Cisco uBR7100 Series Universal Broadband Router Software Configuration Guide

Cisco IOS Release 12.2 BC, 12.1 EC
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Preface

This preface explains the objectives, software options, intended audience, and organization of the *Cisco uBR7100 Series Universal Broadband Router Software Configuration Guide*.

Purpose

This guide describes the basic configuration, maintainenance and troubleshooting for the Cisco uBR7100 series universal broadband routers. This document describes the supported Cisco IOS software feature sets as they exist in these Cisco IOS releases:

- Cisco IOS Release 12.1 EC (through release 12.1(13)EC4)

Note Unless otherwise indicated, the term Cisco uBR7100 series refers to all models of the Cisco uBR7100 series universal broadband router, including the Cisco uBR7111, Cisco uBR7111E, Cisco uBR7114, and Cisco uBR7114E routers.

Cisco IOS Software Options

The Cisco uBR7100 series supports Cisco IOS 12.1(7)EC, with the following software options:

Table 1 Software Options for Cisco uBR7100 Series

Product Number	'Product Description
SU71M3K4-12107EC	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI
SU71M3K4-12107EC=	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI
SU71PK4-12107EC	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI IP+ (default)
SU71PK4-12107EC=	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI IP+
SU71PK4T2-12107EC	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI TELCO-RETURN IP+
SU71PK4T2-12107EC=	Cisco uBR7100 Series IOS DOCSIS 2-WAY BPI TELCO-RETURN IP+
CNR-EVAL	Cisco Network Registrar (CNR), 30-day evaluation kit

Audience

This guide is intended for system administrators and support engineers who configure and maintain the Cisco uBR7100 series router. Many different delivery models exist for Cisco uBR7100 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 STBs, and the ISP owns, operates, and maintains the regional network and IP infrastructure beyond the cable distribution hub. In other cases, the 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 set-top boxes. The guide assumes administrators are familiar with Cisco uBR7100 series hardware, DOCSIS or EuroDOCSIS requirements, and networking.

Organization

This guide includes the following chapters:

Table 2 Document Organization

Title	Description
Chapter 1, "Overview"	Acquaints you with the Cisco uBR7100 series features and Cisco IOS 12.1(7)EC software.
Chapter 2, "Configuring the Cisco CMTS for the First Time"	Provides instructions to make basic configurations to the Cisco uBR7100 series CMTS using AutoInstall, the Setup Facility, or manual configuration mode. Includes sample Cisco uBR7100 series software configurations. **Note** Complete the configurations in this chapter prior to attempting additional configurations later in this guide.
Chapter 3, "Configuring the Cisco Cable Interface"	Describes the command-line interface (CLI), and provides instructions for multiple cable modem card configurations.
Chapter 4, "Configuring Basic Broadband Internet Access"	Describes the parameters of configuring and maintaining basic broadband Internet access.
Chapter 5, "Troubleshooting the System"	Provides troubleshooting instructions for the configuration of the Cisco uBR7100 series CMTS.
Appendix A, "Configuration Register Information for the Cisco uBR7100 Series Universal Broadband Routers"	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.
——→	This pointer highlights an important line of text in an example.
^	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 Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this publication.

Timesaver Means *the described action saves time*. You can save time by performing the action described in the paragraph.

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

Additional References

The following references provide additional information related to the Cisco uBR7100 Series router.
Related Documents

Related Topic	Document Title and Location
General Documentation	• *Cisco uBR7100 Series Technical Documentation Web Page:* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr_rmap.htm
Cisco uBR7100 Series Hardware Installation	• *Cisco uBR7100 Series Hardware Installation Guide:* http://www.cisco.com/en/US/products/hw/cable/ps2211/products_installation_guide_book09186a008007ddda.html
Cisco uBR7100 Series Software Configuration and Features	• *Cisco uBR7100 Series Release Notes* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10krns/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

Obtaining Documentation

The following sections provide sources for obtaining documentation from Cisco Systems.

World Wide Web

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

- http://www.cisco.com
- http://www-china.cisco.com
- http://www-europe.cisco.com

Documentation CD-ROM

Cisco documentation and additional literature are available in a CD-ROM package, which ships 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 as an annual subscription.

Ordering Documentation

Cisco documentation is available in the following ways:

- Registered 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, in North America, by calling 800 553-NETS(6387).

Documentation Feedback

If you are reading Cisco product documentation on the World Wide Web, you can submit technical comments electronically. Click **Feedback** in the toolbar and select **Documentation**. After you complete the form, click **Submit** to send it to Cisco.

