuration Protocol (DHCP) services and forms the basis of a DOCSIS CM provisioning system.

Cisco Network Registrar is a configuration tool that automates dynamic IP address allocation to cable interfaces, PCs, and other devices on the broadband network. Cisco Network Registrar allows you to track serial numbers and MAC addresses for each cable interface on your network, and reduces customer service involvement when tracking subscriber CPE equipment.

For additional information about configuring or using Cisco Network Registrar, refer to the latest Cisco Network Registrar documentation at the Cisco Web site (http://www.cisco.com). One such document is *Installing the Cisco Network Registrar* for the Cisco uBR7200 series routers, and the *Cisco Subscriber Registration Center Device Provisioning Registrar 2.0*, both located on Cisco.com.

Extended Setup Facility

The Cable Interface Setup facility (described previously in this section) creates an initial CMTS configuration. The Extended Setup facility prompts you to configure each interface on the system as you progress through the CMTS configuration. For additional information, refer to the "Configuring the Cable Interface with the Extended Setup Facility" section on page 14.

Cisco IOS Release 12.3 BC Command-line Enhancements

This section describes general Cisco IOS commands introduced or enhanced in Cisco IOS Release 12.3(9a)BC and later releases in the 12.3 BC release train. Also refer to additional feature descriptions for new or enhanced commands that support specific new features.

- Cisco IOS Release 12.3(13a)BC Command-Line Interface (CLI) Enhancements
- Cisco IOS Release 12.3(9a)BC Command-Line Interface (CLI) Enhancements

Cisco IOS Release 12.3(13a)BC Command-Line Interface (CLI) Enhancements

Cisco IOS release 12.3(13a)BC introduces several new or enhanced commands. For this release, these feature-specific commands or enhancements are described with the features they support. Refer to additional feature descriptions in this document for additional information.

Cisco IOS Release 12.3(9a)BC Command-Line Interface (CLI) Enhancements

Cisco IOS Release 12.3(9a)BC introduces or enhances the following CLI commands for the Cisco uBR10012 router:

- **cable arp filter** (See Cable ARP Filter Enhancement)
- **cable logging layer2events**
- **cable source-verify**
- **show cable tech-support**
- **show controllers cable**
- **show tech-support**

For additional information about these command changes, refer to these resources:

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm

DHCP Servers and Feature Support

Cisco IOS software supports multiple DHCP features and server functions on the network for the Cisco uBR10012 router:

- DHCP MAC Address Exclusion List for cable-source verify dhcp Command
- Integrated DHCP Server

DHCP MAC Address Exclusion List for cable-source verify dhcp Command

Cisco IOS Release 12.3(13a)BC introduces the ability to exclude trusted MAC addresses from standard DHCP source verification checks, as supported in previous Cisco IOS releases for the Cisco CMTS. This feature enables packets from trusted MAC addresses to pass when otherwise packets would be rejected with standard DHCP source verification. This feature overrides the **cable source-verify** command on the Cisco CMTS for the specified MAC address, yet maintains overall support for standard and enabled DHCP source verification processes. This feature is supported on Performance Routing Engine 1 (PRE1) and PRE2 modules on the Cisco uBR10012 router chassis.

To enable packets from trusted source MAC addresses in DHCP, use the **cable trust** command in global configuration mode. To remove a trusted MAC address from the MAC exclusion list, use the **no** form of this command. Removing a MAC address from the exclusion list subjects all packets from that source to standard DHCP source verification.

cable trust *mac-address*

no cable trust *mac-address*

Syntax Description

mac-address	The MAC address of a trusted DHCP source, and from which packets will not be subject to standard DHCP source verification.

Usage Guidelines

This command and capability are only supported in circumstances in which the Cable Source Verify feature is first enabled on the Cisco CMTS.

When this feature is enabled in addition to cable source verify, a packet's source must belong to the MAC Exclude list on the Cisco CMTS. If the packet succeeds this exclusionary check, then the source IP address is verified against Address Resolution Protocol (ARP) tables as per normal and previously supported source verification checks. The service ID (SID) and the source IP address of the packet must match those in the ARP host database on the Cisco CMTS. If the packet check succeeds, the packet is allowed to pass. Rejected packets are discarded in either of these two checks.

Any trusted source MAC address in the optional exclusion list may be removed at any time. Removal of a MAC address returns previously trusted packets to non-trusted status, and subjects all packets to standard source verification checks on the Cisco CMTS.

For additional information about the enhanced Cable Source Verify DHCP feature, and general guidelines for its use, refer to the following documents on Cisco.com:

- *IP Address Verification for the Cisco uBR7200 Series Cable Router*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1830/products_feature_guide09186a0080087b55.html
- *Filtering Cable DHCP Lease Queries*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a008021b8fb.html
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html
- CABLE SECURITY, *Cable Source-Verify and IP Address Security*, White Paper

  http://www.cisco.com/en/US/tech/tk86/tk803/technologies_tech_note09186a00800a7828.shtml

Integrated DHCP Server

This network management feature simplifies provisioning, offering an integrated Dynamic Host Configuration Protocol server. For information about configuring DHCP, ToD, or TFTP services, refer to the chapter titled "Configuring DHCP, ToD, and TFTP Services" in the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com.

DOCSIS 1.0 Feature Support

The Cisco uBR10012 router and associated Cisco IOS software support multiple DOCSIS 1.0 enhancements, extensions, and features.

- DOCSIS 1.0 Baseline Privacy Interface
- DOCSIS 1.0 Concatenation Override
- DOCSIS 1.0 Configuration File Settings
- DOCSIS 1.0 Constant Bit Rate Extension
- DOCSIS 1.0 MAC Driver
- DOCSIS 1.0 Quality of Service Support
- DOCSIS 1.0 Payload Header Suppression
- DOCSIS 1.0 per SID Bandwidth Request and Grant Counters
- Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems

For additional information about configuring DOCSIS QoS and other DOCSIS features, refer to the *DOCSIS 1.1 Feature Module for the Cisco uBR7200 Routers* on Cisco.com, and to other documents cited for DOCSIS 1.0 features below.

Caution All DOCSIS 1.0 extensions are activated only when a CM or equivalent device that supports these extensions solicits services using dynamic MAC messages. If the CMs in your network are all DOCSIS 1.0-based, they receive regular DOCSIS 1.0 treatment from the CMTS.

DOCSIS 1.0 Baseline Privacy Interface

The Cisco uBR10012 router supports full DOCSIS 1.0 Baseline Privacy Interface (BPI) specifications. The BPI for DOCSIS 1.0 protects user data privacy across the shared-medium cable network and prevents unauthorized access to DOCSIS-based data transport services across the cable network. BPI encrypts traffic across the RF interface between the CM and CMTS, and includes authentication, authorization, and accounting (AAA) features.

The level of data privacy is roughly equivalent to that provided by dedicated line network access services such as analog modems or digital subscriber lines (DSL). BPI provides basic protection of service, ensuring that a CM, uniquely identified by its MAC address, can obtain keying material for services only when it is authorized to access them.

Note Encryption and decryption are subject to export licensing controls.

BPI supports access control lists (ACLs), tunnels, filtering, protection against spoofing, and commands to configure source IP filtering on RF subnets to prevent subscribers from using source IP addresses that are not valid.

Note

To conform with a recent change in the DOCSIS 1.0 Baseline Privacy Interface (BPI) Specification, Cisco IOS Release 12.2(8)BC1 and later releases require that the Baseline Privacy Configuration Settings Option (Type 17) must be included in the DOCSIS configuration file for all DOCSIS 1.0 cable modems attempting to register for BPI encryption. If the type 17 option is not included, an "Unauthorized SAID" warning will appear in the CMTS console, and the cable modem will not be allowed to come online.

Previous Cisco IOS releases allowed DOCSIS 1.0 cable modems to register for BPI encryption and to come online, even if the DOCSIS configuration file did not include the type 17 option. The change to the DOCSIS BPI specification, however, made the type 17 option mandatory for BPI operation.

For more information about this requirement, see the TAC technical note on Cisco.com at http://www.cisco.com/warp/public/109/bpi_changes_23895.html.

DOCSIS 1.0 Concatenation Override

Cisco IOS release 12.3(13a)BC introduces support for the DOCSIS 1.0 concatenation override feature on the Cisco uBR10012 router. This feature provides the ability to disable concatenation on DOCSIS 1.0 cable modems, even in circumstances where concatenation is otherwise supported for the upstream channel.

DOCSIS 1.0 concatenation allows the cable modem to make a single-time slice request for multiple packets, and to send all packets in a single large burst on the upstream. Concatenation was introduced in the upstream receive driver in the previous Cisco IOS releases that supported DOCSIS 1.0 +. Per-SID counters were later added in Cisco IOS release 12.1(4)CX for debugging concatenation activity.

In some circumstances, overriding concatenation on DOCSIS 1.0 cable modems may be preferable, and Cisco IOS release 12.3(13a)BC supports either option.

Note

Even when DOCSIS 1.0 concatenation is disabled with this feature, concatenation remains enabled for cable modems that are compliant with DOCSIS 1.1 or DOCSIS 2.0.

To enable DOCSIS 1.0 concatenation override with Cisco IOS release 12.3(13a)BC and later releases, use the new **docsis10** keyword with the previously supported **cable upstream** <*n*> **concatenation** command in privileged EXEC mode:

cable upstream <*n*> **concatenation docsis10**

Syntax Description

n	Specifies the upstream port number. Valid values start with 0 for the first upstream port on the cable interface line card.

Examples

The following example illustrates DOCSIS 1.0 concatenation override on the Cisco uBR10012 router:

```
Router# no cable upstream 0 concatenation docsis10
```

In this example, DOCSIS 1.0 cable modems are updated with REG-RSP so that they are not permitted to use concatenation.

For additional information about this command, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com:

http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

DOCSIS 1.0 Configuration File Settings

Refer to these sections for additional information about DOCSIS configuration files:

- "DOCSIS 1.0 Constant Bit Rate Extension" section on page 20
- "DOCSIS 1.0 Traffic Shaping and Rate Limiting Features" section on page 23
- "DOCSIS 1.1 Subscriber Management" section on page 37

For additional information about configuring DOCSIS QoS and other DOCSIS features, refer to the *DOCSIS 1.1 Feature Module for the Cisco uBR7200 Routers on Cisco.com* and to other documents cited below.

DOCSIS 1.0 Constant Bit Rate Extension

This DOCSIS 1.0 extension enables better processing of higher-priority traffic; fields in the DOCSIS configuration file can be used so that when a CM requests a voice SID, the MAC scheduler on the Cisco uBR10012 router schedules fixed periodic slots on the upstream for that traffic flow. The CM does not have to contend for these slots and, because the Cisco uBR10012 router controls the timing of slots, it has precise control over potential delay and jitter.

DOCSIS 1.0 MAC Driver

This DOCSIS 1.0 driver supports CableLabs specifications for the MAC sublayer and associated interfaces. Refer to the "DOCSIS 1.0 MAC Enhancements to Improve Upstream per CM Data Throughput" section on page 20.

DOCSIS 1.0 Quality of Service Support

Cisco uBR10012 router software offers DOCSIS 1.0 Quality of Service (QoS) support. This allows you to define service levels in order to map data packets efficiently into traffic classes. These traffic classes determine how network resources are allocated and controlled. QoS can be delivered through a combined use of IP precedence ToS bits and QoS capabilities of IP and ATM core networks.

Cisco uBR10012 router software supports varying QoS definitions for differentiated services:

- Guaranteed-rate service queue to store bandwidth requests from CMs subscribing to a class with minimum upstream rate on the upstream channel.
- Best-effort service queue to store bandwidth requests from CMs subscribing to a class with no minimum upstream rate on the upstream channel.
- Service priority of 7 to 0; a higher value indicates better service.
- Maximum allowed upstream rate in bps.
- Maximum upstream channel burst in minislots.
- Minimum reserved upstream rate in bps.
- Maximum allowed downstream rate in bps.

Additional information about the capabilities and configuration of DOCSIS QoS are described the following documents:

- *DOCSIS 1.1 Feature Module for the Cisco uBR7200 Routers*
- *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2

DOCSIS 1.0 MAC Enhancements to Improve Upstream per CM Data Throughput

DOCSIS 1.0 supports tiered best-effort and CIR-type service. The Cisco uBR10012 router and CMTS now support a mechanism to dynamically initiate and terminate MAC-level scheduling for high-priority traffic, and to specify exactly what QoS parameters to use.

In DOCSIS 1.0, the CM explicitly requests upstream bandwidth—either in contention or piggyback to grant minislots—for every single packet it wants to send upstream. This limits the maximum upstream data throughput that a CM can receive due to the inherent "request to grant" round-trip latency each packet incurs on the cable system. To support this per-cable-modem upstream throughput increase, the Cisco uBR10012 router software is enhanced. The CMTS can now receive a concatenated burst of multiple MAC frames from the same CM.

Note Both the CMTS and CM must support this capability.

DOCSIS 1.0 Downstream Rate Shaping with Type of Service (ToS)

This feature supports buffering downstream grants to rate-exceeding cable interfaces, without incurring TCP-related timeouts and retransmits. This feature uses the three precedence bits in the ToS field in the IP header to specify class of service assignment for each packet.

Those packets with the IP precedence bit set in the IP packet are given higher priority. This allows the CMTS administrator to calculate the data rate for a given flow, in addition to the data rate configured on a per CM basis.

IP Precedence-Based Downstream Rate Limits

DOCSIS 1.0 provides QoS, based on the SID. Each QoS profile carries a parameter maximum downstream rate, which is used to provide peak rate limiting and traffic shaping on the downstream. When higher-priority and traffic data are combined for a particular CM, rate-exceeded data packets might shut down or delay higher-priority packets, thereby degrading quality. IP precedence bits can be used as a basic differentiator to provide independent rate limits for different traffic streams.

DOCSIS 1.0 Downstream Signal Test Commands

The **cable downstream if-output** command provides several test capabilities and is enhanced with the following options to generate test signals on the downstream interface.

- **cable downstream if-output prbs**—Shuts down the downstream interface and outputs a Pseudo-Random Bit Stream (PRBS) test signal.
- **cable downstream if-output continuous wave**—Shuts down the downstream interface and outputs an unmodulated carrier signal.

Note The previous **cable downstream if-output** command has not changed and continues to output a standard modulated signal. The **no cable downstream if-output** command has not changed and stops all signal output and shuts down the interface.

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide*.

DOCSIS 1.0 Modem Power Enhancement Adjustments for Low SNR Failures

This feature allows Cisco uBR10012 router to adjust better when a CM seems to bounce—the CM requires frequent power adjustments in opposite directions. When this occurs, instead of making large power adjustments for each correction, the administrator can configure the Cisco uBR10012 router to calculate the average value of the power corrections before making power adjustments:

- **cable upstream power-adjust threshold**—This command now accepts a range of 0 to 10 dB (the previous range was 0 to 2 dB).
- **cable upstream power-adjust noise** *% of power adjustment*—This command sets the threshold value (in percent) for a particular upstream, switching between regular power adjustments and the noise power-adjustment method.

The noise power-adjustment method uses an averaging algorithm before sending any correction. For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide*.

DOCSIS 1.0 Multi SID Support

This feature allows the Cisco uBR10012 router to support the definition of multiple SIDs on the upstream. This includes multiple service classes per cable interface, enabling administrators to delegate higher priority as required.

- Higher-priority traffic can be designated on a higher QoS committed information rate (CIR) secondary SID, while data traffic can be forwarded on a best-effort basis on a primary SID.
- Secondary SIDs can be defined to provide higher QoS CIR-type classes for higher-priority traffic. These classes have a nonzero minimum reserved rate (CIR-type service). These SIDs, therefore, receive preferential treatment at the CMTS for grants over any tiered best-effort type data SID for that upstream.

Note Best-effort service involves requests with no minimum upstream rate on the channel. The CMTS treats the primary and secondary SIDs independently for issuing grants. Each SID of a CM has an independent state machine. Channel access for each SID is independent of the other SID.

- Cable-modem-initiated dynamic MAC messages—Dynamic Service Addition (DSA) and Dynamic Service Deletion (DSD). These messages allow dynamic SIDs to be created and deleted at run time.
- Unsolicited grant service (CBR-scheduling) on the upstream helps provide a higher-quality channel for upstream packets from the Cisco uBR924 cable access router, for example.

Caution Reliable operation with higher-priority traffic requires multiple SIDs—at least two per cable interface to separate highest-priority traffic from data traffic. In DOCSIS 1.0, SIDs are set up statically. When supporting extensions to DOCSIS 1.0 or DOCSIS 1.1, SIDs can be set up either statically or dynamically. Both the CMTS and CM must support the feature set.

DOCSIS 1.0 QoS Profile Enforcement

QoS profile enforcement allows you to override the provisioned service class of a cable interface at the time of registration with a CMTS-defined QoS profile. When this feature is enabled, the CMTS provisions each registering CM with a default DOCSIS 1.0 service class, which the CMTS administrator configures.

The administrator-defined service class is enforced on CMs attempting to register with the CMTS. The service class has no upstream or downstream rate limits.

When the CM sends data upstream, it makes bandwidth requests without throttling or dropping packets because of its own rate-policing algorithm. The CMTS does traffic shaping based on the QoS profile enforced by the operator.

Note By default, the system does not enforce a specific QoS profile on the cable interface. The QoS profile assigned to the cable interface depends on the class of service parameters provisioned in the cable interface DOCSIS configuration file.

DOCSIS 1.0 RFC 2233 Support (RF Interface MIB)

The Cisco uBR10012 router supports DOCSIS OSSI Required Objects in RFC 2233.

DOCSIS 1.0 Service Class Profiles

The Cisco uBR10012 router allows you to create multiple service class profiles with the following characteristics:

- A specific QoS profile number
- Traffic priority (7, 6, 5, 4, 3, 2, 1, 0), with 7 being the highest
- Maximum and guaranteed upstream rate in bps
- Maximum upstream channel burst in minislot
- Minimum upstream rate in bps

- Maximum downstream rate in bps
- Maximum transmit burst length
- ToS overwrite byte

Using these service class profiles, you can define a guaranteed-rate service queue to store bandwidth requests from CMs subscribing to a class with minimum upstream rate on the upstream channel, and a best-effort service queue for CMs subscribing to a class with no minimum upstream rate on the upstream channel.

The Cisco uBR10012 router also supports multiple service classes per CM and dynamic service identifiers. This allows the Cisco uBR10012 router to dynamically allocate and delete service flows.

The CMTS also supports QoS profile enforcement to override interference from cable modems that might be improperly rate limited. The CMTS system administrator can assign a default DOCSIS 1.0 service class that overrides a pre-existing service class on the modem. The CMTS can do traffic shaping based on the QoS profile the administrator enforces.

DOCSIS 1.0 Traffic Shaping and Rate Limiting Features

Traffic shaping reduces the chance that information is retransmitted to hosts on the HFC network and, therefore, conserves bandwidth. Without traffic shaping, the Cisco IOS Release 12.2XF software drops bandwidth requests from CMs found to be exceeding their configured peak upstream transmission rate. Dropping bandwidth requests (and eventually upstream packets) from rate-exceeding cable interface causes TCP-related timeouts, which cause the host sending the information to retransmit its information.

The Cisco IOS Release 12.2XF supports the following traffic shaping features:

- **Downstream rate limiting**—Allows downstream grants to rate-exceeding CMs to be buffered without incurring TCP-related timeouts and retransmits. Downstream rate shaping enables you to partition downstream traffic for a CM into multiple classes of service and multiple data rates by using the three precedence bits in the ToS byte in the IP header to specify a class of service assignment for each packet. Those packets with the precedence bit set in the ToS field are given higher priority.

  Using the ToS byte, you can calculate the data rate for a specified flow, in addition to the data rate configured on a per-CM basis. By specifying a maximum data rate for a particular ToS, you can override the common maximum downstream data rate.

Note Packets that contain ToS bytes that have not been configured for downstream data rates continue to use the common data rate limits.

- **Upstream rate limiting**—Allows upstream bandwidth requests from rate-exceeding CMs to be buffered without incurring TCP-related timeouts and retransmits. This enables the CMTS to enforce the peak upstream rate for each CM without degrading overall TCP performance for the subscriber CPEs. Upstream grant shaping is per cable interface (SID).

  Token-bucket policing with shaping is the per-upstream default rate-limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

  Upstream traffic shaping delays the scheduling of an upstream packet, which causes the packet to be buffered on the cable CPE device instead of being dropped. This allows the TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined QoS levels.

DOCSIS 1.0 Payload Header Suppression

Payload Header Suppression (PHS) conserves link-layer bandwidth by suppressing unnecessary packet headers on both upstream and downstream traffic flows. For configuration information, refer to the "Configuring Payload Header Suppression and Restoration" section on page 27.

DOCSIS 1.0 per SID Bandwidth Request and Grant Counters

This feature promotes better control of higher-priority traffic, permitting per-SID bandwidth requests and grants. Profiles can be customized for scheduling parameters required at subscriber sites for the service offering.

The **show interface c***x/y/z* **sid counter** command also supports a **verbose** option that displays:

- Number of bandwidth requests successfully received by the Cisco uBR10012 router from the specified SID on the specified cable interface
- Number of grants issued by the Cisco uBR10012 router to the specified SID

DOCSIS 1.0 ToS Overwrite

Cisco IOS release 12.3(17a)BC2 introduces support for the DOCSIS 1.0 Type of Service (ToS) Overwrite feature. Currently, ToS overwrite requires the creation of static cable QoS profiles, which are then assigned to the ToS fields. This implementation works well if only a few different service types are offered. However, scalability issues arise when large numbers of service types are presented; each requiring a static QoS profile in order to perform ToS overwrite.

The Default DOCSIS 1.0 ToS Overwrite feature eliminates the need to create multiple QoS profiles in order to perform type-of-service (ToS) overwrite by automatically bounding all DOCSIS 1.0 Cable Modem (CM) created profiles to a default ToS overwrite.

Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems

Cisco IOS release 12.3(13a)BC introduces Enhanced Rate Bandwidth Allocation (ERBA) support for DOCSIS 1.0 cable modems and the Cisco uBR10012 router. ERBA allows DOCSIS1.0 modems to burst their temporary transmission rate up to the full line rate for short durations of time. This capability provides higher bandwidth for instantaneous bandwidth requests, such as those in Internet downloads, without having to make changes to existing service levels in the QoS Profile.

This feature enables MSOs to set the DOCSIS 1.0 cable modems burst transmissions, with mapping to overriding DOCSIS 1.1 QoS profile parameters on the Cisco CMTS. DOCSIS 1.0 cable modems require DOCSIS 1.0 parameters when registering to a matching QoS profile. This feature enables maximum downstream line rates, and the ERBA setting applies to all cable modems that register to the corresponding QoS profile.

Note QoS definitions must previously exist on the Cisco CMTS headend to support this feature.

ERBA for DOCSIS 1.0 cable modems is supported with these new or enhanced commands or keywords in Cisco IOS release 12.3(13a)BC:

- **cable qos pro max-ds-burst** *burst-size*
- **show cable qos profile** *n* **[verbose]**

To define ERBA on the downstream for DOCSIS 1.0 cable modems, use the **cable qos promax-ds-burst** command in global configuration mode. To remove this ERBA setting from the QoS profile, use the **no** form of this command.

cable qos pro max-ds-burst *burst-size*

no cable qos pro max-ds-burst

Syntax Description

burst-size	The QoS profile’s downstream burst size in bytes.

To display ERBA settings as applied to DOCSIS 1.0 cable modems and QoS profiles on the Cisco CMTS, use the **show cable qos profile** command in Privileged EXEC mode.

The following example of the **cable qos profile** command in global configuration mode illustrates changes to the **cable qos profile** command. Fields relating to the ERBA feature are shown in bold for illustration:

```
Router(config)# cable qos pro 10 ?
  grant-interval       Grant interval
  grant-size           Grant size
  guaranteed-upstream  Guaranteed Upstream
  max-burst            Max Upstream Tx Burst
  max-ds-burst        Max Downstream Tx burst (cisco specific)
  max-downstream       Max Downstream
  max-upstream         Max Upstream
  name                 QoS Profile name string (cisco specific)
  priority             Priority
  privacy              Cable Baseline Privacy Enable
tos-overwrite        Overwrite TOS byte by setting mask bits to value
```

The following example of the **show cable qos profile** command illustrates that the maximum downstream burst has been defined, and is a management-created QoS profile:

```
Router# show cable qos pro
ID  Prio Max       Guarantee Max        Max   TOS  TOS   Create  B      IP prec.
         upstream  upstream  downstream tx    mask value by      priv  rate
         bandwidth bandwidth bandwidth  burst                    enab  enab
1   0    0         0         0          0     0xFF 0x0   cmts(r) no     no
2   0    64000     0         1000000    0     0xFF 0x0   cmts(r) no     no
3   7    31200     31200     0          0     0xFF 0x0   cmts    yes    no
4   7    87200     87200     0          0     0xFF 0x0   cmts    yes    no
6   1    90000     0         90000      1522  0xFF 0x0   mgmt    yes    no
10  1    90000     0         90000      1522  0x1  0xA0  mgmt    no     no
50  0    0         0         96000      0     0xFF 0x0   mgmt    no     no
51  0    0         0         97000      0     0xFF 0x0   mgmt    no     no
```

The following example illustrates the maximum downstream burst size in sample QoS profile 10 with the **show cable qos prof verbose** command in privileged EXEC mode:

```
Router# show cable qos pro 10 ver
Profile Index                           10
Name
Upstream Traffic Priority               1
Upstream Maximum Rate (bps)             90000
Upstream Guaranteed Rate (bps)          0
Unsolicited Grant Size (bytes)          0
Unsolicited Grant Interval (usecs)      0
Upstream Maximum Transmit Burst (bytes) 1522
Downstreamam Maximum Transmit Burst (bytes) 100000
IP Type of Service Overwrite Mask       0x1
IP Type of Service Overwrite Value      0xA0
Downstream Maximum Rate (bps)           90000
Created By                              mgmt
Baseline Privacy Enabled                no
```

Usage Guidelines

If a cable modem registers with a QoS profile that matches one of the existing QoS profiles on the Cisco CMTS, then the maximum downstream burst size, as defined for that profile, is used instead of the default DOCSIS QoS profile of 1522.

For example, a DOCSIS 1.0 configuration that matches QoS profile 10 in the previous examples would be as follows:

```
03 (Net Access Control)         = 1

04 (Class of Service Encodings Block)
   S01 (Class ID)               = 1
   S02 (Maximum DS rate)        = 90000
   S03 (Maximum US rate)        = 90000
   S06 (US burst)               = 1522
   S04 (US Channel Priority)    = 1
   S07 (Privacy Enable)         = 0
```

The maximum downstream burst size (as well as the ToS overwrite values) are not explicitly defined in the QoS configuration file because they are not defined in DOCSIS. However, because all other parameters are a perfect match to profile 10 in this example, then any cable modem that registers with these QoS parameters has a maximum downstream burst of 100000 bytes applied to it.

For further illustration, consider a scenario in which packets are set in lengths of 1000 bytes at 100 packets per second (pps). Therefore, the total rate is a multiplied total of 1000, 100, and 8, or 800kbps.

To change these settings, two or more traffic profiles are defined, with differing downstream QoS settings as desired. Table 6 provides two examples of such QoS profiles for illustration:

Table 6 Sample QoS Profiles with Differing ERBA (Maximum Downstream) Settings

QoS Profile Setting	QoS Profile 101	QoS Profile 102
Maximum Downstream Transmit Burst (bytes)	max-burst 4000	max-burst 4000
Maximum Downstream Burst (bps)	max-ds-burst 20000	max-ds-burst 5000
Maximum Downstream Bandwidth	max-downstream 100	max-downstream 100

In this scenario, both QoS profiles are identical except for the max-ds-burst size, which is set to 5000 in QoS profile 101 and 5000 in QoS profile 102.

Optimal Settings for DOCSIS 1.0 Downstream Powerburst

DOCSIS allows the setting different token bucket parameters for each service flow, including the token bucket burst size. When burst sizes are closer to 0, QoS is enforced in a stricter manner, allowing a more predictable sharing of network resources, and as a result easier network planning.

When burst sizes are larger, individual flows can transmit information faster (lower latency), although the latency variance can be larger as well.

For individual flows, a larger burst size is likely to be better. As long as the system is not congested, a large burst size reduces the chances of two flows transmitting at the same time, because each burst is likely to take less time to transmit. However, as channel bandwidth consumption increases, it is probably that large burst traffic would exceed the thresholds of buffer depths, and latency is longer than with well shaped traffic.

For additional information about the **cable qos profile** command and configuring QoS profiles, refer to the following documents on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

- *Configuring DOCSIS 1.1 on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b57f.html

DOCSIS 1.0+ Feature Support

In response to the limitations of DOCSIS 1.0 in handling real-time traffic, such as voice calls, Cisco created the DOCSIS 1.0+ extensions to provide the more important QoS enhancements that were expected in DOCSIS 1.1. In particular, the DOCSIS 1.0+ enhancements provide basic Voice-over IP (VoIP) service over the DOCSIS link.

Cisco DOCSIS 1.0+ extensions include the following DOCSIS 1.1 features:

- Multiple SIDs per CM, creating separate service flows for voice and data traffic. This allows the CMTS and CM to give higher priority for voice traffic, preventing the data traffic from affecting the quality of the voice calls.
- CM-initiated dynamic MAC messages—Dynamic Service Addition (DSA) and Dynamic Service Deletion (DSD). These messages allow dynamic SIDs to be created and deleted on demand so that the bandwidth required for a voice call can be allocated at the time a call is placed and then freed up for other uses when the call is over.
- Unsolicited grant service (CBR-scheduling) on the upstream—This helps provide a higher-quality channel for upstream VoIP packets from an Integrated Telephony CM (ITCM) such as the Cisco uBR924 cable access router.
- Ability to provide separate downstream rates for any given CM, based on the IP-precedence value in the packet—This helps separate voice signaling and data traffic that goes to the same ITCM to address rate shaping purposes.
- Concatenation allows a CM to send several packets in one large burst, instead of having to make a separate grant request for each.

Caution All DOCSIS 1.0 extensions are available only when using a CM (such as the Cisco uBR924 cable access router) and CMTS (such as the Cisco uBR10012 router) that support these extensions. The CM activates the use of the extensions by sending a dynamic MAC message. DOCSIS 1.0 CMs continue to receive DOCSIS 1.0 treatment from the CMTS.

DOCSIS 1.1 Feature Support

DOCSIS 1.1 is the first major revision of the initial DOCSIS 1.0 standard for cable networks. Although the initial standard provided quality data traffic over the coaxial cable network, the demands of real-time traffic such as voice and video required many changes to the DOCSIS specification.

Note At the time of publication, the DOCSIS 1.1 specification is still being finalized. This document describes the DOCSIS 1.1 specification SP-RFIv1.1-IO3-991105. See the CableLabs Web site (http://www.cablelabs.com) for the current status on DOCSIS 1.1.

This section describes the major enhancements supported on the Cisco uBR10012 router:

- DOCSIS 1.1 Baseline Privacy Interface Plus Features
- DOCSIS BPI+ Multiple Root Certificate Support
- DOCSIS 1.1 CM Compatibility
- DOCSIS 1.1 CM Database Manager
- DOCSIS 1.1 Concatenation Support
  - See also DOCSIS 1.0 Concatenation Override
- DOCSIS 1.1 Customer Premises Equipment Configurator
- DOCSIS 1.1 Downstream Packet Classifier
- DOCSIS 1.1 Downstream Packet Scheduler

- DOCSIS 1.1 Dynamic MAC Messages
- DOCSIS 1.1 Enhanced Registration
- DOCSIS 1.1 Fragmentation and Reassembly
- DOCSIS 1.1 Layer 2 Fragmentation
- DOCSIS 1.1 MAC Scheduler
- DOCSIS 1.1 Payload Header Suppression and Restoration
- DOCSIS 1.1 Quality of Service Support
- DOCSIS 1.1 Rate Limiting and Traffic Shaping
- DOCSIS 1.1 Service Flow Manager
- DOCSIS 1.1 Service Template and Class Manager
- DOCSIS 1.1 Software Infrastructure
- DOCSIS 1.1 Subscriber Management
- DOCSIS 1.1 Time Slot Scheduling
- DOCSIS 1.1 TLV Parser and Encoder
- DOCSIS 1.1 Token-Bucket Rate Shaping
- DOCSIS 1.1 Two-Way Interoperability
- Optional Upstream Scheduler Modes

DOCSIS 1.1 Baseline Privacy Interface Plus Features

DOCSIS 1.1 enhances the DOCSIS 1.0 BPI security features with BPI+, which includes the following features:

- 1024-bit public key with Pkcs#1 Version 2.0 encryption
- Commands to configure source IP filtering on RF subnets to prevent subscribers from using source IP addresses that are not valid
- Digital certificates that provide secure user identification and authentication
- Filtering
- IP security access control list (ACL) support
- Key encryption that uses 168-bit Triple DES (3DES) encryption that is suitable for the most sensitive applications
- Multicast support
- Protection against spoofing
- Secure software download allows a service provider to upgrade a CM’s software remotely, without the threat of interception, interference, or alteration
- Tunnels

Note BPI+ is described in the *Baseline Privacy Interface Plus Specification* (BPI+_I06-001215), available in PDF format from CableLabs (http://www.cablemodem.com).

Additional Information

For additional information about the differences in DOCSIS specifications, refer to *DOCSIS 1.1 for Cisco uBR7200 Series Universal Broadband Routers* feature module on Cisco.com.

40-bit and 56-bit Baseline Privacy Data Encryption Standard (DES)

The Cisco uBR10012 router supports 40-bit and 56-bit encryption and decryption. When encryption and decryption is enabled, 56-bit is the default. If necessary, administrators can force the Cisco uBR10012 router to generate a 40-bit DES key, where the DES key that is generated and returned masks the first 16 bits of the 56-bit key to zero in software.

Note BPI+ encryption and authentication must be supported and enabled by both the CM and CMTS. In addition, the CM must contain a digital certificate that conforms to the DOCSIS 1.1 and BPI+ specifications.

Access Lists (Per-Modem and Per-Host)

Per-modem and per-host access lists allow the Cisco uBR10012 router to filter incoming packets from individual hosts or cable interfaces based on the source MAC or IP address. This allows access lists to be specified on a per-interface or a per-address basis.

You can preconfigure the filters by using the CLI, following standard Cisco IOS access list and access group configuration procedures. You can assign these filters to a user or modem by using the CLI or SNMP. The feature also supports traps to inform the CMTS about the online or offline status of modems.

Access Lists on the Cisco uBR10012 Router

The Parallel eXpress Forwarding (PXF) processors on the Cisco uBR10012 router provide the increased performance of Turbo Access Control Lists (Turbo ACL) by default by automatically compiling all access lists when access lists are configured.

You do not need to use the **access-list compiled** command to enable the Turbo ACL feature. To display access lists, use the **show access-lists** command without specifying the **compiled** option.

For complete information about access lists, see the "Traffic Filtering and Firewall" volume in the *Cisco IOS Release 12.1 Security Configuration Guide* at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios121/121cgcr/secur_c/scprt3/index.htm

Authentication

DOCSIS 1.1 offers advanced authentication and security through X.509 digital certificates and Triple Data Encryption Standard (3DES) key encryption.

Cisco IOS Firewall

The Cisco uBR10012 router support Network Address Translation (NAT) and firewall functionality. Additional NAT documentation is available online at http://www.Cisco.com.

CM and Host Subnet Addressing

This feature enables the Cisco uBR10012 router to manipulate the GIADDR field of DHCPDISCOVER and DHCPREQUEST packets with a Relay IP address before they are forwarded to the DHCP server. By modifying the GIADDR field based on whether the source is a CM or a host, the Cisco uBR10012 router provides hints to the DHCP server as to where—on which IP subnet—the server should allocate addresses to the requesting client.

Upstream Address Verification

This feature prevents the spoofing of IP addresses. Using the CLI, administrators can determine the IP and MAC address of a given cable interface, and the SID number that shows the IP and MAC addresses of all devices learned in the cable interface’s MAC table.

The CMTS verifies the source IP address against the MAC address for the CM. CM and PC IP addresses are verified to ensure that SID and MAC addresses are consistent. A PC behind a cable interface is assigned an IP address from the DHCP server. If a user on a second PC or cable interface statically assigns the same IP address to a PC, the Cisco uBR10012 router reports this. Using customer databases, administrators can cross-reference the spoofing CM and PC to prevent further usage.

Note The **cable source-verify** [**dhcp**] command (for cable interfaces) specifies that DHCP lease query requests are sent to verify any unknown source IP address found in upstream data packets. Upstream Address Verification requires a DHCP server that supports the new LEASEQUERY message type. Cisco Network Registrar supports the LEASEQUERY message type in Cisco IOS Release 3.01(T) and later releases.

For configuration information, refer to the "Activating CM Upstream Address Verification" section on page 5.

DOCSIS BPI+ Multiple Root Certificate Support

Cisco IOS Release 12.3(13a)BC introduces support for multiple DOCSIS root certificates with Baseline Privacy Interface Plus (BPI+) on the Cisco CMTS. This feature enables the Cisco CMTS to support either North American or European cable modems, with the following guidelines for implementation:

- In circumstances in which it is necessary to change from North American root certificates to European root certificates, or vice versa, it is necessary to over write the existing root certificate on the Cisco CMTS, and to reload the Cisco CMTS with the **reload** or **restart** command.
- The Cisco uBR10-MC5X20S/U Broadband Processing Engine (BPE) supports both North American and European root certificates at the same time, and simultaneous root certificate support is a requirement in this case.

DOCSIS 1.1 CM Compatibility

DOCSIS 1.1 CMs can coexist with DOCSIS 1.0 and 1.0+ CMs in the same network—the Cisco uBR10012 router provides the levels of service that are appropriate for each CM. For additional configuration information, refer to Chapter 3, "Configuring Cable Interface Features for the Cisco uBR10012 Router."

DOCSIS 1.1 CM Database Manager

The CM Database Manager is a new software module that manages CM information on the CMTS. This module can be queried to obtain different types of information on a single CM (or a group of CMs). Using the **show cable modem** command, information maintained on a per-CM basis includes DOCSIS MAC capabilities, counters, errors, QoS configuration, MAC state, connectivity statistics, and so forth.

Command	Purpose
show cable modem [*ip-address* | *interface* | *mac-address*] [*options*]	Displays information for the registered and unregistered CMs.

Syntax Description

ip-address	Identifies the IP address of a specific modem to be displayed.
interface	Displays all CMs on a specific CMTS cable interface.
mac-address	Identifies the MAC address of a specific CM to be displayed.

Several additional command options are available. Refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Examples

```
Router# show cable modem
MAC Address    IP Address      I/F       MAC         Prim RxPwr Timing Num  BPI
                                         State       Sid  (db)  Offset CPEs Enbld
0050.04f9.edf6 10.44.51.49     C7/1/0/U0 online      1   -0.50  3757   0    no
0050.04f9.efa0 10.44.51.48     C7/1/0/U0 online      2   -0.50  3757   0    no
0030.d002.41f5 10.44.51.147    C7/1/0/U0 online      3   -0.25  3829   0    no
0030.d002.4177 10.44.51.106    C7/1/0/U0 online      4   -0.50  3798   0    no
0030.d002.3f03 10.44.51.145    C7/1/0/U0 online      5   0.25   3827   0    no
0050.04f9.ee24 10.44.51.45     C7/1/0/U0 online      6   -1.00  3757   0    no
0030.d002.3efd 10.44.51.143    C7/1/0/U0 online      7   -0.25  3827   0    no
0030.d002.41f7 10.44.51.140    C7/1/0/U0 online      8   0.00   3814   0    no
0050.04f9.eb82 10.44.51.53     C7/1/0/U0 online      9   -0.50  3756   0    no
0050.f112.3327 10.44.51.154    C7/1/0/U0 online      10  0.25   3792   0    no
0030.d002.3f8f 10.44.51.141    C7/1/0/U0 online      11  0.00   3806   0    no
0001.64f9.1fb9 10.44.51.55     C7/1/0/U0 online      12  0.00   4483   0    no
0030.d002.417b 10.44.51.146    C7/1/0/U0 online      13  0.50   3812   0    no
0090.9600.6f7d 10.44.51.73     C7/1/0/U0 online      14  0.00   4071   0    no
0010.9501.ccbb 10.44.51.123    C7/1/0/U0 online      15  0.25   3691   0    no
```

DOCSIS 1.1 Concatenation Support

Concatenation allows the CM to make a single time slice request for multiple packets and send all packets in a single large burst on the upstream. This is in contrast to making an individual grant request for each frame. Concatenation was introduced in the upstream receive driver in the DOCSIS1.0+ releases. Per-SID counters have now been added in Cisco IOS Release 12.2XF for debugging concatenation activity.

Also see the "DOCSIS 1.0 Concatenation Override" section on page 19.

The combination of multiple upstream packets into one packet reduces packet overhead and overall latency, and increases transmission efficiency. Using concatenation, a CM needs to make only one bandwidth request for a concatenated packet, as opposed to making a different bandwidth request for each packet. This technique is particularly effective for real-time traffic.

Tip

Concatenation is supported only with CMs that support DOCSIS concatenation as part of DOCSIS 1.0 extensions. The results of the **show controller** command indicate whether concatenation is enabled on an interface.

Concatenation is enabled by default for current cable interface line cards, but can be disabled with the Cisco IOS **no cable upstream** *number* **concatenation** interface command. A CM is considered noncompliant when it concatenates after the Cisco IOS **no cable upstream** *number* **concatenation** interface command is issued.

Commands

```
Router# show interface cable x/y sid [n] counters [verbose]
Router# show controller cable x/y
Router(config-if)# [no] cable upstream n concatenation
Router# debug cable errors
```

For additional configuration information, refer to the *DOCSIS 1.1 for Cisco uBR7200 Series Universal Broadband Routers* on Cisco.com.

DOCSIS 1.1 Customer Premises Equipment Configurator

Cisco offers an HTML-based DOCSIS 1.1 CPE Configurator tool—described and accessed from http://www.cisco.com/univercd/cc/td/doc/pcat/docsys.htm. The tool is designed to collect information needed to generate a DOCSIS 1.1 CM configuration file. The generated file is in binary format consistent with the *DOCSIS RF Specification* (SP-RFI-105-991105) at http://www.cablemodem.com/specifications.html.

DOCSIS 1.1 Downstream Packet Classifier

Packet classifiers help to map packets into DOCSIS service flows. The CMTS supports downstream IP packet classifiers.

Commands

```
Router# show interface cable x/y classifier
Router# show interface cable x/y service-flow [n] classifiers
Router# debug cable qos
```

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

DOCSIS 1.1 Downstream Packet Scheduler

The Downstream Packet Scheduler is a new module that controls all output packet queueing service on the downstream link of each cable interface.

Commands

```
Router# debug cable qos
Router# show interface cable x/y downstream
```

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

DOCSIS 1.1 Dynamic MAC Messages

DSX MAC messages allow dynamic signaling of QoS between the CM and the CMTS. These messages are DOCSIS link layer equivalents of higher-layer create, modify, and teardown messages. The DSX state machine module on the CMTS manages the several concurrent dynamic service transactions between CMs and the CMTS. It include state machine support for all 3 DOCSIS1.1 dynamic MAC messages (DSX messages):

- Dynamic Service Add (DSA): This message is used to create a new service flow.
- Dynamic Service Change (DSC): This message is used to change the attributes of an existing service flow.
- Dynamic Service Deletion (DSD): This message is used to delete an existing service flow.

Commands

```
Router# debug cable dynsrv
Router# debug cable tlvs
```

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Note In Cisco IOS Release 12.1(4)CX, only cable-modem-initiated DSX messages are supported. CMTS-initiated DSX messages are not supported.

DOCSIS 1.1 Enhanced Registration

The registration module has been enhanced to support multiple registration styles (DOCSIS1.0/DOCSIS1.0+/DOCSIS1.1) in seamless fashion. Besides using services of the new Tag-Length-Value parser and encoder, this module also supports the conditional registration-acknowledgment MAC message state machine.

Commands

```
Router# debug cable registration
Router# debug cable tlvs
```

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

DOCSIS 1.1 Fragmentation and Reassembly

The MAC scheduler fragments data slots to fill the gaps in-between Unsolicited Grant Service (UGS) slots. Fragmentation reduces the jitter experienced by voice packets when large data packets are transmitted on the shared upstream channel and preempt the UGS slots used for voice. Fragmentation splits the large data packets so that they fit into the smaller timeslots available around the UGS slots. The grant fragmentation gets triggered in the MAC scheduler, and fragment reassembly happens in the upstream receive driver.

Note DOCSIS fragmentation should not be confused with the fragmentation of IP packets, which is done to fit the packets on network segments with smaller maximum transmission unit (MTU) size. DOCSIS fragmentation is Layer 2 fragmentation that is primarily concerned with efficiently transmitting lower-priority packets without interfering with high-priority real-time traffic, such as voice calls. IP fragmentation is done at Layer 3 and is primarily intended to accommodate routers that use different maximum packet sizes.

Commands

```
Router# show interface cable x/y sid [n] counters [verbose]
Router(config-if)# [no] cable upstream n fragmentation
Router# debug cable errors
```

DOCSIS 1.1 Layer 2 Fragmentation

Layer 2 fragmentation on the upstream prevents large data packets from affecting real-time traffic, such as voice and video. Large data packets are fragmented and then transmitted in the time slots that are available between the time slots used for the real-time traffic.

DOCSIS 1.1 MAC Scheduler

The MAC scheduler controls all time-slot assignment on the shared upstream channel. This block has been redesigned to support several new scheduling disciplines of DOCSIS1.1. Important enhancements include:

- Support for grant fragmentation.
- Support for multiple unsolicited grants per service ID (SID).
- Support for Unsolicited Grant Service with Activity Detection (UGS-AD) and Real-Time Polling Service (RTPS) slot scheduling mechanisms besides Unsolicited Grant Service (UGS), best effort (BE), and Committed Information Rate (CIR) service of DOCSIS1.0+.
- Enhanced per SID minimum or maximum rate shaping.

All old Cisco features, such as dynamic contention control are supported in the new design.

MAC Scheduler Commands

```
Router# show interface cable x/y mac-scheduler n
Router(config-if)# [no] cable upstream n fragmentation
Router(config-if)# [no] cable upstream n unfrag-slot-jitter
Router# cable service flow inactivity-threshold n
Router# debug cable mac-scheduler
```

DOCSIS 1.1 Payload Header Suppression and Restoration

The Payload Header Suppression (PHS) feature is used to suppress repetitive or redundant portions in packet headers before transmission on the DOCSIS link. This is a new feature in the DOCSIS1.1 MAC driver. The upstream receive driver is now capable of restoring headers suppressed by CMs, and the downstream driver is capable of suppressing specific fields in packet headers before forwarding frames to the CM.

Commands

```
Router# show interface cable x/0 service-flow [sfid] phs
Router# debug cable error
Router# debug cable phs
```

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

DOCSIS 1.1 Quality of Service Support

Enhanced quality of service (QoS) gives priority for real-time traffic such as voice and video.

- The DOCSIS 1.0 QoS model (a service ID (SID) associated with a QoS profile) has been replaced with a service flow model that allows greater flexibility in assigning QoS parameters to different types of traffic and in responding to changing bandwidth conditions.
- DOCSIS 1.1 offers support for multiple service flows per CM, which allows a single CM to support a combination of data, voice, and video traffic.
- DOCSIS 1.1 offers greater granularity in QoS per CM in either direction, using unidirectional service flows.
- Dynamic MAC messages create, modify, and delete traffic service flows to support on-demand traffic requests
- Supported QoS models for the upstream are:
  - Best-effort—Data traffic sent on a non-guaranteed best-effort basis
  - Committed Information Rate (CIR)—Guaranteed minimum bandwidth for data traffic
  - Unsolicited Grants (UGS)—Constant bit rate (CBR) traffic, such as voice, that is characterized by fixed size packets at fixed intervals
  - Real-Time Polling (RTPS)—Real-time service flows, such as video, that produce unicast, variable-size packets at fixed intervals
  - Unsolicited Grants with Activity Detection (USG-AD)—Combination of UGS and RTPS, to accommodate real-time traffic that might have periods of inactivity (such as voice using silence suppression). The service flow uses UGS fixed grants while active, but switches to RTPS polling during periods of inactivity, to avoid wasting unused bandwidth.

The DOCSIS 1.1 QoS framework is based on the following objects:

- **Service class—**A collection of settings maintained by the CMTS that provide a specific QoS service tier to a CM that has been assigned a service flow within a particular service class.
- **Service flow—**A unidirectional sequence of packets receiving a service class on the DOCSIS link.
- **Packet classifier—**A set of packet header fields used to classify packets onto a service flow to which the classifier belongs.
- **PHS rule—**A set of packet header fields that are suppressed by the sending entity before transmitting on the link and that are restored by receiving entity after receiving a header-suppressed frame transmission. Payload Header Suppression increases the bandwidth efficiency by removing repeated packet headers before transmission.

In DOCSIS 1.1, the basic unit of QoS is the service flow, which is a unidirectional sequence of packets transported across the RF interface between the CM and CMTS. A service flow is characterized by a set of QoS parameters such as latency, jitter, and throughput assurances.

Every CM establishes a primary service flow in both the upstream and downstream directions. The primary flows maintain connectivity between the CM and CMTS at all times.

In addition, a DOCSIS 1.1 CM can establish multiple secondary service flows. The secondary service flows either can be created permanently (they persist until the CM is reset or powered off) or can be created dynamically to meet the needs of the on-demand traffic being transmitted.

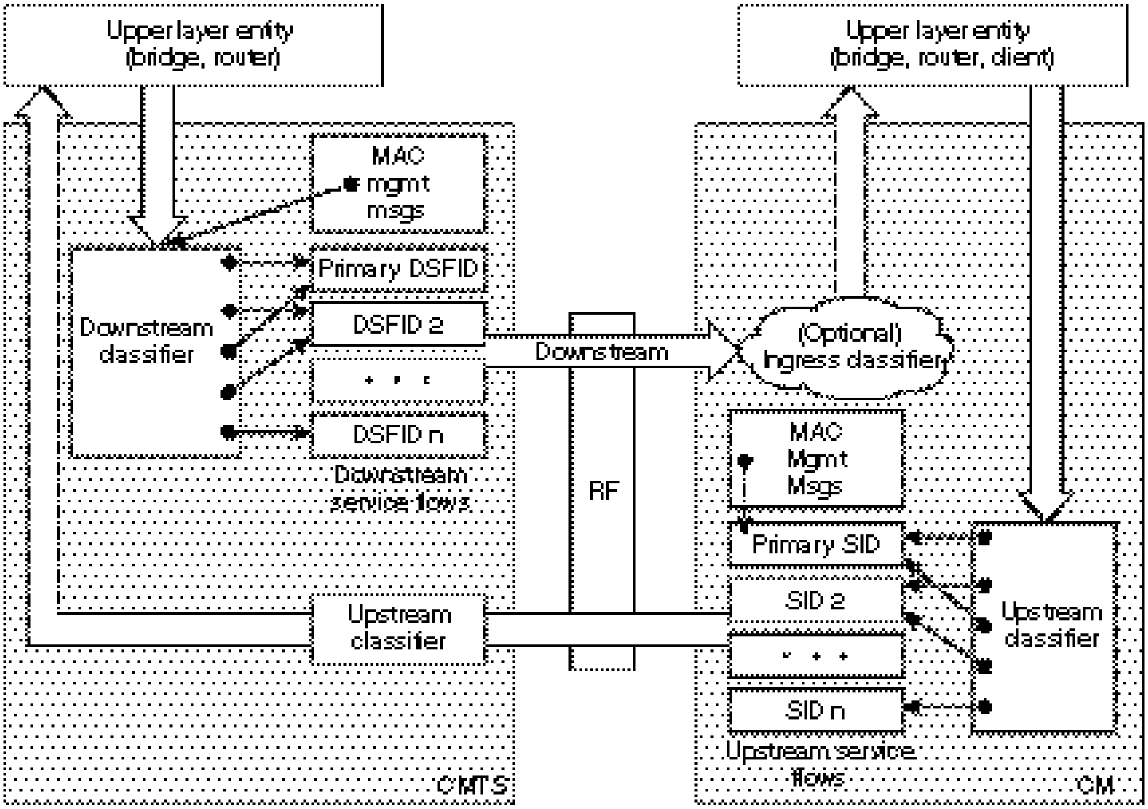
Each service flow has a set of QoS attributes associated with it. These QoS attributes define a particular class of service and determine characteristics such as the maximum bandwidth for the service flow and the priority of its traffic. The class of service attributes can be inherited from a preconfigured CMTS local service class (class-based flows), or they can be individually specified at the time of the creation of the service flow.

Each service flow has multiple packet classifiers associated with it, which determine the type of application traffic allowed to be sent on that service flow. Each service flow can also have a Payload Header Suppression (PHS) rule associated with it to determine which portion of the packet header will be suppressed when packets are transmitted on the flow.

Figure 3 illustrates the mapping of packet classifiers.

Note: By default, the system does not enforce any specific QoS profile on the CM. The QoS profile assigned to the CM depends on the class of service parameters provisioned in the CM's DOCSIS configuration file.

Figure 3 Classification Within the MAC Layer



DOCSIS 1.1 Type of Service Overwrite

This feature allows you to overwrite the ToS byte in the IP datagrams received on the upstream before forwarding them downstream.

DOCSIS 1.1 Rate Limiting and Traffic Shaping

Cisco IOS Release 12.2XF software supports rate limiting per DOCSIS-1.0-99, which limits the data rate to and from a CM; the MAC scheduler supports traffic-shaping capabilities for downstream and upstream traffic.

Rate limiting ensures that no single CM consumes all of the channel bandwidth and allows a CMTS administrator to configure different maximum data rates for different subscribers. Subscribers requiring higher peak rates and willing to pay for this can be configured with higher peak rate limits in their CM DOCSIS configuration file over regular subscribers who pay less and get lower rate limits.

Each time a packet belonging to a flow is transmitted on an output channel, the token-bucket policer function checks the rate limit status of the flow, passing the following parameters:

- Token-bucket peak rate in bits/msec.
- Token-bucket depth (maximum transmit burst) in bits.
- Length of current packet to be sent in bits.
- Pointer to the flow’s token bucket.
- Pointer to the flow’s token bucket last update time stamp.
- Variable to return the msec buffering delay in case the packet needs to be shaped.
- Maximum buffering delay that the subsequent traffic shaper can handle in msecs.

Every flow has its own shaping buffer where rate-exceeded packets are typically held back in first-in, first-out (FIFO) order for later transmission.

When rate-limiting CMs are implemented on the network, the Cisco IOS Release 12.2XF software typically drops packets to enforce the rate limit. Dropping packets from the requesting CM causes the host sending the information to retransmit its information. Retransmitted information wastes bandwidth on the network. If both hosts sending and requesting information are on the cable plant, the upstream bandwidth is wasted as well.

The traffic shaping feature delays the scheduling of the upstream packet, which in turn causes the packet to be buffered on the cable CPE device, instead of being dropped. This allows the user TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber’s defined QoS levels.

The Cisco uBR10012 router supports the following traffic shaping feature:

- **Downstream rate shaping to include ToS**—Allows traffic shaping from the CMTS on a DOCSIS downstream channel. The feature allows administrators to configure the ToS byte to calculate the data rate for a specified flow. You can override the common maximum downstream data rate.

  For additional information about downstream rate limiting (shaping), refer to the “Setting Downstream Rate Limiting and Traffic Shaping” section on page 9.

Tip Packets that contain ToS bytes that have not been configured for downstream data rates continue to use the common data rate limits.

- **Upstream rate shaping**—Allows upstream rate shaping from the CMTS on a DOCSIS upstream channel. Upstream grant shaping is per CM (SID). The grant shaping feature is a configurable option for the current upstream token-bucket rate-limiting algorithm.

For configuration information, refer to the “Setting Upstream Rate Limiting and Traffic Shaping” section on page 24.

Tip Token-bucket policing with shaping is the new per-upstream default rate limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

- **Restricted QoS class assignment**—Allows a CMTS administrator to override the class of service provisioned for a CM. When this feature is enabled, the user-defined QoS profile is enforced on the CM attempting to register with the CMTS, regardless of the provisioned class of service.

For additional information about configuring DOCSIS QoS and other DOCSIS features, refer to the *DOCSIS 1.1 Feature Module for the Cisco uBR7200 Routers*, or to other documents cited below for DOCSIS features.

Tip This feature is added to address instances where a cable operator implemented rate limiting incorrectly. The feature allows an administrator to override the statically provisioned QoS parameters of the CM and force the CM to use a specific QoS profile defined at the CMTS.

DOCSIS 1.1 Service Flow Manager

The Service Flow Manager is a new module that manages different activities related to service flows on a cable interface. Typical events include the creation of new DOCSIS service flows, modification of the attributes of existing service flows, and the deletion of service flows.

Commands

```
Router# show interface cable x/y service-flow
Router# debug cab qos
```

DOCSIS 1.1 Service Template and Class Manager

The Service Template and Class Manager is a software module that controls the creation, updating, and cleanup of various QoS service templates and user-defined service classes on the CMTS.

Commands

```
Router# show cable service-class
Router(config)# cable service class n
Router# debug cable qos
```

DOCSIS 1.1 Software Infrastructure

Supports CableLabs specifications for high-speed Data-over-Cable systems involving the following categories:

- RF interfaces between the Cisco uBR10012 router and the cable network—Downstream and upstream traffic.
- Data interfaces for cable interfaces and CPE devices, as well as the CMTS network-side interface between the Cisco uBR10012 router and the data network.
- Operations support interfaces—Network element management layer interfaces between the network elements and the operations support systems.
- Secure software download allows a service provider to remotely upgrade a CM’s software, without risk of interception or alteration.

DOCSIS 1.1 Subscriber Management

CMs are assigned to operate on specific cable channels to balance activity across several channels. Each Cisco uBR10012 router cable interface card serves a specific downstream channel and upstream segment. Part of network planning is to define the channels to use.

In typical cable networks, administrators limit the configuration responsibilities of field service technicians, and the amount of information collected on subscriber CPE devices. Field service technicians are sent to subscriber homes or businesses to install the CM or STB and ensure that all computing devices are DHCP-enabled.

The CMTS administrator defines and pushes DHCP and DOCSIS configuration files to appropriate servers so that each CM or CM in an STB on the network, when initialized, can transmit a DHCP request, receive its IP address, obtain its TFTP and ToD server addresses, and download its DOCSIS configuration file (and updated software image, if needed).

For additional information, refer to the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com.

Connecting DOCSIS 1.0-Based CMs

DOCSIS 1.0-based CMs cannot connect to the broadband network until the following processes occur:

- The CM initializes and ranges through available frequencies until it finds the first frequency that it can use to communicate to the CMTS—known as scanning for a downstream channel.
- The CM obtains upstream parameters and performs ranging.
- The CM goes through the DHCP server process and establishes IP connectivity, ToD, and security (optional). At this point, the CM cannot determine if it is communicating on the correct channel.
- The CM receives a DOCSIS configuration file from the TFTP server. One of the parameters in the DOCSIS configuration file tells the CM which channel it can use.
- The CM registers with the CMTS.
- If the network supports DOCSIS BPI or other secure data sets, encryption/decryption processes are initialized.
- The CM is ready for normal operations. Once initialized and operational, CMs send requests to initiate data transmission to the CMTS.

  The CMTS system administrator or customer service representative ensures that appropriate databases are updated to activate and support the new subscriber account in the provisioning, billing, or network management systems in use for the network. Each CM or STB serial number and MAC address is typically stored in the billing and administrative system.

Initial and station maintenance management messages are sent to maintain communications between CMs and the CMTS. The following example displays CM reinitialization:

```
6d17h:580447.276 CMAC_LOG_DRIVER_INIT_IDB_RESET              0x080A2400
6d17h:580447.280 CMAC_LOG_LINK_DOWN
6d17h:580447.282 CMAC_LOG_RESET_FROM_DRIVER
6d17h:580447.284 CMAC_LOG_STATE_CHANGE
wait_for_link_up_state
6d17h:580447.286 CMAC_LOG_LINK_UP
6d17h:580447.290 CMAC_LOG_STATE_CHANGE
ds_channel_scanning_state
6d17h:580447.416 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
81/453000000/855000000/6000000
6d17h:580447.420 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
82/93000000/105000000/6000000
6d17h:580447.424 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
83/111025000/117025000/6000000
6d17h:580447.428 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
84/231012500/327012500/6000000
6d17h:580447.432 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
85/333025000/333025000/6000000
6d17h:580447.436 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
86/339012500/399012500/6000000
6d17h:580447.440 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
87/405000000/447000000/6000000
6d17h:580447.444 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
88/123012500/129012500/6000000
6d17h:580447.448 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
89/135012500/135012500/6000000
6d17h:580447.450 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
90/141000000/171000000/6000000
6d17h:580447.454 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
91/219000000/225000000/6000000
6d17h:580447.458 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
92/177000000/213000000/6000000
6d17h:580447.462 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
93/55752700/67753300/6000300
```

```
6d17h:580447.466 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
94/79753900/85754200/6000300
6d17h:580447.470 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
95/175758700/211760500/6000300
6d17h:580447.474 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
96/121756000/169758400/6000300
6d17h:580447.478 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
97/217760800/397769800/6000300
6d17h:580447.482 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
98/73753600/115755700/6000300
6d17h:580447.486 CMAC_LOG_WILL_SEARCH_DS_FREQUENCY_BAND
99/403770100/997799800/6000300
6d17h:580447.490 CMAC_LOG_WILL_SEARCH_SAVED_DS_FREQUENCY     501000000
6d17h:580447.492 CMAC_LOG_WILL_SEARCH_SAVED_DS_FREQUENCY     555000000
6d17h:%LINEPROTO-5-UPDOWN:Line protocol on Interface cable-modem0,
changed state to down
6d17h:580448.496 CMAC_LOG_UCD_MSG_RCVD                       1
6d17h:580448.500 CMAC_LOG_UCD_MSG_RCVD                       2
6d17h:580448.502 CMAC_LOG_UCD_MSG_RCVD                       3
6d17h:580448.504 CMAC_LOG_UCD_MSG_RCVD                       4
6d17h:580449.812 CMAC_LOG_DS_64QAM_LOCK_ACQUIRED             555000000
6d17h:580449.814 CMAC_LOG_DS_CHANNEL_SCAN_COMPLETED
6d17h:580449.816 CMAC_LOG_STATE_CHANGE
wait_ucd_state
6d17h:580450.510 CMAC_LOG_UCD_MSG_RCVD                       1
6d17h:580450.512 CMAC_LOG_UCD_MSG_RCVD                       2
6d17h:580450.514 CMAC_LOG_UCD_MSG_RCVD                       3
6d17h:580450.518 CMAC_LOG_UCD_MSG_RCVD                       4
6d17h:580452.524 CMAC_LOG_UCD_MSG_RCVD                       1
6d17h:580452.528 CMAC_LOG_ALL_UCDS_FOUND
6d17h:580452.530 CMAC_LOG_STATE_CHANGE
wait_map_state
6d17h:580452.534 CMAC_LOG_UCD_NEW_US_FREQUENCY               19984000
6d17h:580452.536 CMAC_LOG_SLOT_SIZE_CHANGED                  8
6d17h:580452.616 CMAC_LOG_FOUND_US_CHANNEL                   4
6d17h:580452.618 CMAC_LOG_UCD_MSG_RCVD                       2
6d17h:580452.620 CMAC_LOG_UCD_MSG_RCVD                       3
6d17h:580452.624 CMAC_LOG_UCD_MSG_RCVD                       4
6d17h:580452.630 CMAC_LOG_MAP_MSG_RCVD
6d17h:580452.632 CMAC_LOG_INITIAL_RANGING_MINISLOTS          40
6d17h:580452.634 CMAC_LOG_STATE_CHANGE
ranging_1_state
6d17h:580452.636 CMAC_LOG_RANGING_OFFSET_SET_TO              9610
6d17h:580452.640 CMAC_LOG_POWER_LEVEL_IS                     28.0  dBmV
(commanded)
6d17h:580452.642 CMAC_LOG_STARTING_RANGING
6d17h:580452.644 CMAC_LOG_RANGING_BACKOFF_SET                0
6d17h:580452.648 CMAC_LOG_RNG_REQ_QUEUED                     0
6d17h:580452.690 CMAC_LOG_RNG_REQ_TRANSMITTED
6d17h:580452.694 CMAC_LOG_RNG_RSP_MSG_RCVD
6d17h:580452.698 CMAC_LOG_RNG_RSP_SID_ASSIGNED               6
6d17h:580452.700 CMAC_LOG_ADJUST_RANGING_OFFSET              2291
6d17h:580452.702 CMAC_LOG_RANGING_OFFSET_SET_TO              11901
6d17h:580452.704 CMAC_LOG_ADJUST_TX_POWER                    9
6d17h:580452.706 CMAC_LOG_POWER_LEVEL_IS                     30.0  dBmV
(commanded)
6d17h:580452.710 CMAC_LOG_STATE_CHANGE
ranging_2_state
6d17h:580452.714 CMAC_LOG_RNG_REQ_QUEUED                     6
6d17h:580453.600 CMAC_LOG_RNG_REQ_TRANSMITTED
6d17h:580453.604 CMAC_LOG_RNG_RSP_MSG_RCVD
6d17h:580453.606 CMAC_LOG_RANGING_SUCCESS
6d17h:580453.608 CMAC_LOG_STATE_CHANGE                       dhcp_state
6d17h:580453.742 CMAC_LOG_DHCP_ASSIGNED_IP_ADDRESS           5.108.1.3
6d17h:580453.744 CMAC_LOG_DHCP_TFTP_SERVER_ADDRESS           128.1.1.2
6d17h:580453.746 CMAC_LOG_DHCP_TOD_SERVER_ADDRESS            128.1.1.2
6d17h:580453.750 CMAC_LOG_DHCP_SET_GATEWAY_ADDRESS
6d17h:580453.752 CMAC_LOG_DHCP_TZ_OFFSET                     28800
6d17h:580453.754 CMAC_LOG_DHCP_CONFIG_FILE_NAME              gold.cm
6d17h:580453.756 CMAC_LOG_DHCP_ERROR_ACQUIRING_SEC_SVR_ADDR
6d17h:580453.760 CMAC_LOG_DHCP_COMPLETE
6d17h:580453.884 CMAC_LOG_STATE_CHANGE
establish_tod_state
6d17h:580453.890 CMAC_LOG_TOD_REQUEST_SENT
```

```
6d17h:580453.904 CMAC_LOG_TOD_REPLY_RECEIVED                3165851032
6d17h:580453.910 CMAC_LOG_TOD_COMPLETE
6d17h:580453.912 CMAC_LOG_STATE_CHANGE
security_association_state
6d17h:580453.916 CMAC_LOG_SECURITY_BYPASSED
6d17h:580453.918 CMAC_LOG_STATE_CHANGE
configuration_file_state
6d17h:580453.920 CMAC_LOG_LOADING_CONFIG_FILE               gold.cm
6d17h:%LINEPROTO-5-UPDOWN:Line protocol on Interface cable-modem0,
changed state to up
6d17h:580454.950 CMAC_LOG_CONFIG_FILE_PROCESS_COMPLETE
6d17h:580454.952 CMAC_LOG_STATE_CHANGE
registration_state
6d17h:580454.956 CMAC_LOG_REG_REQ_MSG_QUEUED
6d17h:580454.960 CMAC_LOG_REG_REQ_TRANSMITTED
6d17h:580454.964 CMAC_LOG_REG_RSP_MSG_RCVD
6d17h:580454.966 CMAC_LOG_COS_ASSIGNED_SID                  1/6
6d17h:580454.970 CMAC_LOG_RNG_REQ_QUEUED                    6
6d17h:580454.976 CMAC_LOG_REGISTRATION_OK
6d17h:580454.978 CMAC_LOG_STATE_CHANGE
establish_privacy_state
6d17h:580454.980 CMAC_LOG_PRIVACY_NOT_CONFIGURED
6d17h:580454.982 CMAC_LOG_STATE_CHANGE
maintenance_state
```

DOCSIS 1.1 Time Slot Scheduling

Enhanced time-slot scheduling mechanisms to support guaranteed delay- or jitter-sensitive traffic on the shared multiple access upstream link. For additional information, refer to the document titled *TCC+ Card for the Cisco uBR10000 Series Router* on Cisco.com and the Documentation CD-ROM.

DOCSIS 1.1 TLV Parser and Encoder

The Type-Length-Value (TLV) parser and encoder is a new module that handles parsing and encoding TLVs on the CMTS. All old DOCSIS1.0/1.0+ TLVs are supported. In addition, many new TLVs have been added in DOCSIS1.1, such as service flow encodings, classifier encodings, and support for PHS rules. The new TLV parser features are used by different MAC message modules.

Commands

```
Router# debug cable tlvs
```

DOCSIS 1.1 Token-Bucket Rate Shaping

Each time a packet belonging to a flow is transmitted on an output channel, the token-bucket policing function checks the rate limit status of the flow, passing information about a number of parameters. For configuration information, refer to one of these two sections:

- "Setting Downstream Rate Limiting and Traffic Shaping" section on page 9
- "Setting Upstream Rate Limiting and Traffic Shaping" section on page 24

DOCSIS 1.1 Two-Way Interoperability

The Cisco uBR10012 router offers interoperability with DOCSIS-based two-way CMs, Cisco cable access routers such as the Cisco uBR924 or Cisco uBR904, or Cisco uBR910 series cable data service units (DSUs). For additional information, refer to Chapter 5, "Configuring Basic Broadband Internet Access."

Optional Upstream Scheduler Modes

With this feature, the user is able to select either Unsolicited Grant Services (UGS) or Real Time Polling Service (rtPS) scheduling types, as well as packet-based or TDM-based scheduling. Low latency queueing (LLQ) emulates a packet-mode-like operation over the Time Division Multiplex (TDM) infrastructure of DOCSIS. As such, the feature provides the typical tradeoff between packets and TDM: with LLQ, the user has more flexibility in defining service parameters for UGS or rtPS, but with no guarantee (other than statistical distribution) regarding parameters such as delay and jitter.

Restrictions

- To ensure proper operation, Call Admission Control (CAC) must be enabled. When the Low Latency Queueing (LLQ) option is enabled, it is possible for the upstream path to be filled with so many calls that it becomes unusable, making voice quality unacceptable. CAC must be used to limit the number of calls to ensure acceptable voice quality, as well as to ensure traffic other than voice traffic.
- Even if CAC is not enabled, the default (DOCSIS) scheduling mode blocks traffic after a certain number of calls.
- Unsolicited Grant Services with Activity Detection (UGS-AD) and Non Real Time Polling Service (nrtPS) are not supported.

New and Changed Commands

cable upstream *n* scheduling type

Use this new command to turn the various scheduling modes on or off, where *n* specifies the upstream port.

```
Router(config-if)# [no] cable upstream n scheduling type [ugs | rtps] mode [llq | docsis]
```

For additional information about scheduler enhancements on the Cisco CMTS, refer to the following:

- *Cisco CMTS Feature Guide — Configuring Upstream Scheduler Modes on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_book09186a008019b6bd.html
- *DOCSIS 1.1 for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b57f.html

High Availability Features

Several powerful High Availability features are supported on the Cisco uBR10012 router:

- Automatic Revert Feature for HCCP N+1 Redundancy Switchover Events
- Backup Path Testing for the Cisco RF Switch
- DSX Messages and Synchronized PHS Information
- Factory-Configured HCCP N+1 Redundancy
- Globally Configured HCCP 4+1 and 7+1 Redundancy on the Cisco uBR10012 Router
- HCCP N+1 Redundancy Supporting DOCSIS 1.1 for the Cisco CMTS
- HCCP Timing and Error Enhancements in HCCP Redundancy Show Commands

- High Availability Support for Encrypted IP Multicast
- Shutdown and No Shutdown Enhancement for Cable Interfaces

Automatic Revert Feature for HCCP N+1 Redundancy Switchover Events

Cisco IOS release 12.3(13a)BC introduces the Auto-Revert feature for the Cisco uBR10012 router, to further enhance HCCP N+1 Redundancy on the Cisco CMTS. With this feature, when a switchover event is performed in manual fashion, from the HCCP Protect line-card, and the Protect line-card has a hardware fault, HCCP automatically reverts back to the HCCP Working line card. This is a very helpful feature, in that periodic switchovers can be performed for regular maintenance or testing purposes, yet subscriber service is not interrupted should such switchovers reveal unexpected problems with HCCP Protect line cards.

For further information about this feature and HCCP N+1 Redundancy on the Cisco CMTS, refer to these documents on Cisco.com:

- “N+1 Redundancy for the Cisco Cable Modem Termination System,” *Cisco CMTS Feature Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

Backup Path Testing for the Cisco RF Switch

Cisco IOS Release 12.3(13a)BC introduces the show hccp channel switch Cisco IOS command, wherein the Cisco RF Switch communicates with each module in the chassis to provide information as programmed in the RF Switch module bitmap. Cisco IOS Release 12.3(13a)BC performs polling every 10 seconds in response to this command, and reports RF Switch information as stored in cache. In normal operation, the switch requires from two to five seconds for SNMP response.

If SNMP errors are detected in response to this command, the switch may require a significantly longer timeout period. Cisco IOS Release 12.3(13a)BC introduces a keyboard break sequence to disrupt this timeout in such circumstances.

To introduce a break for the **show hccp channel switch** command, use the **Ctrl-Shift-6-x** break sequence—hold **Ctrl-Shift** keys, then press **6** then **x**.

After the break sequence, use the **show hccp g m channel** command to examine each individual HCCP member of a group, as required.

For additional information about HCCP N+1 Redundancy on the Cisco CMTS, refer to these documents on Cisco.com:

- “N+1 Redundancy on the Cisco CMTS” chapter in the *Cisco Cable Modem Termination System Feature Guide*:

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

DSX Messages and Synchronized PHS Information

Cisco IOS Release 12.3(17a)BC introduces support for PHS rules in a High Availability environment. In this release, and later releases, PHS rules synchronize and are supported during a switchover event of these types:

- Route Processor Redundancy Plus (RPR+), with Active and Standby Performance Routing Engines (PREs)
- HCCP N+1 Redundancy, with Working and Protect cable interface line cards

For additional information about these enhancements, and related High Availability features, refer to the following documents on Cisco.com:

- *N+1 Redundancy for the Cisco Cable Modem Termination System*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html
- *Route Processor Redundancy Plus for the Cisco uBR10012 Router*

  http://www.cisco.com/en/US/products/hw/cable/ps2209/products_feature_guide09186a00801a24e0.html

Factory-Configured HCCP N+1 Redundancy

Cisco IOS release 12.3(13a)BC introduces factory-configured HCCP configurations at the command-line interface (CLI) that allow plug-and-play operation of the Cisco RF switch in 7+1 HCCP Redundancy configuration. This Cisco IOS release supports additional HCCP commands in global configuration mode that automatically generate bitmaps and interface configuration for HCCP 7+1 line-card level redundancy.

For users in which maximum power is required, Cisco IOS Release 12.3(13a)BC continues to support configurations supported in prior Cisco IOS Releases, making it possible to use the legacy HCCP configuration for both 7+1 and 4+1 HCCP Redundancy in interface level implementation.

For additional information about this feature and HCCP N+1 Redundancy on the Cisco CMTS, refer to these documents on Cisco.com:

- "N+1 Redundancy for the Cisco Cable Modem Termination System," *Cisco CMTS Feature Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

Globally Configured HCCP 4+1 and 7+1 Redundancy on the Cisco uBR10012 Router

Cisco IOS Release 12.3(17a)BC introduces support for globally-configured HCCP N+1 Redundancy on the Cisco uBR10012 router. Cisco IOS Release 12.3(17a)BC supports both 4+1 and 7+1 Redundancy, in these High Availability configurations:

- 7+1 Redundancy, supporting the Cisco uBR10012 router with two Cisco RF Switches

  In this configuration, seven Working cable interface line cards are supported by one Protect cable interface l ine card. Two Cisco RF Switches are connected to seven MC5X20U/D cable interface line cards. Switchover events apply to an entire line card, rather than on an interface level, as in previous Cisco IOS releases supporting 7+1 Redundancy. Global configuration makes this High Availability feature easier to configure and use. 7+1 Redundancy is the default redundancy scheme for the Cisco uBR10012 router in Cisco IOS Release 12.3(17a)BC.

- 4+1 Redundancy, supporting the Cisco uBR10012 router with one Cisco RF Switch

  In this configuration, four Working cable interface line cards are supported by one Protect line card. One Cisco RF Switch is connected to five cable interface line cards. Switchover events apply to an entire line card.

Either form of N+1 Redundancy supports the Cisco uBR-MC5X20U/D broadband processing engine (BPE) on the Cisco uBR10012 router.

Note N+1 Redundancy requires that all BPEs in the Cisco uBR10012 router be the same. Only the Cisco uBR-MC5X20U/D BPE is supported.

Note Cisco IOS Release 12.3(17a)BC introduces simplified global configuration commands, supporting 4+1 or 7+1 Redundancy on the Cisco uBR10012 router. However, earlier configuration commands are not supported when Global-level N+1 Redundancy is configured on the Cisco uBR10012 router.

For additional information about HCCP 4+1 Redundancy, refer to the following document on Cisco.com:

- *N+1 Redundancy for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html

HCCP N+1 Redundancy Supporting DOCSIS 1.1 for the Cisco CMTS

The N+1 Redundancy for the Cisco CMTS feature extends the existing HCCP 1+1 cable interface redundancy feature, where one cable interface is designated the working interface, and a second cable interface is the protect interface. The protect interface comes online only when the working interface fails.

The N+1 Redundancy feature allows a single cable interface to act as the protect interface for up to 7 cable interfaces in the Cisco uBR10012 router, thereby significantly reducing the cost of providing redundant operation. The cable interface connections are made through the Cisco uBR-RFSW RF Switch.

Note For complete information about the N+1 Redundancy feature, see the *"N+1 Redundancy for the Cisco CMTS"* chapter in the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com.

HCCP Timing and Error Enhancements in HCCP Redundancy Show Commands

Cisco IOS release 12.3(13a)BC introduces enhanced information in **show** commands that support HCCP N+1 Redundancy on the Cisco CMTS. These commands allow you to check for synchronization history and errors between the HCCP Working and HCCP Protect cable interface line cards.

Cisco IOS Release 12.3(13a)BC introduces such enhancements to the following **show** commands:

- **show hccp error**
- **show hccp group**

For additional information about this feature and HCCP N+1 Redundancy on the Cisco CMTS, refer to these documents on Cisco.com:

- "N+1 Redundancy for the Cisco Cable Modem Termination System," *Cisco CMTS Feature Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

High Availability Support for Encrypted IP Multicast

Cisco IOS Release 12.3(17a)BC introduces support for IP Multicast streams during switchover events in a High Availability environment. This feature is supported for Route Processor Redundancy Plus (RPR+), N+1 Redundancy, and encrypted BPI+ streams.

For additional information about IP Multicast and High Availability, refer to these documents on Cisco.com:

- *Cisco CMTS Universal Broadband Router MIB Specifications Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_technical_reference_chapter09186a00805fd8fb.html
- *Dynamic Shared Secret for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801b17cc.html
- *IP Multicast in Cable Networks,* White Paper

  http://www.cisco.com/en/US/tech/tk828/technologies_case_study0900aecd802e2ce2.shtml
- *N+1 Redundancy for the Cisco Cable Modem Termination System*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html
- *Route Processor Redundancy Plus for the Cisco uBR10012 Router*

  http://www.cisco.com/en/US/products/hw/cable/ps2209/products_feature_guide09186a00801a24e0.html

Shutdown and No Shutdown Enhancement for Cable Interfaces

Cisco IOS release 12.3(13a)BC introduces a new behavior with the [no] shutdown interface configuration command. In HCCP N+1 Redundancy schemes, an interface that is shut down with the shutdown command does not create an HCCP Switchover event for the associated Working or Protect interface. Instead, cable modems go offline and return online when the **no shutdown** command is issued.

For additional information about this feature and HCCP N+1 Redundancy on the Cisco CMTS, refer to these documents on Cisco.com:

- "N+1 Redundancy for the Cisco Cable Modem Termination System," *Cisco CMTS Feature Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

Intercept Features

The Cisco uBR10012 router supports several intercept features through multiple Cisco IOS release trains:

- Access Control List Support for COPS Intercept
- Basic Wiretap Support
- Cable Monitor Enhancements
- Cable Monitor Support for Cisco MC5x20U-D and Cisco MC28U Broadband Processing Engines
- cable monitor Command
- COPS TCP Support for the Cisco Cable Modem Termination System
- Packet Intercept
- PXF ARP Filter
- PXF Divert Rate Limiting
- Service Independent Intercept (SII) Support

Access Control List Support for COPS Intercept

Cisco IOS Release 12.3(13a)BC introduces enhanced support for Access Control Lists (ACLs) and associated commands for the Common Open Policy Service (COPS) feature.

To configure access control lists (ACLs) for inbound connections to all COPS listener applications on the Cisco CMTS, user the **cops listeners access-list** command in global configuration mode. To remove this setting from the Cisco CMTS, us the **no** form of this command.

cops listeners access-list {*acl-num* | *acl-name*}

no cops listeners access-list {*acl-num* | *acl-name*}

Syntax Description

acl-num	Alphanumeric identifier of up to 30 characters, beginning with a letter that identifies the ACL to apply to the current interface.
acl-name	Numeric identifier that identifies the access list to apply to the current interface. For standard access lists, the valid range is 1 to 99; for extended access lists, the valid range is 100 to 199.

Additional Information

Refer also the Service Independent Interceopt (SII) feature in this document. For additional information, refer to the following documents on Cisco.com:

- *Configuring COPS for RSVP, Cisco IOS Versions 12.2 and 12.3*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b75c9.html

- *Cable Monitor and Intercept Features for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html

- *PacketCable and PacketCable Multimedia on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html

- *Cisco PacketCable Primer White Paper*

  http://www.cisco.com/en/US/netsol/ns341/ns121/ns342/ns343/networking_solutions_white_paper09186a0080179138.shtml

Basic Wiretap Support

This operations feature provides a mechanism that enables capture of user-to-user traffic. The wiretap facility is based on the MAC address of the RF CPE device, so the wiretap facility can be used for either data or digitized higher-priority connections. The feature is controlled by the new interface command, **cable intercept,** which requires a MAC address, an IP address, and a Universal Data Protocol (UDP) port number as its parameters:

cable intercept [*mac-address*] *ip-address udp-port*

When activated, the Cisco uBR10012 router examines each packet for the desired MAC address. When a matching MAC address is found (for either the origination or destination endpoint), a copy of the packet is encapsulated into a UDP packet, which is then sent to the specified server at the given IP address and port.

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Cable Monitor Enhancements

Cisco IOS Release 12.3(17a)BC introduces the following enhancements to the cable monitor feature:

- Access Control Lists are now supported on the Cisco uBR-MC5X20U/D and Cisco uBR-MC28U cable interface line cards
- Unconditional downstream sniffing now enables downstream packets to be monitored, either for MAC or data packets. This enhancement supports both DOCSIS and Ethernet packet encapsulation.

For additional information about this enhancements to the cable monitor feature, refer to the following documents on Cisco.com:

- *Cable Monitor and Intercept Features on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html

Cable Monitor Support for Cisco MC5x20U-D and Cisco MC28U Broadband Processing Engines

Cisco IOS Release 12.3(13a)BC introduces support for the Cable Monitor feature for the Cisco MC5x20U-D broadband processing engine (BPE) and the Cisco MC28U cable interface line card. These field replaceable units (FRUs) apply to the Cisco uBR10012 router, and the latter to the Cisco uBR7246VXR router. This feature enables intercept and monitoring capabilities for DOCSIS-compliant frames.

Note The cable monitor feature does not support access lists for intelligent cable interface line cards such as the Cisco MC28U or Cisco MC16U in the Cisco uBR7246VXR router, or any intelligent cable interface line card in the Cisco uBR10012 router.

The Cable Monitor and Intercept features for Cisco Cable Modem Termination System (CMTS) routers provide a software solution for monitoring and intercepting traffic coming from a cable network. This feature also gives service providers Lawful Intercept capabilities, such as those required by the Communications Assistance for Law Enforcement Act (CALEA).

The following example configures cable monitor for a specific interface and the associated MAC addresses:

```
Router(config)# interface Cable3/0
Router(config-if)# cable monitor interface GigabitEthernet0/1
mac-address 000e.5cc8.fa5f
packet-type data ethernet
Router(config-if)#
mac-address 000e.5cac.59f8
packet-type data ethernet
```

To display cable monitor configuration and status information, use the **show interfaces** command in Privileged EXEC mode:

```
Router# show interfaces cable 3/0 monitor
US/ Time Outbound  Flow     Flow Type      Flow  Packet MAC   MACEncap
DS  Stmp Interface Type     Identifier     Extn. Type   Extn. TypeType
all  no    Gi0/1   mac-addr 000e.5cc8.fa5f yes   data   no     -ethernet
all  no    Gi0/1   mac-addr 000e.5cac.59f8 yes   data   no     -ethernet
```

To display and monitor traffic statistics and counters over time, use the **show cable modem counters** and the **show interfaces** commands in Privileged EXEC mode, as illustrated:

```
Router# show interfaces cable 3/0 monitor
US/ Time Outbound  Flow     Flow Type      Flow  Packet MAC   MACEncap
DS  Stmp Interface Type     Identifier     Extn. Type   Extn. TypeType
all  no    Gi0/1   mac-addr 000e.5cc8.fa5f yes   data   no     -ethernet
all  no    Gi0/1   mac-addr 000e.5cac.59f8 yes   data   no     -ethernet

Router# show cable modem 000e.5cac.59f8  counters
MAC Address    US Packets   US Bytes   DS Packets   DS Bytes
000e.5cac.59f8 7537986      3828867645 7199188      3711248288

Router# show interfaces GigabitEthernet 0/1
GigabitEthernet0/1 is up, line protocol is up
  Hardware is BCM1250 Internal MAC, address is 000e.d6bd.2001 (bia 000e.d6bd.2001)
  Description: ***Sonde_analyse_trafic***
  Internet address is 82.216.52.1/30
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Full-duplex, 100Mb/s, media type is RJ45
```

```
output flow-control is XON, input flow-control is XON
ARP type: ARPA, ARP Timeout 04:00:00
Last input 00:00:08, output 00:00:01, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/5/0 (size/max/drops/flushes); Total output drops:361
Queueing strategy: fifo
Output queue: 0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   1094862 packets input, 70425672 bytes, 0 no buffer
   Received 0 broadcasts, 5 runts, 0 giants, 0 throttles
   0 input errors, 10 CRC, 0 frame, 0 overrun, 0 ignored
   0 watchdog, 37 multicast, 0 pause input
   0 input packets with dribble condition detected
   188665 packets output, 29355747 bytes, 0 underruns       <<< 188665 packets
   0 output errors, 0 collisions, 6 interface resets
   0 babbles, 0 late collision, 0 deferred
   12 lost carrier, 0 no carrier, 0 pause output
   0 output buffer failures, 0 output buffers swapped out
```

When cable monitor is active, counters for the above commands should increase over time. For additional information about cable monitoring on the Cisco CMTS, refer to these documents on Cisco.com:

- *Cable Monitor and Intercept Features for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

cable monitor Command

Cisco IOS Release 12.2(4)XF supports the **cable monitor** command, which allows an external LAN packet analyzer or other server to monitor inbound and outbound data packets for specific types of traffic sent between the Cisco CMTS and the CMs on a cable interface. This feature enables the CMTS administrator to analyze traffic problems with customer data exchanges. For complete information on configuring and using this feature, see the "Cable Monitor for the Cisco CMTS" chapter in the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com and the Documentation CD-ROM.

COPS TCP Support for the Cisco Cable Modem Termination System

Cisco IOS Release 12.3(13a)BC introduces optimized support for the Common Open Policy Service (COPS) feature for the Cisco uBR10012 router. This feature supports two new configuration commands for enabling and setting COPS processes. The COPS feature in Cisco 12.3(13a)BC enables the following COPS functions:

COPS DSCP Marking for the Cisco CMTS

This feature allows you to change the DSCP marking for COPS messages that are transmitted or received by the Cisco router. Differentiated Services Code Point (DSCP) values are used in Quality of Service (QoS) configurations on a Cisco router. DSCP summarizes the relationship between DSCP and IP precedence.

Cisco IOS Release 12.3(13a)BC supports this function with the **cops ip dscp** command in global configuration mode.

COPS TCP Window Size for the Cisco CMTS

This feature allows you to override the default TCP receive window size that is used by COPS processes. This setting can be used to prevent the COPS server from sending too much data at one time.

Cisco IOS Release 12.3(13a)BC supports this function with the **cops tcp window-size** command in global configuration mode.

Note: These two commands affect all TCP connections with all COPS servers.

cops ip dscp

To specify the marking for COPS messages that are transmitted by the Cisco router, use the **cops ip dscp** command in global configuration mode. To remove this configuration, use the **no** form of this command.

cops ip dscp *x*

no cops ip dscp

Syntax Description

x	This value specifies the markings with which COPS messages are transmitted. The following values are supported: • 0-63—DSCP value ranging from 0-63. • af11—Use AF11 dscp (001010) • af12—Use AF12 dscp (001100) • af13—Use AF13 dscp (001110) • af21—Use AF21 dscp (010010) • af22—Use AF22 dscp (010100) • af23—Use AF23 dscp (010110) • af31—Use AF31 dscp (011010) • af32—Use AF32 dscp (011100) • af33—Use AF33 dscp (011110) • af41—Use AF41 dscp (100010) • af42—Use AF42 dscp (100100) • af43—Use AF43 dscp (100110) • cs1—Use CS1 dscp (001000) [precedence 1] • cs2—Use CS2 dscp (010000) [precedence 2] • cs3—Use CS3 dscp (011000) [precedence 3] • cs4—Use CS4 dscp (100000) [precedence 4] • cs5—Use CS5 dscp (101000) [precedence 5] • cs6—Use CS6 dscp (110000) [precedence 6] • cs7—Use CS7 dscp (111000) [precedence 7] • default—Use default dscp (000000) • ef—Use EF dscp (101110)

Defaults

- For messages transmitted by the Cisco router, the default DSCP value is 0.
- For incoming connections to the Cisco router, by default, the COPS engine takes the DSCP value used by the COPS server that initiates the TCP connection.

Usage Guidelines

- The **cops ip dscp** command allows the Cisco router to re-mark the COPS packets for either incoming or outbound connections.
- This command affects all TCP connections with all COPS servers.
- This command does not affect existing connections to COPS servers. Once you issue this command, this function is supported only for new connections after that point in time.

Examples

The following example illustrates the cops ip dscp command with supported command variations:

```
Router(config)# cops ip dscp ?
 <0-63>   DSCP value
 af11     Use AF11 dscp (001010)
 af12     Use AF12 dscp (001100)
 af13     Use AF13 dscp (001110)
 af21     Use AF21 dscp (010010)
 af22     Use AF22 dscp (010100)
 af23     Use AF23 dscp (010110)
 af31     Use AF31 dscp (011010)
 af32     Use AF32 dscp (011100)
 af33     Use AF33 dscp (011110)
 af41     Use AF41 dscp (100010)
 af42     Use AF42 dscp (100100)
 af43     Use AF43 dscp (100110)
 cs1      Use CS1  dscp (001000) [precedence 1]
 cs2      Use CS2  dscp (010000) [precedence 2]
 cs3      Use CS3  dscp (011000) [precedence 3]
 cs4      Use CS4  dscp (100000) [precedence 4]
 cs5      Use CS5  dscp (101000) [precedence 5]
 cs6      Use CS6  dscp (110000) [precedence 6]
 cs7      Use CS7  dscp (111000) [precedence 7]
 default  Use default dscp (000000)
 ef       Use EF   dscp (101110)
```

Additional COPS Information

Cisco 12.3(13a)BC also supports Access Control Lists (ACLs) for use with COPS. Refer to the "Access Control List Support for COPS Intercept" section on page 46.

For additional information about configuring COPS on the Cisco CMTS, refer to the following documents on Cisco.com:

- *Cable Monitor and Intercept Features for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html
- *Configuring COPS for RSVP*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b75c9.html
- *COPS for RSVP*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b679d.html#53452

cops tcp window-size

To override the default TCP receive window size on the Cisco CMTS, use the **cops tcp window-size** command in global configuration mode. This setting allows you to prevent the COPS server from sending too much data at one time. To return the TCP window size to a default setting of 4K, use the **no** form of this command.

cops tcp window-size *bytes*

no cops tcp window-size

Syntax Description

bytes	This is the TCP window size setting in bytes. This value can range from 516 to 65535 bytes.

Defaults

The default COPS TCP window size is 4000 bytes.

Usage Guidelines

This command does not affect existing connections to COPS servers. Once you issue this command, this function is supported only for new connections after that point in time.

Examples

The following example configures the TCP window size to be 64000 bytes.

```
Router(config)# cops tcp window-size 64000
```

The following example illustrates online help for this command:

```
Router(config)# cops tcp window-size ?
 <516-65535>  Size in bytes
```

Additional COPS Information

Cisco 12.3(13a)BC also supports Access Control Lists (ACLs) for use with COPS. Refer to the "Access Control List Support for COPS Intercept" section on page 46.

For additional information about configuring COPS on the Cisco CMTS, refer to the following documents on Cisco.com:

- *Cable Monitor and Intercept Features for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html

- *Configuring COPS for RSVP*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b75c9.html

- *COPS for RSVP*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b679d.html#53452

Packet Intercept

This feature allows you to intercept cable network activities according to the interface MAC address.

To allow the CMTS to forward all traffic to and from a particular CM to a data collector located at particular User Datagram Protocol (UDP) port, use the **cable intercept** command in cable interface configuration mode. To deactivate this function, use the **no** form of this command.

cable intercept *mac-address ip-address udp-port*

no cable intercept *mac-address*

Syntax Description

mac-address	Specifies the MAC address.
ip-address	Specifies the IP address for the destination data collector.
udp-port	Specifies the destination UDP port number for the intercept stream at the data collector. Valid range is 0 to 65535.

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

PXF ARP Filter

Cisco IOS Release 12.3(17a)BC introduces PXF ARP Filter feature. The ARP filter now has a PXF component that filters ARP packets for identified "ARP offenders", thereby decreasing ARP punt rate and RP CPU usage.

For additional information, refer to the following document on Cisco.com

- *Cable ARP Filtering*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801eefa9.html

PXF Divert Rate Limiting

Cisco IOS Release 12.3(17a)BC introduces PXF Divert Rate Limiting feature. Rate-limiting on the divert path causes packets that will cause congestion to toRP queues to be dropped, before any packets have been queued, so valid packets are unaffected.

For additional information, refer to the following document on Cisco.com

- *Cable ARP Filtering*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801eefa9.html

Service Independent Intercept (SII) Support

Cisco CMTS supports the Communications Assistance for Law Enforcement Act (CALEA) for voice and data. Cisco IOS Release 12.3(13a)BC introduces support for Service Independent Intercept (SII) on the Cisco uBR10012 CMTS. Cisco SII provides a more robust level of the lawful intercept (LI) options offered in the Packet Intercept feature. Cisco SII is the next level of support for judicially authorized electronic intercept, to include dial access, mobile wireless, tunneled traffic, and Resilient Transport Protocol (RTP) for voice and data traffic on the Cisco CMTS. SII on the Cisco CMTS includes these functions:

- Packet intercept on specified or unspecified interfaces or ports
- Packet intercept on virtual interface bundles
- Corresponding SNMP MIB enhancements for each of these functions, as intercept requests are initiated by a mediation device (MD) using SNMPv3

Note For restrictions on this platform, see “Overview of CISCO-TAP-MIB” in *Cable Monitor and Intercept Features for the Cisco CMTS*. See Additional Information, page 54.