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:

Attn Document Resource Connection
Cisco Systems, Inc.
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. For Cisco.com registered users, additional troubleshooting tools are available from the TAC website.

Cisco.com

Cisco.com is the foundation of a suite of interactive, networked services that provides immediate, open access to Cisco information and resources at anytime, from anywhere in the world. This highly integrated Internet application is a powerful, easy-to-use tool for doing business with Cisco.

Cisco.com provides a broad range of features and services to help customers and partners streamline business processes and improve productivity. Through Cisco.com, you can find information about Cisco and our networking solutions, services, and programs. In addition, you can resolve technical issues with online technical support, download and test software packages, and order Cisco learning materials and merchandise. Valuable online skill assessment, training, and certification programs are also available.

Customers and partners can self-register on Cisco.com to obtain additional personalized information and services. Registered users can order products, check on the status of an order, access technical support, and view benefits specific to their relationships with Cisco.

To access Cisco.com, go to the following website:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

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

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

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

Contacting TAC by Telephone

If you have a priority level 1 (P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

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

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.

Overview

This chapter describes the Cisco uBR7100 series universal broadband router and its supported service offerings, software, and related hardware features. This chapter contains the following sections:

For software configuration and troubleshooting, refer to the remaining chapters in this guide and to additional information cited in the "Preface" of this guide.

Cisco IOS Releases and Images for the Cisco uBR7100 Series Router

The Cisco uBR7100 series router supports the following Cisco IOS release trains:

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.

Cisco IOS 12.2(15)BC2b Images and Requirements

Table 1-1 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 1-1 Memory Recommendations for the Cisco uBR7100 Series Routers, Cisco IOS Release 12.2(15)BC2b Feature Sets

Feature Set	Software Image	Recommended Flash Memory	Recommended DRAM Memory	Runs From
Two-Way Data/VoIP Images				
DOCSIS Two-Way	ubr7100-p-mz	16 MB Flash	128 MB DRAM	RAM
DOCSIS Two-Way IP Plus	ubr7100-is-mz	16 MB Flash	128 MB DRAM	RAM
DOCSIS Two-Way with BPI	ubr7100-k8p-mz	16 MB Flash	128 MB DRAM	RAM
DOCSIS Two-Way IP Plus with BPI	ubr7100-ik8s-mz	16 MB Flash	128 MB DRAM	RAM
Boot Image				
UBR7100 Boot Image	ubr7100-boot-mz	None	None	—

The image subset legend for Table 5 is as follows:

- i = IP routing, MPLS-VPN support, and noncable interface bridging, including Network Address Translation (NAT)
- k8 = DOCSIS Baseline Privacy and MPLS-VPN support
- p = IP routing with Intermediate System-to-Intermediate System (IS-IS) and Border Gateway Protocol (BGP); MPLS-VPN support; no NAT
- s = "Plus" features: NAT and Inter-Switch Link (ISL)

Note All images support all of the hardware listed in the Cisco uBR7100 Series Release Notes available on Cisco.com, unless otherwise indicated:

http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr7100/ub7100rn/index.htm

12.1 EC Release Train and Images

Release 12.1 EC is an early deployment (ED) release based on Release 12.1 E, which serves as the train's starting point. Release 12.1 E, in turn, is based on Release 12.1 Mainline. Early deployment releases contain fixes to software caveats as well as support for new Cisco hardware and software features. Feature support is cumulative from release to release, unless otherwise noted.

Cisco IOS 12.1 EC Images and Requirements

Table 1-2 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 1-2 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR7100 series universal broadband routers for Cisco IOS Release 12.1(20)EC2. Cisco uBR7100 series universal broadband routers are available with a 16-MB or 20-MB Type II PCMCIA Flash memory card.