Note No new CLI commands are provided for this feature in Cisco IOS Release 12.3(13a)BC.

Cisco IOS Release 12.3(13a)BC enables full Multiple Service Operator (MSO) compliance with SII and LI regulations. Service providers worldwide are legally required to allow government agencies to conduct surveillance on the service provider's traditional telephony equipment. The objective of the SII feature is to enable service providers with New World networks that legally allow government agencies to conduct electronic network surveillance.

Lawful Intercept (LI) describes the process and judicial authority by which law enforcement agencies conduct electronic surveillance of circuit and packet-mode communications. LI is authorized by judicial or administrative order and implemented for either voice or data traffic on the Cisco CMTS. Table 7 lists the differences between packet intercept and SII features as implemented on the Cisco uBR10012.

Table 7 Differences Between Packet Intercept and SII Features on the Cisco uBR10012

Feature	Packet Intercept	Service Independent Intercept
Interface Type	Cable	Cable
IP Masks	255.255.255.255 or 0.0.0.0	255.255.255.255 or 0.0.0.0
L4 Ports	Any single port or 0–65535	Any single port or 0–65535
Protocol	UDP	Any
TOS/DSCP	Not supported	Supported

Additional Information

For additional information, refer to the following documents:

- *Configuring COPS for RSVP, Cisco IOS Versions 12.2 and 12.3*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800b75c9.html

- *Cable Monitor and Intercept Features for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b571.html
- *PacketCable and PacketCable Multimedia on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html
- *Cisco PacketCable Primer White Paper*

  http://www.cisco.com/en/US/netsol/ns341/ns121/ns342/ns343/networking_solutions_white_paper09186a0080179138.shtml

IP Broadcast and Multicast Features

The Cisco uBR10012 router supports the following IP broadcast and Multicast features:

- IP Broadcast Echo
- IP Multicast Echo
- Multicast QoS Support on the Cisco uBR10012 CMTS
- SSM Mapping

IP Broadcast Echo

You can activate upstream IP broadcast echo so that the Cisco uBR10012 router can echo broadcast packets. For configuration information, refer to the "Setting Optional Broadcast and Cable IP Multicast Echo" section on page 28.

IP Multicast Echo

With this feature, you can send a copy of each multicast packet (received from a cable line card) to the downstream ports associated with the MAC domain of the receiving US port. This feature allows for all CMs within a MAC domain to receive multicast packets sent by a CM in the same MAC domain. For additional information, refer to the "Setting Optional Broadcast and Cable IP Multicast Echo" section on page 28.

Multicast QoS Support on the Cisco uBR10012 CMTS

Cisco IOS Release 12.3(13a)BC introduces support for Multicast downstream QoS feature. This feature provides the ability to assign static mapping to a multicast group. The Multicast downstream QoS feature uses the existing infrastructure (DOCSIS 1.1 service flow) to assign a multicast service identifier (SID) to a multicast group used in the Baseline Privacy Interface (BPI) encryption feature.

When disabled, the Multicast downstream QoS feature does not impact any other features. The multicast packets to downstream cable interfaces are sent to the default service flow.

This feature is being implemented in response to CSCeg22989 which states, multicast traffic is not classified to any service flow, and therefore ends up queued on the default service flow. The default service flow has no specific QoS guarantees assigned to it. So once the interface approaches congestion level, multicast packets may be dropped.

Restrictions

- The multicast definitions are per-bundle, not per interface. This means that all downstreams in a bundle share the same multicast to QoS association. The downstreams will create their own service flows according to the same QoS parameters.
- Multicast to QoS definitions can not be assigned per sub-interface
- Multicast SIDs are not deleted when a group becomes idle (no response to IGMP reports).
- The QoS assignments for a multicast group can not be changed dynamically. If the user wishes to change them then a new “cable match” command must be configured.
- Multicast QoS is not supported on Multicast Echo on Cisco uBR10012 router.

New and Changed Commands

cable match address

Use the existing **cable match** command to assign QoS to a multicast group, with BPI either enabled or disabled.

```
router# cable match address <number>|<name> [service-class <name> [bpi-enable]]
router# no cable match address [<number>|<name> [service-class <name> [bpi-enable]]]
```

debug cable mcast-qos

Use this command to turn on CMTS Multicast Qos debugging.

```
router# debug cable mcast-qos
```

SSM Mapping

Cisco IOS Release 12.3(17a)BC introduces Source-Specific Multicast (SSM) Mapping support on the Cisco uBR10012 router.

When the SSM Mapping feature is configured, if a router receives an IGMP version 1 or version 2 membership report for a particular group G, the router translates this in one or more SSM (S, G) channel memberships, such as IGMPv3 (S, G) INCLUDE membership reports) for the well known sources associated with this group.

When the router receives an IGMP version 1 or version 2 membership report for group G, the router uses SSM mapping to determine one or more source IP addresses (Si) for group G. SSM mapping then translates the membership report as an IGMP version 3 report INCLUDE (G, [S1, G], [S2, G]...[Sn, G] and continues as if it had received an IGMP version 3 report. The router then sends out PIM joins toward (S1, G) to (Sn, G) and continues to be joined to these groups as long as it continues to receive the IGMP version 1 or version 2 membership reports and as long as the SSM mapping for the group remains the same.

When SSM Mapping feature is statically configured on the router, the source address or addresses (S) can be discovered either by a statically configured table on the router or by consulting a DNS. When the statically configured table is changed, or when the DNS mapping changes, the router will leave join to the current sources associated with the joined groups.

For additional information about this feature, refer to the following documents on Cisco.com:

- *Source Specific Multicast (SSM) Mapping*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123newft/123t/123t_2/gtssmma.htm

IP Routing Features

The Cisco uBR10012 router offers you several features to assist with IP routing configuration and performance.

- Cable ARP Filter Enhancement
- Configurable Registration Timeout
- Host-to-Host Communication (Proxy Address Resolution Protocol)
- Integrated Time-of-Day Server
- PBR support for the Cisco uBR10012
- Supported Protocols

For additional information about IP routing, refer to these and other documents on Cisco.com:

- *IP Routing Protocols* section in the *Cisco IOS IP Configuration Guide*, Release 12.2
- *IP Routed Protocols*
- *IP Technical Tips* web page by Cisco's Technical Assistance Center (TAC)
- *Routing Protocols* web page by Cisco's Technical Assistance Center (TAC)
- *Top Issues: IP Routing Protocols* web page by Cisco's Technical Assistance Center (TAC)
- Cisco's *Enabled Technologies* web page

Cable ARP Filter Enhancement

The **cable arp filter** command, introduced with Cisco IOS Release 12.2(15)BC2b, enables service providers to filter ARP request and reply packets. This prevents a large volume of such packets from interfering with the other traffic on the cable network.

Cisco IOS Release 12.3(9a)BC introduces enhanced command option syntax for the **cable arp filter** command, where *number* and *window-size* values are optional for **reply-accept** and **request-send** settings.

To control the number of Address Resolution Protocol (ARP) packets that are allowable for each Service ID (SID) on a cable interface, use the **cable arp** command in cable interface configuration mode. To stop the filtering of ARP broadcasts for CMs, use the **no** form of this command.

cable arp filter {**reply-accept** *number window-size* | **request-send** *number window-size*}

no cable arp filter {**reply-accept** | **request-send**}

default cable arp filter {**reply-accept** | **request-send**}

Syntax Description

reply-accept *number window-size*	Configures the cable interface to accept only the specified *number* of ARP reply packets every *window-size* seconds for each active Service ID (SID) on that interface. The cable interface drops ARP reply packets for a SID that would exceed this number. • *number* = (Optional) Number of ARP reply packets that is allowed for each SID within the window time period. The allowable range is 0 to 20 packets, with a default of 4 packets. If *number* is 0, the cable interface drops all ARP reply packets. If not specified, this value uses default. • *window-size* = (Optional) Size of the window time period, in seconds, in which to monitor ARP replies. The valid range is 1 to 5 seconds, with a default of 2 seconds.
request-send *number window-size*	Configures the cable interface to send only the specified *number* of ARP request packets every *window-size* seconds for each active SID on that interface. The cable interface drops ARP requests for a SID that would exceed this number. • *number* = (Optional) Number of ARP request packets that is allowed for each SID within the window time period. The allowable range is 0 to 20 packets, with a default of 4 packets. If *number* is 0, the cable interface does not send any ARP request packets. • *window-size* = (Optional) Size of the window time period, in seconds, in which to monitor ARP requests. The valid range is 1 to 5 seconds, with a default of 2 seconds.

Cisco IOS Release 12.3(9a)BC also removes a prior caveat with HCCP Protect interfaces. Previously, in the event of a revert-back HCCP N+1 switchover, manual removal of **cable arp filter reply** and **cable arp filter request** configurations may have been required afterward on Protect interfaces.

For more information about ARP Filtering, refer to the following document on Cisco.com:

- *Cable ARP Filtering*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/cblarpfl.htm

Configurable Registration Timeout

The registration timeout value (the T9 timer) is configurable. This configurable timer parameter describes the elapsed time from a CM's successful completion of Ranging State 2 to its initial registration request message. During this time, the CM establishes IP connectivity, Time of Day, and security (optional), and transfers operational parameters from the Trivial File Transfer Protocol (TFTP) server.

This capability allows you to change the CM registration value (the T9 timer). Use the **registration-timeout** command to set or reset the T9 timer.

Command	Description
registration-timeout *minutes*	Sets the T9 timer to the new value (from 2 to 60 minutes).
no cable registration-timeout	Resets the T9 timer to its default of 3 minutes.

Host-to-Host Communication (Proxy Address Resolution Protocol)

Proxy Address Resolution Protocol (ARP) allows the Cisco uBR10012 router to issue ARP requests on behalf of CMs on the same cable network subnet. Proxy ARP can help machines on a subnet reach remote subnets without configuring routing or a default gateway.

- The Cisco router's interface should be configured to accept and respond to proxy ARP.
- The workstation must be configured to view the entire network as a single network. This is typically done by configuring the workstation with a smaller subnet mask than the network really uses.
- The router replies to the proxy ARP request with its MAC address. Therefore, the workstation sends all traffic for this destination address to the router, and the router forwards it according to the routing table.

Hosts have no idea of the physical details of their network and assume it to be a flat network in which they can reach any destination simply by sending an ARP request. But using ARP for everything has disadvantages, some of which are listed below:

- This method increases the amount of ARP traffic on your segment.
- Hosts need larger ARP tables to handle IP-to-MAC address mappings.
- Security may be undermined. A machine can claim to be another in order to intercept packets, an act called "spoofing."
- ARP does not work for networks that do not use ARP for address resolution.
- ARP does not generalize to all network topologies (for example, more than one router connecting two physical networks).

For configuration information, refer to "Activating Cable Proxy ARP Requests" section on page 26.

Integrated Time-of-Day Server

This operational feature allows theCisco uBR10012 router to respond to time-of-day (ToD) (RFC 868) queries from cable interfaces during the registration process. For information about configuring DHCP, ToD, or TFTP services, refer to the chapter titled "Configuring DHCP, ToD, and TFTP Services" in the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com.

PBR support for the Cisco uBR10012

Policy-Based Routing (PBR) provides a tool for expressing and implementing the forwarding or routing of data packets, on the basis of the policies that are defined by network administrators. PBR allows policy override on routing protocol decisions by selectively applying policies based on access list and/or packet size.

Network administrators can also use PBR to selectively change the IP ToS, IP precedence, and IP QoS Group fields for matching incoming packets on an interface.

The Cisco uBR10012 universal broadband router supports a maximum of 255 PBR policies and 32 route maps within each policy. The following subset of policy-based routing commands is supported in Cisco IOS release 12.2(11)CY:

- **ip policy** *route-map map-tag*
- **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
- **match** *ip address* {*ACL-number* | *ACL-name*} [*ACL-number* | *ACL-name* ...]
- **match** *length min max*
- **set** [*default*] *interface type number* [*type number* ...]
- **set ip** [*default*] *next-hop ip-address* [*ip-address* ...]
- **set ip precedence** *value*
- **set ip qos-group** *value*

- **set ip tos** *value*
- **show route-map** [*map-tag*]

For more information on PBR, refer to the "Configuring Policy-Based Routing" chapter in the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2 at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fqos_c/fqcprt1/qcfpbr.htm

Supported Protocols

The Cisco uBR10012 router supports multiple protocols of multiple classes, including but not limited to, the following:

- Address Resolution Protocol (ARP)
- Cisco Discovery Protocol (CDP)
- Domain Name System (DNS)
- Internet Protocol (IP) v4/v5
- Simple Network Management Protocol (SNMP) v2 and SNMPv3 Integrated Dynamic Host Configuration Protocol (DHCP) server
- Trivial File Transfer Protocol (TFTP) client
- User Datagram Protocol (UDP)

Note Be aware that when configuring a routing protocol, the Cisco IOS software must reset the interfaces to enable the change. This normally does not significantly affect operations on the interface, except that when this is done on a cable interface, it causes all cable modems on that particular downstream to reinitialize, potentially interfering with data transmission on that downstream. Therefore, you should use routing global configuration commands, such as **router rip**, on a cable interface only when a minimum of subscribers would be affected.

For additional information about configuring IP routing protocols, refer to the "IP Routing Protocols" chapter in the *Cisco IOS IP Configuration Guide*, Release 12.2 on Cisco.com.

Management Features

The Cisco uBR10012 router provides you with the following features that make CMTS headend configuration, management, and DOCSIS support more powerful and efficient:

- Admission Control for the Cisco CMTS
- Broadband Internet Access
- Cable Interface Bundling
- CNEM Compliance
- Customer Premises Equipment Limitation and Override
- DOCSIS 2.0 SAMIS ECR Data Set
- DOCSIS Set-Top Gateway Issue 1.0
- Advanced-mode DOCSIS Set-Top Gateway Issue 1.1
- Downstream Channel ID Configuration
- Downstream Frequency Override
- Dynamic Channel Change (DCC) for Loadbalancing
- Dynamic Modulation Profiles
- Dynamic Upstream Modulation

- EtherChannel Support on the Cisco uBR10012 Universal Broadband Router
- Management Information Base (MIB) Changes and Enhancements
- MIBs Changes and Updates in Cisco IOS Release 12.3(9a)BC
- Pre-equalization Control for Cable Modems
- Route Processor Redundancy Support
- Secure Socket Layer Server for Usage-Based Billing
- SFID Support for Multicast and Cable Interface Bundling
- Simple Network Management Protocol Cable Modem Remote Query
- Simple Network Management Protocol v3
- Spectrum Management
- Advanced Spectrum Management Support on the Cisco uBR10012 CMTS
- Static CPE Override (cable submgmt default Command)
- Statistical Counters
- Subscriber Traffic Management (STM) Version 1.1
- Usage Based Billing (SAMIS)

Admission Control for the Cisco CMTS

Cisco IOS Release 12.3(13a)BC introduces Admission Control for the Cisco Cable Modem Termination System (CMTS).

Admission Control for the Cisco Cable Modem Termination System (CMTS) is a multifaceted feature that implements a Quality of Service (QoS) policy on the CMTS Headend. Admission Control establishes efficient resource and bandwidth utilization in a way that was not possible in prior Cisco IOS releases.

Admission Control monitors multiple system-level resources on the Cisco CMTS, and performs automatic resource allocation on a service-request basis. Admission Control maintains optimal system-level operation by preventing resource consumption that would otherwise degrade the performance for the entire Cisco CMTS. Furthermore, Admission Control can allocate upstream or downstream bandwidth resources to specific DOCSIS traffic types, and maintain such prioritization amidst very dynamic traffic conditions.

Admission Control uses two event types for resource monitoring and management—cable modem registration and dynamic service (voice call) requests. When either of these two events occurs on the Cisco CMTS, Admission Control verifies that the associated resources conform to the configured limits prior to admitting and supporting the service call request.

Admission Control is not a mechanism to apply QOS to the traffic flows. Scheduling and queuing are some of the mechanisms used for implementing the QOS. The QOS is applied on a per-packet basis. Admission Control checks are performed before the flow is committed.

Admission Control in Cisco IOS Release 12.3(13)BC monitors the following resources on the Cisco CMTS.

- *CPU utilization*—Admission Control monitors CPU utilization on the Cisco CMTS, and preserves QoS for existing service flows when new traffic would otherwise compromise CPU resources on the Cisco CMTS.
- *Memory resource utilization (I/O, Processor, and combined total)*—Admission Control monitors one or both memory resources and their consumption, and preserves QoS in the same way as CPU utilization.

- *Bandwidth utilization for upstream and downstream*—Admission Control monitors upstream and downstream bandwidth utilization, and associated service classes, whether for data or dynamic service traffic.

Cisco IOS Release 12.3(13a)BC introduces new configuration, **debug** and **show** commands for Admission Control on the Cisco CMTS. For additional information, refer to the following document on Cisco.com:

- *Admission Control for the Cisco Cable Modem Termination System*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a00804d2537.html

Broadband Internet Access

The Cisco uBR10012 router provides subscribers with broadband Internet access that processes IF/RF signals, TV signals, and analog and digital data signals. For configuration information, refer to Chapter 5, "Configuring Basic Broadband Internet Access."

Cable Interface Bundling

Cable interface bundling provides for IP address conservation with routing capabilities over a two-way cable plant. If you have limited IP address space, interface bundling conserves your IP address resources.

Interface bundling supports sharing one IP subnet across multiple cable interfaces grouped into a cable interface bundle with support for bundle masters. This feature can be used with Multiprotocol Label Switching (MPLS) configurations. For configuration information, refer to the **cable bundle** command in the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

CNEM Compliance

The Consistent Network Element Manageability (CNEM) Compliance feature enhances the network management capability of the CMTS platform by enabling the CMTS platform to be compliant with CNEM 1.3 requirements.

CNEM 1.3 requirements are designed to enable element management systems, with a minimum amount of effort, to maximize their coverage across the Cisco product line of network elements.

For additional information, refer to the following document on Cisco.com:

- *Cisco CMTS Universal Broadband Router MIB Specifications Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_technical_reference_book09186a00801e8b9c.html

Customer Premises Equipment Limitation and Override

Using the **cpe max** command, the Cisco uBR10012 router can report and limit the number of CPEs per CM using the CLI or SNMP. This feature is separate from the ability of a CM to support multiple CPE devices.

Command	Description
cpe max *cpe-num*	Specifies the maximum number of customer premises equipment (CPE) devices that can use the CM to connect to the cable network.
no cpe max	Removes the CPE specification.

Syntax Description		
	cpe-num	Specifies the number of CPEs. Valid range is 1 to 254.

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* and to the *Cisco Cable Modem Termination System Feature Guide*, both on Cisco.com.

DOCSIS 2.0 SAMIS ECR Data Set

The Usage-Based Billing feature for the Cisco Cable Modem Termination System (CMTS) provides subscriber account and billing information in the Subscriber Account Management Interface Specification (SAMIS) format. The SAMIS format is specified by the Data-over-Cable Service Interface Specifications (DOCSIS) Operations Support System Interface (OSSI) specification.

Release 12.3(17a)BC provides enhancements to the OSSI specifications, and billing reports (billing record format), added support to the CISCO-CABLE-METERING-MIB, which contains objects that provide subscriber account and billing information in the Subscriber Account Management Interface Specification (SAMIS) format, added support for DCC and DCC for Load balancing and Downstream LLQ.

For additional information, refer to the following document on Cisco.com:

- *Usage-Based Billing for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801ef1d7.html

DOCSIS Set-Top Gateway Issue 1.0

Cisco IOS Release 12.3(9a)BC introduces support for DOCSIS Set-Top Gateway (DSG) Issue 1.0 on the Cisco uBR10012 universal broadband router. The DOCSIS Set-Top Gateway (DSG) feature allows the Cisco CMTS to provide a class of cable services known as out-of-band (OOB) messaging to set-top boxes (STBs) over existing DOCSIS networks. This allows MSOs and other service providers to combine both DOCSIS and STB operations over one, open, vendor-independent network, without any change to the existing network or cable modems.

DSG is a CableLabs® specification that allows the Cisco CMTS to provide a class of cable services known as out-of-band (OOB) messaging to set-top boxes (STBs) over existing Data-over-Cable Service Interface Specifications (DOCSIS) cable networks. DSG 1.0 allows cable Multi-System Operators (MSOs) and other service providers to combine both DOCSIS and STB operations over a single, open and vendor-independent network without requiring any changes to the existing DOCSIS network infrastructure.

At the time of this Cisco publication, the CableLabs® DOCSIS DSG specification is in the current status of “Issued” as characterized by stability, rigorous review in industry and cross-vendor interoperability.

For additional information about configuring and using DSG 1.0 on the Cisco uBR10012 router, refer to the following document on Cisco.com:

- *DOCSIS Set-Top Gateway for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubrdsg.htm

Advanced-mode DOCSIS Set-Top Gateway Issue 1.1

Cisco IOS Release 12.3(13a)BC introduces support for DOCSIS Set-Top Gateway (DSG) Issue 1.1 on the Cisco uBR10012 router. DSG 1.1 builds on and supports the enhancements of DOCSIS Set-Top Gateway Issue 1.0 in the prior Cisco IOS 12.3(9a)BC release.

A-DSG 1.1 introduces powerful support for DOCSIS 1.1 and DOCSIS 2.0, and the latest DOCSIS DSG specifications. The benefits provided by A-DSG include the following:

- Retains the essential nature of out of band (OOB) messaging, but moves it to a modern technology base.
- Replaces single-vendor, low-density, special-purpose equipment on the network, with significantly increased subscriber bandwidth and traffic.
- Consolidates cable modem and STB data traffic on a shared DOCSIS channel.
- Increases high-speed data (HSD) services to cable TV subscribers over the DOCSIS 1.1 infrastructure,
- Extends support for DOCSIS 1.1 digital video broadcast traffic.
- Enables shared or dedicated support for either HSD or video traffic.
- Supports one- or two-way operations, and advanced, two-way interactive applications such as streaming video, Web browsing, e-mail, real-time chat applications, and targeted advertising services.

These powerful advantages maximize the performance and return of hybrid fiber-coaxial (HFC) plant investments.

Changes from Cisco DSG 1.0

DSG Issue 1.0 is oriented to the DOCSIS DSG-I01 specifications, while DSG Issue 1.1 is oriented towards DOCSIS DSG-I02 specifications, to include the new Advanced Mode DSG (A-DSG).

The following DSG 1.1 features are supported in 12.3(13a)BC while continuing support for Basic Mode DSG:

- DSG 1.1 enables the learning of dynamic tunnel definitions. DSG 1.0 only had static tunnel definitions (programmed into the set-top box).
- DSG 1.1 features new Cisco IOS command-line interface (CLI) configuration and **show** commands for A-DSG configuration and network information.

Unlike earlier issues of DSG, Advanced-mode DSG (A-DSG) uses a DOCSIS MAC Management Message called the Downstream Channel Descriptor (DCD) message, and this DCD message manages the DSG Tunnel traffic. The DCD message is sent once per second on each downstream and is used by the DSG Client to determine which tunnel and classifier to use.

The DCD has a DSG address table located in the DOCSIS MAC management message. The primary difference between DSG 1.0 (and earlier issues) and A-DSG 1.1 is that advanced mode uses DCD messages to manage the DSG tunnels.

The DCD message contains a group of DSG Rules and DSG Classifiers, including the following:

- DSG rules and rule priority
- DSG classifiers
- DSG channel list type/length value (TLV)
- DSG client identifier (whether broadcast, CA System, application, or MAC-level)
- DSG timer list
- DSG upstream channel ID (UCID) list
- Vendor-specific information field

Prerequisites for DSG 1.1

- Cisco IOS release 12.3(13a)BC or a later 12.3 BC release are required.
- Cisco DSG 1.1 is supported on the Cisco uBR10012 router with PRE1 or PRE2 performance routing engine modules.
- Cisco DSG 1.1 is supported on the Cisco uBR10012 router with the following cable interface line cards and broadband processing engines (BPEs):
  - Cisco uBR10-LCP2-MC16C/MC16E/MC16S Cable Interface Line Card
  - Cisco uBR10-LCP2-MC28C Cable Interface Line Card
  - Cisco uBR10-MC5X20S/U Broadband Processing Engine

Restrictions and Caveats for DSG 1.1

Cisco DSG 1.1 has the following restrictions:

- Cisco DSG 1.1 does not support Service Flow Quality of Service (QoS), which is available at Layer 3.
- Cisco DSG 1.1 does not support tunnel security, but strictly access control lists (ACLs).
- Cisco DSG 1.1 does not support subinterfaces.
- Cisco DSG 1.1 does not support HCCP N+1 interoperability.
- Cisco DSG 1.1 does not support SNMP MIBS for A-DSG.

Additional Information about DSG 1.1

- *Advanced-mode DOCSIS Set-Top Gateway Issue 1.1 for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guides_list.html
- *DOCSIS Set-Top Gateway (DSG) for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00802065c8.html
- *Cisco DOCSIS Set-top Gateway* White Paper

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_white_paper09186a00801b3f0f.shtml
- CableLabs *DOCSIS Set-top Gateway (DSG) Interface Specification SP-DSG-I03-041124*

  http://www.cablemodem.com/downloads/specs/CM-SP-DSG-I03-041124.pdf

Advanced-mode DOCSIS Set-Top Gateway Issue 1.2

Cisco IOS Release 12.3(17a)BC2 introduces certified support for advanced-mode DOCSIS Set-Top Gateway (DSG) Issue 1.2. DSG Issue 1.2 introduces support for the latest DOCSIS Set-Top specification from CableLabs™:

- *DOCSIS Set-top Gateway (DSG) Interface Specification*, CM-SP-DSG-I05-050812

  http://www.cablelabs.com/specifications/archives/CM-SP-DSG-I05-050812-Superseded.pdf

Cisco Advanced-mode DSG 1.2 is certified by CableLabs™, and is a powerful tool in support of latest industry innovations. Advanced-mode DSG 1.2 offers substantial support for enhanced DOCSIS implementation in the Broadband Cable environment. The set-top box dynamically learns the overall environment from the Cisco Cable Modem Termination System (CMTS), to include MAC address, traffic management rules, and classifiers. DSG 1.2 supports the DOCS-DSG-IF-MIB as one component of this functionality:

For additional DSG 1.2 information, refer to the following documents on Cisco.com:

- *Advanced-mode DOCSIS Set-Top Gateway 1.2 for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guides_list.html
- *Cisco CMTS Universal Broadband Router MIB Specifications Guide*, Rel 12.3(17a)BC2

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_mib_quick_reference_chapter09186a00806f06e5.html#wp2098579

Downstream Channel ID Configuration

This operational feature allows all cable interfaces on the HFC network to identify themselves using unique downstream channel IDs, instead of their downstream frequencies. CMs communicate their downstream ID when making a connection, not their downstream frequency. System administrators can enter a configurable downstream channel ID to a value other than the default. Thus, each downstream channel ID can be unique on a cable network. For configuration information, refer to "Assigning the Downstream Channel ID" section on page 6.

Downstream Frequency Override

The Cisco uBR10012 router is able to change the downstream frequency for any or all CMs, overriding the DOCSIS configuration file settings. For DOCSIS QoS configuration information, refer to the feature module titled *DOCSIS 1.1 for Cisco uBR7200 Series Universal Broadband Routers* on Cisco.com.

Downstream Load Balancing Distribution with Upstream Load Balancing

Cisco IOS Release 12.3(17b)BC4 introduces further enhancements to downstream load balancing, resulting in equalized upstream load balancing group members. This enhancement synchronizes the pending statistic between different cable interface line cards in the load balancing group.

This enhancement performs downstream load balancing that accounts for loads on upstream channels in the same upstream load balancing group, rather than on the basis of the entire downstream channel load. Prior Cisco IOS releases may not have distributed cable modems evenly over individual upstream channels, nor in a way that accounted for downstream and upstream segment loads that account for one another.

This enhancement applies when downstream load balancing occurs on a headend system with separate upstream load balancing segments; the upstream segments are spread over multiple downstreams segments. This enhancement provides an alternative downstream load balancing scheme that accounts and makes use of per-upstream loads rather than total downstream loads.

For additional information about Load Balancing on the Cisco CMTS, refer to the following documents on Cisco.com:

- *Load Balancing and Dynamic Channel Change on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801b17f2html
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

Dynamic Channel Change (DCC) for Loadbalancing

Cisco IOS Release 12.3(17a)BC introduces Dynamic Channel Change (DCC) and DCC for Load Balancing on the Cisco CMTS.

DCC in DOCSIS 1.1 dynamically changes cable modem upstream or downstream channels without forcing a cable modem to go offline, and without re-registration after the change. DCC supports four different initializations, instead of one, as in earlier DOCSIS support.

DCC and DCC for load balancing is supported on the Cisco uBR7246VXR router and the Cisco uBR10012 router with distributed cable interface line cards, including the Cisco MC28U and the Cisco MC5X20S/U/H.

- Load Balancing techniques allow for moving cable modems with DCC by using configurable initialization techniques.
- DCC allows line card channel changes across separate downstream channels in the same cable interface line card, with the DCC initialization techniques ranging from 0 to 4.
- DCC transfers cable modem state information from the originating downstream channel to the target downstream channel, and maintains synchronization of the cable modem information between the cable interface line card and the Network Processing Engine (NPE) or Route Processor (RP).
- When the target channel is in ATDMA mode, only DOCSIS 2.0-capable modems can be successfully load balanced. (Only DOCSIS 2.0-capable modems can operate on an ATDMA-only upstream channel.) Cisco recommends identical channel configurations in a load balancing group.

Dynamic Channel Change for Load Balancing entails the following new or enhanced commands in Cisco IOS Release 12.3(17a)BC, and later releases:

Global Configuration Commands

- **cable load-balance group** *group-num* **dcc-init-technique** <**0-4**>
- **cable load-balance group** *group-num* **policy { pcmm | ugs }**
- **cable load-balance group** *group-num* **threshold** {**load** | **pcmm** | **stability** | **ugs**} <**1-100**>
- **cable load-balance group** *group-num* **threshold load** <**1-100**> {**minimum**}
- **cable load-balance group** *group-num* **threshold load** <**1-100**> {**enforce**}

Testing Command

- **test cable dcc** *mac-addr* {*slot/port* | *slot/subslot/port*} *target-us-channel-id ranging-technique*

For configuration, command reference, testing, and examples for DCC on the Cisco CMTS, refer to the following documents on Cisco.com:

- *Load Balancing and Dynamic Channel Change (DCC) on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801b17f2.html

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801b17f2.html

Dynamic Modulation Profiles

For each modulation profile configuration, the Cisco uBR10012 router supports the following:

- Burst profile interval usage code
- Burst profile number
- Burst type
- Differential encoding enable and disable
- FEC correctable bytes value
- Forward error correction (FEC) code word length

- Guard time size
- Last code word shortened or lengthened
- Maximum burst size (see also
- Preamble length and unique word length
- Scrambler enable and disable
- Scrambler seed value

For additional information about configuring dynamic upstream modulation and modulation profiles, refer to the chapter titled *Spectrum Management for the Cable Modem Termination System* in the *Cisco Cable Modem Termination System Feature Guide*.

Dynamic Upstream Modulation

This spectrum management feature provides improved performance using proactive spectrum management functions. This feature monitors the signal-to-noise ratio (SNR) and forward error correction (FEC) counters in the active return path of each upstream port. It tracks whether the upstream channel signal quality can support the modulation scheme configured, and adjusts to the most robust modulation scheme when necessary.

For additional information about configuring dynamic upstream modulation and modulation profiles, refer to the chapter titled *Spectrum Management for the Cable Modem Termination System* in the *Cisco Cable Modem Termination System Feature Guide*.

EtherChannel Support on the Cisco uBR10012 Universal Broadband Router

Cisco IOS Release 12.3(9a)BC introduces support for Gigabit EtherChannel (GEC) on the Cisco uBR10012 universal broadband router with the PRE2 performance routing engine modules. Cisco IOS Release 12.3(9) supports Gigabit Ethernet interfaces for IEEE 802.1Q inter-VLAN trunking with increased bandwidth on the Cisco uBR10012 router.

Note FastEtherChannel (FEC) interfaces and ATM trunking are not supported on the Cisco uBR10012 router.

EtherChannel provides Gigabit Ethernet (GE) speeds by grouping multiple GE-speed ports into a logical port channel that supports speeds up to 8 Gbps. This provides fault-tolerant, high-speed links between switches, routers and servers.

Trunking is configured between the switch and the router to provide inter-VLAN communication over the network. Trunking carries traffic from several VLANs over a point-to-point link between the two network devices. In a campus network, trunking is configured over an EtherChannel link to carry the multiple VLAN information over a high-bandwidth channel.

For additional information about configuring EtherChannel on the Cisco uBR10012 router, refer to the following document on Cisco.com:

- *EtherChannel for the Cisco Cable Modem Termination System*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cfig_nts/ethrchan.htm

Management Information Base (MIB) Changes and Enhancements

MIB enhancements in Cisco IOS Release 12.3(17a)BC provide enhanced management features that enable the Cisco uBR 7200 Series router and the Cisco uBR10012 router to be managed through the Simple Network Management Protocol (SNMP). These enhanced management features allow you to:

- Use SNMP set and get requests to access information in Cisco CMTS universal broadband routers.
- Reduce the amount of time and system resources required to perform functions like inventory management.

- A standards-based technology (SNMP) for monitoring faults and performance on the router.
- Support for SNMP versions (SNMPv1, SNMPv2c, and SNMPv3).
- Notification of faults, alarms, and conditions that can affect services.

For additional information, refer to the following document on Cisco.com:

- *Cisco CMTS Universal Broadband Router MIB Specifications Guide*, the Revision History table:

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cmtsmib/cmtsmbpf.htm
- To access the *Cisco CMTS Universal Broadband Router MIB Specifications Guide*, go to:

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cmtsmib/index.htm

MIBs Changes and Updates in Cisco IOS Release 12.3(9a)BC

Cisco IOS Release 12.3(9a)BC adds the following new MIB support for the Cisco uBR10012 router.

- CISCO-CABLE-METERING-MIB
- CISCO-CABLE-QOS-MONITOR MIB
- CISCO-CABLE-SPECTRUM-MIB
- CISCO-ENHANCED-MEMPOOL-MIB
- CISCO-PROCESS-MIB
- DOCS-QOS-MIB
- DSG-IF-MIB

For additional information about MIBs for the Cisco CMTS, refer to the following resources on Cisco.com:

- *Cisco CMTS Universal Broadband Router MIB Specifications Guide*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cmtsmib/
- *SNMP Object Navigator*

  http://www.cisco.com/pcgi-bin/Support/Mibbrowser/unity.pl

CISCO-CABLE-METERING-MIB

The CISCO-CABLE-METERING-MIB contains objects that provide subscriber account and billing information in the Subscriber Account Management Interface Specification (SAMIS) format, also known as Usage-Based Billing on the Cisco CMTS. This format is specified by the Data-over-Cable Service Interface Specifications (DOCSIS) Operations Support System Interface (OSSI) specification.

The MODULE-IDENTITY for the CISCO-CABLE-METERING-MIB is ciscoCableMeteringMIB, and its top-level OID is 1.3.6.1.4.1.9.9.424 (iso.org.dod.internet.private.enterprises.cisco.ciscoMgmt.ciscoCableMeteringMIB).

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

Additional Information

For additional SAMIS information, refer to the following resource:

- *Usage Based Billing for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubrsamis.htm

CISCO-CABLE-QOS-MONITOR MIB

Cisco IOS Release 12.3(9a)BC introduces additional features for the CISCO-CABLE-QOS-MONITOR MIB, including the following:

- Clarified the descriptions of a number of objects.
- Added a number of objects in the ccqmCmtsEnforceRuleTable to support DOCSIS 1.1 and DOCSIS 2.0 cable modems and to support peak and off-peak monitoring.
- Added the ccqmCmtsIfBwUtilTable to provide thresholds for downstream/upstream bandwidth utilization.
- Deprecated and removed ccqmCmtsEnfRuleByteCount.

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

CISCO-CABLE-SPECTRUM-MIB

Cisco IOS Release 12.3(9) introduces support for the CISCO-CABLE-SPECTRUM-MIB on the Cisco uBR10012 universal broadband router, with these additional MIB object enhancements:

- ccsFlapListMaxSize and ccsFlapListCurrentSize SNMP objects provide additional description for cable flap lists.
- Added the ccsCmFlapTable to replace the ccsFlapTable. The new object uses `downstream`, `upstream` and `Mac` as indices to replace the ccsFlapTable object.
- The enhanced ccsSNRRequestTable object provides a table of SNR requests with modified description.
- Added the ccsUpSpecMgmtUpperBoundFreq object to assist with spectrum management on the Cisco CMTS.
- Added the ccsCompliance5 object.
- Added ccsCmFlapResetNow to reset the flap list for a particular cable modem.
- Updated the descriptions for ccsFlapListMaxSize, ccsFlapListCurrentSize, and ccsSNRRequestTable.

The following objects are also now deprecated:

- ccsFlapPowerAdjustThreshold
- ccsFlapMissThreshold
- ccsFlapResetAll
- ccsFlapClearAll
- ccsFlapLastClearTime

The maximum number of entries in the flap-list was changed from a maximum of 8191 for the entire router, to the following:

- 8191 entries for each Broadband Processing Engine (BPE) cable interface, such as the Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR10-MC5X20S/U.
- 8191 maximum flap-list entries for all non-BPE cable interfaces, such as the Cisco uBR-MC16C, Cisco uBR-MC16S, and Cisco uBR-MC28C.

Two objects are now used to track the flap list size:

- ccsFlapListMaxSize—Reflects the flap list size, as configured by the **cable flap-list size** command.
- ccsFlapListCurrentSize—Reflects the current size of the flap list for each MAC domain (downstream).

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

CISCO-ENHANCED-MEMPOOL-MIB

Cisco IOS Release 12.3(9) introduces support for the CISCO-CABLE-SPECTRUM-MIB on the Cisco uBR10012 universal broadband router. The CISCO-ENHANCED-MEMPOOL-MIB enables you to monitor CPU and memory utilization for “intelligent” line cards and broadband processing engines on the Cisco uBR10012 router. These include the Cisco MC16X and MC28X series line cards.

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

CISCO-PROCESS-MIB

Cisco IOS Release 12.3(9) introduces support for the CISCO-PROCESS-MIB on the Cisco uBR10012 universal broadband router with PRE2 modules.The CISCO-PROCESS-MIB enables you to monitor CPU and memory utilization for RF cards, cable interface line cards and broadband processing engines on the Cisco uBR10012 router.

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

DOCS-QOS-MIB

Cisco IOS Release 12.3(9) introduces additional MIB object enhancements for the DOCS-QOS-MIB on the Cisco uBR10012 universal broadband router:

- Updated with the DOCSIS operations support system interface (OSSI) v2.0-N-04.0139-2.
- The default values of docsQosPktClassIpSourceMask and docsQosPktClassIpDestMask objects are set to 0xFFFFFFFF.

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

DSG-IF-MIB

The DSG-IF-MIB defines objects that are used to configure, control, and monitor the operation of the DOCSIS Set-top Gateway (DSG) 1.0 feature on Cisco uBR7200 series and Cisco uBR10012 routers.

Note The MODULE-IDENTITY for the DSG-IF-MIB is dsgIfMib, and its top-level OID is 1.3.6.1.4.1.9.9.999 (iso.org.dod.internet.private.enterprises.cisco.ciscoMgmt.dsgIfMib). Because this is an experimental MIB, its top-level OID is expected to change when the DSG specifications are finalized.

Note Refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide* on Cisco.com for additional information and MIBs constraints.

Pre-equalization Control for Cable Modems

Cisco IOS Release 12.3(17a)BC introduces pre-equalization control for cable modems on a per-modem basis. This feature enhances support for pre-equalization control on an interface basis, using the Organizational Unique Identifier (OUI), which is also supported.

When pre-equalization is enabled on an upstream interface, this feature allows you to disable pre-equalization adjustment selectively, for a specific cable modem or a group of cable modems. This feature prevents cable modems from flapping when processing pre-equalization requests sent from the Cisco CMTS.

Restrictions

This feature observes the following restrictions in Cisco IOS Release 12.3(17a)BC:

- For pre-equalization to be supported on a per-modem basis, the cable modem must send verification of pre-equalization after it registers with the Cisco CMTS.
- The option of excluding the OUI is a global configuration. For the cable modem on which OUI is excluded, the excluded OUI is disabled for all interfaces. This method uses a list of OUI values, recording which modems are sent and not sent pre-equalization.

cable pre-equalization exclude

To exclude a cable modem from pre-equalization during registration with the Cisco CMTS, use the **cable pre-equalization exclude** command in global configuration mode. Exclusion is supported for a specified cable modem, or for a specified OUI value for the entire interface. To remove exclusion for the specified cable modem or interface, use the **no** form of this command. Removing this configuration returns the cable modem or interface to normal pre-equalization processes during cable modem registration.

cable pre-equalization exclude {**oui** | **modem**} *mac-addr*

no cable pre-equalization exclude {**oui** | **modem**} *mac-addr*

Syntax Description

oui	Organizational Unique identifier for the interface specified. Using this keyword excludes the specified OUI during cable modem registration for the associated interface.
modem	Cable Modem identifier for the cable modem specified. Using this keyword excludes the cable modem.
mac-addr	Identifier for the OUI or cable modem to be excluded.

Command Default

Pre-equalization is enabled by default on the Cisco router, and for cable modems that have a valid and operational DOCSIS configuration file. When enabled, pre-equalization sends ranging messages for the respective cable modems. When disabled with the new **exclude** command, pre-equalization is excluded for the respective cable modems.

Command Modes

Global configuration mode

Command History

Release	Modification
12.3(17a)BC	This command was introduced to the Cisco uBR10012 router and the Cisco uBR7246VXR router.

Usage Guidelines

The pre-equalization exclusion feature should be configured for the running configuration of the Network Processing Engine (NPE), the Performance Routing Engine (PRE), and the line card console.

Examples

The following example configures pre-equalization to be excluded for the specified cable modem. Pre-equalization data is not sent for the corresponding cable modem:

```
Router(config)# cable pre-equalization exclude modem mac-addr
```

The following example configures pre-equalization to be excluded for the specified OUI value of the entire interface. Pre-equalization data is not sent for the corresponding OUI value of the entire interface:

```
Router(config)# cable pre-equalization exclude oui mac-addr
```

The following series of commands configures pre-equalization on the Cisco uBR10012 router with MC5X20U BPEs. On the PRE Console, configure the following commands.

```
Router# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# cable pre-equalization exclude oui 00.09.04
Router(config)# end
Router# show run
Router# show running-config | inc oui
cable pre-equalization exclude oui 00.09.04
Router#
```

On the line card console for the same Cisco uBR10012 router, verify the configuration with the following command:

```
clc_7_1# show running-config | inc oui
cable pre-equalization exclude oui 00.09.04
clc_7_1#
```

The following series of commands configures pre-equalization on the Cisco uBR72436VXR router with MC28U cable interface line cards. On the Network Processing Engine (NPE) console, configure and verify with the following commands.

```
npeg1-test# conf t
Enter configuration commands, one per line. End with CNTL/Z.
npeg1-test(config)# cable pre-equalization exclude oui 00.09.24
npeg1-test(config)# end
npeg1-test#show ru
02:58:10: %SYS-5-CONFIG_I: Configured from console by consolen
npeg1-test# show running-config | inc oui
cable pre-equalization exclude oui 00.09.24
npeg1-test#
```

On the line card console for the same Cisco uBR7246VXR router, verify the configuration with the following command:

```
clc_4_0# show running-config | inc oui
cable pre-equalization exclude oui 00.09.24
clc_4_0#
```

After either of these exclusion methods for pre-equalization are configured, you can verify that all ranging messages do not include pre-equalization data. Use the following debug commands in global configuration mode:

- **debug cable range**
- **debug cable interface** cx/x/x mac-addr

Verify the ranging message for the non-excluded cable modems include pre-equalization data, and for the excluded cable modems, the ranging messages do not include such data.

The following example removes pre-equalization exclusion for the specified OUI and interface. This results in the cable modem or OUI to return to normal pre-equalization functions. Ranging messages resume sending pre-equalization data.

```
Router(config)# no cable pre-equalization exclude { oui | modem } mac-addr
```

Removal of this feature can be verified with the following **debug** command:

- **debug cable interface** cx/x/x mac-ad—Verifies the ranging message for all non-excl modems include pre-eq data, and for the excluded modems ranging messages do not include pre-eq data.

For additional information about this or other commands, refer to the following documents on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_command_reference_book09186a0080108e88.html

- *DOCSIS 1.1 for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b57f.html

Route Processor Redundancy Support

Cisco IOS Release 12.2(4)XF introduces support for Route Processor Redundancy (RPR) on the Cisco uBR10012 universal broadband router. The RPR feature enables the Cisco uBR10012 to use two PRE1 or PRE2 modules in a redundant configuration, so that if the primary PRE module fails or becomes inactive, the system automatically performs a failover, where the secondary PRE1 module takes over and assumes full responsibility for systems operations.

The RPR feature does not require a full reboot of the system to perform a failover. When the system is originally initialized, the secondary PRE1 or PRE2 module performs an abbreviated initialization routine—the module performs all self-checks and loads the Cisco IOS software, but instead of performing normal systems operations it begins monitoring the primary PRE module. If the secondary PRE1or PRE2 module detects a failure in the primary module, it can quickly assume the primary responsibility for systems operations.

Secure Socket Layer Server for Usage-Based Billing

Cisco IOS Release 12.3(17a)BC introduces support for the Secure Socket Layer (SSL) Server, used with the Usage-Based Billing feature of the Cisco CMTS. Usage-Based Billing implements the DOCSIS Subscriber Account Management Interface Specification (SAMIS) format.

This new capability enables the configuration of the SSL server between the Cisco CMTS and a collection server. Configuration, certificate creation, and **debug** commands are added or enhanced to support the SSL Server and certificates with the Usage-Based Billing feature.

For additional information, refer to the following document on Cisco.com:

- *Usage-Based Billing for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a00801ef1d7.html

SFID Support for Multicast and Cable Interface Bundling

Cisco IOS Release 12.3(9a)BC removes the prior restriction in Caveat CSCea45592 that prevented the creation of DOCSIS 1.1 upstream packet classifiers and service flow IDs (SFIDs) when configuring multicast groups with bundled cable interfaces. Cable interface bundling now supports SFIDs on Multicast groups.

Note SFIDs map individual CPE devices to separate MPLS-Virtual Private Network (VPN) interfaces.

Note Cisco IOS Release with the Cisco uBR10012 router does not support overlapping IP addresses with MPLS-VPN.

For additional configuration information, refer to the following document on Cisco.com:

- *Cable Interface Bundling for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/ufg_bund.htm

Simple Network Management Protocol Cable Modem Remote Query

The cable modem remote-query command was introduced for the Cisco uBR10012 router in the Cisco IOS Release 12.2(4)BC1b, and allows customers to query the cable modem performance statistics directly from the cable modem termination system (CMTS).

Users can poll the cable modems periodically using Simple Network Management Protocol (SNMP) and cache the information such as:

- IP address
- MAC address
- S/N ratio
- Upstream Transmit Power on the CMTS

This information helps the operators to know at a glance the state of a single modem and to have an overall status of the plant. For configuration information, refer to the *Configuring cable modem remote-query Command* at http://www.cisco.com/warp/public/109/remote_query.shtml.

Simple Network Management Protocol v3

SNMP version 3 offers enhanced security features and increases interoperability and ease of network management. The implementation set of MIBs allows the SNMP manager to gather data such as system card descriptions, serial numbers, hardware and software revision levels, and slot location. For additional information, refer to the "Configuring Global Parameters" section on page 8, and to the "MIBs Changes and Updates in Cisco IOS Release 12.3(9a)BC" section on page 69.

Service Class Setting Using SNMP

The Cisco uBR10012 router supports objects related to class of service. This aids in network management.

Spectrum Management

Spectrum management is a software and hardware feature provided in the CMTS so that the CMTS may sense both downstream and upstream plant impairments, report them to a management entity, and automatically mitigate them where possible. Spectrum management provides many capabilities that are described further in the *Cisco Cable Modem Termination System Feature Guide*.

Advanced Spectrum Management Support on the Cisco uBR10012 CMTS

Cisco IOS release 12.3(13a)BC introduces Advanced Spectrum Management for the Cisco uBR10012 router, with the following enhancements:

- Supports additional software functionality for the Cisco uBR10-LCP2-MC16C/E/S cable interface line card and the Cisco MC5x20S/U broadband processing engine.
- Supports spectrum analyzer functionality.
- Supports proactive channel management and hopping decisions, so as to avoid the negative impact of ingress noise, and to maintain uninterrupted subscriber service.
- Offers flexible configuration choices, allowing MSOs to determine the priority of the actions to be taken when ingress noise on the upstream channel exceeds the allowable thresholds. The configurable actions are frequency hopping, switching the modulation profile, and reducing the channel width.
- Performs Cisco Network Registrar (CNR) calculations using DSP algorithms in real-time on a per-interface and a per-modem basis.
- Intelligently determines when to modify the frequency, channel width, or modulation profile, based on CNR calculations in the active channel, the number of missed station maintenance polls, and the number of correctable or non-correctable Forward Error Correction (FEC) errors. Previously, channel hopping occurred when the number of missed station maintenance polls exceeded a user-defined threshold or the SNR reported by the Broadcom chip exceeded the DOCSIS thresholds.
- Enhances the Dynamic Upstream Modulation feature for the Cisco uBR-MC16S line card. This feature supports dynamic modulation using two upstream profiles. The primary profile (typically using 16-QAM or a mixed modulation profile) remains in effect at low noise conditions, but if upstream conditions worsen, the cable modems switch to the secondary profile (typically using QPSK modulation) to avoid going offline. When the noise conditions improve, the modems are moved back to the primary profile.

Commands for Enhanced Spectrum Management

A variety of commands for enhanced spectrum management now provide new options.

- **cable upstream** *n* **threshold cnr-profile1** *threshold1-in-dB* **cnr-profile2** *threshold2-in-dB* **corr-fec** *fec-corrected* **uncorr-fec** *fec-uncorrected*
- **cable upstream** *n* **upstream threshold snr-profiles** *threshold1-in-dB threshold2-in-dB*
- **cable upstream** *n* **threshold corr-fec** *corrfec-threshold*
- **cable upstream** *n* **threshold uncorr-fec** *uncorrfec-threshold*
- **show cable hop** *n* **upstream history**
- **show cable hop** *n* **upstream threshold**

Note For additional information and examples, see “Configuring Proactive Channel Management” and “Verifying the Spectrum Management Configuration” in *Spectrum Management for the Cisco CMTS*, at the following URL
:
http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/ufg_spec.htm

For additional information about spectrum management and advanced spectrum management on the Cisco CMTS, refer to the following documents on Cisco.com:

- *Spectrum Management and Advanced Spectrum Management for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b586.html
- *Advanced Spectrum Management Feature for the Cisco uBR-MC16S Cable Interface Line Card*

  http://www.cisco.com/en/US/products/sw/iosswrel/ps5013/products_feature_guide09186a00801999b2.html

Static CPE Override (cable submgmt default Command)

The **cable submgmt static-cpe-override** command enables Multiple Service Operators (MSOs) to override network DHCP settings on CPE devices when performing troubleshooting with a laptop computer and console connection to the Cisco universal broadband router.

For additional information about using the **cable submgmt static-cpe-override** command, refer to these documents on Cisco.com:

- *Cisco CMTS Static CPE Override*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cfig_nts/stat_cpe.htm
- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm

Statistical Counters

The **show controller c***x/y* **upstream** command has been enhanced to display additional statistical counters in the output.

Command	Description
show controller c*x***/0 upstream** *number*	Provides statistical counters in the enhanced output that include: • Average percentage of upstream utilization in minislots • Average percentage of contention slots • Average percentage of initial ranging slots • Average percentage of minislots that were due because the MAP scheduler was not able to request them in time

For additional command information, refer to the *Cisco IOS Interface Command Reference Guide, Release 12.2* on Cisco.com.

Subscriber Traffic Management (STM) Version 1.1

Cisco IOS Release 12.3(9a)BC introduces support for Subscriber Traffic Management (STM) through Version 1.1 on the Cisco uBR10012 universal broadband router. STM 1.1 supports DOCSIS 1.1-compliant cable modems.

The STM feature enables service providers to identify and control subscribers who exceed the maximum bandwidth allowed under their registered quality of service (QoS) profiles. STM 1.1 works with Network-Based Application Recognition (NBAR) and Access control lists (ACLs) to ensure full network performance to other network subscribers that abide by their service agreements. STM 1.1 also works in conjunction with the Cisco Broadband Troubleshooter 3.2 to support additional network management and troubleshooting functions in the Cisco CMTS.

STM 1.1 extends earlier STM functions to monitor a subscriber's traffic on DOCSIS 1.1 primary service flows and supports these additional features:

- Cisco Broadband Troubleshooter (CBT) 3.2 supports STM 1.1.
- DOCSIS 1.0-compliant and DOCSIS 1.1-compliant cable modem are supported.
- Monitoring and application of traffic management policies are applied on a service-flow basis.
- Monitoring window duration increased from seven to 30 days.

For additional information about STM 1.1 and Cisco CBT 3.2, refer to the following document on Cisco.com:

- *Subscriber Traffic Management for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubsubmon.htm
- *Release Notes for Cisco Broadband Troubleshooter Release 3.2*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/trblshtr/cbt32/cbt32rn.htm

Usage Based Billing (SAMIS)

Cisco IOS Release 12.3(9a)BC introduces the Usage-Based Billing feature on the Cisco uBR10012 router, supporting DOCSIS 1.0- and DOCSIS 1.1-compliant cable modems. This feature provides subscriber account and billing information in the Subscriber Account Management Interface Specification (SAMIS) format. SAMIS is specified by the Data-over-Cable Service Interface Specifications (DOCSIS) Operations Support System Interface (OSSI) specification.

The CISCO-CABLE-METERING-MIB is also introduced with Cisco IOS Release 12.3(9a)BC in support of SAMIS.

For additional information about configuring and monitoring Usage-Based Billing (SAMIS) on the Cisco uBR10012 CMTS, refer to the following document on Cisco.com:

- *Usage Based Billing for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubrsamis.htm

PacketCable and Voice Support Features

The Cisco uBR10012 router supports the following PacketCable and PacketCable MultiMedia features:

- PacketCable 1.0 With CALEA
- PacketCable Emergency 911 Cable Interface Line Card Prioritization

- PacketCable Emergency 911 Services Listing and History
- Packetcable Multimedia for the Cisco CMTS

PacketCable 1.0 With CALEA

Cisco IOS Release 12.3(9a)BC introduces DOCSIS 1.1 support for PacketCable 1.0 with Communications Assistance for Law Enforcement Act (CALEA) on the Cisco uBR10012 universal broadband router with the Cisco uBR10-MC5X20S/U Broadband Processing Engine (BPE).

PacketCable is a program initiative from Cablelabs and its associated vendors to establish a standard way of providing packet-based, real-time video and other multimedia traffic over hybrid fiber-coaxial (HFC) cable networks. The PacketCable specification is built upon the Data-over-Cable System Interface Specifications (DOCSIS) 1.1, but it extends the DOCSIS protocol with several other protocols for use over non-cable networks, such as the Internet and the public switched telephone network (PSTN).

This allows PacketCable to be an end-to-end solution for traffic that originates or terminates on a cable network, simplifying the task of providing multimedia services over an infrastructure composed of disparate networks and media types. It also provides an integrated approach to end-to-end call signaling, provisioning, quality of service (QoS), security, billing, and network management.

Cisco IOS Release 12.2(11)BC1 and later releases in the Cisco IOS 12.3 release train support the PacketCable 1.0 specifications and the CALEA intercept capabilities of the PacketCable 1.1 specifications.

For additional information about configuring PacketCable on the Cisco CMTS, refer to the following document on Cisco.com:

- *Configuring PacketCable on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html

PacketCable Emergency 911 Cable Interface Line Card Prioritization

Cisco IOS Release 12.3(13a)BC introduces PacketCable Emergency 911 cable interface line cad prioritization on the Cisco CMTS. This feature enables cable interface line cards that are supporting an Emergency 911 call to be given automatic priority over cable interface line cards supporting non-emergency voice calls, even in the case of HCCP switchover events. In such cases, Protect HCCP line card interfaces automatically prioritize service to Emergency 911 voice calls, should Working HCCP cable interface line cards be disrupted. This feature is enabled by default in Cisco IOS release 12.3(13a)BC, and may not be disabled with manual configuration.

Note Emergency 911 cable interface line card prioritization applies only to PacketCable voice calls.

During HCCP switchover events, cable modems recover in the following sequence in Cisco IOS release 12.3(13a)BC:

1. Cable modems supporting Emergency 911 voice traffic
2. Cable modems supporting non-emergency voice traffic
3. Cable modems that are nearing a T4 timeout event, in which service would be disrupted
4. Remaining cable modems

To view information about Emergency 911 voice events and cable interface line card prioritization on the Cisco CMTS, use the **show hccp** <*int x*> <*int y*> **modem** and **show hccp event-history** commands in privileged EXEC mode.

- *PacketCable and PacketCable Multimedia on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html
- *Cisco PacketCable Primer White Paper*

  http://www.cisco.com/en/US/netsol/ns341/ns121/ns342/ns343/networking_solutions_white_paper09186a0080179138.shtml

PacketCable Emergency 911 Services Listing and History

Cisco IOS release 12.3(13a)BC introduces enhanced informational support for PacketCable Emergency 911 calls on the Cisco CMTS, to include the following information and related history:

- active Emergency 911 calls
- recent Emergency 911 calls
- regular voice calls
- voice calls made after recent Emergency 911 calls

This feature is enabled and supported with the following new Cisco IOS command-line interface (CLI) configuration and **show** commands:

- **cable high-priority-call-window** <*minutes*>
- **show cable calls** [*interface cx/y* | *slot z*]
- **show cable calls** [*interface* | *slot*] for the Cisco uBR 7200 Series
- **show cable calls** [*interface* | *slot/subslot*] for the Cisco uBR10012 router
- **show cable modem** [*ip_addr* | *mac_addr* | *interface*] **calls**

To set the call window (in minutes) during which the Cisco CMTS maintains records of Emergency 911 calls, use the **cable high-priority-call-window** command in global configuration mode. To remove the call window configuration from the Cisco CMTS, use the no form of this command:

cable high-priority-call-window <*minutes*>

no cable high-priority-call-window

The following command example configures the call window on the Cisco uBR10012 router to be 1 minute in length:

```
Router(config)# cable high-priority-call-window 1
```

To observe Emergency 911 calls made within the configured window, use the **show cable calls** command in privileged EXEC mode:

show cable calls

The following command example illustrates that one Emergency 911 call was made on the Cable8/1/1 interface on the Cisco uBR10012 router during the window set for high priority calls:

```
Router# show cable calls

Interface   ActiveHiPriCalls  ActiveAllCalls  PostHiPriCallCMs  RecentHiPriCMs
Cable5/0/0  0                 0               0                 0
Cable5/0/1  0                 0               0                 0
Cable5/1/0  0                 0               0                 0
Cable5/1/1  0                 0               0                 0
Cable5/1/2  0                 0               0                 0
Cable5/1/3  0                 0               0                 0
Cable5/1/4  0                 0               0                 0
Cable6/0/0  0                 0               0                 0
```

```
Cable6/0/1  0                 0               0                 0
Cable7/0/0  0                 0               0                 0
Cable7/0/1  0                 0               0                 0
Cable8/1/0  0                 0               0                 0
Cable8/1/1  1                 1               0                 0
Cable8/1/2  0                 0               0                 0
Cable8/1/3  0                 0               0                 0
Cable8/1/4  0                 0               0                 0

Total       1                 1               0                 0
```

The following command example illustrates the change on the Cisco uBR10012 router when this Emergency 911 calls ends:

```
Router# show cable calls

Interface   ActiveHiPriCalls  ActiveAllCalls  PostHiPriCallCMs  RecentHiPriCMs
Cable5/0/0  0                 0               0                 0
Cable5/0/1  0                 0               0                 0
Cable5/1/0  0                 0               0                 0
Cable5/1/1  0                 0               0                 0
Cable5/1/2  0                 0               0                 0
Cable5/1/3  0                 0               0                 0
Cable5/1/4  0                 0               0                 0
Cable6/0/0  0                 0               0                 0
Cable6/0/1  0                 0               0                 0
Cable7/0/0  0                 0               0                 0
Cable7/0/1  0                 0               0                 0
Cable8/1/0  0                 0               0                 0
Cable8/1/1  0                 0               0                 1
Cable8/1/2  0                 0               0                 0
Cable8/1/3  0                 0               0                 0
Cable8/1/4  0                 0               0                 0

Total       0                 0               0                 1
```

The following command example illustrates available information when making a voice call from the same MTA to another MTA on the same interface:

```
Router# show cable calls

Interface   ActiveHiPriCalls  ActiveAllCalls  PostHiPriCallCMs  RecentHiPriCMs
Cable5/0/0  0                 0               0                 0
Cable5/0/1  0                 0               0                 0
Cable5/1/0  0                 0               0                 0
Cable5/1/1  0                 0               0                 0
Cable5/1/2  0                 0               0                 0
Cable5/1/3  0                 0               0                 0
Cable5/1/4  0                 0               0                 0
Cable6/0/0  0                 0               0                 0
Cable6/0/1  0                 0               0                 0
Cable7/0/0  0                 0               0                 0
Cable7/0/1  0                 0               0                 0
Cable8/1/0  0                 0               0                 0
Cable8/1/1  0                 2               1                 1
Cable8/1/2  0                 0               0                 0
Cable8/1/3  0                 0               0                 0
Cable8/1/4  0                 0               0                 0

Total       0                 2               1                 1
```

The following command example illustrates available information when a voice call from the same MTA to another MTA on the same interface ends:

```
Router# show cable calls

Interface   ActiveHiPriCalls  ActiveAllCalls  PostHiPriCallCMs  RecentHiPriCMs
Cable5/0/0  0                 0               0                 0
Cable5/0/1  0                 0               0                 0
Cable5/1/0  0                 0               0                 0
```

```
Cable5/1/1  0                 0               0                 0
Cable5/1/2  0                 0               0                 0
Cable5/1/3  0                 0               0                 0
Cable5/1/4  0                 0               0                 0
Cable6/0/0  0                 0               0                 0
Cable6/0/1  0                 0               0                 0
Cable7/0/0  0                 0               0                 0
Cable7/0/1  0                 0               0                 0
Cable8/1/0  0                 0               0                 0
Cable8/1/1  0                 0               0                 1
Cable8/1/2  0                 0               0                 0
Cable8/1/3  0                 0               0                 0
Cable8/1/4  0                 0               0                 0

Total       0                 0               0                 1
```

The following example illustrates the **show cable modem calls** command on the Cisco uBR10012 router over a period of time, with changing call status information:

```
Router# scm call

Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                    (min:sec)
0000.cab7.7b04 10.10.155.38    C8/1/1/U0 18    R                   0:39
Router# scm call

Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                    (min:sec)
```

The above example illustrates that call information disappears when a call ends. The following example illustrates a new Emergency 911 call on the Cisco CMTS:

```
Router# show cable modem calls

Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                    (min:sec)
0000.cab7.7b04 10.10.155.38    C8/1/1/U0 18    HV                  1:30

The following example illustrates a the end of the Emergency 911 call on the Cisco CMTS:

Router# show cable modem calls

Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                    (min:sec)
0000.cab7.7b04 10.10.155.38    C8/1/1/U0 18    R                   0:3
```

The following example illustrates a non-emergency voice call on the Cisco CMTS from the same MTA:

```
Router# show cable modem calls
```

```
Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                   (min:sec)
0000.ca36.f97d 10.10.155.25    C8/1/1/U0 5     V                     -
0000.cab7.7b04 10.10.155.38    C8/1/1/U0 18    RV                     0:30
```

The following example illustrates a the end of the non-emergency voice call on the Cisco CMTS:

```
Router# show cable modem calls

Cable Modem Call Status Flags:
H: Active high priority calls
R: Recent high priority calls
V: Active voice calls (including high priority)

MAC Address    IP Address      I/F       Prim  CMCallStatus  LatestHiPriCall
                                         Sid                   (min:sec)
0000.cab7.7b04 10.10.155.38    C8/1/1/U0 18    R                      0:36
```

- *PacketCable and PacketCable Multimedia on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html

- *Cisco PacketCable Primer White Paper*

  http://www.cisco.com/en/US/netsol/ns341/ns121/ns342/ns343/networking_solutions_white_paper09186a0080179138.shtml

Packetcable Multimedia for the Cisco CMTS

Cisco IOS Release 12.3(13a)BC introduces support for PacketCable Multimedia (PCMM) on the Cisco uBR10012 universal broadband router, and fully supports the CableLabs *PacketCable Multimedia Specification*, PKT-SP-MM-I02-040930.

http://www.packetcable.com/specifications/multimedia.html

As described by CableLabs, some key features of the PCMM service delivery framework include the following:

- Simple, powerful access to DOCSIS 1.1 QoS mechanisms supporting both time and volume-based network resource authorizations
- Abstract, event-based network resource auditing and management mechanisms
- A robust security infrastructure that provides integrity and appropriate levels of protection across all interfaces

More specifically, Cisco IOS Release 12.3(13a)BC expands or changes several PacketCable functions in earlier Cisco IOS releases, including the following:

- **Additional COPS Decision Messages**—PCMM supports additional COPS decision messages, such as the following. The new objects for messages, such as Gate-Set, Gate-Set-Ack and Gate-Info, include different traffic profile definitions, different gate object formats, with additional objects for gate state reporting and flow utilization.
  - Gate-Set
  - Gate-Set-Ack
  - Gate-Set-Err

  - Gate-Info
  - Gate-Info-Ack
  - Gate-Info-Err
  - Gate-Delete
  - Gate-Delete-Ack
  - Gate-Delete-Err
  - State-Report
- **Different COPS client and UDP port for COPS sessions—**PCMM uses a different COPS client type than does basic PacketCable, and PCMM uses a different UDP port for its COPS sessions. This can help to distinguish between PacketCable and PCMM COPS sessions on the Cisco CMTS.
- **MultiMedia State Machine**—PCMM supports a different MultiMedia state machine than does PacketCable. The following are machine state changes introduced in PCMM with Cisco IOS Release 12.3(13a)BC:
  - PCMM gates are all unidirectional. In PacketCable, each gate is associated with both an upstream and downstream service flow. Although unidirectional flows are allowed, a bidirectional phone connection only has one gate.

    PCMM differs in that each gate is now unidirectional, and is associated with only one service flow. As a result, the gate info element structure in PCMM differs significantly from that of PacketCable. PCMM only needs to maintain one set of service flow information, rather than maintaining both upstream and downstream information as does PacketCable.
  - DOCSIS DSX service flow information is now maintained on the Cisco CMTS. With PacketCable, gates are authorized, reserved, or committed first on the Cisco CMTS with a specific gate ID, and then the Cisco CMTS initiates a DSX exchange using the reserved or committed gate ID in the message. With PacketCable, the cable modem must issue the DSX message and create the service flows. However, with PCMM, when a gate is reserved or committed, the DSX message is generated and sent immediately by the Cisco CMTS. Therefore, the Policy Server sends all of the service flow information necessary to setup the service flow to the Cisco CMTS instead of the cable modem. This causes a major change in the state machine that controls the gate allocation procedures.
  - New timer definitions and event actions are supported on PCMM. New timer definitions and timer event actions are supported for proper behavior of the net state machine. Some of the timers used with PacketCable have been eliminated, while the events associated with other times have changed for PCMM.
  - New state transitions that did not exist in PacketCable 1.x have been added to PCMM. Specifically, a gate can now be transitioned back from Committed to Authorized or Reserved state.
  - Cable interface line cards and broadband processing engines perform distributed DOCSIS functions. The Cisco MC28U cable interface line card on the Cisco uBR7200 series routers, and all the line cards on the Cisco uBR10012 router, are considered distributed, because the DOCSIS functionality is performed by the line card processor. The GCP signaling for PCMM and the gate state machine will executed on the NPE or RP processor. Because of the split in this functionality, IPC signaling resides between the gate state machine and the DOCSIS layer processing.
- **Event management**—Event management messages have been modified to include information on the modified traffic profiles, and to match changes in the PCMM state machine. In addition, objects have been added to help support Gate usage and Gate commit time objects, used for usage limit based and time based gates.

For additional information about PacketCable and PacketCable Multimedia on the Cisco CMTS, refer to the following documents on Cisco.com:

- *PacketCable and PacketCable Multimedia on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008019b576.html
- *Cisco PacketCable Primer White Paper*

  http://www.cisco.com/en/US/netsol/ns341/ns121/ns342/ns343/networking_solutions_white_paper09186a0080179138.shtml

"PacketCable is a CableLabs®-led initiative that is aimed at developing interoperable interface specifications for delivering advanced, real-time multimedia services over two-way cable plant. Built on top of the industry's highly successful cable modem infrastructure, PacketCable networks use Internet protocol (IP) technology to enable a wide range of multimedia services, such as IP telephony, multimedia conferencing, interactive gaming, and general multimedia applications." (PacketCable.com)

CableLabs® describes key features of the PacketCable Multimedia IP service delivery framework as follows:

- Simple, powerful access to DOCSIS® 1.1 QoS mechanisms supporting both time and volume-basednetwork resource authorizations
- Abstract, event-based network resource auditing and management mechanisms
- A robust security infrastructure that provides integrity and appropriate levels of protection across all interfaces

PacketCable™ is a registered trademark of CableLabs®. Additional information and specifications are available online at the following CableLabs websites:

- PacketCable website

  http://www.packetcable.com
- PacketCable Multimedia specifications

  http://www.packetcable.com/specifications/multimedia.html

Security Features

The Cisco uBR10012 router supports multiple security features:

- Address Verification
- CM Transmission Burst Size
- Dynamic or Mobile Host Support
- Dynamic Shared Secret (DMIC) with OUI Exclusion

Note: Refer also to security features described in the "DOCSIS 1.1 Feature Support" section on page 27.

Address Verification

The Cisco uBR10012 router supports verification of cable interface and PC addresses to ensure that the cable interface service ID (SID) and MAC addresses are consistent. This security feature helps ensure that IP addresses are not spoofed. A PC behind a cable interface is assigned an IP address from the DHCP server. If a user on a second PC or cable interface statically assigns the same IP address to a PC, the Cisco uBR10012 router finds this case to help block the spoofing user. Using the command-line interface (CLI), administrators can determine the IP and MAC address of a given cable interface, and the SID number that shows the IP and MAC addresses of all devices learned in the cable interface MAC table. Using the service provider customer databases, administrators can cross-reference the spoofing cable interface and PC and prevent usage.

Refer to Chapter 4, “Managing Cable Modems on the Hybrid Fiber-Coaxial Network” to configure address verification.

CM Transmission Burst Size

The Cisco uBR10012 router allows CMs to register with a maximum transmission burst size up to 2000 bytes. This applies to DOCSIS 1.0 and 1.1 CMs that are configured with concatenation and no IP fragmentation.

For additional information about configuring dynamic upstream modulation and modulation profiles, refer to one or more of these documents on Cisco.com:

- *Cisco Cable Modem Termination System Feature Guide*
- *Cisco uBR7200 Series Dynamic Upstream Modulation* at http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_r_sw/spec_mgt.htm

Dynamic or Mobile Host Support

The **cable source-verify** command allows the CMTS administrator to bring up a PC behind one CM, then move it to another CM. This adds information for the hosts involved in host tables. To prevent security breaches, this feature supports pinging the host using the old SID to verify that it has indeed been moved. The security applies to upstream and downstream configuration.

Command	Description
cable source-verify dhcp	Configures the DHCP server to verify addresses.

Note The **no cable arp** command should be configured in the CMTS to prevent it from sending ARP requests.

The **no cable arp** command prevents the CMTS from sending an arp downstream to CPE hosts or to devices behind CMs requesting an IP/MAC address association. If the CMTS already knows the association, or is able to learn it in some other manner, IP packets are forwarded. Otherwise, if the destination is unknown, the packets are dropped.

Devices on a CM network may share a large subnet, but cannot communicate with each other without first going through the CMTS. The **no cable proxy arp** command prevents the CMTS from replying to arp requests for hosts on the same subnet, and thus prevents peer to peer communication between subscribers behind CMs.

For additional command information, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Dynamic Shared Secret (DMIC) with OUI Exclusion

Cisco IOS Release 12.3(9a)BC introduces the option of *excluding* the Organizational Unique Identifiers (OUIs) from being subjected to the DMIC check. The new **cable dynamic-secret exclude** command allow specific cable modems to be excluded from the Dynamic Shared Secret feature on the following Cisco CMTS platforms:

- Cisco uBR7246VXR universal broadband router
- Cisco uBR10012 universal broadband router

The Dynamic Shared Secret feature automatically creates a unique DOCSIS shared secret on a per-modem basis, creating a one-time use DOCSIS configuration file that is valid only for the current session. This ensures that a DOCSIS configuration file that has been downloaded for one cable modem can never be used by any other modem, nor can the same modem reuse this configuration file at a later time.

This patent-pending feature is designed to guarantee that all registered modems are using only the quality of service (QoS) parameters that have been specified by the DOCSIS provisioning system for that particular modem at the time of its registration.

For additional command information, refer to the following document on Cisco.com:

- *Configuring a Dynamic Shared Secret for the Cisco CMTS*
  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cfig_nts/ubrdmic.htm
- *Cisco Broadband Cable Command Reference Guide*
  http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm

Testing, Troubleshooting and Diagnostic Features

The Cisco uBR10012 router supports several troubleshooting and diagnostic features:

- Cisco Broadband Troubleshooter 3.2
- CBT 3.2 Spectrum Management Support with the Cisco uBR10-MC5X20S/U BPE
- Dynamic Ranging
- Flap List Support
- Online Offline Diagnostics (OOD) Support for the Cisco uBR10012 Universal Broadband Router

Cisco Broadband Troubleshooter 3.2

Cisco IOS Release 12.3(9a)BC introduces support for the Cisco Broadband Troubleshooter (CBT) Version 3.2 on the Cisco uBR10012 universal broadband router, with newly supported interoperability for the following additional software features:

- CBT 3.2 Spectrum Management Support with the Cisco uBR10-MC5X20S/U BPE, page 88
- Subscriber Traffic Management (STM) Version 1.1, page 78

Multiple Service Operators (MSO) provide a variety of services such as TV, video on demand, data, and voice telephony to subscribers. Network Administrators and radio frequency (RF) technicians need specialized tools to resolve RF problems in the MSO’s cable plant. Cisco Broadband Troubleshooter 3.2 (CBT 3.2) is a simple, easy-to-use tool designed to accurately recognize and resolve such issues.

The user can select up to three different cable modems (CMs) under the same CMTS or three different upstreams under the same CMTS. In addition, CBT 3.2 introduces the ability to display upstreams and cable modems combined (mixed) on the same trace window for monitoring and for playback.

Note
CBT 3.2 resolves the former CBT 3.1 caveat CSCee03388. With CBT 3.1, trace windows did not support the *mixing* of upstreams or cable modems.

For additional information about CBT 3.2, spectrum management and STM 1.1, refer to the following documents on Cisco.com:

- *Release Notes for Cisco Broadband Troubleshooter Release 3.2* http://www.cisco.com/univercd/cc/td/doc/product/cable/trblshtr/cbt32/cbt32rn.htm

- *Spectrum Management for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/ufg_spec.htm
- *Subscriber Traffic Management for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubsubmon.htm

CBT 3.2 Spectrum Management Support with the Cisco uBR10-MC5X20S/U BPE

Cisco IOS Release 12.3(9a)BC introduces support for remote spectrum management for the Cisco uBR10012 router. Cisco uBR10012 spectrum management supports interoperability with these enhancements to the Cisco CMTS in Cisco IOS 12.3(9a)BC:

- Cisco Broadband Troubleshooter 3.2, page 87, supporting the Cisco uBR10-MC5X20S/U Broadband Processing Engine (BPE)
- Subscriber Traffic Management (STM) Version 1.1, page 78

Additional supported spectrum management functions are available on the Cisco uBR10012 router. For a complete list, and the latest information about Spectrum Management on the Cisco uBR10012 router, refer to the following documents on Cisco.com:

- *Spectrum Management for the Cisco CMTS*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cfig_nts/ufg_spec.htm
- *Release Notes for Cisco Broadband Troubleshooter Release 3.2*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/trblshtr/cbt32/cbt32rn.htm

Dynamic Ranging

Dynamic ranging is the Cisco patent-pending troubleshooting feature that supports quick restoration of service following a catastrophic plant failure. With dynamic ranging, hundreds of cable interfaces can come back online quickly, because the time that cable interfaces spend deferring contention-ranging slots is minimized. This reduces cable interface reinitialization time.

This results from use of Cisco uBR10012 router algorithms that vary the number of contention bandwidth-request minislots and request slots. Software converts unallocated minislots in the current MAC allocation and management messages—known as MAPs—into request minislots as needed. At low upstream loads, most of the MAPs of that upstream have no grants to serve, and the scheduler converts all unallocated (ungranted) minislots into request minislots. This helps ensure a low access delay for CMs at low loads due to the abundance of request opportunities. At high upstream loads, the scheduler has data grants to be served before allocating the next request region, and automatically reduces the number of request minislots.

The initial ranging slots—also called initial maintenance slots—are each about 2 msecs wide. These slots are used by CMs joining the cable network, and thus, are subject to ranging collisions. CMs use these slots for initial connectivity with the CMTS only. After the initial ranging message from the CM is received successfully, the CM no longer uses such contention-ranging slots for subsequent operations.

The CMTS periodically polls CMs with unicast station maintenance slots. Any action that involves a simultaneous bringing up of many CMs on an upstream channel—service restoration after a catastrophic power failure, online insertion and removal (OIR) for CMTS cable interface line cards, or fiber node servicing—gives rise to an impulse-ranging contention state on each of the affected upstream channels. Rebooted CMs on the upstream attempt to send initial ranging MAC messages using broadcast initial ranging slots at roughly the same time. Without theCisco uBR10012 router algorithms enabled, CMs can repeatedly collide and back off a random number of initial ranging slots independently before trying again.

With Cisco uBR10012 router algorithms enabled, the CMTS can detect such high-contention scenarios, and can increase the frequency of initial ranging slots to assist in quick resolution of ranging contention. After the high collision state is over—few persistent ranging collisions occur on the upstream—the CMTS detects this condition and switches back to the steady state mode. In the steady state mode, the frequency of initial ranging slots is a function of the upstream channel utilization. If extra upstream bandwidth is available, the CMTS allocates more initial upstream ranging slots. As soon as the MAC scheduler needs the upstream bandwidth for data grants, the MAC scheduler reduces the frequency of initial ranging slots.

For additional information about dynamic ranging on multiple components, refer to the Cisco Web site at http://www.cisco.com.

Flap List Support

The cable flap list troubleshooting feature tracks “flapping” CMs—CMs that have intermittent connectivity problems. Such connectivity problems might originate in the upstream or downstream portion of the cable plant, or originate in the CM itself. For additional information, refer to flap list information contained in the *Cisco Cable Modem Termination System Feature Guide*.

Online Offline Diagnostics (OOD) Support for the Cisco uBR10012 Universal Broadband Router

Cisco IOS Release 12.3(13a)BC introduces support for Online Offline Diagnostics (OOD) in the field for the Cisco uBR1002 router, including support in a high availability environment with HCCP N+1 Redundancy. The Online Offline Diagnostics (OOD) feature introduces a Field Diagnostic tool that provides a method of testing and verifying line card hardware problems.

This feature is supported on the following field replaceable units (FRUs) of the Cisco uBR10012 router:

- Cisco uBR10012 PRE1 and PRE2 Performance Routing Engine (PRE1 and PRE2) modules
- Cisco uBR10K-MC520S/U broadband processing engine (BPE)
- Cisco uBR10012 OC-48 DPT/POS WAN interface module

To view a list of hardware on the Cisco uBR10012 router that is supported by Field Diagnostics, refer to the following document:

- *Online Offline Diagnostics—User’s Guide for Cisco uBR10012 Router Field Diagnostics*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10kts/index.htm

If you would like to perform a hardware diagnostic test on a line card in your Cisco uBR10000 series router, an OOD Field Diagnostic image can be downloaded free of charge from Cisco Systems and used to test whether the line card problems are indeed due to faulty hardware. The test results verify whether or not the hardware is faulty.

Virtual Interfaces

The Cisco uBR10012 router supports the following virtual interface features, primarily in the Cisco IOS 12.3 BC release train:

- Virtual Interface and Frequency Stacking Support on the Cisco uBR10-MC5X20S/U BPE
- Virtual Interface Support for HCCP N+1 Redundancy
- Virtual Interface Bundling on the Cisco uBR10-MC5X20S/U BPE

Virtual Interface and Frequency Stacking Support on the Cisco uBR10-MC5X20S/U BPE

Virtual interfaces (VI) and frequency stacking (FS) are two features that allow user-configurable MAC domains and multiple frequencies on one physical connector.

- Virtual interfaces allow up to eight upstreams (USs) per downstream (DS). A virtual interface links an upstream (US) port to a physical connector.

  Cisco IOS Release 12.3(9a)BC introduces Virtual Interface Support for HCCP N+1 Redundancy with the Cisco uBR10-MC5X20S/U BPE.
- Frequency stacking allows two frequencies to be configured on one physical connector.

  Cisco IOS Release 12.3(9a)BC introduces support for frequency stacking on the Cisco uBR10012 router.

The Cisco uBR10-MC5X20S/UBPE can be configured (initially) to match the DS and US configuration of an existing line card, and then the cable operator can modify the configurations according to their needs. This supports different DS-to-US port ratios as such combination ratios evolve (1x6 » 1x4 » 1x1). For example, the line card can be used in 1x1 configuration for a business customer and in 1x7 configuration for residential customers.

For additional information about configuring virtual interfaces and frequency stacking, refer to the following document on Cisco.com:

- *Virtual Interfaces and Frequency Stacking Configuration on MC5x20S and MC28U Linecards*

  http://www.cisco.com/en/US/tech/tk86/tk804/technologies_white_paper09186a0080232b49.shtml
- *Configuring Virtual Interfaces on the Cisco uBR10-MC5X20S/U Card*

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/mc5x2vif.htm

Virtual Interface Support for HCCP N+1 Redundancy

Cisco IOS Release 12.3(9a)BC introduces support for HCCP N+1 Redundancy for virtual interfaces configured on the Cisco uBR10012 universal broadband router using the Cisco uBR10-MC5X20S/U BPE.

HCCP N+1 Redundancy is an important step toward high availability on CMTS and telecommunications networks that use broadband media. HCCP N+1 Redundancy can help limit Customer Premises Equipment (CPE) downtime by enabling robust automatic switchover and recovery in the event that there is a localized disruption in service.

Beginning with Cisco IOS Release 12.2(15)BC2a, HCCP N+1 Redundancy adds synchronization between HCCP Working interface configurations and those inherited upon switchover to HCCP Protect interfaces. This makes the configuration of both easier and switchover times faster.

For additional information about configuring virtual interfaces in HCCP N+1 redundancy on the Cisco CMTS, refer to the following document on Cisco.com:

- *N+1 Redundancy for the Cisco Cable Modem Termination System* http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008015096c.html

- *Configuring Virtual Interfaces on the Cisco uBR10-MC5X20S/U Card*
  http://www.cisco.com/en/US/products/hw/modules/ps4969/products_feature_guide09186a00801b17cd.html

Virtual Interface Bundling on the Cisco uBR10-MC5X20S/U BPE

Cisco IOS Release 12.3(13a)BC introduces support for virtual interface bundling on the Cisco uBR10012 universal broadband router and the Cisco uBR10-MC5X20S/U Broadband Processing Engine (BPE), and the Cisco uBR7246VXR router.

In prior Cisco IOS releases, cable interface bundling was limited to physical interfaces as master or slave interfaces, and **show** commands did not supply bundle information.

Virtual interface bundling removes the prior concepts of master and slave interfaces, and introduces these additional changes:

- Virtual interface bundling uses *bundle interface* and *bundle members* instead of master and slave interfaces.
- The virtual bundle interface is virtually defined, as with IP loopback addresses, for example.
- Virtual interface bundling supports bundle information in multiple **show ip interface** commands.

Virtual interface bundling prevents loss of connectivity on physical interfaces should there be a failure, problematic online insertion and removal (OIR) of one line card in the bundle, or erroneous removal of configuration on the master interface.

Virtual interface bundling supports and governs the following Layer 3 settings for the bundle member interfaces:

- IP address
- IP helper-address
- source-verify and lease-timer functions
- cable dhcp-giaddr (The giaddr field is set to the IP address of the DHCP client.)
- Protocol Independent Multicast (PIM)
- Access control lists (ACLs)
- Sub-interfaces

For additional configuration information, examples, and guidelines for virtual interface bundling, refer to the following documents on Cisco.com:

- *Cable Interface Bundling and Virtual Interface Bundling for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_chapter09186a008022eba7.html
- *Virtual Interfaces and Frequency Stacking Configuration on MC5x20S and MC28U Line Cards*

  http://www.cisco.com/en/US/tech/tk86/tk804/technologies_white_paper09186a0080232b49.shtml
- *Virtual Interfaces on the Cisco uBR10-MC5X20S/U Card*

  http://www.cisco.com/en/US/partner/products/hw/modules/ps4969/products_feature_guide09186a00801b17cd.html

VLAN Features

Cisco IOS IEEE 802.1Q provides support for IEEE 802.1Q encapsulation for Virtual LANs (VLANs). VLANs can be implemented with Cisco IOS platforms in environments where the IEEE 802.1Q encapsulation standard is required. With the introduction of the Cisco IOS IEEE 802.1Q Support feature, Cisco IOS supported 802.1Q VLAN encapsulation, in addition to the currently supported ISL and IEEE 802.10 SDE encapsulations.

Release 12.2(11)CY adds 802.1Q VLAN support for the Cisco uBR10012 universal broadband router. Service providers can use 802.1Q VLANs on Gigabit Ethernet interfaces to provide isolation between different content providers' traffic. 802.1Q VLANs may be mapped to MPLS VPN, maintaining traffic separation across an MPLS infrastructure.

For more information, refer to the ***IEEE 802.1.Q Configuration Guide*** at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/access/mar_3200/mar_conf/m511m80.htm

Refer also to the *Cisco IOS IEEE 802.1Q Support Guide* for command reference information at the following URL:

http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/120newft/120t/120t1/8021q.htm#xtocid1 367322

VPN and Layer 2 Tunneling Features

The Cisco uBR10012 router supports multiple features and functions for virtual private networks (VPNs), to include the following:

- Dynamic SID/VRF Mapping Support
- Generic Routing Encapsulation (GRE) Tunneling on the Cisco uBR10012
- IPv6 over L2VPN
- MPLS-VPN Network Support
- NetFlow Accounting Versions 5 and 8 Support
- Transparent LAN Service (TLS) on the Cisco uBR10012 Router with IEEE 802.1Q
- Transparent LAN Service and Layer 2 Virtual Private Networks

Dynamic SID/VRF Mapping Support

Cisco IOS release 12.3(13a)BC introduces support for dynamic service ID (SID) and VRF mapping on the Cisco CMTS, to support VoIP with MPLS. Formerly, the MPLS SID mapping feature only applied to provisioned service flows. This feature enables the mapping of all PacketCable DQoS service flows to one particular VRF.

For additional information, refer to the following:

- *Mapping Service Flows to MPLS VPN on the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide_book09186a008019b6bd.html

Generic Routing Encapsulation (GRE) Tunneling on the Cisco uBR10012

Cisco IOS Release 12.3(17a)BC introduces Generic Routing Encapsulation (GRE) Tunneling on the Cisco uBR10012.

Generic Route Encapsulation (GRE) is a tunneling protocol that can encapsulate a variety of packet types inside IP tunnels, creating a virtual point-to-point link to Cisco routers at remote points over an IP internetwork.

IPv6 over L2VPN

Beginning with Cisco IOS Release 12.3(17a)BC, the Cisco uBR10012 router now supports IPv6 using Layer 2 VPNs based on SID to 802.1q mapping. The Cisco uBR10012 router already supported Transparent LAN service with Layer 2 VPNs in Cisco IOS Release 12.3(13a)BC and later releases. As more Internet users switch to IPv6, the Cisco IPv6 protocol support helps enable the transition. IPv6 fixes a number of limitations in IPv4, such as limited numbers of available IPv4 addresses in addition to improved routing and network autoconfiguration. This feature allows customers to introduce IPv6 into their network with minimal operational impact.

For additional information about this feature, refer to the following documents on Cisco.com:

- IPv6 Documentation: overview, technology, design and configuration information

  http://www.cisco.com/en/US/tech/tk872/tsd_technology_support_protocol_home.html

MPLS-VPN Network Support

Using Multiprotocol Label Switching Virtual Private Network technology (MPLS VPN), service providers can create scalable and efficient private networks using a shared hybrid fiber-coaxial (HFC) network and Internet protocol (IP) infrastructure. For overview and configuration information, refer to the "Multiprotocol Label Switching" section in the *Cisco IOS Switching Services Configuration Guide*, Release 12.2 on Cisco.com.

NetFlow Accounting Versions 5 and 8 Support

Cisco IOS Release 12.3(9a)BC introduces support for NetFlow Accounting Versions 5 and 8 on the Cisco uBR10012 router.

Note The Cisco uBR10012 router requires the PRE2 performance routing engine module to support Netflow in Cisco IOS Release 12.3(9a)BC, and later releases in the 12.3 BC train. Also note that performance with packets-per-second (PPS) is reduced by 50% when Netflow is enabled, as two passes per packet are required.

NetFlow enables you to collect traffic flow statistics on your routing devices. NetFlow provides network administrators with access to "call detail recording" information from their data networks. Exported NetFlow data can be used for a variety of purposes, including network management and planning, enterprise accounting and departmental chargebacks, ISP billing, data warehousing and data mining for marketing purposes.

NetFlow is based on identifying packet flows for ingress IP packets. It does not require any connection-setup protocol either between routers or to any other networking device or end station and does not require any change externally—either to the traffic or packets themselves or to any other networking device.

NetFlow is completely transparent to the existing network, including end stations and application software and network devices like LAN switches. Also, NetFlow is performed independently on each internetworking device, it need not be operational on each router in the network. Using NetFlow Data

Export (NDE), you can export data to a remote workstation for data collection and further processing. Network planners can selectively invoke NDE on a router or on a per-subinterface basis to gain traffic performance, control, or accounting benefits in specific network locations.

NetFlow Version 5 Features and Format

NetFlow exports flow information in UDP datagrams in one of two formats. The version 1 format was the initially released version, and version 5 is a later enhancement to add Border Gateway Protocol (BGP) autonomous system (AS) information and flow sequence numbers.

In Netflow Version 1 and Version 5 formats, the datagram consists of a header and one or more flow records. The first field of the header contain the version number of the export datagram. Typically, a receiving application that accepts either format allocates a buffer big enough for the biggest possible datagram from either format and uses the version from the header to determine how to interpret the datagram. The second field in the header is the number of records in the datagram and should be used to index through the records.

All fields in either version 1 or version 5 formats are in network byte order. Table 5 and Table 6 describe the data format for version 1, and Table 7 and Table 8 describe the data format for version 5.

We recommend that receiving applications check datagrams to ensure that the datagrams are from a valid NetFlow source. We recommend you first check the size of the datagram to make sure it is at least long enough to contain the version and count fields. Next we recommend you verify that the version is valid (1 or 5) and that the number of received bytes is enough for the header and count flow records (using the appropriate version).

Because NetFlow export uses UDP to send export datagrams, it is possible for datagrams to be lost. To determine whether or not flow export information is lost, the version 5 header format contains a flow sequence number. The sequence number is equal to the sequence number of the previous plus the number of flows in the previous datagram. After receiving a new datagram, the receiving application can subtract the expected sequence number from the sequence number in the header to get the number of missed flows.

Table 8 lists the byte definitions for Netflow Version 5 header format.

Table 8 Netflow Version 5 Header Format

Bytes	Content	Description
0-3	version and count	Netflow export format version number and number of flows exported in this packet (1-30).[1]
4-7	SysUptime	Current time in milliseconds since router booted
8-11	unix_secs	Current seconds since 0000 UTC 1970.
12-15	unix_nsecs	Residual nanoseconds since 0000 UTC 1970.
16-19	flow_sequence	Sequence counter of total flows seen.
20-23	reserved	Unused (zero) bytes.

[1] Netflow Version 5 export packets (set with **ip flow-export** command) allow the number of records stored in the datagram to be a variable between 1 and 30.

Table 9 lists the byte definitions for Version 5 flow record format.

Table 9 Netflow Version 5 Flow Record Format

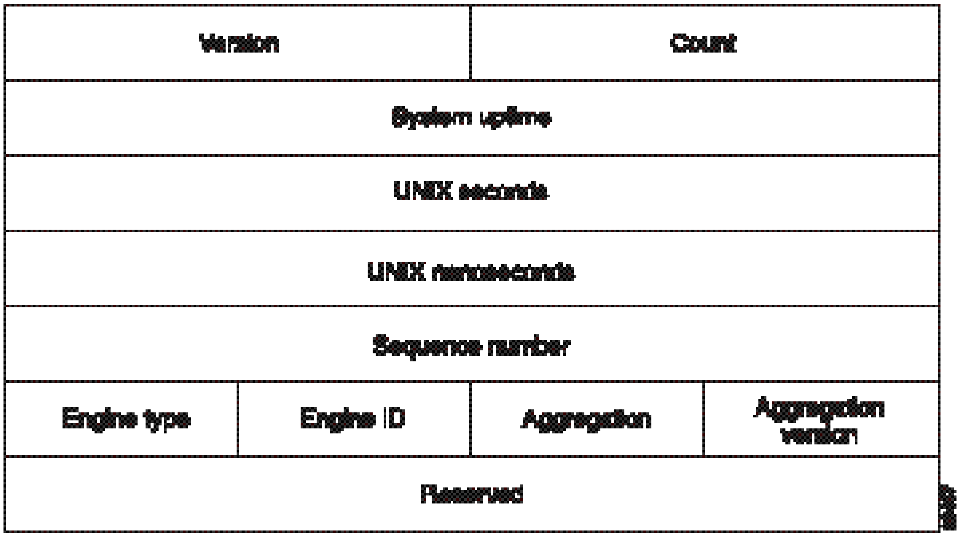
Bytes	Content	Description
0-3	srcaddr	Source IP address.
4-7	dstaddr	Destination IP address.
8-11	nexthop	Next hop router's IP address.
12-15	input and output	Input and output interface's SNMP index.
16-19	dPkts	Packets in the flow.
20-23	dOctets	Total number of Layer 3 bytes in the flow's packets.
24-27	First	SysUptime at start of flow.
28-31	Last	SysUptime at the time the last packet of flow was received.
32-35	srcport and dstport	TCP/UDP source and destination port number or equivalent.
36-39	pad1, tcp_flags, prot, and tos	Unused (zero) byte, Cumulative OR of TCP flags, IP protocol (for example, 6=TCP, 17=UDP), and IP type-of-service.
40-43	src_as and dst_as	AS of the source and destination, either origin or peer.
44-47	src_mask, dst_mask, and pad2	Source and destination address prefix mask bits, pad 2 is unused (zero) bytes.

Netflow Version 8 Features and Format

NetFlow exports flow information in UDP datagrams in one of several formats. Version 8, a new data export version, has been added to support data exports from aggregation caches. Version 8 allows for export datagrams to contain a subset of the usual version 5 export data, which is valid for a particular aggregations scheme type.

Figure 4 illustrates the Netflow Version 8 header format.