Table 1-2 Memory Recommendations for the Cisco uBR7100 Series Routers, Cisco IOS Release 12.1(20)EC2 Feature Sets

Feature Set	Software Image	Recommended Flash Memory	Recommended DRAM	Memory Runs From
Two-Way Data/VoIP Images				
DOCSIS Two-Way with BPI	ubr7100-k1p-mz	16 MB Flash	128 MB DRAM	RAM
DOCSIS Two-Way IP Plus with BPI	ubr7100-ik1s-mz	16 MB Flash	128 MB DRAM	RAM
DOCSIS Telco-Return IP Plus with BPI	ubr7100-ik1st-mz	16 MB Flash	128 MB DRAM	RAM
Boot Image				
UBR7100 Boot Image	ubr7100-boot-mz	None	None	—

The image subset legend for Table 3 is as follows:

- i = IP routing, MPLS-VPN support, and noncable interface bridging, including Network Address Translation (NAT)
- k1 = DOCSIS Baseline Privacy and MPLS-VPN support
- p = IP routing with Intermediate System-to-Intermediate System (IS-IS) and Border Gateway Protocol (BGP); MPLS-VPN support; no NAT
- s = "Plus" features: NAT and Inter-Switch Link (ISL)
- t = Telco-Return

Note All images support all of the hardware listed in the Cisco uBR7100 Series Release Notes available on Cisco.com, unless otherwise indicated:

http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr7100/ub7100rn/index.htm

Cisco uBR7100 Series Configuration Tools

Cisco Network Registrar (CNR)

Cisco provides the Cisco Network Registrar (CNR) with each Cisco uBR7100 series router. CNR dramatically improves the reliability of naming and addressing services for enterprise and service provider networks. CNR provides scalable DNS and DHCP services and forms the basis of a DOCSIS cable modem provisioning system.

CNR is a configuration tool that automates dynamic IP address allocation to cable interfaces, PCs, and other devices on the broadband network. CNR 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 using CNR, refer to the latest CNR documentation at Cisco.com.

DOCSIS CPE Configurator

Cisco also offers an HTML-based DOCSIS CPE Configurator tool that can be accessed from Cisco.com. The tool is designed to collect information needed to generate a DOCSIS CM configuration file. The generated file is in binary format consistent with the DOCSIS RF Specification (SP-RFI-105-991105).

Cable Modem Configuration File Editor

The Cisco uBR7100 series routers support the **cable config-file** command, which provide for the online creation of DOCSIS configuration files, which can then be stored on the router's Flash memory or copied to a TFTP server. The CLI commands to create these configuration files can be part of the Cisco IOS configuration file that the router loads on power-up so that they are immediately available to cable modems on the network.

Cisco IOS Software Operational Overview

The Cisco uBR7100 series 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 uBR7100 series 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 uBR7100 series 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.

Operating Standards for Cisco IOS Software

The Cisco uBR7100 series routers support both the DOCSIS and EuroDOCSIS specifications, depending on the model. The Cisco uBR7111 and Cisco uBR7114 routers support DOCSIS operations, and the Cisco uBR7111E and Cisco uBR7114E routers support EuroDOCSIS operations. The following sections describe each standard in more detail.

DOCSIS Cable Plants

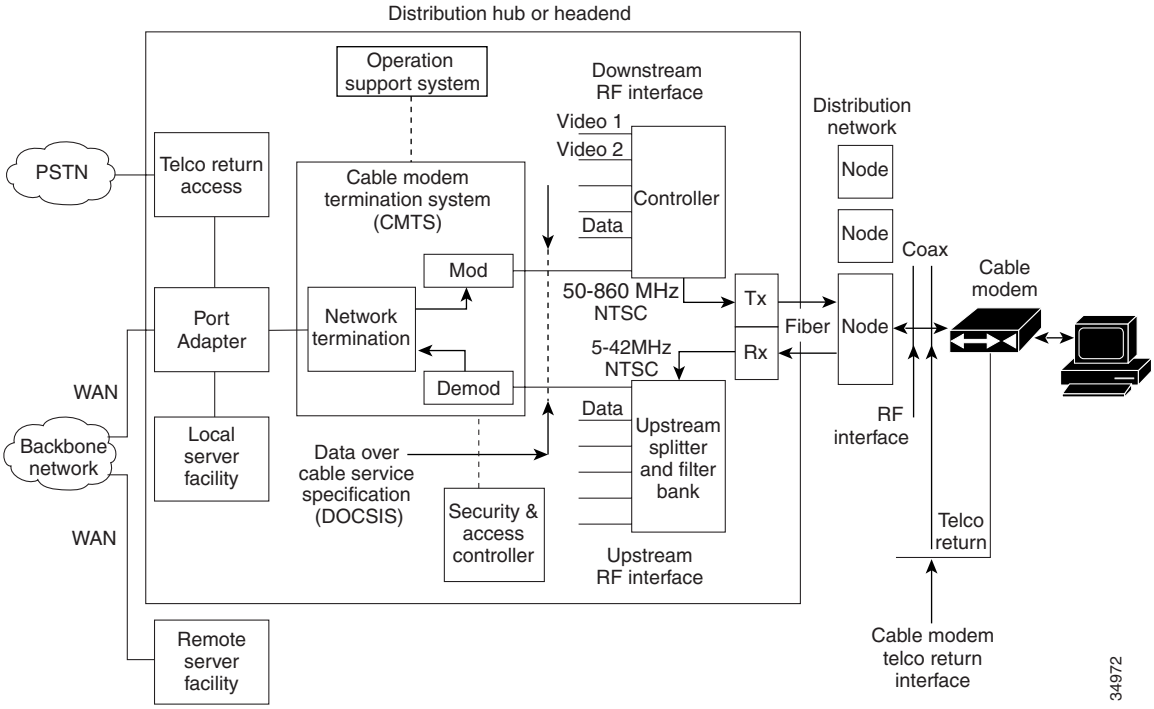
When using the DOCSIS specification, a cable plant modulates and demodulates data using 6-MHz downstream channels in the 54 to 860-MHz range and upstream channels in the 5 to 42 MHz range. The cable interface supports NTSC channel operation, using standard (STD), Harmonic Related Carrier (HRC), or Incremental 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 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.