Figure 4 Version 8 Header Format



Version | Count

System uptime

UNIX seconds

UNIX nanoseconds

Sequence number

Engine type | Engine ID | Aggregation | Aggregation version

Reserved

Table 3 lists definitions for terms used in the version 8 header.

Table 10 Terms and Definitions for Version 8 Headers

Term	Definition
Version	The flow export format version number. In this case, the number is “8”.
Count	The number of export records in the datagram.
System Uptime	The number of milliseconds since the router was last booted.
UNIX Seconds	The number of seconds since 0000 Universal Time Code (UTC) 1970.
UNIX Nanoseconds	The number of residual nanoseconds since 0000UTC 1970.
Sequence Number	Sequence counter of total flows sent for this export stream.
Engine Type	The type of switching engine. RP=0 and LC=1.
Engine ID	The slot number of the NetFlow switching engine.
Aggregation	The type of aggregation scheme being used.
Aggregation Version	The aggregation subformat version number. The current value is “2”.

Additional Information about Netflow on the Cisco CMTS

For additional information about configuring Netflow Accounting on Cisco CMTS, refer to the following documents on Cisco.com:

- *NetFlow Overview*, Version 5

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1828/products_configuration_guide_chapter09186a00800ca62d.html
- *NetFlow Overview*, Version 8

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1831/products_configuration_guide_chapter09186a00800ca6cb.html
- *Configuring NetFlow* (Versions 1 and 5)

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1826/products_configuration_guide_chapter09186a00800880f9.html
- *Configuring NetFlow* (Version 8)

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1831/products_configuration_guide_chapter09186a00800ca6cc.html

  http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_configuration_guide_chapter09186a00800ca7f8.html
- *Cisco IOS NetFlow* documentation home page

  http://www.cisco.com/warp/public/732/Tech/nmp/netflow/netflow_documentation.shtml
- *Cisco IOS NetFlow White Papers*

  http://www.cisco.com/warp/public/732/Tech/nmp/netflow/netflow_techdoc.shtml
- *Cisco IOS Software Home Page for NetFlow*

  http://www.cisco.com/warp/public/732/Tech/nmp/netflow/index.shtml

Transparent LAN Service (TLS) on the Cisco uBR10012 Router with IEEE 802.1Q

Cisco IOS 12.3(9a)BC introduces support for the Transparent LAN Service over Cable feature on the Cisco 10012 router. This feature enhances existing Wide Area Network (WAN) support to provide more flexible Managed Access for multiple Internet service provider (ISP) support over a hybrid fiber-coaxial (HFC) cable network.

This feature allows service providers to create a Layer 2 tunnel by mapping an upstream service identifier (SID) to an IEEE 802.1Q Virtual Local Area Network (VLAN).

For additional information about configuring TLS on the Cisco uBR10012 CMTS, refer to the following document on Cisco.com:

- *Transparent LAN Service over Cable*

  http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cfig_nts/tls-cmts.htm

Cisco TLS for the Cisco uBR10012 router requires the PRE2 performance routing engine module with Cisco IOS Release 12.3(9a)BC or a later release in the Cisco IOS 12.3BC train.

Transparent LAN Service and Layer 2 Virtual Private Networks

Cisco IOS Release 12.3(13a)BC introduces the following changes or requirements for the TLS feature with Layer 2 VPNs:

- When the TLS feature is used with Layer 2 VPNs, the participating cable modems must have the Baseline Privacy Interface security feature (BPI) enabled. Otherwise, the Cisco CMTS drops such Layer 2 traffic in the upstream or downstream.
- Information about Customer Premises Equipment (CPE) does not display in the output of the **show cable modem** command.

Refer to the following documents on Cisco.com for additional TLS information:

- *TLS for the Cisco CMTS*

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_feature_guide09186a0080159396.html
- *TLS Over Cable* - TAC Document #60027

  http://www.cisco.com/en/US/products/hw/cable/ps2217/products_configuration_example09186a008029160d.shtml

CHAPTER 2

Configuring the Cable Modem Termination System for the First Time

This chapter describes how to start up and configure the Cisco uBR10000 series Cable Modem Termination System (CMTS) for the first time. The chapter contains the following sections:

Section	Purpose
"Preparing for Configuration" section on page 2	Identifies tasks and analysis that you must complete prior to powering on and configuring the Cisco uBR10012 router.
"Understanding Cisco uBR10012 Router Configuration Fundamentals" section on page 3	Describes the basic principles of using passwords and summarizes the initial router configuration utilities that are available to you. The remainder of this chapter provides instructions for each utility.
"Configuring the Cisco uBR10012 Router Using AutoInstall" section on page 7	Describes how to use the AutoInstall process, which is designed to configure the Cisco uBR10012 router automatically *after* connection to your WAN.
"Configuring the Cisco uBR10012 Router Using the Setup Facility" section on page 8	Describes how to use the Setup facility (also called the System Configuration dialog) for configuring your CMTS, an alternative to AutoInstall. The Setup facility supports several functions so that cable interfaces and cable interface line cards are fully operational (after initial setup). Use the Setup facility *prior to* completing a WAN or LAN connection to your router.
"Configuring the Cisco uBR10012 Router Manually Using Configuration Mode" section on page 13	Describes how to configure the Cisco uBR10012 router manually if you prefer not to use the Setup or AutoInstall facilities.
"Configuring the Cable Interface with the Extended Setup Facility" section on page 14	Provides instructions for using the Setup facility to create an initial configuration. The extended setup prompts you to configure each interface on the system.
"Reviewing Your Settings and Configurations" section on page 17	Provides commands to check your settings and review any changes to your configuration.

Preparing for Configuration

Complete these prerequisite steps before you power on and configure the Cisco uBR10012 router:

- Ensure that 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 Data-over-Cable Service Interface Specifications (DOCSIS) downstream and upstream radio frequency (RF) requirements.
- Ensure that your Cisco uBR10012 router is installed according to the instructions in the hardware installation guide that came with your CMTS.
- Ensure that all other required headend or distribution hub routing and network interface equipment is installed, configured, and operational (based on the supported services). This includes:
  - All routers
  - Servers (Dynamic Host Configuration Protocol (DHCP) servers, Trivial File Transfer Protocol (TFTP) servers, and time-of-day (ToD) servers)
  - Network management systems
  - Other configuration or billing systems
- Ensure that DHCP and DOCSIS configuration files have been created and pushed to appropriate servers so that each CM, when initialized, can:
  - Transmit a DHCP request
  - Receive an IP address
  - Obtain TFTP and ToD server addresses
  - Download a DOCSIS configuration file (or updated software image if using Cisco uBR924 cable access routers or Cisco uBR910 cable data service units (DSUs) in your network)
- Ensure that customer premises equipment (CPE)—CMs or set-top boxes (STBs), PCs, telephones, or facsimile machines—meet requirements for your network and service offerings.
- Be familiar with your channel plan to assign appropriate frequencies. Outline your strategies for setting up bundling, if applicable to your headend or distribution hub. As appropriate, obtain:
  - Passwords
  - IP addresses
  - Subnet masks
  - Device names

After these prerequisites are met, you are ready to configure the Cisco uBR10012 router. This includes, at a minimum:

- Configuring a host name and password for the Cisco uBR10012 router
- Configuring the CMTS to support IP over the cable plant and network backbone

⚠ Caution If you plan to use service-class-based provisioning, the service classes must be configured at the CMTS before CMs attempt to make a connection.

Understanding Cisco uBR10012 Router Configuration Fundamentals

This section describes the basic parameters of using passwords.

Note These sections provide minimal configuration instructions. For additional configuration information, refer to subsequent chapters in this guide. For examples of Cisco uBR10000 series CMTS configuration files, refer to the "Viewing Sample Configuration Files" section on page 17.

Tip Be sure that you have appropriate addresses and values based on your network before you attempt to configure the router. Enter the **show version** command to display the release of Cisco IOS software on your router.

Using the Enable Secret and the Enable Passwords

The Cisco uBR10012 router is administered using the Cisco command interpreter, called the EXEC. You must boot and log in to the router before you can enter an EXEC command.

Step 1 Connect a terminal to the I/O controller console port of the Cisco uBR10012 router and establish a terminal session. You can open a Terminal application (Hyper Terminal) on a PC as follows:

a. Connect using: Direct to Com 1

b. Set bits per second: 9600

c. Set data bits: 8

d. Set parity: none

e. Set stop bit: 1

f. Set flow control: none

Step 2 Power on the Cisco uBR10000 series. Enter **no** to choose the normal operating mode of the router. The user EXEC prompt appears:

```
Would you like to enter the initial dialog?[yes]: no
Router>
```

Setting Password Protection

Note For security purposes, the EXEC has two levels of access to commands: user EXEC mode and privileged EXEC mode. The commands available at the user level are a subset of those available at the privileged level.

Tip Because many privileged-level EXEC commands are used to set operating parameters, password-protect these commands to prevent unauthorized use.

At the EXEC prompt, enter one of the following two commands to set password protection:

- **enable secret** *password* (which is a very secure, encrypted password)
- **enable** *password* (which is a less secure, nonencrypted password)

To gain access to privileged-level commands, enter the desired password.

Note An enable secret password can contain from 1 to 25 uppercase and lowercase alphanumeric characters. An enable password can contain any number of uppercase and lowercase alphanumeric characters. A number cannot be the first character. Spaces are valid password characters; for example, "two words" is a valid password. Leading spaces are ignored. Trailing spaces are recognized. Alphanumeric characters are recognized as uppercase or lowercase.

Passwords should be different for maximum security. If you enter the same password for both during the setup script, the system accepts it, but you receive a warning message indicating that you should enter a different password.

Replacing or Recovering a Lost Password

This section describes how to recover a lost enable or console login password and how to replace a lost enable secret password on your Cisco uBR10012 router.

Note It is possible to recover the enable or console login password. The enable secret password is encrypted, however, and must be replaced with a new enable secret password.

Overview of the Password Recovery Process

Following is an overview of the general steps in the password recovery procedure:

Step 1 If you can log in to the router, enter the **show version** command to determine the existing configuration register value.

Step 2 Press the **Break** key to get to the bootstrap program prompt (ROM monitor). You might need to reload the system image by power cycling the router.

Step 3 Change the configuration register so that the following functions are enabled:

- Break
- Ignore startup configuration
- Boot from Flash memory

Note The key to recovering a lost password is to set the configuration register bit 6 (0x0040) so that the startup configuration (usually in NVRAM) is ignored. This allows you to log in without using a password and to display the startup configuration passwords.
Cisco recommends setting the configuration register to 0x142.

Step 4 Power cycle the router by turning power off and then back on.

Step 5 Log in to the router and enter the privileged EXEC mode.

Step 6 Enter the **show startup-config** command to display the passwords.

Step 7 Recover or replace the displayed passwords.

Step 8 Change the configuration register back to its original setting.

Note To recover a lost password if Break is disabled on the router, you must have physical access to the router.

Replacing or Recovering Passwords

Complete the following steps to recover or replace a lost enable, enable secret, or console login password:

Step 1 Attach an ASCII terminal to the console port on your Cisco uBR10012 router.

Step 2 Configure the terminal to operate at 9600 baud, 8 data bits, no parity, and 2 stop bits.

Step 3 If you can log in to the router as a nonprivileged user, enter the **show version** command to display the existing configuration register value. Note the value for later use. If you cannot log in to the router at all, continue with the next step.

Step 4 Press the **Break** key or send a Break from the console terminal.

- If Break is enabled, the router enters the ROM monitor, indicated by the ROM monitor prompt (`rommon n>`), where *n* is the number of the command line. Proceed to Step 6.
- If Break is disabled, power cycle the router (turn the router off or unplug the power cord, and then restore power). Proceed to Step 5.

Step 5 Within 60 seconds of restoring the power to the router, press the **Break** key or send a Break. This action causes the router to enter the ROM monitor and display the ROM monitor prompt (`rommon 1>`).

Step 6 To set the configuration register on a Cisco uBR10012 router, use the configuration register utility by entering the **confreg** command at the ROM monitor prompt as follows:

```
rommon 1> confreg
```

Answer **yes** to the enable `ignore system config info?` prompt and note the current configuration register settings.

Step 7 Initialize the router by entering the **reset** command as follows:

```
rommon 2> reset
```

The router initializes, the configuration register is set to 0x142, the router boots the system image from Flash memory and enters the System Configuration dialog (setup), as follows:

```
--- System Configuration Dialog --
```

Step 8 Enter **no** in response to the System Configuration dialog prompts until the following message appears:

```
Press RETURN to get started!
```

Step 9 Press **Return.** The user EXEC prompt appears as follows:

```
Router>
```

Step 10 Enter the **enable** command to enter privileged EXEC mode.

Step 11 Enter the **show startup-config** command to display the passwords in the configuration file as follows:

```
Router# show startup-config
```

Step 12 Scan the configuration file display looking for the passwords; the enable passwords are usually near the beginning of the file, and the console login or user EXEC password is near the end. The passwords displayed will look something like this:

```
enable secret 5 $1$ORPP$s9syZt4uKn3SnpuLDrhuei
enable password 23skiddoo
.
.
line con 0
 password onramp
```

Note The enable secret password is encrypted and cannot be recovered; it must be replaced. The enable and console passwords can be encrypted text or clear text.

Proceed to the next step to replace an enable secret, console login, or enable password. If there is no enable secret password, note the enable and console login passwords if they are not encrypted and proceed to Step 17.

Caution Do not perform the next step unless you have determined that you must change or replace the enable, enable secret, or console login passwords. Failure to follow the steps as presented here could cause your router configuration to be erased.

Step 13 Enter the **configure memory** command to load the startup configuration file into running memory. This action allows you to modify or replace passwords in the configuration.

```
Router# configure memory
```

Step 14 Enter the **configure terminal** command for configuration mode:

```
Router# configure terminal
```

Step 15 To change all three passwords, enter the following commands:

```
Router(config)# enable secret newpassword1
Router(config)# enable password newpassword2
Router(config)# line con 0
Router(config)# password newpassword3
```

Change only the passwords necessary for your configuration. You can remove individual passwords by using the **no** form of the previous commands. For example, entering the **no enable secret** command removes the enable secret password.

Step 16 You must configure all interfaces to *not* be administratively shut down as follows:

```
Router(config)# interface fast ethernet 0/0/0
Router(config)# no shutdown
```

Enter the equivalent commands for all interfaces that were originally configured. If you omit this step, all interfaces are administratively shut down and unavailable when the router is restarted.

Step 17 Use the **config-register** command to set the configuration register to the original value noted in Step 3 or Step 7.

Step 18 Press **Ctrl-Z** or type **end** to exit configuration mode:

```
Router(config)# end
```

Caution Do not perform the next step unless you have changed or replaced a password. If you have skipped Step 13 through Step 16 previously, then proceed now to Step 20. Failure to observe this sequence causes the system to erase your router configuration file.

Step 19 Enter the **copy running-config startup-config** command to save the new configuration to nonvolatile memory:

```
Router# copy running-config startup-config
```

Step 20 Enter the **reload** command to reboot the router:

```
Router# reload
```

Step 21 Log in to the router with the new or recovered passwords.

Configuring the Cisco uBR10012 Router Using AutoInstall

The AutoInstall process is designed to configure the Cisco uBR10012 router automatically after connection to your WAN.

For AutoInstall to work properly, a TCP/IP host on your network must be preconfigured to provide the required configuration files. The TCP/IP host can exist anywhere on the network as long as the following conditions are maintained:

- The host must be on the LAN or WAN side of the router's line card connection to the WAN.
- The User Datagram Protocol (UDP) broadcasts to and from the router.
- The TCP/IP host is enabled.

This functionality is coordinated by your system administrator at the site where the TCP/IP host is located. You should not use AutoInstall unless the required files are available on the TCP/IP host. Refer to the following publications for more information about AutoInstall:

- *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2 at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/ffun_c/index.htm
- *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2 at http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/ffun_r/index.htm

Preparing for the AutoInstall Process

Complete the following steps to prepare your Cisco uBR10012 router for the AutoInstall process:

Step 1 Attach the appropriate synchronous serial cable to the synchronous serial interface 0 on the router.

Step 2 Turn the power switch on each power supply to the ON (|) position. This action turns on power to the router.

The router loads the operating system image from Flash memory; this process can take several minutes. If the remote end of the WAN connection is connected and properly configured, the AutoInstall process begins.

Step 3 When the AutoInstall process is completed, use the **copy running-config startup-config** command to write the configuration data to the router's nonvolatile random-access memory (NVRAM):

```
Router# copy running-config startup-config
```

Completing this step saves the configuration settings that the AutoInstall process created to NVRAM. If you fail to do this, your configuration will be lost the next time you reload the router.

Configuring the Cisco uBR10012 Router Using the Setup Facility

The Cisco uBR10000 series Setup facility (also called the System Configuration dialog) is a useful and efficient tool for configuring your CMTS. The Setup facility supports the following functions so that cable interfaces and cable interface line cards are fully operational (after initial setup):

- Cable-specific commands
- Upstream frequency definition

For each cable interface, the following information is mandatory:

```
Per upstream:
        cable upstream n frequency f
        no cable upstream n shutdown
```

Options include definition of the following information:

- DHCP server address.
- Options are also provided to set downstream frequency for the upconverter per interface.

If you do not plan to use AutoInstall, do not connect the router's WAN or LAN cable to the channel service unit (CSU) and data service unit (DSU). If the WAN or LAN cable is connected to the CSU and DSU and the router does not have a configuration stored in NVRAM, the router attempts to run AutoInstall at startup.

Tip The router might take several minutes to determine that AutoInstall is not set up to a remote TCP/IP host. When the router determines that AutoInstall is not configured, it defaults to the Setup facility. If the LAN or WAN cable is not connected, the router boots from Flash memory and automatically runs the Setup facility.

Note You can run the Setup facility when the enable prompt (#) is displayed, by entering the **setup** command in privileged EXEC mode.

Configuring Global Parameters

When you first start the program, configure the global parameters to control system-wide settings:

Step 1 Connect a console terminal to the console port on the I/O controller, and then boot the router.

Step 2 After booting from Flash memory, the following information appears after about 30 seconds. When you see this information, you have successfully booted your router:

```
            Restricted Rights Legend

Use, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph
(c) of the Commercial Computer Software - Restricted
Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

            Cisco Systems, Inc.
            170 West Tasman Drive
            San Jose, California 95134-1706
```

```
Cisco Internetwork Operating System Software
IOS (tm) 10000 Software (UBR10K-P6-M), Version 12.2(2)XF
TAC Support: http://www.cisco.com/cgi-bin/ibld/view.pl?i=support
Copyright (c) 1986-2001 by Cisco Systems, Inc.
Compiled Fri 20-Jul-01 16:15 by test
Image text-base: 0x60008960, data-base: 0x612E0000

cisco uBR10000 (PRE-RP) processor with 98304K/32768K bytes of memory.
Processor board ID TBA05080458
R7000 CPU at 262Mhz, Implementation 39, Rev 2.1, 256KB L2, 2048KB L3 Cache
Backplane version 1.0, 8 slot

Last reset from unexpected value
Toaster processor tmc0 is running.
Toaster processor tmc1 is running.
1 Ethernet/IEEE 802.3 interface(s)
1 FastEthernet/IEEE 802.3 interface(s)
509K bytes of non-volatile configuration memory.

46976K bytes of ATA PCMCIA card at slot 0 (Sector size 512 bytes).
32768K bytes of Flash internal SIMM (Sector size 256KB).

Press RETURN to get started!
```

Note The first two sections of the configuration script, the banner and the installed hardware, appear only at initial system startup. On subsequent uses of the Setup facility, the script begins with the following prompt.

```
        --- System Configuration Dialog ---
Continue with configuration dialog? [yes/no]: yes

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

Basic management setup configures only enough connectivity
for management of the system, extended setup will ask you
to configure each interface on the system
```

Step 3 When asked if you want to continue with the System Configuration dialog and enter basic management setup (displays the current interface summary), enter **yes** or press **Return**:

```
Continue with configuration dialog? [yes/no]: yes
.
.
.
Would you like to enter basic management setup? [yes/no]: yes
```

The interface summary appears, showing the state of configured and unconfigured interfaces.

Step 4 Choose which protocols to support on your interfaces. For IP-only installations, you can accept the default values for most of the questions. A typical configuration using IP follows and continues through Step 7:

```
Configuring global parameters:

  Enter host name [Router]: router
```

Step 5 Enter the enable secret password, the enable password, and the virtual terminal password:

```
The enable secret password is a one-way cryptographic secret
password used instead of the enable password when it exists.

  Enter enable secret: ******
```

```
The enable password is used when there is no enable secret
password and when using older software and some boot images.

  Enter enable password: ******

Enter virtual terminal password: ******
```

Step 6 The Simple Network Management Protocol (SNMP) is the most widely supported open standard for network management. SNMP provides a means to access and set configuration and run-time parameters of routers and communication servers. SNMP also defines a set of functions that can be used to monitor and control network elements.

Enter **yes** to accept SNMP management; enter **no** to refuse it:

```
Configure SNMP Network Management? [no]:
    Community string [public]:
```

Step 7 In all cases, you will use IP routing. When you are using IP routing, select an interior routing protocol. You can specify one of only two interior routing protocols to operate on your system using the Setup facility, either Interior Gateway Routing Protocol (IGRP) or Routing Information Protocol (RIP).

To configure IP routing, enter **yes** (the default) or press **Return**, and then select an interior routing protocol:

```
  Configure IP? [yes]:
    Configure IGRP routing? [yes]:
      Your IGRP autonomous system number [1]: 15
```

Step 8 Configure your line card interface parameters. The following example shows how an 8-port Ethernet line card is installed in line card slot 3. The Setup facility determines the status of all interfaces.

To configure each active interface port for IP, enter **yes** (the default) or press **Return**. For all inactive ports, the default is **no**. You can press **Return** to accept the default.

```
Configuring interface Ethernet 1/0:
  Is this interface in use? [yes]:
  Configure IP on this interface? [yes]:
    IP address for this interface [19.2.22.4]:
    Number of bits in subnet field [8]:
    Class A network is 19.0.0.0, 8 subnet bits; mask is /16

Configuring interface Ethernet1/1:
  Is this interface in use? [no]:

Configuring interface Ethernet1/2:
Is this interface in use? [no]:

Configuring interface Ethernet1/3:
  Is this interface in use? [no]:

Configuring interface Ethernet1/4:
  Is this interface in use? [no]:

Configuring interface Ethernet1/5:
  Is this interface in use? [no]:

Configuring interface Ethernet1/6:
  Is this interface in use? [no]:

Configuring interface Ethernet1/7:
  Is this interface in use? [no]:
```

Step 9 Configure your cable interface. The following example shows a Cisco uBR10012 router with cable interface. The Setup facility, for the most part, determines the status of all interfaces.

To configure each active interface port, enter **yes** (the default) or press **Return**. For all inactive ports, the default is **no**. You can press **Return** to accept the default.

```
Configuring interface cable 5/0/0:
  Is this interface in use? [yes]:
  Configure this interface? [yes]:
  IP address for this interface [19.2.22.5]:
  Number of bits in subnet field [8]:
  Class A network is 19.0.0.0, 8 subnet bits; mask is /16

Configuring interface cable 1/1:
  Is this interface in use? [yes]:
  Configure this interface? [yes]:
  IP address for this interface [19.2.22.6]:
  Number of bits in subnet field [8]:
  Class A network is 19.0.0.0, 8 subnet bits; mask is /16
```

The configuration program displays the newly created command interface script:

```
The following command script was created:

hostname router
enable secret 5 $1$f0fc$A38P/KN/9yD3sEKSt6hKQ/
enable password betty
line vty 0 4
password wilma
snmp-server community public
!
ip routing
!
interface cable 5/0/0
ip address 19.2.22.5 255.255.0.0

router igrp 15
network 19.0.0.0
!
end
```

Step 10 When asked if you want to use this configuration, enter **yes** or press **Return.**

```
Use this configuration? [yes/no]: yes
```

Step 11 Save your settings to NVRAM. (Refer to the "Configuring the Cable Interface with the Extended Setup Facility" section on page 14.)

Note You must always manually save the configuration settings to NVRAM whenever they are modified.

Configuring Upstream Frequencies

Upstream parameters must be configured manually. After the **Setup facility** is run, upstream ports have a default state of "shutdown." You have two methods to configure upstream channel frequencies:

- Configure a fixed frequency between 5 to 42 MHz for North American channel plans, and enable the upstream port.
- Create a global spectrum group, assign the interface to it, and enable the upstream port.

The cable interface card receiver accepts time-division multiplexed burst transmissions from cable interfaces (or CMs in set-top boxes), which are DOCSIS-based. The upstream port becomes "up" when it is assigned an upstream frequency and is configured to be administratively up.

The upstream port is frequency-agile. The frequency can change while the interface is up and carrying traffic, if you define spectrum groups per the example provided.

Configuring Individual Upstream Modulation Profiles

You can define individual modulation profiles. A modulation profile consists of a table of physical layer characteristics for the different types of upstream bursts such as initial maintenance, long grant, request data, request, short grant, and station maintenance.

Note Only qualified personnel should define upstream modulation profiles.

Complete these steps to activate upstream interfaces:

Step 1 After the Setup facility has initially configured noncable interfaces on the Cisco uBR10012 router, enter the **enable** command and your password (privileged EXEC).

Step 2 Enter the **configure terminal** command to get into global configuration mode.

Step 3 In global configuration mode, configure modulation profiles and spectrum groups for your Cisco uBR10012 router using the **cable modulation-profile** and **cable spectrum-group** commands.

Step 4 In cable interface configuration mode, configure various characteristics for the interface in question, using the **cable upstream** commands.

Note Refer to Chapter 3, “Configuring Cable Interface Features for the Cisco uBR10012 Router,” for further information.

Configuring the Cisco uBR10012 Router Manually Using Configuration Mode

You can configure the Cisco uBR10012 router manually if you prefer not to use the Setup facility or AutoInstall. Complete the following steps:

Step 1 Connect a console terminal to the console port on the I/O controller.

Step 2 When asked if you want to enter the initial dialog, answer **no** to go into the normal operating mode of the router:

```
Would you like to enter the initial dialog? [yes]: no
```

Step 3 After a few seconds, the user EXEC prompt `(Router>)` appears. Type **enable** to enter enable mode (configuration changes can be made only in enable mode):

```
Router> enable
```

The prompt changes to the enable mode (also called privileged EXEC) prompt:

```
Router#
```

Step 4 Enter the **configure terminal** command at the enable prompt to enter configuration mode from the terminal:

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
```

Tip To see a list of the configuration commands available to you, enter **?** at the prompt or type **help** while in configuration mode.

Step 5 At the `Router(config)#` prompt, enter the **interface** *type slot/port* command to enter the interface configuration mode:

```
Router(config)# interface cable slot/port
Router(config-if)#
```

Step 6 Set the downstream center frequency to reflect the digital carrier frequency of the downstream RF carrier (the channel) for the downstream port:

```
Router(config-int)# cable downstream frequency down-freq-hz
```

Note This command has no effect on the external upconverter. It is informational only.

Step 7 Activate the downstream port on the cable interface line card to support digital data transmission over the hybrid fiber-coaxial network:

```
Router(config-int)# no shutdown
```

Step 8 Enter the fixed center frequency in Hz for your downstream RF carrier and the port number:

```
Router(config-int)# cable upstream port frequency up-freq-hz
```

Note Be sure not to select an upstream frequency that interferes with that used for any other upstream application in your cable plant.

Step 9 Repeat Step 8 for each upstream port on the cable interface line card.

Step 10 Activate the upstream port:

```
Router(config-int)# no cable upstream port shutdown
```

Step 11 Repeat Step 10 to activate each port used on your cable interface line card.

Step 12 Exit to return to the configuration mode:

```
Router(config-if)# exit
Router(config)#
```

Step 13 Enter the next interface to configure, following Step 6 through Step 12, or type **exit** to return to enable mode.

```
Router(config)# exit
Router#
%SYS-5-CONFIG_I: Configured from console by console#
```

Step 14 Save the configuration to NVRAM:

```
Router# copy running-config startup-config
```

Configuring the Cable Interface with the Extended Setup Facility

The Setup facility creates an initial configuration. The basic management setup configures only enough connectivity for management of the system. The Extended Setup facility prompts you to configure each interface on the system.

To invoke the configuration facility, use the following command:

```
Router# setup
```

The following is the System Configuration dialog:

```
Continue with configuration dialog? [yes/no]: yes
```

MAC-Layer Addressing

The MAC-layer or hardware address is a standardized data link layer address required for certain network interface types. These addresses are not used by other devices in the network; they are unique to each port. The Cisco uBR10012 router uses a specific method to assign and control the MAC-layer addresses for line cards.

All LAN interfaces (ports) require unique MAC-layer addresses, also known as hardware addresses. Typically, the MAC address of an interface is stored on a memory component that resides directly on the interface circuitry; however, the online insertion and removal (OIR) feature requires a different method. The OIR feature lets you remove a line card and replace it with another identically configured one. If the new line card matches the line card you removed, the system immediately brings it online.

To support OIR, an address allocator with a unique MAC address is stored in an EEPROM on the Cisco uBR10012 router midplane. Each address is reserved for a specific port and slot in the router regardless of whether a line card resides in that slot.

Caution When hot swapping a line card with a different type of interface, you might have to reconfigure the interfaces. Refer to the hardware installation guide that ships with your CMTS or to the appropriate field-replaceable unit (FRU) document for more specific information regarding OIR.

The MAC addresses are assigned to the slots in sequence. This address scheme allows you to remove line cards and insert them into other Cisco uBR10012 router without causing the MAC addresses to move around the network or be assigned to multiple devices.

Storing the MAC addresses for every slot in one central location means that the addresses stay with the memory device on which they are stored.

Identifying the Cable Interface Line Card

Identifying CM Line Cards

The following Cisco cable interfaces can be installed in a Cisco CMTS:

- The Cisco uBR10012 router supports one downstream modulator and one upstream demodulator.
  - The Cisco uBR10012 router supports the following defaults: QAM-256 at 40 MBps downstream, and QAM-16 at 5 Mbps upstream.
  - The card supports upstream channel widths of 200 kHz, 400 kHz, 800 kHz, 1.6 MHz, and 3.2 MHz.
  - The card outputs +42 dBmV and +/- 2 dBmV.
  - The downstream modulator has both an RF output, using the integrated upconverter, and an intermediate frequency (IF) output, which must be connected to an external upconverter.

Identifying CM Line Card Slots

On the Cisco uBR10012 router, the cable interface line card is fixed and is always slot 1. To display information about a specific cable interface slot’s downstream channel, use the **show interfaces cable** command with the CM card’s slot number and downstream port number in the following format:

```
show interfaces cable slot/downstream-port [downstream]
```

Use the slot number and downstream port number to display information about a downstream interface. You can abbreviate the command to **sh int c**. The following example shows the display for upstream channel port 0 on a Cisco uBR10012 router:

```
Router# sh int c 5/0/0
```

To display information about a specific cable interface slot’s upstream channel, use the **show interfaces cable** command. Include these CM card parameters:

- Slot number
- Downstream port number
- Upstream port number

Use this format:

```
show interfaces cable slot/downstream-port [upstream] upstream-port
```

Use the slot number, downstream port number, and upstream port number to display information about an upstream interface. You can abbreviate the command to **sh int c**.

The following example shows the display for upstream channel port 0 in cable interface slot 3 of a Cisco uBR10012 router that is turned up:

```
Router# sh int c3/0/0 upstream
```

Configuring Global Parameters

Step 1 Access the host by responding to the following prompt: `Enter host name [cmts]:`

Step 2 The enable secret password is used to protect access to privileged EXEC and configuration modes. This password, after entered, becomes encrypted in the configuration.

Respond to this prompt: `Enter enable secret [Use current secret]:` **aa**

Next, the enable password is used when you do not specify an enable secret password, with some older software versions, and some boot images.

Step 3 Respond to this prompt: `Enter enable password [rHoz]:` **bb**

Next, use the virtual terminal password to protect access to the router over a network interface.

Step 4 Respond to this prompt: `Enter virtual terminal password [cc]:` **cc**

The following system information appears.

```
Configure SNMP Network Management? [no]:
Configure IP? [yes]:
Configure IGRP routing? [yes]:
Your IGRP autonomous system number [1]:
Configure CLNS? [no]:
Configuring interface parameters:
Do you want to configure FastEthernet0/0  interface? [yes]:
Use the 100 Base-TX (RJ-45) connector? [yes]:
Operate in full-duplex mode? [no]:
Configure IP on this interface? [yes]: no
Do you want to configure Ethernet1/0  interface? [yes]: n
Do you want to configure Cable5/0/0  interface? [yes]:
Downstream setting frequency  : 531000000
For cable upstream [0]
Shut down this upstream ? [yes/no]: no
Frequency  : 33808000
Would you like to configure the DHCP server ? [yes/no]: yes
IP address for the DHCP server
[X.X.X.X]: 10.0.0.2
Configure IP on this interface? [no]: yes
IP address for this interface: 10.20.133.65
Subnet mask for this interface [255.0.0.0] : 255.255.255.248
Class A network is 10.0.0.0, 29 subnet bits; mask is /29
```

The following configuration command script is created:

```
interface cable5/0/0
ip address 10.20.133.65 255.255.255.248
no ip mroute-cache
no keepalive
cable insertion-interval 500
cable downstream annex B
cable downstream modulation 64qam
cable downstream interleave-depth 32
cable downstream frequency 531000000
cable upstream 0 frequency 33808000
cable upstream 0 power-level 0
no cable upstream 0 shutdown
cable helper-address 10.0.0.2
```

Note For modems to acquire an IP address, they must have direct access to DHCP, TFTP, or ToD servers, or have a static route set.

Saving Your Configuration Settings

To store the configuration or changes to your startup configuration in NVRAM, enter the **copy running-config startup-config** command at the `Router#` prompt:

```
Router# copy running-config startup-config
```

This command saves the configuration settings you set using configuration mode, the Setup facility, or AutoInstall.

Tip If you do not save your settings, your configuration will be lost the next time you reload the router.

Reviewing Your Settings and Configurations

You can check your settings and review any changes to your configuration using various software commands.

- To view information specific to the hardware and cable interface configuration on your Cisco uBR10012 router, use **show** commands.
  - Use this command to verify the downstream center frequency:

    ```
    Router# show controllers cable slot/port downstream
    ```

  - Use this command to verify the current value of an upstream port frequency:

    ```
    Router# show controllers cable slot/port upstream
    ```

  - Use this command to check the value of the settings you entered:

    ```
    Router# show running-config
    ```

- To review changes you make to the configuration, use the EXEC **show startup-config** command to display the information stored in NVRAM.

Viewing Sample Configuration Files

This section provides examples of Cisco uBR10012 router configuration files. To view the current configuration of a Cisco uBR10012 router, enter the **show running-config** command at the command-line interface (CLI) prompt in EXEC mode or privileged EXEC mode.

Baseline Privacy Interface Configuration Files

The Cisco uBR10000 series CMTS supports 56-bit and 40-bit encryption and decryption; 56 bit is the default. After you choose a CMTS image that supports Baseline Privacy Interface (BPI), BPI is enabled by default for the Cisco uBR10000 series CMTS. Key commands that appear in the Cisco uBR10012 router configuration file that denote that encryption and decryption are supported include:

- **int cable 5/0/0**
- **cable privacy kek grace-time 800**
- **cable privacy kek life-time 750000**
- **cable privacy tek grace-time 800**
- **cable privacy tek life-time 56000**
- **cable privacy enable**
- **cable privacy mandatory**

Note The cable interface must also support encryption and decryption.

When Baseline Privacy is enabled, the Cisco uBR10012 router routes encrypted and decrypted packets from a host or peer to another host or peer. BPI is configured with key encryption keys (KEKs) and traffic encryption keys (TEKs). A KEK is assigned to a CM, based on the CM's service identifier (SID), and permits the CM to connect to the Cisco uBR10012 router when Baseline Privacy is activated. The TEK is assigned to a CM when its KEK has been established. The TEK is used to encrypt data traffic between the CM and the Cisco uBR10012 router.

KEKS and TEKs can be set for Baseline Privacy on the HFC network to expire based on a **grace-time** or a **life-time** value, defined in seconds. A **grace-time** value assigns a temporary key to a CM to access the network. A **life-time** value assigns a more permanent key to a CM. Each CM that has a **life-time** value assigned requests a new lifetime key from the Cisco uBR10012 router before the current one expires.

To set the duration in *seconds* for KEK or TEK **grace-time** or **life-time**, use the following commands in global configuration mode. To restore the default values, use the **no** form of each command.

```
cable privacy kek {grace-time [seconds] | life-time [seconds]}
no cable privacy kek {grace-time | life-time}

cable privacy tek {grace-time [seconds] | life-time [seconds]}
no cable privacy tek {grace-time | life-time}
```

Syntax Description

grace-time *seconds*	(Optional) Length of key encryption grace-time in seconds. Valid range is 300 to 1800 seconds. The default *grace-time* value is 600 seconds.
life-time *seconds*	(Optional) Length of the key encryption life-time in seconds.Valid range is 86,400 to 604,8000. The default *life-time* value is 604800 seconds.

Tip Use the **show cable modem** command to identify a CM with encryption and decryption enabled. The *online(pk)* output of this command reveals a CM that is registered with BPI enabled and a KEK assigned. The *online(pt)* output reveals a CM that is registered with BPI enabled and a TEK assigned.

Should you want to change the Cisco uBR10000 series default of 56-bit encryption and decryption to 40-bit, use the "40 bit DES" option:

```
Router(config-if)# cable privacy ?
  40-bit-des           select 40 bit DES
  ^^^^^^^^^^
  authenticate-modem   turn on BPI modem authentication
  authorize-multicast  turn on BPI multicast authorization
  kek                  KEK Key Parms
  mandatory            force privacy be mandatory
  tek                  TEK Key Parms
```

Software then generates a 40-bit DES key, where the DES key that is generated and returned masks the first 16 bits of the 56-bit key to zero in software. To return to 56-bit encryption and decryption after changing to 40-bit, enter the **no** command in front of the "40 bit des" option.

Configuring Cable Interface Features for the Cisco uBR10012 Router

The cable interface in the Cisco uBR10012 router serves as the cable TV radio frequency (RF) interface, supporting downstream and upstream signals. The downstream is output as an intermediate-frequency (IF) signal suitable for use with an external upconverter. Your cable plant, combined with your planned and installed subscriber base, service offering, and external network connections, determines what combination of Cisco uBR10000 series cable interfaces, network uplink line cards, and other components that you should use.

- Up to eight Cisco line cards (cable interface line card and Line Card Processor (LCP) combined) can be housed in a chassis.
- Cable interface line cards support varied downstream and upstreams ports. Refer to the "Hardware Supported on the Cisco uBR10012 Router" section on page 8 for a summary.

The Cisco IOS software command-line interface (CLI) can be used to configure the Cisco cable interface line card for correct operation on the hybrid fiber-coaxial (HFC) cable network. This chapter describes the following tasks to configure the Cisco cable interfaces:

Section	Purpose
"Administratively Shutting Down and Restarting an Interface" section on page 2	Provides instructions for interface shutdown and restart for use with interface configurations requiring shutdown.
"Configuring the Downstream Cable Interface" section on page 3	Provides instructions for performing required upstream configuration tasks.
"Configuring the Upstream Cable Interface" section on page 11	Provides instructions for performing several optional cable interface configurations.
"Configuring Optional Cable Interface Features" section on page 26	Provides instructions for performing several optional cable interface configurations.
"Cable Interface Configuration Examples" section on page 30	Provides examples of some cable interface configurations corresponding to earlier procedures in this chapter.

The *Cisco Cable Modem Termination System Feature Guide* at http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/ contains several additional interface and router configurations applicable to the Cisco uBR10000 series CMTS.

Administratively Shutting Down and Restarting an Interface

You can disable an interface by shutting it down. Shutting down an interface disables all functions on the specified interface and marks the interface as unavailable on the display of all monitoring commands. This information is communicated to other network servers through all dynamic routing protocols. The interface will not be mentioned in any routing updates. On serial interfaces, shutting down an interface causes the dedicated Token Ring (DTR) signal to be dropped. On Token Ring interfaces, shutting down an interface causes the interface to deinsert from the ring. On Fiber Distributed Data Interfaces (FDDIs), shutting down an interface causes the optical bypass switch, if present, to go into bypass mode.

To shut down an interface and then restart it, use the following commands in interface configuration mode:

Command	Purpose
shutdown	Shuts down an interface.
no shutdown	Enables an interface that has been disabled.

To check whether an interface is disabled, use the **show interfaces** command in Privileged EXEC mode. An interface that has been shut down is shown as administratively down in the **show interfaces** command display.

One reason to shut down an interface is if you want to change the electrical interface type or mode of a port online. You replace the serial adapter cable, for example, and use software commands to restart the interface, and if necessary, to reconfigure the port for the new interface.

At system startup or restart, the Fast Serial Interface Processor (FSIP) polls the interfaces and determines the electrical interface type of each port (according to the type of port adapter cable attached). However, it does not necessarily poll an interface again when you change the adapter cable online.

To ensure that the system recognizes the new interface type, shut down the interface using the **shutdown** command, and enable the interface after changing the cable. Refer to your hardware documentation for more details.

Examples

The following example turns off the Ethernet interface in slot 2 at port 4:

```
interface ethernet 2/4
shutdown
```

The following example restarts the interface:

```
interface ethernet 2/4
no shutdown
```

Configuring the Downstream Cable Interface

These configurations are required. The first step in configuring the Cisco cable interface is to configure the downstream cable interface. Configuring the downstream cable interface consists of the following procedures:

Task	Description
"Activating Downstream Cable Address Resolution Protocol Requests" section on page 4	Provides instructions to activate ARP requests on the cable interface so that the Cisco uBR10000 series CMTS can perform IP address resolution on the downstream path.
"Activating Downstream Ports" section on page 5	Provides instructions to activate and verify a downstream port on a cable interface card for digital data transmissions over the HFC network.
"Assigning the Downstream Channel ID" section on page 6	Provides instructions to assign and verify a numeric channel ID to the downstream port on the Cisco cable interface line card.
"Setting the Downstream Helper Address" section on page 6	Provides instructions to specify an IP address of a Dynamic Host Configuration Protocol (DHCP) server where User Datagram Protocol (UDP) broadcast packets will be sent.
"Setting the Downstream Interleave Depth" section on page 7	Provides instructions to set the downstream interleave depth in milliseconds for the downstream port on the Cisco cable interface line card.
"Setting the Downstream Modulation" section on page 8	Provides instructions to define the speed in symbols per second at which data travels downstream to the subscriber's CM.
"Setting the Downstream MPEG Framing Format" section on page 9	Provides instructions to set and verify the downstream MPEG framing format, which must be compatible with DOCSIS specifications and your local cable plant operations.
"Setting Downstream Rate Limiting and Traffic Shaping" section on page 9	Provides instructions to use the token bucket policing algorithm with traffic shaping options or the weighted discard algorithm to buffer, shape, or discard packets that exceed a set bandwidth.

Note
In most applications, default values for the commands used in these configuration steps are adequate to configure the Cisco uBR10012 router. You do not need to specify individual parameters unless you want to deviate from system defaults.

For information on other configuration options, refer to the *Cisco Broadband Cable Command Reference Guide* at http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/ and the Documentation CD-ROM.

Activating Downstream Cable Address Resolution Protocol Requests

This configuration is required. Address Resolution Protocol (ARP) is an Internet protocol used to map IP addresses to MAC addresses on computers and other equipment installed in a network. You must activate ARP requests on the cable interface so that the Cisco uBR10000 series CMTS can perform IP address resolution on the downstream path.

Note The default values for the commands used in this configuration step are adequate in most cases to configure the Cisco uBR10000 series CMTS.

To activate ARP requests, use the following command in cable interface configuration mode.

Command	Purpose
`Router(config-if)# cable arp`	Enable ARP. This is the default.

Verifying ARP Requests

To verify that cable ARP is activated, enter the **more system:running-config** command and look for the cable interface configuration information. If ARP is activated, it does not appear in this output. If ARP is deactivated, it appears in the output as `no cable arp`.

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0
ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable arp
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

Tip If you are having difficulty with verification, verify that you entered the correct port and cable interface line card slot number when you activated ARP and when you entered the **show interface cable** command.

Activating Downstream Ports

To activate a downstream port on a Cisco uBR10000 series cable interface card for digital data transmissions over the HFC network, complete the steps in the following table.

	Command	Purpose

Step 1	`Router>` **`enable`**
	`Password:` *`password`*
	`Router#`
		Enters enable (privileged EXEC) mode.
		Enter the password.
		You have entered privileged EXEC mode when the prompt displays the pound symbol (`#`).

Step 2	`Router#` **`configure terminal`**
	`Enter configuration commands, one per line. End with CNTL/Z.`
	`Router(config)#`
		Enters global configuration mode. You have entered global configuration mode when the `(config)#` prompt appears.
		This command can be abbreviated to **config t** or **conf t**.

Step 3	`Router(config)#` **`interface cable5/0/0`**
	`Router(config-if)#`
		Enters cable interface configuration mode.
		In this example, the interface is downstream port 0 on the cable interface card installed in slot 1 of the Cisco uBR10000 series CMTS.

Step 4	`Router(config-if)# cable downstream if-output`	Default. Activates downstream digital data from the Cisco uBR10012 router.
	`Router(config-if)# no cable downstream if-output`	Deactivates downstream digital data. This command mutes the IF output of the cable interface card and shuts down the interfaces.
Step 5	`Router(config-if)#` **`no shutdown`**	Places the downstream port in the “admin up” state.

Step 6	`Router(config-if)#` **`end`**
	`Router#`
		Returns to privileged EXEC mode.

	`%SYS-5-CONFIG_I: Configured from console by console`	This message is normal and does not indicate an error.

Verifying the Downstream Ports

To determine if the downstream carrier is active (up), enter the **show controllers cable** command for the downstream port that you just configured. For National Television Standards Committee (NTSC) 6 MHz operations, see the following example:

```
Router# show controllers cable5/0/0 downstream
Cable5/0/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Assigning the Downstream Channel ID

To assign a numeric channel ID to the downstream port on the Cisco cable interface line card, use the following command in cable interface configuration mode. The acceptable range is 0 to 255.

```
Router(config-if)# cable downstream channel-id id
```

Note The **cable downstream channel-id** command must be used with the following command:

```
cable downstream frequency 54000000-1000000000 broadcast frequency - h
```

These commands are used in instances where you want to send multiple downstream frequencies to a single region that contains CMs that can connect only to upstream ports on the same cable interface line card. You must configure unique channel IDs for each downstream that any CM is capable of receiving. The downstream frequency setting must match the setting on the upconverter.

Caution After defining unique downstream IDs, test the CMs for correct operation. Cisco recommends that when using this feature, you re-test each subsequent software release of CM code to verify correct operation and to ensure reasonable acquisition time for new installations. Failure to use these commands in conjunction or to test the involved CMs can result in customer service outages of indefinite duration.

Verifying the Downstream Channel ID

To verify the downstream channel ID, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
Router# show controllers cable5/0/0 downstream
Cable5/0/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
Downstream channel ID: 1
```

Setting the Downstream Helper Address

Specify an IP address of a Dynamic Host Configuration Protocol (DHCP) server where User Datagram Protocol (UDP) broadcast packets will be sent. You can specify a DHCP server for UDP broadcast packets from cable interfaces, and a DHCP server for UDP broadcast packets from hosts. To set a downstream helper address, use the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	`Router(config-if)# cable helper-address 10.x.x.x cable-modem`	Set the downstream helper address to the DHCP server at IP address 10.*x.x.x* for UDP broadcast packets from cable modems. Note Use the IP address of the DHCP server. Both 10.*x.x.x* and 172.56.*x.x* are private ranges.
Step 2	`Router(config-if)# cable helper-address 172.56.x.x host`	Set the downstream helper address to the DHCP server at IP address 172.56.*x.x* for UDP broadcast packets from hosts.

Verifying the Downstream Helper Address

To verify the downstream helper address setting, enter the **show running-config** command and look for `cable helper-address` in the cable interface configuration information:

```
Router# show running-config
Building configuration...

Current configuration:
!
interface cable5/0/0
ip address 10.254.254.254 255.0.0.0
 no ip directed-broadcast
 cable helper-address 192.168.1.1
 no keepalive
```

Perform these steps if you are having difficulty with verification:

Step 1 Check the cables, upconverters, RF levels, and frequencies if the cable interfaces do not find a downstream signal.

Step 2 Check the cables, RF levels, and upstream frequencies, and enter a **no shut** command if the cable interfaces find a downstream signal, but not an upstream signal.

Step 3 Check the provisioning servers.

- Ping the DHCP server using the source IP address option—the primary IP address of a cable interface.
- Check IP routing if the cable interfaces acquire an RF upstream and downstream lock, but do not stay up.

Step 4 Check DHCP options and the IP address of the Time-of-Day (ToD) server:

- Ping the ToD server using the source IP address option.
- Check IP routing.
- Verify that the TFTP filename is correct.
- Verify that the TFTP file is in the correct directory on the TFTP server.
- Ensure that the TFTP file has read privileges.
- Ping the TFTP server using the source IP address option, and check IP routing if the cable interfaces acquire an RF and a DHCP, but fail on ToD or TFTP.

Setting the Downstream Interleave Depth

Set the interleave depth for the downstream port on the Cisco cable interface line card. A higher interleave depth provides more protection from bursts of noise on the HFC network; however, it increases downstream latency.

Note The valid values are 8, 16, 32 (default), 64, and 128.

To set the downstream interleave depth in milliseconds, use the following command in cable interface configuration mode:

```
Router(config-if)# cable downstream interleave-depth {8|16|32 |64|128}
```

Verifying the Downstream Interleave Depth

To verify the downstream interleave depth setting, enter the **show controllers cable** command for the downstream port you have just configured:

```
Router# show controllers cable5/0/0 downstream
Cable5/0/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=
```

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that the downstream carrier is active, using the **cable downstream if-output** command.

Setting the Downstream Modulation

To set the downstream modulation, define the speed in symbols per second at which data travels downstream to the subscriber’s CM. A symbol is the basic unit of modulation. Quadrature Phase Shift Key (QPSK) encodes 2 bits per symbol, Quadrature Amplitude Modulation (QAM) -16 encodes 4 bits per symbol, QAM-64 encodes 6 bits per symbol, and QAM-256 encodes 8 bits per symbol.

Note Setting a downstream modulation rate of QAM-256 requires approximately a 6 dB higher signal-to-noise ratio (SNR) than QAM-64 at the subscriber’s cable interface. If your network is marginal or unreliable at QAM-256, use the QAM-64 format instead. Also, consider the significance of your data.

To set the downstream modulation, use the following command in cable interface configuration mode. The standard DOCSIS modulation rate (and the Cisco default) is QAM-64.

```
Router(config-if)# cable downstream modulation 64qam
```

Verifying the Downstream Modulation

To verify the downstream modulation setting, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
Router# show controllers cable5/0/0 downstream
Cable5/0/0 Downstream is up
 Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
 FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
```

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers

Step 5 Verify that the downstream carrier is active, using the **cable downstream if-output** command

Step 6 Verify that you have selected the default if you are not certain about the modulation rate needed.

Setting the Downstream MPEG Framing Format

The MPEG framing format must be compatible with DOCSIS specifications (viewable at http://www.cablemodem.com/specifications.html) and your local cable plant operations.

Tip Annex B is the DOCSIS MPEG framing format standard for North America.

Note Annex B framing format is automatically set when configuring Cisco cable interface line cards. The cable interface line card's downstream ports and the connected CMs on the network must be set to the same MPEG framing format and must support DOCSIS operations as appropriate.

The following command appears in the Cisco uBR10012 router configuration file to designate Annex B operation. This command sets the downstream MPEG framing format.

```
Router(config-if)# cable downstream annex {B}
```

Verifying the Downstream MPEG Framing Format

To verify the downstream MPEG framing format setting, enter the **show controllers cable** command for the downstream port you have just configured. See the following example:

```
router# show controllers cable5/0/0 downstream
Cable5/0/0 Downstream is up
Frequency=96000000, Channel Width 6 MHz, 64-QAM, Symbol Rate 5.056941 Msps
FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
Downstream channel ID: 0
```

Setting Downstream Rate Limiting and Traffic Shaping

Downstream traffic shaping enables you to use the token bucket policing algorithm with traffic shaping options or the weighted discard algorithm to buffer, shape, or discard packets that exceed a set bandwidth. Downstream traffic shaping is disabled by default.

To enable downstream traffic shaping for a downstream port on a Cisco cable interface line card, use one of the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	Router(config-if)# **cable downstream rate-limit token-bucket**	Enables traffic shaping on the downstream port using the token bucket policing algorithm. With this command, the Cisco uBR10012 router automatically drops packets that are in violation of the allowable bandwidth.
	Router(config-if)# **cable downstream rate-limit token-bucket shaping**	Enables traffic shaping on the downstream port using the token bucket policing algorithm with traffic shaping.
	Router(config-if)# **cable downstream rate-limit token-bucket shaping granularity 8**	Enables traffic shaping on the downstream port using the token bucket policing algorithm with specific traffic shaping time granularity. Acceptable values are 1, 2, 4, 8, or 16 milliseconds.
	Router(config-if)# **cable downstream rate-limit token-bucket shaping max-delay 256**	Enables traffic shaping on the downstream port using the token bucket policing algorithm with specific maximum traffic shaping buffering delay. Acceptable values are 128, 256, 512, or 1028 milliseconds.
Step 2	Router(config-if)# **cable downstream rate-limit weighted-discard 3**	Enables traffic shaping on the downstream port using the weighted discard algorithm and assigns a weight for the exponential moving average of the loss rate. Acceptable values are 1 to 4.
Step 3	Router(config-if)# **^Z** Router#	Exits back to EXEC mode so that you can verify the steps.

Verifying Downstream Traffic shaping

To determine if downstream traffic shaping is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If downstream traffic shaping is configured and enabled, a traffic shaping entry appears in the output. If downstream traffic shaping is disabled, no traffic shaping entry appears.

```
Router# show running-config
Building configuration...
Current configuration:
!
interface cable5/0/0
ip address 10.254.254.254 255.0.0.0
no ip directed-broadcast
cable helper-address 192.168.1.1
no keepalive
cable downstream annex B
cable downstream modulation 64qam
```

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected the default if you are not certain about the modulation rate needed.

Step 6 Verify that the downstream carrier is active using the **cable downstream if-output** command.

Configuring the Upstream Cable Interface

These configurations are required. Upstream cable interface commands configure the frequency and input power level of the upstream signal, in addition to error detection and correction of the upstream signal. The configuration of the upstream cable interface depends on the characteristics of your cable plant.

Perform the following tasks in this section to configure the upstream cable interface.

Note For some of these tasks, default values are adequate to configure the device.

Task	Description
"Activating Upstream Admission Control" section on page 12	Provides information about the upstream admission control feature, and provides instructions to set the upstream admission control as a percentage of the upstream channel capacity.
"Activating Upstream Differential Encoding" section on page 13	Provides brief explanation and instructions to activate differential encoding on the upstream, which is a digital encoding technique whereby a binary value is denoted by a signal change rather than a particular signal level.
"Activating Upstream Forward Error Correction" section on page 14	Provides instructions to activate forward error correction (FEC). The Cisco uBR10000 series CMTS uses FEC to attempt to correct any upstream data that might have been corrupted.
"Activating the Upstream Ports" section on page 14	Provides instructions to activate upstream ports. Each upstream port must be activated to enable upstream data transmission from the CMs on the HFC network to the Cisco uBR10000 series CMTS.
"Activating Upstream Power Adjustment" section on page 15	Provides instructions to enable upstream power adjustment. This feature sets the minimum power adjustment in dB that will allow continued ranging status.
"Activating the Upstream Scrambler" section on page 16	Provides instructions to activate the upstream scrambler on the upstream RF carrier, which enables CMs on the HFC network to use built-in scrambler circuitry for upstream data transmissions.
"Activating Upstream Timing Adjustment" section on page 16	Provides instructions to activate upstream timing adjustment on the specified interface. This feature sets the minimum timing adjustment that allows continued ranging status.
"Setting Upstream Backoff Values" section on page 17	Provides DOCSIS-compliant instructions that define contention resolution for CMs wanting to transmit data or requests on the upstream channel. Contention resolution is achieved with a truncated binary exponential backoff value.
"Setting the Upstream Channel Width" section on page 19	Provides instructions to enter the upstream channel width in hertz (Hz). Also describes NTSC spectrum parameters and spectrum management processes.
"Setting the Upstream Frequency" section on page 20	Provides instructions to set upstream channel frequency for the RF output that complies with the expected input frequency of the Cisco cable interface line card.

Task	Description
"Setting the Upstream Input Power Level" section on page 22	Provides instructions to set the upstream input power level in decibels per millivolt (dBmV), and provides additional information about the Cisco uBR10000 series CMTS controls the output power levels of CMs
"Setting Upstream Rate Limiting and Traffic Shaping" section on page 24	Provides instructions to activate traffic shaping on the upstream. Upstream traffic shaping, available on the DOCSIS upstream channel, delays the scheduling of the upstream packet, which in turn causes the packet to be buffered on the cable customer premises equipment (CPE) device, instead of being dropped.
"Specifying Upstream Minislot Size" section on page 23	Provides instructions to specify the minislot size (in ticks) for specific upstream cable interfaces. The minislot size and the channel width are related to certain degree but not tightly coupled.

Activating Upstream Admission Control

Upstream admission control tallies up the total amount of guaranteed minimum upstream throughput reserved by CMs on an upstream interface. Once the total exceeds an allowable level, no more CMs requiring a guaranteed minimum upstream rate are allowed online on that upstream port.

Cisco CMTS upstream admission control is turned off by default and must be activated. To set the upstream admission control as a percentage of the upstream channel capacity, use the following command in cable interface configuration mode. The admission control is set as a percentage of the specified upstream channel capacity. The acceptable range is from 10 to 1000 percent.

```
Router(config-if)# cable upstream usport admission-control percentage
```

For example:

```
7246VXR(config-if)# cable upstream 0 admission-control ?
    Max Reservation Limit As Percentage of Raw Channel Capacity
```

Syntax Description

usport	The upstream port that has admission control enabled.
percentage	The optional *percentage* parameter specifies the overbooking rate that will be used when deciding the amount of bandwidth that is available to be guaranteed.

Note

If *percentage* is left blank or set to 100%, the CMTS will only allow a total up to the real available upstream bandwidth to be guaranteed. If percentage is set to its maximum of 1000, then up to 10 times the real interface bandwidth may be "guaranteed".

Verifying Upstream Admission Control

To determine if upstream admission control is configured and activated, enter the **show running-config** command in privileged EXEC mode and look for the cable interface configuration information. If upstream admission control is configured and enabled, an admission control entry appears in the **show running-config** command output, indicating the user-defined percentage of upstream channel capacity allowable. If upstream admission control is disabled, no admission control entry appears in the output.

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Activating Upstream Differential Encoding

Differential encoding on the upstream is a digital encoding technique whereby a binary value is denoted by a signal change rather than a particular signal level. To enable differential encoding on upstream traffic to a specified cable interface, use the following command in cable interface configuration mode. Upstream differential encoding is enabled by default.

```
Router(config-if)# cable upstream usport differential-encoding
```

Verifying Upstream Differential Encoding

To determine if upstream differential encoding is activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream differential encoding is enabled, a differential encoding entry appears in the **show running-config** output. If upstream differential encoding is disabled, no differential encoding entry appears in the output.

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Activating Upstream Forward Error Correction

The Cisco uBR10000 series CMTS uses forward error correction (FEC) to attempt to correct any upstream data that might have been corrupted. When FEC is activated, all CMs on the network also activate FEC.

Note Although upstream FEC is an option, Cisco recommends that you use upstream FEC. FEC is activated by default and should not be disabled.

To activate the upstream forward error correction and to enable FEC, use the following command in cable interface configuration mode.

```
Router(config-if)# cable upstream usport fec
```

Verifying Upstream FEC

To verify whether FEC is activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If FEC is enabled, an FEC entry appears in the **show running-config command** output. If FEC is disabled, no FEC entry appears in the output.

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Activating the Upstream Ports

Each upstream port must be activated to enable upstream data transmission from the CMs on the HFC network to the Cisco uBR10000 series CMTS.

Note The upstream cable interface does not operate until you either set a fixed upstream frequency or create and configure a spectrum group. Refer to the "Setting the Upstream Frequency" section on page 20 for details.

To activate the upstream ports, use the following commands in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# interface cable slot/port`	Specifies a cable interface and enters cable interface configuration mode.
Step 2	`Router(config-if)# no cable upstream usport shutdown`	Enables upstream data traffic.

Verifying the Upstream Ports

To determine if the upstream ports are activated or deactivated, enter the **show interface cable** command for the upstream port just configured:

```
Router# show interface cable5/0/0
Cable5/0/0 is up, line protocol is up
 Hardware is BCM3210 FPGA, address is 00e0.1e5f.7a60 (bia 00e0.1e5f.7a60)
 Internet address is 1.1.1.3/24
 MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
 Encapsulation, loopback not set, keepalive not set
 ARP type: ARPA, ARP Timeout 04:00:00
 Last input 00:00:25, output 00:00:00, output hang never
 Last clearing of “show interface” counters never
 Queuing strategy: fifo
 Output queue 0/40, 0 drops; input queue 0/75, 0 drops
 5 minute input rate 0 bits/sea, 0 packets/sec
 5 minute output rate 0 bits/sec, 0 packets/sec
     10878 packets input, 853740 bytes, 0 no buffer
     Received 3679 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     5401 packets output, 645885 bytes, 0 underruns
     0 output errors, 0 collisions, 9 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Activating Upstream Power Adjustment

To enable upstream power adjustment for a specified cable interface, use one of the following commands in cable interface configuration mode.

Command	Purpose
Router(config-if)# **cable upstream** ***usport*** **power-adjust continue** *db*	Sets the minimum power adjustment in dB that allows continued ranging status. Valid values are 2 to 15 dB. Default = 2 dB.
Router(config-if)# **cable upstream** ***usport*** **power-adjust noise** *percentage*	Sets the minimum number (percentage) of power-adjustment packets required to justify changing the upstream power rating. Valid values are 10 to 100 percent. Default = 30 percent.
Router(config-if)# **cable upstream 0 power-adjust threshold** *db*	Sets the power-adjustment threshold in dB. Valid values are 0 to 2 dB. Default = 1 dB.
Router(config-if)# **end** Router#	Returns to enable (privileged EXEC) mode.

To return the automatic upstream power-adjustment ranging value to the default of 2 dB, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport power-adjust continue
```

To return the automatic upstream power-adjustment noise value to the default of 30 percent, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport power-adjust noise
```

To return the upstream power-adjustment threshold value to the default of 1 dB, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport power-adjust threshold
```

Verifying Upstream Power Adjustment

To determine if upstream power adjustment is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream power adjustment is enabled, any or all three of the **continue**, **noise**, and **threshold** power-adjustment entries appear in the **show running-config** command output. If all three upstream power adjustments are disabled, no power-adjustment entry appears in the **show running-config command** output.

Activating the Upstream Scrambler

The scrambler on the upstream RF carrier enables CMs on the HFC network to use built-in scrambler circuitry for upstream data transmissions. The scrambler circuitry improves reliability of the upstream receiver on the cable interface line card.

Caution The upstream scrambler is activated by default and should not be disabled under normal circumstances. Disabling it can result in corrupted packets. Disable it only for prototype modems that do not support the upstream scrambler.

To activate the upstream scrambler, use the following command in cable interface configuration mode. The upstream scrambler is enabled by default.

```
Router(config-if)# cable upstream usport scrambler
```

Verifying the Upstream Scrambler

To determine if the upstream scrambler is activated, enter the **more system:running-config** command and look for the cable interface configuration information. Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Activating Upstream Timing Adjustment

To enable upstream timing adjustment for a specified cable interface, use one of the following commands in cable interface configuration mode.

\

Command	Purpose
`Router(config-if)# cable upstream usport time-adjust continue seconds`	Sets the minimum timing adjustment that allows continued ranging status. Valid values are 2 to 64 seconds. Default = 2 seconds.
`Router(config-if)# cable upstream usport time-adjust threshold seconds`	Sets the timing adjustment threshold value in seconds. Valid values are 1 to 32 seconds. Default = 1 second.

`Router(config-if)# end`
`Router#`
	Returns to enable (privileged EXEC) mode.

To return the upstream time-adjustment ranging value to the default of 2 seconds, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport time-adjust continue
```

To return the upstream time adjustment threshold value to the default of 1 second, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport time-adjust threshold
```

Verifying Upstream Timing Adjustment

To determine if upstream timing adjustment is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream timing adjustment is enabled, either or both of the **continue** and **threshold** timing-adjustment entries appear in the **show running-config** command output. If both the **continue** and **threshold** upstream timing adjustments are disabled, no timing adjustment entry appears in the **show running-config** command output.

Tip Perform the following steps if you are having difficulty with verification:

Step 1 Verify that the cable connections are not loose or disconnected.

Step 2 Verify that the cable interface line card is firmly seated in its chassis slot

Step 3 Verify that the captive installation screws are tight.

Step 4 Confirm that you have entered the correct slot and port numbers.

.

Setting Upstream Backoff Values

The DOCSIS-specified method of contention resolution for CMs wanting to transmit data or requests on the upstream channel is a truncated binary exponential backoff value, with the initial backoff window and the maximum backoff window controlled by the CMTS. The Cisco uBR10000 series CMTS specifies backoff window values for both data and initial ranging, and sends these values downstream as part of the Bandwidth Allocation Map (MAP) MAC message.

The values are configurable on the Cisco uBR10000 series software and are power-of-two values. For example, a value of 4 indicates a window between 0 and 15; a value of 10 indicates a window between 0 and 1023. You can set fixed start and end values for data backoff on the upstream ports, or you can set the upstream ports for automatic data backoff. You have the same options for ranging backoff. For both backoff windows, the default start value is 0; the default end value is 4. Valid values are from 0 to 15.

Note Cisco does not recommend that you adjust default values, but that you enable the automatic dynamic backoff algorithm. Refer to the "Configuring Dynamic Contention Algorithms (Cable Insertion Interval, Range, and Data Backoff)" section on page 7.

To set data or ranging backoff values for an upstream port, use one or more of the following commands, in cable interface configuration mode.

	Command	Purpose

Step 1	`Router(config-if)#` **`cable upstream`** *`usport`* **`data-backoff`** *`start end`*
	or
	`Router(config-if)# cable upstream` *`usport`* **`data-backoff automatic`**
		Optimizes the **automatic** setting for as many as 250 cable interfaces per upstream port. Sets manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.
		Configures the default backoff window values of 0 and 4.

Step 2	`Router(config-if)#` **`cable upstream`** *`usport`* **`range`** *`start end`*
	or
	`Router(config-if)#` **`cable upstream`** *`usport`* **`range automatic`**
		Optimizes the **automatic** setting for as many as 250 cable interfaces per upstream port. Sets manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.
		Configures the default backoff window values of 0 and 4.

When considering whether to adjust backoff values, keep the following considerations in mind:

- The cable interface reconnection time after a power outage is related to the following factors:
  - DHCP, ToD, and TFTP servers often operate well below 1 percent load under normal situations, but can jump to over 100 percent after an outage.
  - Adjusting the backoffs to larger numbers slows cable interface reconnection and reduces server load.
  - Backoffs that are too small result in cable interfaces failing to range the upstream RF levels correctly and cycling to maximum power, thus increasing connection time and reducing network performance.
  - Backoffs that are too large result in increased recovery time after a large service outage.
  - There is significant variation in cable interface performance (brand to brand) in cable interface restart time.
- All cable interfaces should recover in 0 to 10 minutes after all services are restored (Cisco uBR10012 router, RF transport, DHCP, TFTP, and ToD servers). A CM that takes longer than 10 minutes could be experiencing a problem with the modem itself, a problem with CMTS settings, or a problem in the DOCSIS provisioning servers.

Note Upstream segments serving a relatively large number of cable interfaces (for example, more than 1600) might suffer recovery times greater than 10 minutes.

Verifying Upstream Data Backoff

To verify backoff window settings, enter the **show controllers cable** command for the upstream port you have just configured:

```
Router# show controllers cable5/0/0 u0
Cable5/0/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
```

```
Tx Backoff Start 0, Tx Backoff End 4
Modulation Profile Group 1
part_id=0x3137, rev_id=0x03, rev2_id=0xFF
nb_agc_thr=0x0000, nb_agc_nom=0x0000
Range Load Reg Size=0x58
Request Load Reg Size=0x0E
Minislot Size in number of Timebase Ticks is = 8
Minislot Size in Symbols = 64
Bandwidth Requests = 0xFE
Piggyback Requests = 0xD
Invalid BW Requests= 0x2
Minislots Requested= 0x2963
Minislots Granted  = 0x2963
Minislot Size in Bytes = 16
Map Advance = 4000 usecs
UCD Count = 32964
DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

Setting the Upstream Channel Width

Use the commands below to enter the upstream channel width in hertz (Hz). For NTSC operations, valid values are 200000 Hz (160 kilo symbols per second [ksps]), 400,000 Hz (320 ksps), 800,000 Hz (640 ksps), 1,600,000 Hz (1280 ksps), and 3,200,000 Hz (2560 ksps). The default is 1,600,000 Hz.

If no acceptable channels of the specified width are found, the spectrum management card automatically begins to scan the upstream spectrum for the next largest available channel width; for example, if the spectrum management card is unable to find a usable 1.6 MHz upstream channel, it automatically begins searching for usable 800 kHz channels.

Caution Higher symbol rates are more susceptible to RF noise and interference. If you use a symbol rate or modulation format beyond the capabilities of your HFC network, you might experience packet loss or loss of cable interface connectivity.

Note For QAM-16 channel widths of 400 kHz (320 ksps) or greater, Cisco recommends that you use QAM-16 modulation for long and short data, and that you use QPSK for request, initial, and station communications. For QAM-16 channel widths of 200 kHz (160 ksps), all communication must be able to use QAM-16. That is, 160 ksps with QAM-16 requires an exceptional signal-to-noise ratio (SNR) in your upstream channels. When you use QAM-16 for request, initial, and station maintenance messages with channel widths greater than 400 kHz, the QAM-16 preamble and message data take longer to transmit than the QPSK format.

Note To set the upstream channel width, use the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	`Router(config-if)#` **`cable upstream`** *`usport`* **`channel-width`** *`width`*	Enters the channel width for your upstream RF carrier in Hz.
Step 2	`Router(config-if)#` **`no cable upstream`** *`usport`* **`channel-width`**	Returns the channel width to its default setting of 1,600,000 Hz.

For additional information about channel width and minislot size, refer to the *Cable Radio Frequency (RF) FAQs* at http://www.cisco.com/warp/public/109/cable_faq_rf.html.

Verifying Upstream Channel Width

To verify the current value of the upstream channel width, enter the **show controllers cable** command for the upstream port you just configured. A sample follows below:

```
Router# show controllers cable5/0/0 u0
Cable5/0/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Perform these steps if you are having difficulty with verification:

Step 1 Use a valid combination of modulation format (QPSK and QAM-16), minislot size, frequency, and the **no shutdown** command.

Step 2 Use a recommended or previously tested modulation profile. It is not uncommon to create a modulation profile that does not allow cable interface-to-headend communication. Because each message type is individually specified, some messages might not work.

Step 3 Verify using IP ping packets of varying lengths (64 to 1500 bytes). Ping from the headend to the cable interface.

Step 4 Verify with your cable interface vendor that your CM software is fully certified or compatible with DOCSIS 1.0 and extensions, as appropriate.

Setting the Upstream Frequency

The upstream channel frequency of your RF output must be set to comply with the expected input frequency of your Cisco cable interface line card. To configure upstream channel frequencies, perform one of the following tasks:

- Configure a fixed frequency from 5 to 42 MHz for NTSC operations, then enable the upstream port.
- Create a global spectrum group, assign the interface to it, and enable the upstream port.

Note You can also select a default that does not set a specific fixed value.

Note The upstream port is frequency agile. If you define spectrum groups, the frequency can change while the interface is up and carrying traffic.

A modulation profile consists of a table of physical layer characteristics for the different types of upstream bursts; for example, initial maintenance, long grant, request/data, request, short grant, and station maintenance.

Note The upstream cable interface does not operate until you either set a fixed upstream frequency or create and configure a spectrum group.

If you are setting a fixed upstream frequency, make sure that the frequency selected does not interfere with the frequencies used for any other upstream applications running on the cable plant.

To set a fixed upstream frequency, use the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	`Router(config-if)#` **`cable upstream`** *`usport`* **`frequency`** *`up-freq-hz`*	Enters the fixed center frequency for your upstream RF carrier in Hz.
Step 2	`Router(config-if)#` **`no cable upstream`** *`usport`* **`shutdown`**	Places the upstream port in the "admin up" state.

Tip For National Television Standards Committee (NTSC) operations, valid ranges are 5000000 to 42000000 Hz.

Caution Some cable systems cannot reliably transport frequencies near these band edges. The wider the upstream channel (in MHz), the more difficulty you might have. Enter a center frequency between 20 and 38 MHz if you have difficulty.

Note You can also select a default that does not set a specific fixed value. The Cisco uBR10000 series software instructs the cable interfaces to use this frequency as the center frequency.

Verifying the Upstream Frequency

To verify the current value of the upstream frequency, enter the **show controllers cable** command for the upstream port you have just configured:

```
Router# show controllers cable5/0/0 u0
Cable5/0/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Note The upstream frequency displayed in the **show controllers cable** command output might not match the frequency that you entered when you set the upstream frequency. The Cisco uBR10000 series CMTS might select an upstream frequency close to the frequency you entered that offers better performance. The Cisco uBR10000 series CMTS selects the closest frequency available.

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you have selected a valid frequency for your router.

Setting the Upstream Input Power Level

The Cisco uBR10012 router controls the output power levels of CMs to meet the desired upstream input power level. The nominal input power level for the upstream RF carrier is specified in decibels per millivolt (dBmV). The default setting of 0 dBmV is the optimal setting for the upstream power level.

The valid range for the input power level depends on the data rate. At 1.6 MHz, the valid range is –10 to 25 dBmV. If your power levels operate at greater than the maximum valid level, use an inline attenuator to bring the power level to within the valid range.

Caution If you increase the input power level, CMs on your HFC network increase their transmit power level. This increases the carrier-to-noise ratio (C/N) on the network, but also increases distortion products. Composite Second Order Beat (CSO) and Composite Triple Beat (CTB) values worsen by 2 dB for every 1 dB-increased C/N. The return path laser immediately enters a nonlinear mode called *clipping,* and all communication becomes unreliable. Many return lasers send short bursts above the clipping thresholds and fail on longer or successive bursts.

You should not adjust your input power level by more than 5 dB in a 30-second interval. If you increase the power level by more than 5 dB within 30 seconds, cable interface service on your network is disrupted. If you decrease the power level by more than 5 dB within 30 seconds, cable interfaces on your network are forced offline.

Note When you run the **cable upstream 0 power-level** command, Cisco recommends that the adjacent channel not have a large variation. The recommended maximum input power variance is 5 to 6 dBmV.

To set the upstream input power level in dBmV, use the following command in cable interface configuration mode. The default is 0 dBmV.

```
Router(config-if)# cable upstream usport power-level dbmv
```

Verifying the Upstream Input Power Level

To verify the current value of the upstream input power level, enter the **show controllers cable** command for the upstream port you have just configured:

```
Router# show controllers cable5/0/0 u0
Cable5/0/0 Upstream 0 is up
  Frequency 24.016 MHz, Channel Width 0.800 MHz, QPSK Symbol Rate 0.640 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
```

Perform these steps if you are having difficulty with verification:

1. Verify that the upstream amplitude of an optimal RF carrier (injected at the fiber node reference input point) reaches the cable interface line card input point at a consistent level (node-to-node and port-to-port).
2. Verify that this absolute level, as installed, matches both the design and software settings on the Cisco uBR10000 series CMTS.

Note Software adjustments of 1 to 3 dB can be used to adjust for minor variations in measurement or setup and port-to-port calibration differences. These adjustments can significantly improve cable interface performance, particularly in marginal situations. Larger adjustments should be made in conjunction with spectrum analyzer support at the headend or distribution hub.

Specifying Upstream Minislot Size

To specify the minislot size (in ticks) for specific upstream cable interfaces, use the following command in cable interface configuration mode. Acceptable values are 2, 4, 8, 16, 32, 64, and 128. The default is 8.

```
Router(config-if)# cable upstream usport minislot-size size
```

For additional information about channel width and minislot size, refer to the *Cable Radio Frequency (RF) FAQs* at http://www.cisco.com/warp/public/109/cable_faq_rf.html.

Verifying Upstream Minislot Size

To verify upstream minislot size, enter the **show controllers cable** command for the upstream port you have just configured:

```
Router# show controllers cable5/0/0 u0
Cable5/0/0 Upstream 0 is up
Frequency 24.016 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR 33.2560 dB
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 2288
  Ranging Backoff automatic (Start 0, End 3)
  Ranging Insertion Interval automatic (60 ms)
  Tx Backoff Start 0, Tx Backoff End 4
  Modulation Profile Group 1
  part_id=0xFFFF, rev_id=0xFF, rev2_id=0xFF
  nb_agc_thr=0x0000, nb_agc_nom=0x0000
  Range Load Reg Size=0x58
  Request Load Reg Size=0x0E
  Minislot Size in number of Timebase Ticks is = 8
  Minislot Size in Symbols = 64
  Bandwidth Requests = 0xFE
  Piggyback Requests = 0xD
  Invalid BW Requests= 0x2
  Minislots Requested= 0x2963
  Minislots Granted  = 0x2963
  Minislot Size in Bytes = 16
  Map Advance = 4000 usecs
  UCD Count = 32964
  DES Ctrl Reg#0 = C000C043, Reg#1 = 0
```

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Setting Upstream Rate Limiting and Traffic Shaping

Upstream traffic shaping, available on the DOCSIS upstream channel, delays the scheduling of the upstream packet, which in turn causes the packet to be buffered on the cable customer premises equipment (CPE) device, instead of being dropped. This allows the user's TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined quality of service (QoS) levels.

The CMs are buffered without incurring TCP-related timeouts and retransmits. This enables the CMTS to enforce the peak upstream rate for each CM, without degrading overall TCP performance for the subscriber CPEs. Upstream grant shaping is per cable interface (per service ID (SID)).

Token-bucket policing with shaping is the per-upstream default rate-limiting setting at the CMTS. Shaping can be enabled or disabled for the token-bucket algorithm.

To enable upstream traffic shaping for an upstream port on a Cisco cable interface line card, use one of the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	`Router(config-if)# cable upstream usport rate-limit`	Enables traffic shaping for the specified upstream cable interface.
	`Router(config-if)# cable upstream usport rate-limit token-bucket`	Enables traffic shaping for the upstream cable interface employing the token-bucket policing algorithm. With this command the Cisco uBR10000 series CMTS automatically drops packets in violation of allowable upstream bandwidth.
	`Router(config-if)# cable upstream usport rate-limit token-bucket shaping`	Default. Enables traffic shaping for the upstream cable interface employing the token-bucket policing algorithm with traffic shaping.

Step 2	`Router(config-if)# ^Z`
	`Router#`
		Exits back to the EXEC mode so that you can verify upstream traffic shaping.

To disable upstream traffic shaping for an upstream port, enter the following command in cable interface configuration mode:

```
Router(config-if)# no cable upstream usport rate-limit
```

The software supports:

- Generic calendar queuing routines
- New token-bucket policing function
- Grant shaping application of the calendar queues
- Upstream rate-shaping option to the **token-bucket** keyword
- A default state change from 1-second burst policing to token bucket with shaping

Tip Upstream grant shaping is per CM (per service ID (SID)). Shaping can be enabled or disabled for the token-bucket algorithm.

Note Before the introduction of this feature, the CMTS would drop bandwidth requests from a CM it detected as exceeding its configured peak upstream rate. Such request dropping affects the throughput performance of IP-based protocols such as FTP, TCP, and Simple Network Management Protocol (SNMP). With this feature, the CMTS can shape (buffer) the grants for a CM that is exceeding its upstream rate, rather than dropping the bandwidth requests.

```
Router# show interface c5/0/0 sid 1 counters
00:02:23: %ENVM-3-LASTENV: Cannot save environmental data
Sid  Req-polls  BW-reqs    Grants     Packets    Frag       Concatpkts
     issued     received   issued     received   complete   received
1    0          22         22         22         0          0
2    0          3          3          2          0          0
3    0          0          0          0          0          0
```

Verifying Upstream Traffic Shaping

To determine if upstream traffic shaping is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream traffic shaping is configured and enabled, a traffic shaping entry appears in the **show running-config** output. If upstream traffic shaping is disabled, **no cable upstream rate-limit** appears in the output.

You can also perform the following tasks to verify that traffic shaping is enabled on the upstream channel:

Step 1 Configure a low-peak upstream rate limit for the CM in its QoS profile. Either use the command-line interface (CLI) to modify the modem's QoS profile, or edit the modem's TFTP configuration file. refer to the *DOCSIS 1.1 for the Cisco uBR7200 Series Universal Broadband Routers* feature module at http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_r_sw/docsis11.htm.

Step 2 Use a regular rate-limiting algorithm on the upstream without rate shaping, and note the drops of the excess bandwidth requests from this CM when it exceeds its peak upstream rate.

Use the **show interface c*x/y* sid counters verbose** command to see the bandwidth request drops. Verify that the upstream rate received by that modem is less than its configured peak rate, due to the timeouts and backoffs produced by the drop in bandwidth requests. Enter the **show interface c*x/y* service flow qos** command to see the input rate at CMTS in bps.

Step 3 Enable grant shaping on the upstream channel by using the new **shaping** keyword extension to the token-bucket algorithm CLI command.

Step 4 Make the CM exceed its peak upstream rate by generating upstream traffic, and note the effect of grant buffering (shaping) at the CMTS. If you use CM-to-CMTS pings, there is a perceivable decrease in the frequency of the pings.

Let the pings run long enough to allow the averages at the CMTS to settle; then view the upstream rate received by this single modem. Use the **show interface c*x/y*** command and see the input rate in bps. This value should be close to the modem's peak upstream rate. Also note the drop counts for the modem's SID by using the **show interface sid counters** command, and verify that the CMTS no longer drops the bandwidth requests from the CM.

The bandwidth request drop count (from the previous nonshaping test) remains unchanged when upstream rate shaping is used, indicating that the CMTS is actually shaping (buffering) the grants for the modem. Verify that the input rate at the CMTS (from the single rate-exceeded CM) stabilizes close to the configured peak rate of 128 Kbps.

Troubleshooting Tips

Perform these steps if you are having difficulty with verification:

Step 1 Ensure that the cable connections are not loose or disconnected.

Step 2 Ensure that the cable interface line card is firmly seated in its chassis slot.

Step 3 Ensure that the captive installation screws are tight.

Step 4 Verify that you have entered the correct slot and port numbers.

Step 5 Verify that you selected a valid frequency for your router.

Configuring Optional Cable Interface Features

This section builds on the required cable interface features documented earlier in this chapter. This section provides instructions for several optional cable interface configurations. These interface features pertain to heightened performance and security measures.

Note Default settings are typically adequate to configure optional features on the system. Change default settings only with careful prior analysis.

Section	Purpose
"Activating Host-to-Host Communication (Proxy ARP)" section on page 26	Allows the Cisco uBR10012 router to issue cable Address Resolution Protocol (ARP) requests on behalf of CMs on the same cable network subnet.
"Activating Packet Intercept Capabilities" section on page 27	Specifies a MAC address on the cable network for which interception capabilities are to be activated.
"Configuring Payload Header Suppression and Restoration" section on page 27	Provides command information to set up the Payload Header Suppression (PHS) feature, which is used to suppress repetitive or redundant portions in packet headers before transmission on the DOCSIS link.
"Setting Optional Broadcast and Cable IP Multicast Echo" section on page 28	Sets additional IP parameters to enable downstream echoing of upstream data.

Activating Host-to-Host Communication (Proxy ARP)

Cable proxy ARP allows the Cisco uBR10012 router to issue cable ARP requests on behalf of CMs on the same cable network subnet.

Note Because the downstream and upstreams are separate interfaces, modems cannot directly perform ARP with other modems on the cable plant.

Note The default values for the commands used in this configuration task are adequate in most cases to configure the Cisco uBR10012 router.

Activating Cable Proxy ARP Requests

To activate cable proxy ARP for host-to-host communications, use the following command in cable interface configuration mode.

Command	Purpose
`Router(config-if)# cable proxy-arp`	Enables proxy ARP on the cable interface. This is the default.

Verifying Cable Proxy ARP Requests

To verify if cable proxy ARP has been activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If cable proxy ARP has been activated, it does not appear in the output. If cable proxy ARP has been deactivated, it appears in the output as `no cable proxy-arp`.

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0

 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable proxy-arp
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

Tip If you are having difficulty with verification, make sure that you entered the correct port and cable interface line card slot number when you activated cable proxy ARP.

Activating Packet Intercept Capabilities

To activate packet intercept functionality, use the following commands in cable interface configuration mode.

Command	Purpose
`Router(config-if)#` **`cable intercept`** *`xxxx.xxxx.xxxx`*	Specifies a MAC address on the cable network for which interception capabilities are to be activated. There is a limit of 10 MAC addresses.
`Router(config-if)#` **`no cable intercept`** *`xxxx.xxxx.xxxx`*	Disables interception after it is enabled.

Configuring Payload Header Suppression and Restoration

Payload Header Suppression (PHS) is a new feature in the DOCSIS1.1 MAC driver. The PHS feature is used to suppress repetitive or redundant portions in packet headers before transmission on the DOCSIS link. The upstream receive driver is now capable of restoring headers suppressed by CMs, and the downstream driver is capable of suppressing specific fields in the packet header before forwarding the frame to the CM.

Command	Purpose
`show interface cable` *`x/0/0`* **`service-flow`** [*`sfid`*] **`phs`**	Displays cable interface information.
`debug cable error`	Displays errors that occur in the cable MAC protocols. To disable debugging output, use the **no** form of the command.
`debug cable phs`	Displays the activities of the PHS and restoration driver. The **no** form of this command disables debugging output.

Setting Optional Broadcast and Cable IP Multicast Echo

You can set additional IP parameters to enable downstream echoing of upstream data. This section contains two procedures to configure these optional IP parameters:

- "Setting IP Multicast Echo" section on page 28
- "Setting IP Broadcast Echo" section on page 29

Note The default values for the commands used in these configuration steps are adequate in most cases to configure the Cisco uBR10012 router.

Setting IP Multicast Echo

The Cisco uBR10012 router echoes IP multicast packets by default. To activate IP multicast echo if it has been previously disabled, use the following command in cable interface configuration mode.

Command	Purpose
`Router(config-if)#` **`cable ip-multicast-echo`**	Enables IP multicast echo. This is the default.

To disable IP multicast echo, enter the **no cable ip-multicast-echo** command in cable interface configuration mode.

Verifying IP Multicast Echo

To determine whether IP multicast echo is activated or deactivated, enter the **more system:running-config** command, and look for the cable interface configuration information. If IP multicast echo is activated, there is no notation in the output, because this is the default setting. If IP multicast echo is deactivated, a notation appears in the output:

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0

 ip address 1.1.1.1 255.255.255.0
 no keepalive
 no cable ip-multicast-echo
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

Tip If you are having difficulty with verification, make sure that you entered the correct slot and port numbers when you entered cable interface configuration mode.

Access Lists and the cable ip-multicast echo Command

The **cable ip-multicast-echo** command is enabled by default on the Cisco uBR10012 router, so that multicast IP packets that arrive on the upstream at the Cisco CMTS are forwarded on the appropriate downstream ports so that they are delivered to the other CMs and CPE devices on that segment of the network. This allows the cable network to behave like a standard Ethernet network in terms of its handling of multicast IP traffic.

However, on the Cisco uBR10012 router, input access lists are not applied to the multicast traffic that is echoed on each downstream. To control the echoed multicast traffic, you therefore need to configure an output access list and apply it to each downstream interface.

Refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com for additional information on access lists and multicast echo:

http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm

Setting IP Broadcast Echo

By default, the Cisco uBR10012 router does not echo IP broadcast packets. To activate IP broadcast echo, use the following command in cable interface configuration mode.

Command	Purpose
`Router(config-if)# cable ip-broadcast-echo`	Enables IP broadcast echo.

To disable IP broadcast echo when it is enabled, enter the **no cable ip-broadcast-echo** command in cable interface configuration mode.

Verifying IP Broadcast Echo

To determine whether IP broadcast echo is activated or deactivated, enter the **more system:running-config** command and look for a notation in the cable interface configuration information:

```
Router# more system:running-config
Building configuration...

Current configuration:
!
interface cable5/0/0

 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable ip-broadcast-echo
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 frequency 15008000
 no cable upstream 0 shutdown
```

Cable Interface Configuration Examples

This section provides the following configuration examples:

- "Subinterface Configuration Example" section on page 30
- "Cable Interface Bundling Example" section on page 30
- "Cable Interface Bundle Master Configuration Example" section on page 31
- "PE Router Configuration Example" section on page 31
- "P Router Configuration Example" section on page 35
- "BGP Routing Sessions Configuration Example" section on page 36
- "PE-to-PE Routing Sessions Configuration Example" section on page 36
- "BGP PE-to-CE Routing Sessions Configuration Example" section on page 36
- "RIP PE-to-CE Routing Sessions Configuration Example" section on page 37
- "Static Route PE-to-CE Routing Sessions Configuration Example" section on page 37

Subinterface Configuration Example

The following example shows how to define a subinterface on the cable5/0/0:

```
interface cable5/0/0
! No IP address
! MAC level configuration only


! first subinterface
interface cable5/0/0.1
description Management Subinterface
ip address 10.255.1.1 255.255.255.0
cable helper-address 10.151.129.2

! second subinterface
interface cable5/0/0.2
ip address 10.279.4.2 255.255.255.0
cable helper-address 10.151.129.2

! third subinterface
interface cable5/0/0.3
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. In this example, the interfaces `int c5/0/0` and `int c4/0` are bundled.

```
int c5/0/0
ip address 209.165.200.225 255.255.255.0
ip address 209.165.201.1 255.255.255.0 secondary
cable helper-address 10.5.1.5
! MAC level configuration
cable bundle 1 master
int c4/0/0
! No IP address
! MAC layer configuration only
cable bundle 1
```

Subinterface Definition on Bundle Master Example

The following example shows how to define subinterfaces on a bundle master and define Layer 3 configurations for each subinterface. In this example, the interfaces `int c5/0/0` and `int c4/0/0` are bundled.

```
int c5/0/0
! No IP address
! MAC level configuration only
cable bundle 1 master

int c4/0/0
! No IP address
! MAC layer configuration
cable bundle 1

! first subinterface
int c5/0/0.1
ip address 10.22.64.0 255.255.255.0
cable helper-address 10.4.1.2

! second subinterface
int c5/0/0.2
ip address 10.12.39.0 255.255.255.0
cable helper-address 10.4.1.2

! third subinterface
int c5/0/0.3
ip address 10.96.3.0 255.255.255.0
cable helper-address 10.4.1.2
```

Cable Interface Bundle Master Configuration Example

The following example shows 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  Bundle master
  <cr>
Router(config-if)# cable bundle 25 master ?
  <cr>
Router(config-if)# cable bundle 25 master
Router(config-if)#
07:28:17: %uBR10000-5-UPDOWN: Interface Cable5/0/0 Port U0, changed state to down
07:28:18: %uBR10000-5-UPDOWN: Interface Cable5/0/0 Port U0, changed state to up
```

PE Router Configuration Example

This example (system information display) identifies the version of Cisco IOS software installed and displays PE configurations:

```
! Defines the hostname of the Cisco uBR10012
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 uBR10012 image named
! AdamSpecial from slot 0.
boot system flash slot0:uBR10000-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 10.0.0.0 255.255.255.0
 no ip directed-broadcast
!
! Assigns an IP address to this Fast Ethernet interface. MPLS tag-switching must be
! enabled on this interface.
interface FastEthernet0/0/0
 description Connection to MSO core.
 ip address 10.0.0.0 255.255.255.0
 no ip directed-broadcast
 full-duplex
 tag-switching ip
!
! Enters cable interface configuration mode and configures the physical aspects of the
! 5/0/0 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 Cable5/0/0
 no ip address
 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 the physical aspects of the 5/0/0.1 cable subinterface. If cable modems have
! not been assigned IP addresses, they will automatically come on-line using the settings
! for subinterface X.1.
interface Cable5/0/0.1
 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 10.0.0.0 255.255.255.0
!
! 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 the physical aspects of the 5/0/0.2 cable subinterface.
interface Cable5/0/0.2
 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 10.1.0.0 255.255.255.0 secondary
!
! Defines a range of IP addresses and masks to be assigned to host devices associated
! with the MSO as ISP network.
 ip address 10.1.0.0 255.255.255.0
!
! 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 the physical aspects of the 5/0.3 cable subinterface
interface Cable5/0/0.3
 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 the physical aspects of the 5/0/0.4 cable subinterface
interface Cable5/0/0.4
 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
! cable 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

This example (system information display) identifies the version of Cisco IOS software installed and displays PE configurations:

```
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 FastEthernet0/0/0
 ip address 1.7.108.2 255.255.255.0
 no ip directed-broadcast
 no ip mroute-cache
 shutdown
 full-duplex
 no cdp enable
!
router ospf 222
 network 10.0.1.0 255.255.255.0 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/ubr10k-p6-mz.122-2.XF
!
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
```

BGP Routing Sessions Configuration Example

To configure BGP routing sessions in a provider network, use the following commands in router configuration mode on the PE router:

Step 1 Configure the BGP routing process with the autonomous system number:

```
Router(config)# router bgp 42
```

Step 2 Specify a neighbor's IP address or BGP peer group, identifying it to the local autonomous system:

```
Router(config-router)# neighbor 200.28.28.40
Activate the advertisement of the IPv4address family.
Router(config-router)# neighbor 200.28.28.40 activate
```

PE-to-PE Routing Sessions Configuration Example

To configure PE-to-PE routing sessions in a provider network, use the following commands in router configuration mode on the PE router:

Step 1 Define internal Border Gateway Protocol (iBGP) parameters for VPNv4 network-layer reachability information (NLRI) exchange:

```
Router(config-router)# address-family vpnv4 unicast
```

Step 2 Define an IBGP session to exchange VPNv4 NLRIs:

```
Router(config-router-af)# neighbor 200.28.28.45 remote-as 48
Router(config-router-af)# exit
```

Step 3 Activate the advertisement of the IPv4address family:

```
Router(config-router)# neighbor 200.28.28.45 activate
```

BGP PE-to-CE Routing Sessions Configuration Example

To configure BGP PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

Step 1 Define external Border Gateway Protocol (eBGP) parameters for PE-to-CE routing sessions:

```
Router(config-router)# address-family ipv4 unicast vrf
go_fast_internet_company
```

Step 2 Define an eBGP session between PE and CE routers and activate the advertisement of the IPv4 address family:

```
Router(config-router-af)# neighbor 200.28.28.46 remote-as 49
Router(config-router-af)# neighbor 200.28.28.46 activate
```

RIP PE-to-CE Routing Sessions Configuration Example

To configure RIP PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

Step 1 Enable RIP, define RIP parameters for PE-to-CE routing sessions, and enable RIP on the PE-to-CE link:

```
Router(config)# router rip
Router(config-router)# address-family ipv4 unicast vrf
go_fast_internet_company
Router(config-router-af)# network 200.28.28.47
```

Static Route PE-to-CE Routing Sessions Configuration Example

To configure static route PE-to-CE routing sessions, use the following commands in router configuration mode on the PE router:

Step 1 Define static route parameters for each PE-to-CE session and for each BGP PE-to-CE routing session.

```
Router(config)# ip route vrf go_fast_internet_company 200.28.28.46
255.255.255.0 200.28.28.50
Router(config-router)# address-family ipv4 unicast vrf
go_fast_internet_company
```

Step 2 Redistribute VRF static routes and directly connected networks into the VRF BGP table.

```
Router(config-router-af)# redistribute static
Router(config-router-af)# redistribute static connected
```

Managing Cable Modems on the Hybrid Fiber-Coaxial Network

Note

Writer’s Note - Reinstate all topics/procedures that were removed for uBR10K SCG. Use the previous uBR7200 SCG as first source. Verify that interface examples are taken from uBR7200, not from uBR10K. This chapter ready for update, and is confirmed for this pending edition.