DOCSIS-compliant cable plants that support North American channel plans use ITU J.83 Annex B RF. Figure 1-1 illustrates a DOCSIS two-way and telco-return architecture.

Figure 1-1 DOCSIS Two-Way and Telco-Return 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) Synchronous Optical Network (SONET) or Asynchronous Transfer Mode (ATM) rings. The backbone network can connect to other networks, including the Public Switched Telephone Network (PSTN), other cable system backbones, or to public Internet interconnect points that multiple ISPs use.

The CMTS Media Access Control (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 modem card with its upstreams on another card, or one or more CMTS MAC domains per cable modem 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.

Border Gateway Protocol (BPG) 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. Cisco routers incorporate Cisco IOS software, which offers advanced software features, including quality of service (QoS), Weighted Fair Queuing (WFQ), and IP multicast.

The data path for DOCSIS networks is divided into the downstream (traffic sent from the CMTS to the CM) and the upstream (traffic sent from the CM to the CMTS). Because 90% of traffic in a typical Internet session is sent from the Internet to the user, the downstream is assigned the majority of the bandwidth allocated to each user.

A single downstream can support thousands of users, depending on their particular service needs. All of the users on a downstream might share the same upstream (as would be the case with a Cisco uBR7111 installation), or they might be split across several upstreams (as would be the case with a Cisco uBR7114 installation). For installations that have not been upgraded to two-way operations, the upstream can be provided through a telco-return connection, where the cable modem directs the upstream traffic through a modem that connects to the headend through the public telephone switched network (PTSN).

The following sections describe the downstream and upstream signals in more detail.

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 uBR7100 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 a multicast routing peer.

The Cisco uBR7100 series software periodically sends MAC (Media Access Control) 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 such as Resource Reservation Protocol (RSVP) that allows 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 uBR7100 series 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.

Tip DOCSIS 1.0 extensions address the problem of QoS for VoIP until the DOCSIS 1.1 specification is finalized. Currently, only certain vendors offer products that 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 which are used to create a constant bit rate-like stream between the CMTS and the CM, in contrast to typical data applications where CMs request grants from the CMTS before they can transmit upstream.

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 also 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. Refer to the"Automatic Provisioning of Cable Modems" section on page 1-9 for CM provisioning and initialization processes.
- 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 uBR7100 series 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 uBR7100 series equipment periodically broadcasts upstream channel descriptor (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, QPSK is recommended 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.

Automatic Provisioning of Cable Modems

A key component of DOCSIS networks is the ability to automatically provision each CM or STB as it comes online. To allow for this, the systems administrator creates DHCP and DOCSIS configuration files on the appropriate servers such 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).

The automatic provisioning scenario uses the following servers, which must be available to the CM through the cable interface:

- DHCP server—The CM must contact a DHCP server through the cable interface to obtain its IP address and other information, such as the default gateway and TFTP server from which to download its DOCSIS configuration file. If the CM cannot contact the DHCP server, it refuses to come online and restarts the registration process.
- TFTP server—The CM must download its DOCSIS configuration file from a TFTP server (as specified in RFC 1350) that is accessible through the cable interface. If the CM cannot download the DOCSIS configuration file, it refuses to come online and restarts the registration process. The TFTP server can be a separate workstation (such as a Unix or Windows NT computer), or the Cisco uBR7100 series router can also operate as a TFTP server for smaller installations.