After you have completed upstream and downstream configuration in Chapter 3, “Configuring Cable Interface Features for the Cisco uBR10012 Router,” you have additional options to manage how your CMs operate in the hybrid fiber-coaxial (HFC) network. You can set the following CM functions:

Section	Purpose
“Activating CM Authentication” section on page 4	Configures the Cisco uBR10000 series CMTS to require all CMs to return a known text string to register with the CMTS and gain access to the network.
“Activating CM Authentication” section on page 2	Configures the Cisco uBR10000 series CMTS to require all CMs to return a known text string to register with the CMTS and gain access to the network.
“Activating CM Insertion Interval” section on page 3	Limits the amount of time that a CM requests a channel for the first time from the Cisco uBR10012 router. (A CM's initial channel request is known as *insertion*.)
“Activating CM Upstream Address Verification” section on page 5	Ensures that only CMs that have received DHCP leases through the Cisco uBR10000 series CMTS can access the HFC network.
“Clearing CM Counters” section on page 5	Clears the counters for the CMs in the station maintenance list.
“Clearing CM Reset” section on page 6	Removes one or more CMs from the station maintenance list and resets the cable modem (or all CMs) on the network.
“Configuring CM Registration Timeout” section on page 7	Specifies the registration timeout interval for CMs connected to the Cisco uBR10012 router.
“Configuring Dynamic Contention Algorithms (Cable Insertion Interval, Range, and Data Backoff)” section on page 7	Configures the algorithms that control the capacity of the contention subchannel and how efficiently a given contention subchannel capacity is used.

Section	Purpose
"Configuring the Dynamic Map Advance Algorithm" section on page 8	Enhances the upstream throughput from a CM connected to the Cisco uBR10000 series CMTS. The system employs a new algorithm that automatically tunes the lookahead time in MAC allocation and management messages (MAPs), based on several input parameters for the corresponding upstream channel.
"Configuring Maximum Hosts Attached to a CM" section on page 9	Specifies the maximum number of hosts that can be attached to a subscriber's CM.
"Configuring Per-Modem Filters" section on page 9	Provides instructions to configure the Cisco uBR10012 router to filter incoming packets from individual hosts or cable interfaces based on the source Media Access Controller (MAC) or Internet Protocol (IP) address.
"Configuring Sync Message Interval" section on page 10	Specifies the sync message interval between successive sync message transmissions from the Cisco uBR10000 series CMTS.

Note Cisco recommends using default values for most commands. The default values for the commands used in these configuration steps are, in most cases, adequate to configure the Cisco uBR10012 router.

Note For information about setting rate limiting on CMs, refer to these sections in Chapter 3:

- "Setting Downstream Rate Limiting and Traffic Shaping" section on page 9
- "Setting Upstream Rate Limiting and Traffic Shaping" section on page 24

Activating CM Authentication

The Cisco uBR10012 router can be configured to require all CMs to return a known text string to register with the CMTS and gain access to the network. The text string can be from 1 to 80 characters in length. To activate CM authentication, use the following command from cable interface configuration mode.

To configure authentication and data privacy parameters, use the **cable shared-secret** command in cable interface configuration mode. To disable authentication during the CM registration phase, use the **no** form of this command.

cable shared-secret [**0** | **7**] *authentication-key*

no cable shared-secret

Syntax Description

0	(Optional) Specifies that an unencrypted message will follow.
7	(Optional) Specifies that an encrypted message will follow.
authentication-key	Text string is a shared secret string. When you enable the service password-encryption option, the password is stored in encrypted form. The text string is a 64-character authentication key.

Examples

The following example shows how to activate CM authentication using 3344912349988...sf as the shared secret key and indicating that an encrypted message follows:

```
Router(config-if)# cable shared-secret 7 3344912349988cisco@xapowenaspasdpuy230jhm...sf
```

Verify CM Authentication

To verify whether CM authentication is activated or deactivated, enter the command **more system:running-config** and look for the cable interface configuration information. If CM authentication is deactivated, it appears in this output as `no cable secret-shared.`

Activating CM Insertion Interval

When a CM is ready to transmit data, it requests a channel from the Cisco uBR10012 router. You can limit the amount of time that a CM requests a channel for the first time from the Cisco uBR10012 router. A CM's initial channel request is known as *insertion*. The valid range is 100 to 2000 milliseconds.

To activate the CM insertion interval, use the following command in cable interface configuration mode.

Command	Purpose
cable insertion-interval *milliseconds*	Sets the insertion interval in milliseconds.

Validating CM Insertion Interval

To verify that a CM insertion interval has been set, enter the command **more system:running-config** command, and look for the cable interface configuration information, as shown in this command output excerpt:

```
Router# more system:running-config
Building configuration...
Current configuration:
!
interface Cable5/0/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
 cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
!
```

Troubleshooting CM Insertion Interval

If you are having trouble, make sure that you entered the correct slot and port numbers when you typed the command.

Activating CM Authentication

The Cisco uBR10000 series CMTS can be configured to require all CMs to return a known text string to register with the CMTS and gain access to the network. The text string can be from 1 to 80 characters in length. The default setting is "on" (CM authentication is activated).

To activate CM authentication, use the following command in cable interface configuration mode:

Command	Purpose
cable shared-secret [*0*|*7*] **authorization-key**	Enables CM authentication: - *0* specifies an unencrypted authentication key. - *7* specifies an encrypted authentication key.
no cable shared-secret	Disables CM authentication.

Tip Be sure that you enter the correct slot and port number in cable interface configuration mode. Verify that the CM is using baseline privacy interface (BPI) and that it is assigned to a quality of service (QoS) with privacy active. Verify that the cable interface configuration file contains a matching key.

Verifying CM Authentication

To verify if CM authentication has been activated or deactivated, enter the command **more system:running-config** and look for the cable interface configuration information. If CM authentication has been activated, it does not appear in this output. If CM authentication has been deactivated, it appears in this output as "`no cable secret-shared`," as shown in this command output excerpt:

```
Router# more system:running-config
Building configuration...
Current configuration:
!
interface Cable5/0/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
  no cable secret-shared
  cable insertion-interval 150000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
!
```

Troubleshooting CM Authentication

If you are having trouble, make sure that you entered the correct slot and port numbers when you entered cable interface configuration mode. For additional troubleshooting information, refer to Chapter 6, "Troubleshooting the System."

Activating CM Upstream Address Verification

CM upstream address verification ensures that only CMs that have received Dynamic Host Configuration Protocol (DHCP) leases through the Cisco uBR10012 router can access the HFC network. The Cisco uBR10012 router discards all packets received from or for hosts that have not received Dynamic Host Configuration Protocol (DHCP)-assigned addresses. The default setting is "off" (CM upstream address verification is deactivated).

To activate or deactivate CM upstream verification, use the following command in the cable interface configuration mode:

Command	Purpose
cable source-verify [**dhcp**]	Activates CM upstream verification. The **dhcp** option specifies that queries be sent to verify unknown IP addresses in upstream data packets.
no cable source-verify	Returns to the default upstream verification state.

Verifying CM Upstream Address Verification

To verify that CM upstream verification has been activated or deactivated, enter the command **more system:running-config** and look for the `no cable source-verify` notation in the cable interface configuration information. If CM upstream verification has been deactivated, it does not appear in this output. If CM upstream verification has been activated, it appears in this output as `cable source-verify`, as shown in this command output excerpt:

```
Router# more system:running-config
Building configuration...
Current configuration:
!
interface Cable5/0/0
 ip address 1.1.1.1 255.255.255.0
 no keepalive
  cable source-verify
  cable insertion-interval 2000
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream symbol-rate 5056941
 cable upstream 0 frequency 15008000
 cable upstream 0 fec
 cable upstream 0 scrambler
 no cable upstream 0 shutdown
!
```

Tip Be sure that you enter the correct slot and port number when you enter the cable interface configuration mode.

Note If the Cisco uBR10012 router is reloaded or the Address Resolution Protocol (ARP) table is cleared, all hosts on the network are forced to release and renew their IP addresses. Some systems might require restarting if the IP protocol stack is unable to renew using a broadcast IP address.

Clearing CM Counters

To clear the counters for the CMs in the station maintenance list, use one of the following commands in cable interface configuration mode.

Command	Purpose
clear cable modem *mac-addr* **counters**	Clears the counters in the station maintenance list for the CM with a specific MAC address.
clear cable modem *ip-addr* **counters**	Clears the counters in the station maintenance list for the CM with a specific IP address.
clear cable modem all counters	Clears the counters in the station maintenance list for all CMs.

Verifying Clear CM Counters

To determine if the counters in the station maintenance list are cleared, enter one of the **following** commands. The station maintenance list counter is 0.

Command	Purpose
show cable modem *ip-address*	Displays the status of a CM identified by its IP address.
show cable modem *mac-address*	Displays the status of a CM identified by its MAC address.
show cable modem *interface-address*	Displays the status of all CMs on a particular upstream.

Clearing CM Reset

To remove one or more CMs from the station maintenance list and reset the cable modem (or all CMs) on the network, use one of the following commands in cable interface configuration mode.

Command	Purpose
clear cable modem *mac-addr* **reset**	Removes the CM with a specific MAC address from the station maintenance list and resets it.
clear cable modem *ip-addr* **reset**	Removes the CM with a specific IP address from the station maintenance list and resets it.
clear cable modem all reset	Removes all CMs from the station maintenance list and resets them.

Verifying Clear CM Reset

To determine if the **clear cable modem reset** command has removed a CM from the station maintenance list and forced it to start a reset sequence, enter the **show cable modem** command.

Tip Be sure that you entered the correct CM IP address or MAC address when you typed the **clear cable modem reset** command. It might take up to 30 seconds for the CM to start the reset sequence.

Note The **clear cable modem reset** command is useful if a Simple Network Management Protocol (SNMP) manager is not available, or if the CM is unable to obtain an IP address or respond to SNMP messages.

Configuring CM Registration Timeout

By default, registered CMs that have no upstream activity for three minutes are timed out and disconnected from the Cisco uBR10012 router. This timeout interval can be decreased to 2 minutes or increased up to 60 minutes.

To specify the registration timeout interval for CMs connected to the Cisco uBR10012 router, use the following command in cable interface configuration mode.

Command	Purpose
cable registration-timeout *n*	Specifies the maximum number of minutes allowed to elapse with no upstream activity before terminating the connection. Valid range is from 2 to 60 minutes. Default = 3 minutes.

Configuring Dynamic Contention Algorithms (Cable Insertion Interval, Range, and Data Backoff)

The Cisco uBR10000 series software includes the following algorithms that control the capacity of the contention subchannel and control the efficient use of a given contention subchannel capacity:

- Algorithm that dynamically controls the rate of upstream contention slots—initial ranging and bandwidth requests.
- Algorithm that varies the backoff parameters that CMs use. Backoff variation falls within each of the initial ranging and bandwidth request upstream contention subchannels.

In high contention mode, the Cisco uBR10000 series MAC scheduler uses collision statistics and sustains a high frequency of initial ranging slots until it detects a steady ranging state. The CMTS dynamically varies the frequency of initial ranging slots using the data grant utilization on the upstream channels. The CMTS trades upstream bandwidth between data grants and initial ranging slots. The CMTS autodetects a high collision state and switches to low insertion interval mode after a steady state is achieved where few collisions occur.

The CMTS is careful when monitoring the ranging channel health to revert to a steady state. In steady state mode, data grants—grant utilization—receive preference over initial ranging slots.

Although the binary exponential backoff algorithm operates in a distributed fashion at different CMs, the CMTS provides centralized control for the backoff algorithm. To achieve this, it remotely monitors traffic load—the backlog developing on the contention channel—and then varies the backoff start and end specified in the MAPs for that upstream channel. This ensures that colliding CMs are properly randomized in time.

The following cable interface commands are available to configure the dynamic contention algorithms:

```
[no] cable insertion-interval [automatic [Imin [Imax]]] | [msecs]
[no] cable upstream port num range-backoff [automatic] | [start end]
[no] cable upstream port num data-backoff [automatic] | [start end]
```

cable insertion-interval Command Examples

To deviate from system defaults when modifying the dynamic contention algorithm, use one of the following commands in cable interface configuration mode.

Command	Purpose
[**no**] **cable insertion-interval** [**automatic** [*Imin* [*Imax*]]] | [*msecs*]	Enables or disables the dynamic ranging interval algorithm. If lower and upper bounds for varying the period are not specified, the system uses default frequency values of initial ranging upstream slots between 50 milliseconds to 2 seconds, respectively.
cable insertion-interval automatic min 25-2000	Sets the lower bound on the initial ranging period for the automatic ranging algorithm.
cable insertion-interval max 500-2000	Sets the upper bound on initial ranging period for the automatic ranging algorithm.
no cable insertion-interval	Resets fixed initial ranging period to default value of 500 msecs. Also invokes fixed initial ranging algorithm.
cable insertion-interval 100-2000	Enables fixed initial ranging period algorithm with specified fixed period (msecs).

Tip System defaults are to have dynamic ranging interval enabled, dynamic ranging backoff enabled, and fixed data backoffs for each upstream of a cable interface.

The default **automatic** insertion interval setting enables the Cisco automatic initial ranging period algorithm, where lower and upper default values of 50 msecs and 2 secs are used. The default **automatic range-backoff** setting enables the dynamic backoff algorithm.

Configuring the Dynamic Map Advance Algorithm

A CMTS administrator can enhance the upstream throughput from a CM connected to the Cisco uBR10000 series CMTS. The system employs a new algorithm that automatically tunes the lookahead time in MAPs, based on several input parameters for the corresponding upstream channel. The use of dynamic and optimal lookahead time in MAPs significantly improves the per-modem upstream throughput.

Caution Only a trained CMTS administrator should adjust these values.

To configure the dynamic map advance algorithm, use the following command in cable interface configuration mode.

Command	Purpose
cable map-advance dynamic [*n*]|**static**	Specifies a value to enhance the upstream throughput from a CM connected to the Cisco uBR10012 router. The *n* argument provides the safety factor for the dynamic map advance algorithm. This argument is specified in usecs and controls the amount of extra lookahead time in MAPs to account for inaccuracies of the measurement system and software latencies. The default value is 1000 usecs. You can vary this value from 500 to 1500 usecs. This argument is a delta value added to the dynamic **map-advance** setting that the algorithm computes. Using larger safety factors increases the run-time lookahead in MAPs, but reduces the upstream performance. Use the **static** keyword for the **cable map-advance** command. The Cisco uBR10012 router uses a fixed lookahead time in MAPs, regardless of the real propagation delay of the farthest CM on the network. This fixed lookahead time is computed based on the worst-case parameters, such as farthest DOCSIS propagation delay for the CMs.

Caution If you are adjusting the dynamic map-advance algorithm, do not reduce the safety factor below the default value of 1000 usecs in a production network, until you are confident that the reduced safety factor suffices for your deployment. The default value is chosen to be a safe operating point for the algorithm.

Configuring Maximum Hosts Attached to a CM

To specify the maximum number of hosts that can be attached to a subscriber's CM, use the following command in cable interface configuration mode.

Command	Purpose
cable max-hosts *n*	Specifies the maximum number of hosts that can be attached to a CM on this interface. Valid range is from 0 to 255 hosts. Default = 0.
no cable max-hosts	Resets the allowable number of hosts attached to a CM to the default value of 0 hosts.

Configuring Per-Modem Filters

You can configure the Cisco uBR10012 router to filter incoming packets from individual hosts or cable interfaces based on the source Media Access Controller (MAC) or Internet Protocol (IP) address. Definition of filters follows standard Cisco IOS configuration practices for access lists and groups.

Note Configuring per modem or host filters is supported in Cisco IOS Release 12.0(5)T1 or higher, as well as in Cisco IOS Release 12.0(6)SC or higher.

To configure per modem filters, use the following commands in cable interface configuration mode.

	Command	Purpose
Step 1	Router(config-if)# **cable** {modem | host | device} *{<macaddr><ipaddr> | }* **access group** <*acl*>	Configure access lists to be specified on a per-interface and per-direction basis. The packets received from cable interfaces and/or individual hosts are filtered based on the cable interface or the host the packets are received from. Use *modem* if the device is a CM. Use *host* if the device is a CPE device attached to a CM. Define the filter to be applied to the device and a given address. The *macaddr* specifies the CM's or CPE device's unique MAC address. Use the *ipaddr* option to specify the CM or CPE device's current IP address. Use the *acl* option to assign the CM or CPE device to an access list. This defines the per-CM or per-host filter requirements implemented at the CMTS, rather than at the CM. Access list numbers are 1 to 99 for fast IP access lists, 100 to 199 for show extended IP access lists. Note Access list numbers of 700 to 799 do not apply.

Caution The system applies filters after the CM registers with the CMTS. Filter definitions are not saved across system reboots and must be applied each time a CM registers.

The software supports traps to alert CMTS administrators on CMs going offline or back online. A typical registration and login procedure is shown below:

1. The CM registers with theCisco uBR10000 series.
2. The Cisco uBR10000 series sends traps to management systems in use for the network.
3. The management system sets per modem filters using SNMP or *rsh.*
4. The user logs in at the server.
5. The login server obtains required modem and CPE information from the Cisco uBR10000 series.
6. The login server sets per-CPE filter in the Cisco uBR10000 series. The per-CPE filter overrides the per modem filter settings.
7. If the CM goes offline for a brief period of time, filters defined using the Cisco uBR10000 series remain active. If a CM stays offline for more than 24 hours, filter settings are reset.
8. If the user logs out or the login server detects that the user is not online, the login server sets default filters for the CM or the CPE device.

Configuring Sync Message Interval

To specify the sync message interval between successive sync message transmissions from the Cisco uBR10012 router, use the following command in cable interface configuration mode.

Command	Purpose
cable sync-interval *msec*	Specifies the interval in milliseconds between successive sync message transmissions from the Cisco uBR10000 series CMTS. Valid values are from 1 to 200 msec. Default = 10 msec.
no cable sync-interval	Returns the sync message interval to its default value of 10 msec.

Verifying Sync Message Interval

To determine if a sync message interval is configured, enter the **show running-config** command and look for the cable interface configuration information. If the sync message interval is deactivated or reset to its default value, the `no sync interval` command line appears in the output.

CHAPTER 5

Configuring Basic Broadband Internet Access

This chapter describes the parameters of configuring and maintaining basic broadband Internet access. The chapter contains these sections:

- "Overview of Basic Broadband Internet Access" section on page 5-1
- "Recommended Basic Configuration for High-Speed Internet Access" section on page 5-2
- "Basic Internet Access Sample Configuration File" section on page 5-3

Overview of Basic Broadband Internet Access

A Cisco uBR10012 router and an intermediate frequency (IF)-to-radio frequency (RF) upconverter are installed at the headend or distribution hub to transmit digital data. The Cisco uBR10012 router downstream ports transmit IF signals to the upconverter, which translates the downstream signals to RF for broadcast.

Receivers, scramblers, and descramblers then process the TV signals to encode or decode signals as needed for broadcast. Modulators format the analog TV and digital signals.

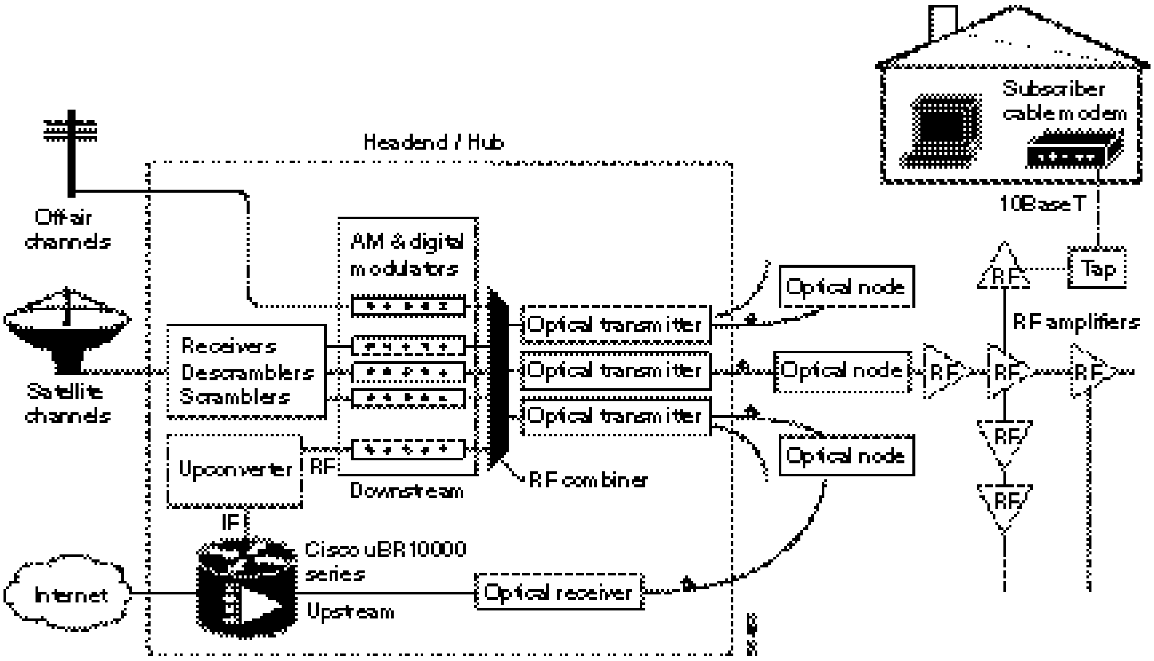
The analog and digital signals then pass through the RF combiner. The signals are broadcast from the headend through optical transmitters to fiber nodes.

Amplifiers, coaxial cable, and taps carry the signals to the subscriber premises. Signals are processed as follows:

- Tuners that handle MPEG video, audio, and broadcast services in set-top boxes (STBs), TVs, and VCRs receive one-way analog signals.
- CMs receive digital data signals:
  - Two-way CMs transmit RF signals back through amplifiers to optical fiber receivers at the headend. These receivers pass the upstream signal to upstream ports on the Cisco uBR10012 router, where they are processed.

Figure 5-1 illustrates this general signal flow and associated processes in the CMTS.

Figure 5-1 Two-Way Internet Access Network Example



Note The external upconverter shown in Figure 5-1 is needed only if you are not using the router's integrated upconverter.

Recommended Basic Configuration for High-Speed Internet Access

The Cisco uBR10012 router is fully capable of self-provisioning all CMs and hosts to which it is attached. The router supports multiple IP subnets, including different subnets for hosts and CMs. Configuration options are limited only by available configuration file length.

The Cisco uBR10012 router automatically connects DOCSIS-compliant CMs and hosts right out of the box. Therefore, the factory-supplied configuration activates the downstream RF to 851 MHz center frequency, and the upstream to 37 MHz.

Step 1 Connect one upstream port and the downstream port to a duplex filter.

Note Do not combine multiple ports, because they are all set on the same frequency.

Step 2 Use at least 40 dB attenuation before the first modem, and modems will connect in under 5 minutes.

Basic Internet Access Sample Configuration File

The following sample configuration file for the Cisco uBR10012 router includes the following features:

- Basic DOCSIS Internet Access
- DHCP Address Pools—The Cisco uBR10012 router acts as a DHCP server, providing different address spaces on the basis of the CM's service level, including those customers whose network access should be denied access because they have cancelled their service. Different default pools can be used for CMs and for the IP hosts behind them. Static IP addresses can also be assigned to specific clients on the basis of the client's MAC address.
- DOCSIS CM Configuration Files—These configuration files provide several different service level options:
  - platinum.cm—Users are given a maximum upstream bandwidth of 128 kbps, with a guaranteed minimum bandwidth of 10 kbps. The downstream has a maximum bandwidth of 10 Mbps. Up to 8 PCs are allowed on this connection.
  - gold.cm—Users are given a maximum upstream bandwidth of 64 kbps and a maximum downstream bandwidth of 5 Mbps. Up to 3 PCs are allowed on this connection.
  - silver.cm—Users are given a maximum upstream bandwidth of 64 kbps and a maximum downstream bandwidth of 1 Mbps. Only 1 PC is allowed on this connection.
  - disable.cm—Users are denied access to the cable network. This configuration file can be used for users who have cancelled service or have not paid their bills.

```
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service compress-config
service udp-small-servers max-servers 500
!
hostname uBR10000
!
boot system slot0:
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable time-server
!
cable config-file platinum.cm
   service-class 1 max-upstream 128
   service-class 1 guaranteed-upstream 10
   service-class 1 max-downstream 10000
   service-class 1 max-burst 1600
   cpe max 8
   timestamp
!
cable config-file gold.cm
   service-class 1 max-upstream 64
   service-class 1 max-downstream 5000
   service-class 1 max-burst 1600
   cpe max 3
   timestamp
!
cable config-file silver.cm
   service-class 1 max-upstream 64
   service-class 1 max-downstream 1000
   service-class 1 max-burst 1600
   cpe max 1
   timestamp
!
```

```
cable config-file disable.cm
   access-denied
   service-class 1 max-upstream 1
   service-class 1 max-downstream 1
   service-class 1 max-burst 1600
   cpe max 1
   timestamp
!
ip subnet-zero
ip cef
no ip domain-lookup
ip dhcp excluded-address 10.128.1.1 10.128.1.15
ip dhcp excluded-address 10.254.1.1 10.254.1.15
ip dhcp ping packets 1
!
ip dhcp pool CableModems
     network 10.128.1.0 255.255.255.0
     bootfile platinum.cm
     next-server 10.128.1.1
     default-router 10.128.1.1
     option 128 ip 10.128.1.1
     option 4 ip 10.128.1.1
     option 2 hex ffff.8f80
     option 11 ip 10.128.1.1
     option 10 ip 10.128.1.1
     lease 1 0 10
!
ip dhcp pool hosts
     network 10.254.1.0 255.255.255.0
     next-server 10.254.1.1
     default-router 10.254.1.1
     dns-server 10.254.1.1 10.128.1.1
     domain-name ExamplesDomainName.com
     lease 1 0 10
!
ip dhcp pool staticPC(012)
     host 10.254.1.12 255.255.255.0
     client-identifier 0108.0009.af34.e2
     client-name staticPC(012)
     lease infinite
!
ip dhcp pool goldmodem
     host 10.128.1.129 255.255.255.0
     client-identifier 0100.1095.817f.66
     bootfile gold.cm
!
ip dhcp pool DisabledModem(0010.aaaa.0001)
     host 10.128.1.9 255.255.255.0
     client-identifier 0100.1095.817f.66
     bootfile disable.cm
!
ip dhcp pool DisabledModem(0000.bbbb.0000)
     client-identifier 0100.00bb.bb00.00
     host 10.128.1.10 255.255.255.0
     bootfile disable.cm
!
interface Cable5/0/0
   description Cable Downstream Interface
   ip address 10.254.1.1 255.255.255.0 secondary
   ip address 10.128.1.1 255.255.255.0
   no keepalive
   cable downstream annex B
   cable downstream modulation 64qam
   cable downstream interleave-depth 32
   cable downstream frequency 851000000
   cable down rf-power 55
   cable upstream 0 description Cable upstream interface, North
   cable upstream 0 frequency 37008000
   cable upstream 0 power-level 0
   cable upstream 0 admission-control 150
   no cable upstream 0 shutdown
   cable upstream 1 description Cable upstream interface, South
   cable upstream 1 frequency 37008000
   cable upstream 1 power-level 0
   cable upstream 1 admission-control 150
   no cable upstream 1 shutdown
   cable upstream 2 description Cable upstream interface, East
   cable upstream 2 frequency 37008000
   cable upstream 2 power-level 0
   cable upstream 2 admission-control 150
   no cable upstream 2 shutdown
   cable upstream 3 description Cable upstream interface, West
   cable upstream 3 frequency 37008000
   cable upstream 3 power-level 0
   cable upstream 3 admission-control 150
   no cable upstream 3 shutdown
   no cable arp
   cable source-verify dhcp
   cable dhcp-giaddr policy
!
ip classless
no ip forward-protocol udp netbios-ns
ip route 0.0.0.0 0.0.0.0 FastEthernet0/0
ip http server
!
!
alias exec scm show cable modem
alias exec scf show cable flap
alias exec scp show cable qos profile
!
line con 0
   transport input none
line aux 0
line vty 0 4
   login
!
end
```

To set up spectrum management in your configuration, use the following commands to set up the critical elements:

```
cable spectrum-group 1 frequency 40000000
cable spectrum-group 1 frequency 20000000 2
```

In this illustration, the user has configured spectrum management group number “1” to be available to upstream channels. As defined by the two previous command lines, the “preferred” choice is for the upstream to operate on a 40-MHz channel. If that channel is not suitable for the transmission scheme available, the upstream automatically moves over to transmitting at 20 MHz and increases the receive power rating by 2 dB.

The command lines in the sample configuration file beginning with the **cable modulation-profile** command contain the critical elements necessary to set up a modulation profile in your overall configuration:

```
cable modulation-profile 3 request 0 16 1 8 16qam scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 3 initial 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 3 station 5 34 0 48 16qam scrambler 152 no-diff 256 fixed uw16
cable modulation-profile 3 short 5 75 6 8 16qam scrambler 152 no-diff 144 fixed uw8
cable modulation-profile 3 long 8 220 0 8 16qam scrambler 152 no-diff 160 fixed uw8
```

In this case, the user has configured modulation profile number “3” to be available to upstream channels wherever they are configured to apply it. Note that this modulation profile has been configured to operate with a QAM-16 modulation scheme. The default modulation scheme for any upstream profile (if it is not set to QAM-16) is QPSK.

Later in the configuration file example, upstream port 0 on the cable interface card installed in slot 5 uses both the spectrum management and the modulation profile configured in the sample:

```
cable upstream 0 spectrum-group 1
cable upstream 0 modulation-profile 3
```

Troubleshooting the System

This chapter contains troubleshooting information for various functions of your Cisco uBR10000 series Cable Modem Termination System (CMTS) and includes the following sections:

Section	Purpose
"Understanding show Command Responses" section on page 2	Provides **show** command options for deriving system information.
"Using a Headend CM to Verify Downstream Signals" section on page 12	Uses a Cisco uBR924 cable access modem to verify the downstream signal originating from a Cisco uBR10012 router.
"Performing Amplitude Averaging" section on page 12	The system uses an averaging algorithm to determine the optimum power level for a CM with low carrier-to-noise ratio that is making excessive power adjustments—known as flapping. This section shows how you can interpret these power adjustments as indicating unstable return path connections.
"Setting Downstream Test Signals" section on page 15	Provides configuration commands that allow you to create downstream test signals.
"Pinging Unresponsive CMs" section on page 16	Allows a cable system administrator to quickly diagnose the health of a channel between the Cisco uBR10000 series cable interface and the CM.
"Using Cable Interface debug Commands" section on page 17	Provides instructions for troubleshooting cable interface line cards.

Note: For detailed information about troubleshooting your CMTS platform using cable flap lists, refer to the chapter "Flap List Troubleshooting for the Cisco CMTS" in the *Cisco Cable Modem Termination Feature Guide* on Cisco.com.

Note: For additional online troubleshooting resources, visit the Cisco Technical Assistance Center's *Troubleshooting Assistant* Web page at http://te.cisco.com/SRVS/CGI-BIN/WEBCGI.EXE?New,KB=Cable.

Understanding show Command Responses

This section summarizes cable-related **show** commands. For additional command information about these and other CMTS commands, refer to these additional resources on Cisco.com:

- *Cisco Broadband Cable Command Reference Guide*
- *Cisco Cable Modem Termination System Feature Guide*

show cable flap-list

To display the cable flap-list on a Cisco uBR10012 router, use the **show cable flap-list** command in privileged EXEC mode.

show cable flap-list

show cable flap-list cable *slot/port* [**upstream** port] [**sort-flap** | **sort-time**]

show cable flap-list sort-interface [**sort-flap** | **sort-time**]

Syntax Description

cable *slot/port*	(Optional) Displays the flap list for a particular cable interface.
upstream *port*	(Optional) Displays the flap list for a particular upstream on the selected cable interface.
sort-interface	(Optional) Displays the flap list for all cable interfaces, sorted by interface.
sort-flap	(Optional) Sorts the list by the number of times the CM has flapped.
sort-time	(Optional) Sorts the list by the most recent time the CM is detected to have flapped.

For the Cisco uBR10012 router, the **sort** option applies to one line card at a time, then the list is merged together. For example, the flap list is sorted for cable7/0/0, appears on the console, and then is sorted for cable 7/0/1, which then appears on the console, and so on.

The **show cable flap-list** and **show cable modem** commands indicate when the Cisco uBR10012 router has detected an unstable return path for a particular modem and has compensated with a power adjustment. An asterisk (*) appears in the power-adjustment field for a modem when a power adjustment has been made; an exclamation point appears when the modem has reached its maximum power transmit level and cannot increase its power level any further.

Examples

The following example shows the output of the show cable flap-list command:

```
Router# show cable flap-list
MAC Address     Upstream     Ins    Hit    Miss   CRC    P-Adj Flap  Time
 0010.7bb3.fd19  Cable5/0/U1  0      2792   281    0     *45    58    Jul 27 16:54:50
 0010.7bb3.fcfc  Cable5/0/U1  0      19     4      0     !43    43    Jul 27 16:55:01
 0010.7bb3.fcdd  Cable5/0/U1  0      19     4      0     *3     3     Jul 27 16:55:01
```

Note The asterisk (*) in the P-Adj field indicates that a power adjustment has been made for that CM. The exclamation point (!) indicates that the CM has reached its maximum power transmit level and cannot increase its power level further.

The following example shows the return for flap-list tables sorted by MAC address and by time:

```
Router# show cable flap-list sort-flap
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
.1eab.2c0b     C6/0/0 U0    108    318     27      0      0    108 Sep 10 15:26:56
.1eb2.bb07     C6/0/0 U0      0    293     31      1      1      1 Sep 10 15:15:49
.7b6b.71cd     C6/0/0 U0      1    288     32      0      0      1 Sep 10 15:12:13
.1eb2.bb8f     C6/0/0 U0      1    295     30      0      0      1 Sep 10 15:11:44

Router# show cable flap-list sort-time
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
00e0.2222.2202 C4/0/0 U0    464   2069    242      0    421    885 Oct 16 22:47:23
0010.7b6b.57e1 C4/0/0 U0      0   2475     43      0   1041   1041 Oct 16 22:47:04
```

For additional information about using cable flap lists, refer to the chapter “Flap List Troubleshooting for the Cisco CMTS” in the *Cisco Cable Modem Termination System Feature Guide* on Cisco.com.

show cable modem

To display information for the registered and unregistered CMs, use the **show cable modem** command in privileged EXEC mode.

show cable modem [*ip-address* | *interface* | *mac-address*] [*options*]

Some command options differ between the Cisco uBR10012 router (Cisco IOS Release 12.2 XF) and the Cisco uBR7200 series routers (Cisco IOS 12.1 EC).

Note

Commencing with Cisco IOS Release 12.0(7)XR and 12.1(1a)T1, the output of this command was enhanced to show that the Cisco CMTS has detected an unstable return path for a particular CM and has compensated with a power adjustment.

- An asterisk (*) appears in the `p-adj` (power adjustment) field for a modem when a power adjustment has been made.
- An exclamation point (!) appears when the modem has reached its maximum power transmit level and cannot increase its power level any further.

Syntax Description

ip-address	Identifies the IP address of a specific modem to be displayed.
interface	Displays all CMs on a specific CMTS cable interface.
mac-address	Identifies the MAC address of a specific CM to be displayed.
Available options when displaying information for a cable interface or for a single CM	
access-group	Displays access group.
connectivity	Displays connectivity content.
counters	Displays cable counters.
errors	Displays error details for one or all CMs.
flap	Displays flap content.
mac	Displays the DOCSIS MAC version and capabilities.
maintenance	Displays station maintenance error statistics.
offline	Displays CMs that are offline.
phy	Displays the phy layer content.
registered	Displays information for CMs that have registered with the CMTS.
remote-query	Displays the signal-noise ratio (SNR) and power statistics that the CMTS has acquired from polling the CMs. NOTE - In Cisco 12.1 CX and above, the phy option should be used instead of the remote-query option.
summary	Displays the total number, number of active, and number of registered modems per interface. This option can be used with total and upstream options to display details for specific line cards and ports.
unregistered	Displays information for CMs that have not registered with the CMTS.
verbose	Displays detailed information, replacing the former **detail** option, and providing information such as: • Signal-to-noise ratio (SNR) information for each CM on each interface • Summary display of the total number of modems connected for each upstream channel • Total number of registered and unregistered modems for the specified interface or upstream Total number of offline modems for the specified interface or upstream and status for each offline modem before it went offline

Available options when displaying information for a single CM	
classifiers	Displays the classifiers for the modem.
classifiers cache	Displays the classifiers in the cache maintained for each CM. (This cache is based on IP header field values and speeds up classifier lookups and reduces per packet processing overhead.)
classifiers verbose	Displays detailed information for the modem's classifiers.
cpe	Displays the CPE devices accessing the cable interface through the CM.
cnr	(For Cisco uBR-MC16S only) Displays the upstream carrier/noise ratio (CNR) for the specified CM (in dB).

Examples

The following sample output from the **show cable modem** command shows the default CM displays for individual CM.

```
Router# show cable modem

MAC Address    IP Address      I/F      MAC         Prim RxPwr Timing Num  BPI
                                        State       Sid  (db)  Offset CPEs Enbld
0010.7b6b.58c1 0.0.0.0         C4/0/0/U5 offline      5   -0.25  2285   0    yes
0010.7bed.9dc9 0.0.0.0         C4/0/0/U5 offline      6   -0.75  2290   0    yes
0010.7bed.9dbb 0.0.0.0         C4/0/0/U5 offline      7    0.50  2289   0    yes
0010.7b6b.58bb 0.0.0.0         C4/0/0/U5 offline      8    0.00  2290   0    yes
0010.7bb3.fcd1 10.20.113.2     C5/0/0/U5 online       1    0.00  1624   0    yes
0010.7bb3.fcdd 0.0.0.0         C5/0/0/U5 init(r1)     2   -20.00 1624   0    no
0010.7b43.aa7f 0.0.0.0         C5/0/0/U5 init(r2)     3    7.25  1623   0    no

Router# show cable modem 0010.7bb3.fcd1
MAC Address    IP Address      I/F      MAC         Prim RxPwr Timing Num  BPI
                                        State       Sid  (db)  Offset CPEs Enbld
0010.7bb3.fcd1 10.20.113.2     C5/0/0/U5 online       1    0.00  1624   0    yes
```

The following example shows sample output for the **verbose** option for a particular CM:

```
Router# show cable modem 0010.7bb3.fcd1 verbose
MAC Address                           : 0010.7bb3.fcd1
IP Address                            : 10.20.113.2
Prim Sid                              : 1
Interface                             : C5/0/0/U5
Upstream Power                        : 0 dBmV (SNR = 33.25 dBmV)
Downstream Power                      : 0 dBmV (SNR = ----- dBmV)
Timing Offset                         : 1624
Received Power                        :   0.25
MAC Version                           : DOC1.0
Capabilities                          : {Frag=N, Concat=N, PHS=N, Priv=BPI}
Sid/Said Limit                        : {Max Us Sids=0, Max Ds Saids=0}
Optional Filtering Support            : {802.1P=N, 802.1Q=N}
Transmit Equalizer Support            : {Taps/Symbol= 0, Num of Taps= 0}
Number of CPEs                        : 0(Max CPEs = 0)
Flaps                                 : 373(Jun 1  13:11:01)
Errors                                : 0 CRCs, 0 HCSes
Stn Mtn Failures                      : 0 aborts, 3 exhausted
Total US Flows                        : 1(1 active)
Total DS Flows                        : 1(1 active)
Total US Data                         : 1452082 packets, 171344434 bytes
Total US Throughput                   : 0 bits/sec, 0 packets/sec
Total DS Data                         : 1452073 packets, 171343858 bytes
Total DS Throughput                   : 0 bits/sec, 0 packets/sec
```

For additional information, examples, command history and related commands, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

show cable modem maintenance

To display station maintenance error statistics, use the **show cable modem maintenance** command in privileged EXEC mode.

show cable modem maintenance

Syntax Description

maintenance	Displays station maintenance error statistics.

When a CM is detected to be offline by the CMTS—no reply after 16 retries of station maintenance requests—the CM is marked offline. Besides marking the CM and service identifier (SID) state offline, the SID is removed immediately from the CMTS ranging list, and an aging timer is started to clean up the SID completely if the CM does not attempt to come online within the next 24 hours.

Output fields are described below:

- The *SM Exhausted Count* value refers to the number of times a CM was dropped because it did not reply to station maintenance requests. A CM is removed from the station maintenance list after 16 times of periodic ranging opportunity without seeing the RNG_REQ from the modem.
- The *SM Aborted Count* value refers to the number of times the CM was dropped because its operational parameters were unacceptable. This includes such reasons as the power level is outside the acceptable range, or the timing offset keeps changing. The respective times in the command output indicate when this happened.

Examples

The following example shows sample output for the maintenance option for a particular CM:

```
Router# show cable modem 0010.7bb3.fcd1 maintenance

MAC Address    I/F         Prim  SM Exhausted          SM Aborted
                           Sid   Count Time            Count Time
0010.7bb3.fcd1 C5/0/0/U5     1     3     Jun 1  10:24:52 0     Jan 1  00:00:00
```

show cable modulation-profile

To display modulation profile group information for a Cisco CMTS, use the **show cable modulation-profile** command in Privileged EXEC mode.

show cable modulation-profile [*profile*] [*iuc-code*]

Note

Commencing with Cisco IOS Release 12.1(2)EC, this command replaced the **show cable burst-profile** command. Commencing with Cisco IOS Release 12.1(3a)EC, the **reqdata** type option was added.

Syntax Description

profile	(Optional) Profile number. Valid values are from 1 to 8.
iuc-code	(Optional) Internal usage code. Valid options are: • **initial**—Initial Ranging Burst • **long**—Long Grant Burst • **reqdata**—Request/Data Burst • **request**—Request Burst • **short**—Short Grant Burst • **station**—Station Ranging Burst

Examples

The following is sample output from the show cable modulation-profile command:

```
CMTS01# show cable modulation-profile 1

Mo IUC     Type  Preamb Diff FEC     FEC   Scrambl Max  Guard Last Scrambl Preamb
                 length enco T       CW    seed    B    time  CW          offset
                                bytes    size           size  size  short

1  request qpsk  64     no   0x0     0x10  0x152   1    8     no    yes     56
1  initial qpsk  128    no   0x5     0x22  0x152   0    48    no    yes     0
1  station qpsk  128    no   0x5     0x22  0x152   0    48    no    yes     0
1  short   qpsk  72     no   0x5     0x4B  0x152   0    8     no    yes     48
```

For additional information, examples, command history and related commands, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

show cable qos profile

To display quality-of-service (QoS) profiles for a Cisco CMTS, use the **show cable qos profile** command in privileged EXEC mode.

show cable qos profile *profile-index* [**verbose**]

Note

Commencing with Cisco IOS Release 12.0(7)XR, the verbose option was added. Commencing with Cisco IOS Release 12.1(4)CX, this command was deprecated for DOCSIS 1.1 use because DOCSIS 1.1 replaces the QoS profile model with a service flow model. The **show interface cable qos paramset** command is used for DOCSIS 1.1 operation.

Syntax Description

profile-index	Displays cable QoS table. Valid range is 1 to 255.
verbose	Displays detail information about the quality-of-service profiles.

Examples

The following example displays the QoS tables for profiles 1, 2, 3, and 4:

```
Router# show cable qos profile

Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create     B
class        upstream  upstream  downstream burst  mask value by         priv
             bandwidth bandwidth bandwidth                               enab
1       0    0         0         0          0      0x0  0x0   cmts       no
2       0    64000     0         1000000    0      0x0  0x0   cmts       no
3       0    1000      0         1000       0      0x0  0x0   cmts       no
4       7    2000000   100000    4000000    0      0x0  0x0   cm         yes
```

The following example displays **verbose** output for profile 1:

```
Router# show cable qos profile verbose

hccp-server# show cable qos profile verbose
Profile Index                           1
Name                                    Default
Upstream Traffic Priority               0
Upstream Maximum Rate (bps)             0
Upstream Guaranteed Rate (bps)          0
Unsolicited Grant Size (bytes)          0
Unsolicited Grant Interval (usecs)      0
Upstream Maximum Transmit Burst (bytes) 0
IP Type of Service Overwrite Mask       0x0
IP Type of Service Overwrite Value      0x0
Downstream Maximum Rate (bps)           0
Created By                              cmts(r)
Baseline Privacy Enabled                no
```

For additional information, examples, command history and related commands, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

show interface cable

To display the current configuration and status of a cable interface, use the show interface cable command in privileged EXEC mode.

show interface cable *slot/port* [*options*]

Syntax Description

slot/port	Identifies the Cisco CMTS chassis slot number and downstream port number.
options	Cable-specific options are documented in their own command reference pages in the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Examples

The following example displays **show interface cable** command output for a CM located in slot 1 and port 0:

```
Router# show interface cable 5/0/0

Cable5/0/0 is up, line protocol is up
  Hardware is BCM3210 FPGA, address is 00e0.1e5f.7a60 (bia 00e0.1e5f.7a60)
  Internet address is 1.1.1.3/24
  MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec, rely 255/255, load 1/255
  Encapsulation, loopback not set, keepalive not set
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 4d07h, output 00:00:00, output hang never
  Last clearing of “show interface” counters never
  Queuing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
        10908 packets input, 855000 bytes, 0 no buffer
        Received 3699 broadcasts, 0 runts, 0 giants, 0 throttles
        3 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
        5412 packets output, 646488 bytes, 0 underruns
        0 output errors, 0 collisions, 13082 interface resets
        0 output buffer failures, 0 output buffers swapped out
```

show interface cable sid

To display the service identifier (SID) for a CM, use the **show interface cable sid** command in privileged EXEC mode.

show interface cable *x/y* **sid** [**counters** | **qos**] [**verbose**]

Syntax Description

x/y	Identifies the Cisco CMTS chassis slot number and downstream port number in *slot*/*port* format. Valid values are from 3 to 6.
sid	Service identification number.
counters	Displays the values of the per-SID usage counters. Same as the keyword **stats** in pre 11.3(6)NA releases.
qos	Displays the QoS characteristics received by each SID.
verbose	Displays detailed information.

Examples

The following sample output from the **show interface cable sid** command shows the one form of the command:

```
Router# show int c4/0/0 sid

Sid  Prim  MAC Address IP Address Type Age    Admin   Sched Sfid
                                                      State   Type
5 0010.7b6b.58c1 10.20.114.34      stat 2d1h36menable  BE     1
6 0010.7bed.9dc9 10.20.114.37      stat 2d1h36menable  BE     13
7 0010.7bed.9dbb 10.20.114.38      stat 2d1h36menable  BE     15
8 0010.7b6b.58bb 10.20.114.112     stat 2d1h34menable  BE     17
9 0010.7b6b.58bb 10.20.114.112     dyna 2d1h34menable  BE     19
```

For additional information, examples, command history and related commands, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

show cable modulation-profile

To display modulation profile group information for a Cisco CMTS, use the show cable modulation-profile command in privileged EXEC mode.

show cable modulation-profile [*profile*] [*iuc-code*]

Note The **show cable modulation-profile** command replaces the former **show cable burst-profile** command.

Syntax Description

profile	(Optional) Profile number. Valid values are from 1 to 8.
iuc-code	(Optional) Internal usage code. Valid options are: **initial**—Initial Ranging Burst **long**—Long Grant Burst **reqdata**—Request/Data Burst **request**—Request Burst **short**—Short Grant Burst **station**—Station Ranging Burst

Examples

The following is sample output from the **show cable modulation-profile** command:

```
Router# show cable modulation-profile 1

Mo IUC     Type  Preamb Diff FEC     FEC   Scrambl Max  Guard Last Scrambl Preamb
                 length enco T       CW    seed    B    time  CW           offset
                                bytes    size           size  size  short

1  request qpsk  64     no   0x0     0x10  0x152   1    8     no   yes     56
1  initial qpsk  128    no   0x5     0x22  0x152   0    48    no   yes     0
1  station qpsk  128    no   0x5     0x22  0x152   0    48    no   yes     0
1  short   qpsk  72     no   0x5     0x4B  0x152   0    8     no   yes     48
```

For additional information, examples, command history and related commands, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com.

Using a Headend CM to Verify Downstream Signals

You can use a Cisco uBR924 cable access modem to verify the downstream signal originating from a Cisco uBR10012 router. Be sure that you configure the Cisco uBR924 according to DOCSIS CM practices.

To verify the downstream signal from a Cisco uBR10012 router using a Cisco uBR924, follow the procedure below:

Step 1 After the Cisco uBR924 is operational and you have an input signal between 0 and +5 dBmV, use the **show controller c0 tuner** command.

Step 2 Scan the output for the value corresponding to the signal-to-noise (SNR) estimate variable. If this value is at least 35 dB, you have an optimized signal. If the value is less than 34 dB, adjust the upconverter at the cable headend.

Tip The SNR estimate for a CM installed at a headend should be between 35 and 39 dB. Although the exact value displayed varies from CM to CM, values collected on the same CM from measurement to measurement will be consistent. Maximizing SNR optimizes CM reliability and service quality.

Performing Amplitude Averaging

The Cisco uBR10012 router uses an averaging algorithm to determine the optimum power level for a CM with low carrier-to-noise ratio that is making excessive power adjustments—known as flapping. To avoid dropping flapping CMs, the Cisco uBR10012 router averages a configurable number of RNG-REQ messages before it makes power adjustments. By compensating for a potentially unstable return path, the Cisco uBR10012 router maintains connectivity with affected CMs. You can interpret these power adjustments, however, as indicating unstable return path connections.

The **show cable flap-list** and **show cable modem** commands are expanded to indicate the paths on which the Cisco uBR10012 router is making power adjustments and the modems that have reached maximum transmit power settings. These conditions indicate unstable paths that should be serviced.

The following example shows the output of the **show cable flap-list** command:

```
Router# show cable flap-list
MAC Address     Upstream     Ins   Hit   Miss  CRC   P-Adj Flap  Time
 0010.7bb3.fd19  Cable5/0/0/U1  0     2792  281   0    *45    58    Jul 27 16:54:50
 0010.7bb3.fcfc  Cable5/0/0/U1  0     19    4     0    !43    43    Jul 27 16:55:01
 0010.7bb3.fcdd  Cable5/0/0/U1  0     19    4     0    *3     3     Jul 27 16:55:01
```

The asterisk (*) indicates that the CMTS is using the power-adjustment method on this modem. An exclamation point (!) indicates that the modem has reached maximum transmit power.

Output of the **show cable modem** command appears below:

```
Router# show cable modem
MAC Address    IP Address      I/F        MAC         Prim RxPwr Timing Num  BPI
                                          State       Sid  (db)  Offset CPEs Enbld
0050.04f9.edf6 10.44.51.49     C7/1/0/U0 online      1    -0.50  3757   0    no
0050.04f9.efa0 10.44.51.48     C7/1/0/U0 online      2    -0.50  3757   0    no
0030.d002.41f5 10.44.51.147    C7/1/0/U0 online      3    -0.25  3829   0    no
0030.d002.4177 10.44.51.106    C7/1/0/U0 online      4    -0.50  3798   0    no
0030.d002.3f03 10.44.51.145    C7/1/0/U0 online      5    0.25   3827   0    no
0050.04f9.ee24 10.44.51.45     C7/1/0/U0 online      6    -1.00  3757   0    no
0030.d002.3efd 10.44.51.143    C7/1/0/U0 online      7    -0.25  3827   0    no
0030.d002.41f7 10.44.51.140    C7/1/0/U0 online      8    0.00   3814   0    no
0050.04f9.eb82 10.44.51.53     C7/1/0/U0 online      9    -0.50  3756   0    no
0050.f112.3327 10.44.51.154    C7/1/0/U0 online      10   0.25   3792   0    no
0030.d002.3f8f 10.44.51.141    C7/1/0/U0 online      11   0.00   3806   0    no
0001.64f9.1fb9 10.44.51.55     C7/1/0/U0 online      12   0.00   4483   0    no
0030.d002.417b 10.44.51.146    C7/1/0/U0 online      13   0.50   3812   0    no
0090.9600.6f7d 10.44.51.73     C7/1/0/U0 online      14   0.00   4071   0    no
0010.9501.ccbb 10.44.51.123    C7/1/0/U0 online      15   0.25   3691   0    no
```

The asterisk (*) in the **show cable modem** command output indicates that the CMTS is using the power adjustment method on this CM. The ! symbol indicates that the CM has reached maximum transmit power.

This section documents the commands pertaining to amplitude averaging:

- **cable upstream power-adjust noise**
- **cable upstream frequency-adjust averaging**

Enabling or Disabling Power Adjustment

To enable the power-adjustment capability, use the **cable upstream power-adjust** command in interface configuration mode. To disable the power-adjustment capability, use the **no** form of this command.

cable upstream *n* **power-adjust** {**threshold** [*threshold #*] | **continue** [*tolerable value*] | **noise** [*% of power adjustment*]}

no cable upstream power-adjust

Syntax Description

Syntax	Description
n	Specifies the upstream port number.
threshold #	Specifies the power-adjustment threshold. The threshold range is from 0 to 10 dB. The default is 1 dB.
tolerable value	Determines if the status of the RNG-RSP should be set to CONTINUE or SUCCESS. The range is from 2 to 15 dB. The default is 2 dB.
% of power adjustment	Specifies the percentage of power-adjustment packets required to switch from the regular power-adjustment method to the noise power-adjustment method. Range is from 10 to 100 percent. The default is 30 percent.

Note The threshold default is 1 dB. The tolerable value default is 2 dB. The power adjustment is 30 percent.

Caution Default settings are adequate for system operation. Amplitude averaging is an automatic procedure. In general, Cisco does not recommend that you adjust values. Cisco does recommend, however, that you clean up your cable plant should you encounter flapping CMs.

Note In some instances, you might adjust certain values:

If CMs cannot complete ranging because they have reached maximum power levels, you might try to set the *tolerable value* CONTINUE field to a larger value than the default of 2 dB. Values larger than 10 dB on “C” versions of cable interface line cards, or 5 dB on FPGA versions, are not recommended.

If the flap list shows CMs with a large number of power adjustments, but the CMs are not detected as noisy, you might try to decrease the percentage for noisy. If you think that too many CMs are unnecessarily detected as noisy, you might try to increase the percentage.

Setting Frequency Threshold to Affect Power Adjustment

To control power-adjustment methods by setting the frequency threshold, use the **cable upstream freq-adj averaging in** interface configuration mode. To disable power adjustments, use the **no** form of this command.

cable upstream *n* **freq-adj averaging** *% of frequency adjustment*

no cable upstream freq-adj averaging

Syntax Description

Syntax	Description
n	Specifies the upstream port number.
averaging	Specifies that a percentage of frequency-adjustment packets is required to change the adjustment method from the regular power-adjustment method to the noise power-adjustment method.
% of frequency adjustment	Specifies the percentage of frequency-adjustment packets required to switch from the regular power-adjustment method to the noise power-adjustment method. Valid range is from 10 to 100 percent.

The following example shows how to change the power-adjustment method when the frequency adjustment packet count reaches 50 percent:

```
Router(config-if)# cable upstream 0 freq-adj averaging 50
```

Setting Downstream Test Signals

This feature provides configuration commands that allow you to create downstream test signals. Both pseudo random bit stream (PRBS) and unmodulated carrier test signals are now supported.

A PRBS test signal is a random data pattern that has been modulated to look like a real data stream. An unmodulated test signal is a continuous sine wave that looks like a carrier wave on the downstream transmission.

See the following sections for the required tasks to create PRBS and unmodulated carrier test signals:

- "Configuring Unmodulated Test Signals" section on page 15
- "Configuring PRBS Test Signals" section on page 15
- "Verifying Test Signal Output" section on page 15

Configuring Unmodulated Test Signals

	Command	Purpose
Step 1	Router(config-if# **cable downstream if-output continuous-wave**	Generates an unmodulated continuous wave signal on the downstream channel. The interface is shut down.
Step 2	Router(config-if# **no cable downstream if-output**	Stops sending test signals. Note Remember to reenable the interface to resume normal operations.

Configuring PRBS Test Signals

	Command	Purpose
Step 1	Router(config-if# **cable downstream if-output prbs**	Generates a PRBS test signal on the downstream channel. The interface is shut down.
Step 2	Router(config-if# **no cable downstream if-output**	Stops sending test signals. Note Remember to reenable the interface to resume normal operations.

Verifying Test Signal Output

To verify the output of a continuous wave test signal or the output of a PRBS test signal, use a spectrum analyzer on the downstream channel. The downstream carrier is enabled as a default.

The standard mode of operation is modulated signal output and the interface is active. For PRBS and continuous wave output, the selected interface is shut down.

The functioning of the **no cable downstream if-output** command has not changed. The interface is shut down.

Pinging Unresponsive CMs

Pinging a CM

Ping DOCSIS is a Cisco patent-pending feature that allows a cable system administrator to quickly diagnose the health of a channel between the Cisco uBR10012 router and the cable interface. The technology uses 1/64—the bandwidth of IP ping—and works with CMs that do not have an IP address. This allows cable operators to ping CMs that are unable to complete registration, that have internal bugs, or that are unresponsive due to a crash.

The Ping DOCSIS feature includes a real-time view and plot of requested power adjustments, and a measure of optimal headend reception power. This gives the cable operator the ability to solicit a configurable number of periodic ranging requests from a cable interface.

To ping a specific cable interface to determine if it is online, use the following command in EXEC mode.

Command	Purpose
`Router# ping docsis addr`	Pings the CM with a specific MAC address or IP address to see if it is online.

Verifying the Ping

The **ping docsis** command returns a verification from a CM that is pinged:

```
Queuing 5 MAC-layer station maintenance intervals, timeout is 25 msec:
!!!!!
Success rate is 100 percent (5/5)
```

Tip If you are having trouble, make sure that you are using a valid MAC or IP address for the cable interface you want to ping.

Using Cable Interface debug Commands

To troubleshoot cable interfaces, use the following **debug** commands in enable (privileged EXEC) mode.

Command	Purpose
`debug cable ?`	Displays all debug cable commands that are available.
`undebug all`	Turns off all debugging information to the console and chooses a more selective **debug** command. Note Refer to the **debug** commands that follow.

Caution The following commands can generate large amounts of output as the number of cable modems grows. On heavily loaded systems with thousands of CMs, these commands can dramatically affect router performance.

debug cable arp

To activate the debugging of Address Resolution Protocol (ARP) requests on the cable interfaces, use the **debug cable arp** command in privileged EXEC mode. To deactivate debugging of ARP requests, use the **no** form of this command.

debug cable arp

When this command is activated, all cable ARP request messages are displayed on the Cisco uBR10012 router console.

debug cable error (for MAC Protocol Errors)

To display errors that occur in the cable MAC protocols, use the **debug cable error** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug cable error

no debug cable error

When this command is activated, all cable ARP request messages are displayed on the Cisco uBR10012 router console. When this command is activated, any errors that occur in the cable MAC protocol are displayed on the Cisco uBR10012 router console.

debug cable keyman (for Baseline Privacy Activity)

To activate the debugging of key encryption key (KEK) and traffic encryption key (TEK) BPI key management, use the **debug cable keyman** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug cable keyman

no debug cable keyman

When this command is activated, all activity related to KEK and TEK keys appears on the Cisco uBR10012 router console.

debug cable mac-messages

To activate the debugging of messages generated in the cable MAC that frames and encrypts downstream RF signals, use the **debug cable mac-messages** command in privileged EXEC mode. To deactivate the debugging of cable MAC messages, use the **no** form of this command.

debug cable mac-messages

no debug cable mac-messages

When this command is activated, messages generated by the cable MAC are displayed on the Cisco uBR10000 series console.

debug cable map

To display map debugging messages, use the **debug cable map** command in privileged EXEC mode. Use the **no** form of this command to disable debugging output.

debug cable map sid [*sid-num*]

no debug cable map

debug cable phy

To activate the debugging of messages generated in the cable PHY, use the **debug cable phy** command in privileged EXEC mode. To deactivate the debugging of the cable PHY, use the **no** form of this command.

debug cable phy

no debug cable phy

Cable PHY is the physical layer where upstream and downstream activity between the Cisco uBR10012 router and the HFC network is controlled. When this command is activated, messages generated in the cable PHY are displayed on the Cisco uBR10012 router console.

debug cable privacy (for Baseline Privacy)

To activate the debugging of baseline privacy, use the **debug cable privacy** command in privileged EXEC mode. To disable debugging output, use the **no** form of this command.

debug cable privacy

no debug cable privacy

debug cable qos

To activate the debugging of QoS, use the **debug cable qos** command in privileged EXEC mode. To deactivate debugging of QoS, use the **no** form of this command.

debug cable qos

no debug cable qos

When this command is activated, messages related to QoS parameters are displayed on the Cisco uBR10012 router console.

debug cable range (for Ranging Messages)

To activate the debugging of ranging messages from cable interfaces on the HFC network, use the **debug cable range** command in privileged EXEC mode. To deactivate debugging of cable interface ranging, use the **no** form of this command.

debug cable range

no debug cable range

When this command is activated, ranging messages generated when cable interfaces request or change their upstream frequencies are displayed on the Cisco uBR10012 router console.

debug cable receive (for Upstream Messages)

To activate the debugging of upstream messages from cable interfaces, use the **debug cable receive** command in privileged EXEC mode. To deactivate debugging of upstream messages, use the **no** form of this command.

debug cable receive

no debug cable receive

When this command is activated, any messages generated by cable interfaces and sent to the Cisco uBR10012 router are displayed on the router console.

debug cable reg (for Modem Registration Requests)

To activate the debugging of registration requests from cable interfaces on the HFC network, use the **debug cable reg** command in privileged EXEC mode. To deactivate debugging of cable registration, use the **no** form of this command.

debug cable reg

no debug cable reg

When this command is activated, messages generated by cable interfaces as they make requests to connect to the network are displayed on the Cisco uBR10012 router console.

debug cable reset (for Reset Messages)

To activate the debugging of reset messages from cable interfaces on the HFC network, use the **debug cable reset** command in privileged EXEC mode. To deactivate debugging of cable reset messages, use the **no** form of this command.

debug cable reset

no debug cable reset

When this command is activated, reset messages generated by cable interfaces are displayed on the Cisco uBR10012 router console.

debug cable specmgmt (for Spectrum Management)

To activate the debugging of spectrum management (frequency agility) on the HFC network, use the **debug cable specmgmt** command in privileged EXEC mode. To deactivate debugging of cable spectrum management, use the **no** form of this command.

debug cable specmgmt

no debug cable specmgmt

When this command is activated, messages generated because of spectrum group activity are displayed on the Cisco uBR10012 router console. Spectrum group activity can be additions or changes to spectrum groups, or frequency and power level changes controlled by spectrum groups.

debug cable startalloc (for Channel Allocations)

To activate the debugging of channel allocations on the HFC network, use the **debug cable startalloc** command in privileged EXEC mode. To deactivate debugging of cable channel allocations, use the **no** form of this command.

debug cable startalloc

no debug cable startalloc

When this command is activated, messages generated when channels are allocated to cable interfaces on the HFC network are displayed on the Cisco uBR10012 router console.

debug cable transmit (for CMTS Transmissions)

To activate the debugging of transmissions from the Cisco uBR10012 router across the HFC network, use the **debug cable transmit** command in privileged EXEC mode. To deactivate debugging of cable transmissions, use the **no** form of this command.

debug cable transmit

no debug cable transmit

When this command is activated, messages generated at the headend are displayed on the Cisco uBR10012 router console.

debug cable ucc (for Upstream Channel Change Messages)

To activate the debugging of upstream channel change (UCC) messages generated when cable interfaces request or are assigned a new channel, use the **debug cable ucc** command in privileged EXEC mode. To deactivate debugging of cable upstream channel changes, use the **no** form of this command.

debug cable ucc

no debug cable ucc

When this command is activated, messages related to upstream channel changes are displayed on the Cisco uBR10012 router console.

debug cable ucd (for Upstream Channel Description Messages)

To activate the debugging of upstream channel descriptor (UCD) messages, use the **debug cable ucd** command in privileged EXEC mode. To deactivate debugging of cable upstream channel descriptor, use the **no** form of this command:

debug cable ucd

no debug cable ucd

UCD messages contain information about upstream channel characteristics and are sent to the cable modems on the HFC network. CMs that are configured to use enhanced upstream channels use these UCD messages to identify and select an enhanced upstream channel to use. When this command is activated, messages related to upstream channel descriptors are displayed on the Cisco uBR10012 router console.

DOCSIS and CMTS Architectural Overview

This appendix provides a brief overview of general DOCSIS architecture and enhancements, all of which highlight the power and performance of the Cisco uBR10000 series CMTS.

- "DOCSIS Specification Summary" section on page A-1
- "CMTS Traffic Engineering" section on page A-5

For a more comprehensive explanation of DOCSIS concepts and features, refer to these documents on Cisco.com:

- *DOCSIS 1.1 for Cisco uBR7200 Series Universal Broadband Routers*
- *Cable FAQs*

Note At the time of publication, the DOCSIS 1.1 specification is still being finalized. This document cites DOCSIS 1.0 and DOCSIS 1.1 specifications located at http://www.cablemodem.com/specifications.html.

DOCSIS Specification Summary

Data is modulated and demodulated using the North American DOCSIS specifications, with downstream 6-MHz channels in the 54- to 860-MHz range and upstream ranges of 5 to 42 MHz. The cable interface supports NTSC channel operation, using standard (STD), Harmonic Related Carrier (HRC), or Incremental Related Carrier (IRC) frequency plans conforming to EIA-S542.

NTSC uses a 6 MHz-wide modulated signal with an interlaced format of 25 frames per second and 525 lines per frame. NTSC is compatible with the Consultive Committee for International Radio (CCIR) Standard M. PAL, used in West Germany, England, Holland, Australia, and several other countries.

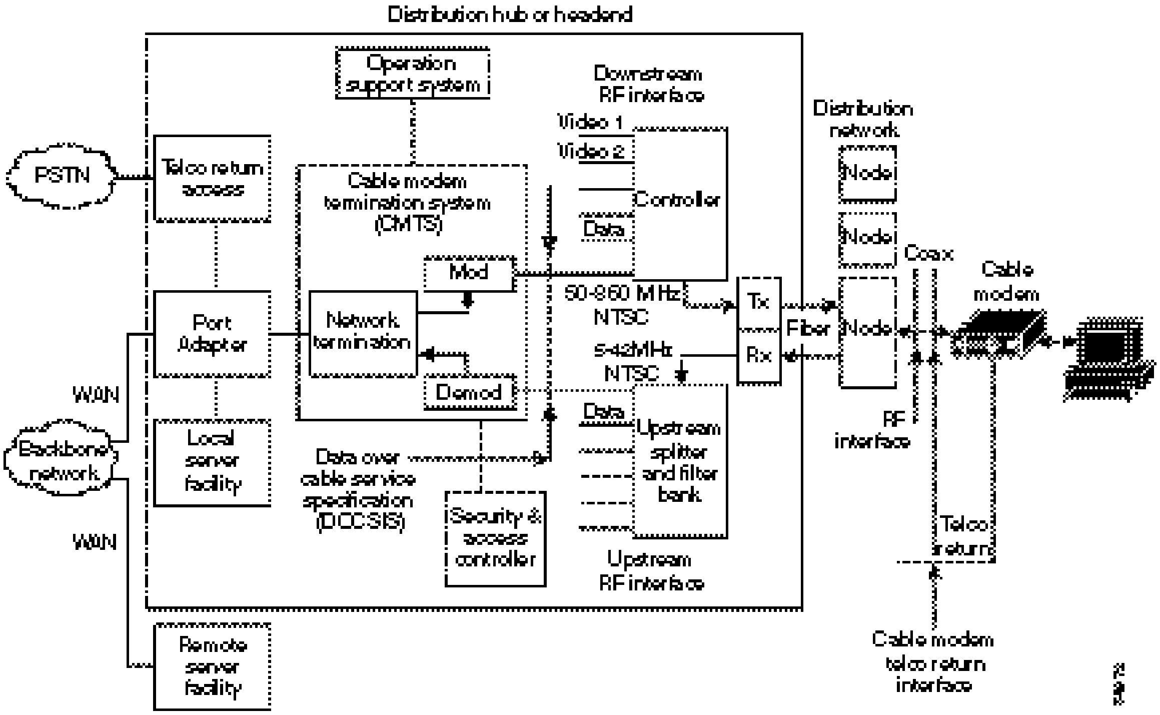
Note Cisco 6-MHz products can be used in Cisco 8-MHz cable plants. The products, however, operate at a maximum downstream bandwidth of 27 Mbps, ignoring 2 MHz of available channel width, and limiting upstream channel choices to the range below 42 MHz.

The DOCSIS radio frequency (RF) specification defines the RF communication paths between the CMTS and CMs (or CMs in STBs). The DOCSIS RF specification defines the physical, link, and network layer aspects of the communication interfaces. It includes specifications for power level, frequency, modulation, coding, multiplexing, and contention control. Cisco offers products that support all DOCSIS error-correction encoding and modulation types and formats, and products that support DOCSIS Annex B operations.

Overview of DOCSIS NTSC Cable Plants

DOCSIS-compliant cable plants that support North American channel plans use ITU J.83 Annex B RF. Figure 0-1 illustrates a DOCSIS two-way architecture.

Figure 0-1 DOCSIS Two-Way Architecture



Larger cable companies typically have high-speed fiber backbones that carry Internet data, voice, and video between the following cable company facilities:

- Regional processing centers
- Headends
- Hubs

The fiber backbone can be made up of OC-3 (155 Mbps) to OC-48 (2488 Mbps) SONET or ATM rings. The backbone network can connect to other networks, including the Public Switched Telephone Network (PSTN), to other cable system backbones, or to public Internet interconnect points that multiple ISPs use.

The CMTS MAC domain typically includes one or more downstream paths and one or more upstream paths. Depending on the CMTS configuration, the CMTS MAC domain can be defined to have its downstreams on one cable interface line card with its upstreams on another card, or one or more CMTS MAC domains per cable interface line card.

Cisco provides high-speed routers to route interactive traffic between the backbone and Ethernet in the headend internal network. Signaling protocols maintain the network intelligence needed to route traffic optimally, automatically building and maintaining routing tables to direct traffic and signal failures for rerouting in the network.

QoS Policy Propagation on Border Gateway Protocol

BGP typically operates between the cable operator’s regional network and external networks, providing routing information exchange between different networks. The Open Shortest Path First (OSPF) protocol is used in regional networks usually. For additional explanation of BGP in the context of DOCSIS NTSP cable plants, refer to “Overview of DOCSIS NTSC Cable Plants” section on page A-2.

The Policy Propagation feature is a packet classification feature that provides a powerful, scalable means of utilizing BGP attributes to propagate destination-based packet classification policy throughout a large network via BGP routing updates.

IP precedence classes or QoS group IDs are associated with BGP community values, and in turn customers’ prefixes are tagged with appropriate community values based on the class of service they have purchased from the network operator.

Normal BGP protocol operation then performs path selection, and the community value is mapped to the associated IP precedence class and installed in the express forwarding table along with the associated routing prefixes. Subsequent packets express forwarded to the selected destination prefixes are then tagged with the appropriate IP precedence value. Thus, packet classification policy can be propagated by scale via BGP without writing and deploying complex access lists at each of a large number of routers, which in turn ensures that return traffic to premium customers is handled as premium traffic by the network.

Overview of DOCSIS-Compliant Downstream Signals

Downstream signals are modulated using QAM-64 or QAM-256 quadrature amplitude modulation, based on the cable interface card used, your cable plant, and the significance of the data. DOCSIS defines the messages and data types for CMTS to CM (or CM in an STB) communications. All CMs listen to all frames transmitted on the downstream channel on which they are registered and accept those where the destinations match the units themselves or the devices that each CM supports.

The Cisco uBR10000 series CMTS supports multicast groups using standard protocols such as Protocol Independent Multicast (PIM), Distance Vector Multicast Routing Protocol (DVMRP), and Internet Group Management Protocol (IGMP) to determine if multicast streams are to be forwarded to a prescribed downstream CM or STB, or to a multicast routing peer.

The Cisco uBR10000 series software periodically sends MAC allocation and management messages—known as MAPs—to all CMs on the network, defining the transmission availability of channels for specific periods of time. The MAP rate is fixed—every 2 milliseconds.

Different transmission intervals are defined that associate an interval with a service identifier (SID). SIDs define the devices allowed to transmit, and provide device identification and class of service management. Software defines what type of transmission is allowed during the interval.

The CMTS system administrator typically assigns one or more SIDs to each CM, corresponding to the classes of service the CM requires. Each MAP is associated with a particular upstream channel. The SID concept supports multiple data flows and use of protocols that allow IP backbone QoS features to be extended to the CMTS. The CMTS schedules the times granted for sending and receiving packets, and if defined, manipulates the type of service (ToS) field in the IP packet header to accommodate QoS.

Note Cisco IOS Release 12.2XF software supports extensions to DOCSIS 1.0 to operate with DOCSIS 1.0-based CMs or cable RF CPE devices (such as Cisco uBR924 cable access routers or Cisco uBR910 cable data service units) that also support DOCSIS 1.0 extensions.

DOCSIS 1.0 extensions build intelligence into the MAP file, which the CMTS sends to voice-enabled CMs to address jitter and delay. The extensions support unsolicited grants that are used to create a constant bit-rate-like stream between the CMTS and the CM. This is in contrast to typical data applications where CMs request grants from the CMTS before they can transmit upstream.

Overview of DOCSIS-Compliant Upstream Signals

The upstream channel is characterized by many CMs (or CMs in STBs) transmitting to the CMTS. These signals typically operate in a burst mode of transmission. Time in the upstream channel is slotted.

The CMTS provides time slots and controls the usage for each upstream interval. The CMTS sends regular mappings of minislot structure in downstream broadcast MAP messages. The CMTS allocates contention broadcast slots that all CMs can use, and allocates upstream minislots for unicast or noncontention data from specific CMs.

The CMTS allocates two basic types of contention slots on the upstream:

- Initial ranging slots that CMs use during their initialization phase to join the network. When the CMTS receives an initial ranging request from a CM using this kind of slot, the CMTS subsequently polls the CM, and other operational CMs, in unicast, noncontention station maintenance slots.
- Bandwidth-request minislots that CMs use to request data grants from the CMTS to send data upstream in noncontention mode. Any CM can use this type of minislot to request a data grant from the CMTS.

The stream of initial ranging slots and bandwidth request minislots comprise two separate contention subchannels on the upstream. Cisco IOS Release 12.2XF software uses a “dynamic bandwidth-request minislots-per-MAP” algorithm to dynamically control the rate of contention slots for initial ranging and bandwidth requests. The CMTS uses a common algorithm to vary backoff parameters that CMs use within each of the two upstream contention subchannels. The CMTS uses these algorithms to dynamically determine the initial ranging slots and bandwidth-request minislots to allocate on the slotted upstream.

When power is restored after a catastrophic power failure, a large number of CMs attempt to join the network simultaneously. This represents an impulse load on the initial ranging subchannel. The CMTS increases the frequency of initial ranging slots so that CMs can quickly join the network.

During high upstream data loads, the CMTS conserves the scarce upstream channel bandwidth resource and is more frugal in introducing upstream initial ranging slots. The CMTS schedules bandwidth-request minislots at low loads to provide low access delay. At high upstream loads, the CMTS reduces the number of contention-based request minislots in favor of data grants, while maintaining a minimum number of request slots.

Note The system default is to have the automatic dynamic ranging interval algorithm enabled, automatic dynamic ranging backoff enabled, and data backoffs for each upstream on a cable interface. Commands to configure the dynamic contention algorithms include:

[**no**] **cable insertion-interval** [*automatic* [*Imin* [*Imax*]] in msecs
[**no**] **cable upstream** *port number* **range backoff** [*automatic*] | [start | *end*]
[**no**] **cable upstream** *port number* **data-backoff** [*automatic*] | [start | *end*]

Caution In general, Cisco discourages adjusting default settings. Only personnel who have received the necessary training should attempt to adjust values.

The Cisco uBR10000 series equipment periodically broadcasts upstream channel descriptor interface line card or (UCD) messages to all CMs. These messages define upstream channel characteristics that include upstream frequencies, symbol rates and modulation schemes, forward error correction (FEC) parameters, and other physical layer values.

Upstream signals are demodulated using Quadrature Phase Shift Keying (QPSK) or quadrature amplitude modulation (QAM). QPSK carries information in the phase of the signal carrier, whereas QAM uses both phase and amplitude to carry information.

Tip

If your cable plant is susceptible to ingress or noise, Cisco recommends QPSK, based on the importance of the data. Frequencies below 20 MHz are more susceptible to noise and might require lower symbol rates. Higher frequencies might be able to support higher rates and use QAM modulation instead.

Overview of DOCSIS Two-Way Server Requirements

A TFTP server, DHCP server, and ToD server are required to support DOCSIS 1.0-based CMs on the network. A DOCSIS 1.0-based CM does not boot if these servers are not available.

Log server and security servers are not required to configure and operate a CM. If the log server or security servers are not present, a CM generates warning messages, but continues to boot and function properly.

ToD and TFTP servers are standard Internet implementations of the RFC 868 and RFC 1350 specifications. Most computers running a UNIX-based operating system, supply ToD and TFTP servers as a standard software feature. Typically, the ToD server is embedded in the UNIX *inetd* and requires no additional configuration. The TFTP server is usually disabled in the standard software, but can be enabled by modifying the *inetd.conf* file. Microsoft NT server software includes a TFTP server that can be enabled with the services control panel. Microsoft NT does not include a ToD server. A public domain version of the ToD server for Microsoft NT can be downloaded from several sites. For configuration information, refer to Chapter 3, "Configuring Cable Interface Features for the Cisco uBR10012 Router."

CMTS Traffic Engineering

Sending data reliably upstream is a critical issue. Designing a robust upstream architecture requires balancing system parameters, establishing subscriber data requirements, and configuring the network to support those requirements.

Upstream spectrum varies greatly between cable plants. Maintaining stable return paths also differs based on varying patterns and levels of ingress noise and interference. Common problems in cable plants include:

- Electrical and magnetic interference (EMI)
- Thermal noise
- Carrier to noise (C/N) imbalances
- Interference of leaking signals
- Ingress due to other channels appearing at the desired channel frequency
- Distortion due to non-linearities of cable equipment
- Cross modulation—carrier to frequency distortion
- Hum and low frequency distortion
- Improper RF amplifier tuning
- Non-unity gains due to incorrect usage of attenuators
- Low-quality subscriber equipment
- Out of range signal power from the CMTS to the CM

When configuring your system, configure downstream and upstream parameters based on the fiber nodes involved, the required services the CM or STB supports, the importance of the data, and desired performance capabilities.

Your cable plant determines its data performance. Design your network to maximize its performance and capacity at minimum cost, while meeting subscriber data requirements. Select or customize upstream profiles for maximum trade-offs between bandwidth efficiency and upstream channel robustness once you are familiar with the system and have characterized your network. For example, QAM-16 requires approximately 7 dB higher C/N ratio to achieve the same bit error rate (BER) as QPSK, but it transfers information at twice the rate of QPSK.

Note Older plants and plants with long amplifier cascades are more susceptible to ingress than newer plants. These plants produce more noise and signal level variances.

Tips Cisco recommends you keep input to all amplifiers at the same power level in the upstream direction and keep output of all amplifiers in the downstream direction at the same power level. This is called unity gain. Tune amplifiers and other equipment properly at desired frequencies. To characterize and improve your cable plant's stability, follow procedures in the *Cisco uBR10000 Series Universal Broadband Router Hardware Installation Guide* on Cisco.com.

A DOCSIS cable plant has the following groups of traffic to size based on current service offerings:

- Basic Internet access data, which is asymmetrical; asymmetrical traffic supports a larger data rate in one direction—the downstream.
- VoIP traffic, which requires constant bandwidth, has low tolerance to latency and jitter, and is typically symmetrical—supporting the same data rate in downstream and upstream directions. VoIP generally requires phase-lock and jitter attenuation.
- VPN traffic, which requires secure transmissions; traffic is typically symmetrical since telecommuters exchange more data upstream than residential Internet access customers.
- Video, which can include digital video channels based on the services in your network.
- Signaling and maintenance—the DOCSIS MAC layer support includes DOCSIS encapsulation, initial maintenance, station maintenance, registration, frequency hop, and upstream channel changes.

You have a wide range of options to engineer your network. Define your network based on your cable facilities—headend or distribution hub—and your anticipated service offerings, subscription, and required service levels. Define data requirements relative to the number of subscribers to support and their usage patterns. Select upstream symbol rate, modulation format, and other parameters based on data requirements and return path characterizations.

If the service is asymmetrical, determine the ratio of downstream to upstream data rates. For basic Internet access where the majority of traffic is sent to a subscriber and the subscriber sends only a small amount of data upstream, use ratios ranging from 5:1 to 10:1.

Determine what data rate the service should support. Define the maximum and minimum data rate, answering the following questions. Do you want to define the minimum data rate relative to the maximum? Will the minimum data rate equal the maximum? Will it be a percentage of the maximum? Will the minimum data rate be zero?

Note The minimum data rate has the greatest impact on the network. The network must be sized to accommodate this level of traffic to fulfill the defined service data requirements. The amount of bandwidth available to a group of subscribers establishes where, within the defined maximum and minimum data rates, a subscriber within a group is able to operate.

For video traffic planning purposes, use a typical bit rate to calculate densities of video streams within a channel. For QoS calculations, limit the number of video streams per channel to prevent packet drops. The key traffic parameter is how many IP video streams will fit into the RF channel.

Ideally, the network is sized so that it supports all subscribers being active at the same time at the maximum data rate. This results in an expensive network, however, where full capacity, particularly for residential subscribers, is rarely used. Cisco recommends designing your network to support a given level of over-subscription.

Note Configure your network to support a percentage of all subscribers at a given data rate. At this level, the network supports the bandwidth needs of all active users. Provided the over-subscription rate is low enough, such that service definitions are met, all subscribers receive the service to which they subscribed.

Caution With over-subscription, the network is unable to support all subscribers being active at the maximum data rate. If the over-subscription is severe enough, subscribers may be denied service.

Parameters to determine the over-subscription level include:

- Peak percentage of simultaneous users—Not all subscribers access the network at the same time. Subscribers have different access patterns that vary based on profiles; working hours; family demographics; type of user—telecommuter or residential Internet access customer. Only a portion of subscribers are active at a given time. This number serves as the "peak percentage of simultaneous users parameter"— busy hour number of subscribers.
- Average data rate per subscriber—Not only are all subscribers not active at the same time, but they do not continuously operate at peak rate. Using basic Internet access as an application, data that subscribers request and send downstream and upstream is subject to bursts. A group of subscribers, therefore, has an average data rate less than the maximum rate defined by the service.

Note For some services, the average value might be the maximum rate. VoIP is such an application.

How bandwidth contention is handled depends on the mix of services defined and individual service definitions.

Percentage of homes passed subscribing to the service is another factor to consider. If this parameter is set too conservatively, the network is under-engineered and requires modification to grow the service. If set too aggressively, the network is over-engineered and costs for services are higher than they should be.

Full implementation of service levels requires additional higher layer items including scheduling, queuing priorities, bandwidth allocation. These items are addressed in DOCSIS 1.0 extensions. Refer to the "Overview of Cisco uBR10012 Universal Broadband Router Software" section on page 1-1 and to additional chapters of this guide for additional information.

For detailed engineering calculations, refer to the Cisco *Multimedia Traffic Engineering for HFC Networks* publication (PDF format) on CIsco.com.

APPENDIX B

Configuration Register Information for the Cisco uBR10012 Universal Broadband Router

The following information is found in this appendix:

Configuration Bit Meanings

Use the processor configuration register information contained in this appendix to do the following:

- Set and display the configuration register value
- Force the system into the bootstrap program
- Select a boot source and default boot filename
- Enable or disable the Break function
- Control broadcast addresses
- Set the console terminal baud rate
- Load operating software from ROM
- Enable booting from a Trivial File Transfer Protocol (TFTP) server

Table B-1 lists the meaning of each of the configuration memory bits. Following the table is a more in-depth description of each setting.

Table B-1 Configuration Register Bit Settings

Bit No.	Hex	Meaning
00–03	0x0000–0x000F	Boot field
06	0x0040	Causes the system software to ignore nonvolatile random-access memory (NVRAM) contents
07	0x0080	OEM (original equipment manufacturer) bit enabled

Table B-1 Configuration Register Bit Settings (continued)

Bit No.	Hex	Meaning
08	0x0100	Break disabled
10	0x0400	IP broadcast with all zeros
11–12	0x800–0x1000	Console line speed
13	0x2000	Boots default ROM software if initial boot fails
14	0x4000	IP broadcasts do not have network numbers
15	0x8000	Enables diagnostic messages and ignores NVRAM contents

Bits 0–3

The lowest four bits of the processor configuration register (bits 3, 2, 1, and 0) form the boot field. Table B-2 provides information about the bits settings.

Table B-2 Bits 0–3 Settings

Boot Field	Meaning
0	Stays at the system bootstrap prompt (ROM monitor) on a reload or power cycle
1	Boots the boot helper image as a system image
2	Full boot process, which loads the Cisco IOS image into Flash memory
2-F	Specifies a default filename for booting over the network from a TFTP server

The boot field specifies a number in binary. If you set the boot field value to 0, you must have a console port access to boot the operating system manually. Boot the operating system by entering the **b** command at the bootstrap prompt as follows:

```
> b [tftp] flash filename
```

Definitions of the various command options follow:

b—Boots the default system software from ROM

b flash—Boots the first file in Flash memory

b *filename [host]*—Boots over the network using TFTP

b flash *filename*—Boots the file (*filename*) from Flash memory

If you set the boot field value to a value of 2 through F, and there is a valid system boot command stored in the configuration file, the router boots the system software as directed by that value. (See Table B-3.) If you set the boot field to any other bit pattern, the router uses the resulting number to form a default boot filename for netbooting.

If there are no **boot** commands in the configuration file, the router attempts to boot the first file in system Flash memory. If no file is found in system Flash memory, the router attempts to netboot a default file with a name derived from the value of the boot field (for example, cisco2-7200). If the netboot attempt fails, the boot helper image in boot flash memory will boot up.

If **boot** commands are in the configuration file, the router software processes each **boot** command in sequence until the process is successful or the end of the list is reached. If the end of the list is reached without a file being successfully booted, the router will retry the **netboot** commands up to six times if bit 13 of the configuration register is set, otherwise it will load the operating system software available in ROMmon. If bit 13 is not set, the router will continue to netboot images indefinitely. The default setting for bit 13 is 0. If bit 13 is set, the system boots the boot helper image found in boot flash memory without any retries.

The server creates a default filename as part of the automatic configuration processes. To form the boot filename, the server starts with Cisco and links the octal equivalent of the boot field number, a dash, and the image name. Table B-3 lists the default boot filenames or actions.

Note A **boot system configuration** command in the router configuration in NVRAM overrides the default netboot filename.

Table B-3 Default Boot Filenames

Action/File Name	Bit 3	Bit 2	Bit 1	Bit 0
Bootstrap mode	0	0	0	0
ROM software	0	0	0	1
Flash software	0	0	1	0
cisco3-< image-name1>	0	0	1	1
cisco4-<image-name2>	0	1	0	0
cisco5-<image-name3>	0	1	0	1
cisco6-<image-name4>	0	1	1	0
cisco7-<image-name5>	0	1	1	1
cisco10-<image-name6>	1	0	0	0
cisco11-<image-name7>	1	0	0	1
cisco12-<image-name8>	1	0	1	0
cisco13-<image-name9>	1	0	1	1
cisco14-<image-name10>	1	1	0	0
cisco15-<image-name11>	1	1	0	1
cisco16-<image-name12>	1	1	1	0
cisco17-<image-name13>	1	1	1	1

Bit 6

Bit 6 causes the system software to ignore nonvolatile random-access memory (NVRAM) contents.

Bit 7

Bit 7 enables the OEM bit. It disables the bootstrap messages at startup.

Bit 8

Bit 8 controls the console Break key. Setting bit 8 (the factory default) causes the processor to ignore the console Break key. Clearing bit 8 causes the processor to interpret Break as a command to force the system into the bootstrap monitor, halting normal operation. A Break can be sent in the first sixty seconds while the system reboots, regardless of the configuration settings.

Bit 10 and Bit 14

Bit 10 controls the host portion of the Internet IP broadcast address. Setting bit 10 causes the processor to use all zeros; clearing bit 10 (the factory default) causes the processor to use all ones. B it 10 interacts with bit 14, which controls the network and subnet portions of the IP broadcast address. Table B-4 shows the combined effect of bit 10 and bit 14.

Table B-4 Bit 10 and Bit 14 Settings

Bit 14	Bit 10	IP Address (<net> <host>)
Off	Off	<ones><ones>
Off	On	<zeros><zeros>
On	On	<net><zeros>
On	Off	<net><ones>

Note The console line rate on Cisco universal broadband routers is fixed at 9600 and cannot be changed. For additional information about configuring baud rates, refer to oneor more of these documents on Cisco.com:

- “Replacing or Recovering Passwords” in the *Cisco uBR10012 Universal Broadband Router Troubleshooting Guide*:

  http://www.cisco.com/en/US/products/hw/cable/ps2209/products_maintenance_guide_chapter09186a0080206653.html

Bit 11 and Bit 12

Bit 11 and Bit 12 in the configuration register determine the baud rate of the console terminal. Table B-5 shows the bit settings for the four available baud rates. (The factory set default baud rate is 9600.)

Table B-5 Bit 11 and Bit 12 Settings

Baud	Bit 12	Bit 11
9600	0	0
4800	0	1
2400	1	1
1200	1	0

Note The console line rate on Cisco universal broadband routers is fixed at 9600 and cannot be changed. For additional information about configuring baud rates, refer to oneor more of these documents on Cisco.com:

- “Replacing or Recovering Passwords” in the *Cisco uBR10012 Universal Broadband Router Troubleshooting Guide*:

  http://www.cisco.com/en/US/products/hw/cable/ps2209/products_maintenance_guide_chapter09186a0080206653.html

Bit 13

Bit 13 determines the server response to a bootload failure. If **boot** commands are in the configuration file, the router software processes each **boot** command in sequence until the process is successful or the end of the list is reached. If the end of the list is reached without a file being successfully booted, the router will retry the **netboot** commands up to six times if bit 13 of the configuration register is set, otherwise it will load the operating system software available in ROMmon. If bit 13 is not set, the router will continue to netboot images indefinitely. The default setting for bit 13 is 0. If bit 13 is set, the system boots the boot helper image found in boot flash memory without any retries.

Bit 15

Bit 15 enables diagnostic messages and ignores NVRAM contents.

Displaying the Configuration Register While Running Cisco IOS

The configuration register can be viewed by using the **show version** or **show hardware** command.

The following example illustrates output from the **show version** command for a Cisco uBR10012 router with the Cisco OC-48 DPT/POS interface module in POS mode:

```
Router# show version

Cisco Internetwork Operating System Software
IOS (tm) 10000 Software (UBR10K-K8P6-M), Experimental Version 12.2(20021115:194156)
[REL-ftp_p2_clip
per_srp.ios-weekly 103]
Copyright (c) 1986-2002 by cisco Systems, Inc.
Compiled Fri 15-Nov-02 18:05 by richv
Image text-base: 0x60008940, data-base: 0x61A80000

ROM: System Bootstrap, Version 12.0(9r)SL2, RELEASE SOFTWARE (fc1)

R7582-ubr10k-UUT uptime is 10 hours, 14 minutes
System returned to ROM by power-on
System image file is "bootflash:ubr10k-k8p6-mz.oc48.15Nov02"

cisco uBR10012 (PRE1-RP) processor with 393215K/131072K bytes of memory.
Processor board ID TBA05080267
R7000 CPU at 262Mhz, Implementation 39, Rev 2.1, 256KB L2, 2048KB L3 Cache
Backplane version 1.0, 8 slot
```

```
Last reset from power-on
Toaster processor tmc0 is running.
Toaster processor tmc1 is running.
1 OC12 POS controller (1 POS)
1 TCCplus card(s)
1 FastEthernet/IEEE 802.3 interface(s)
1 Gigabit Ethernet/IEEE 802.3 interface(s)
3 Packet over SONET network interface(s)
2 Cable Modem network interface(s)
509K bytes of non-volatile configuration memory.

46976K bytes of ATA PCMCIA card at slot 0 (Sector size 512 bytes).
32768K bytes of Flash internal SIMM (Sector size 256KB).
Configuration register is 0x0

Router#
```

Displaying the Configuration Register While Running ROM Monitor

If the bootstrap prompt “>”, the **o** command displays the virtual configuration register currently in effect. It includes a description of the bits. See the following sample output:

```
>o
Configuration register + 02x100 at last boot
Bit#       Configuration register option settings:
15         Diagnostic mode disabled
14         IP broadcasts do not have network numbers
13         Boot default ROM software if network boot fails
12-11      Console speed is 9600 baud
10         IP broadcasts with ones
09         Do not use secondary bootstrap
08         Break disabled
07         OEM disabled
06         Ignore configuration disabled
05         Fast boot disabled
04         Fan boot disabled
03-00      Boot to ROM monitor
```

If the prompt is “rommon1”, the **confreg** command displays the virtual configuration register currently in effect. It includes a description of the bits. See the following sample output:

```
rommon 1 > confreg

Configuration Summary
enabled are:
load rom after netboot fails
console baud: 9600
boot: the ROM Monitor

Do you wish to change the configuration? y/n  [n]
```

Setting the Configuration Register While Running Cisco IOS

The configuration register can be set in the configuration mode with the **config-register 0x**<value> command. See the following sample output:

```
Router# config t
Enter configuration commands, one per line. End with CNTRL/Z.
Router(config)#config-register 0x2142
Router(config)#end
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Setting the Configuration Register While Running ROM Monitor

If the prompt is “>”, the **or0x**<value> command sets the configuration register. See the following sample output:

```
>o/r 0x2102
>
```

If the prompt is “rommon1”, the **confreg** command sets the configuration register. It prompts the user about each bit. See the following sample output:

```
rommon 1 > confreg

Confiuration Summary
enabled are:
load rom after netboot fails
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration y/n    [n]:  y
enable  “diagnostic mode”? y/n   [n]:   n
enable   “use net in IP bcast address”? y/n  [n]:   n
disable  “use rom after netboot fails”? y/n  [n]:  n
enable   “use all zero broadcast”? y/n  [n]:  n
enable   “break/abort has effect”? y/n  [n]:  n
enable   “ignore system config info”? y/n   [n]:  n
change console baud rate? y/n  [n]:  n
change the boot characteristics? y/n   [n]:y
enter to boot:
0 = ROM Monitor
1 = the boot helper image
2 - 15 = boot system
    [0]: 2

Configuration Summary:
enabled are:
load rom after netboot fails
console baud: 9600
boot: image sepcified by the boot system commands or default to: cisco2-c7200

do you wish to change the configuration? y/n   [n]   n

You must reset or power cycle for new config to take effect
rommon 2 >
```

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