  Using information in the DOCSIS configuration file, the CM can also use the TFTP server to download an updated software image or another configuration file (such as a Cisco IOS configuration file).

Note Most Unix-based systems include a TFTP server but it must be enabled by modifying the *inetd.conf* file. TFTP server for the Microsoft Windows NT and 2000 operating systems might be part of the operating system, depending on how it was installed, or a TFTP server can be downloaded from ftp.cisco.com.

- ToD server—The CM automatically attempts to connect to a ToD server (as specified in RFC 868) to obtain the current time so it can accurately timestamp its log and other messages. However, this server is optional, and if the CM cannot connect to the ToD server within a specified number of retries, the CM will abandon the attempt and continue with the provisioning process.

Note A TOD server is typically embedded in systems using the Unix operating system and is automatically enabled through the *inetd* utility. Microsoft Windows NT and 2000 do not include a ToD server, but public domain versions of this software are available for download several sites on the Internet.

- Log server—The CM can be optionally configured to send system log messages to a SYSLOG server. This is useful but not required for DOCSIS operations.

- Security and authentication servers—These servers are optional for two-way installations but are required for a telco-return installation.

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, time of day (TOD, optional), 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 Trivial File Transfer Protocol (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 baseline privacy interface (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 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 is a typical sequence of messages:

1. An offline CM powers up and brings up its cable interface.
2. The CM begins searching on the cable interface for an available downstream frequency.
3. The CM continues searching the downstream frequencies until it finds an active and available frequency and locks on to that frequency.
4. The CMTS sends one or more Upstream Channel Description (UCD) messages to the CM containing information about the upstream channel it should use.
5. The CM scans each upstream channel identified in the UCD messages, and if a usable channel is found, it obtains the bandwidth allocation map for the channel. If no usable channel is found, the CM attempts to lock on another downstream.
6. The CM begins its initial ranging, using a temporary identifier on the upstream, to obtain its permanent Service ID (SID) and initial upstream frequency and power levels.
7. When ranging is successful, the CM transmits a DHCP request on the cable interface.
8. The DHCP server receives the DHCP request and replies with a DHCP reply that contains the information appropriate for this particular CM (IP address, default gateway, ToD server address, TFTP server address, and so forth).
9. The CM then contacts the ToD server to obtain a current timestamp. This step is optional but is recommended because it allows the CM to timestamp its log and other messages, which can be helpful in troubleshooting problems and managing the network.

Note The initial DOCSIS 1.0 specification required that the CM successfully obtain a response from the ToD server before going online. Later versions of the specification made this optional—if the CM cannot contact the ToD server after a certain number of attempts, it continues as is with the provisioning cycle.

10. The CM also contacts the designated TFTP server to obtain its DOCSIS configuration file. If a valid DOCSIS configuration file is received, the CM configures itself accordingly.
11. If specified in the DOCSIS configuration file, the CM enables BPI encryption and negotiates with the CMTS for the proper key values.
12. The CM also performs any other steps specified by the DOCSIS configuration file, such as downloading a new software image or downloading a secondary configuration file (for example, downloading a Cisco IOS configuration file).
13. The CM then goes online and enters the maintenance state, passing traffic to and from its connected CPE devices.

EuroDOCSIS Cable Plants

The EuroDOCSIS standard builds on the DOCSIS protocol, adding support at the physical layer for PAL and SECAM channel plans. PAL uses a 625-line scan picture delivered at 25 frames per second where the color carrier phase definition changes in alternate scan lines. SECAM uses an 819 line scan picture that provides better resolution than PAL's 625-line and NTSC's 525-line resolutions.

The configuration and setup of EuroDOCSIS-based cable plants is similar to those of DOCSIS plants, except that they use the EuroDOCSIS J.112 (Annex A) standard, which uses a similar physical layer as Digital Audio Video Council/Digital Video Broadcast (DAVIC/DVB) J.83 Annex A networks. EuroDOCSIS operation permits full bandwidth utilization of the 8 MHz downstream channel in the 85-to-860 MHz range, allowing up to 50 Mbps throughput. EuroDOCSIS also offers an upstream frequency selection of 5 to 65 MHz, instead of the 5 to 42 MHz range used in DOCSIS networks.

Caution The Cisco uBR7111E and Cisco uBR7114E routers support only Annex A operation and should not be used in production cable plants that support a 6 MHz channel plan.

A typical EuroDOCSIS architecture has four subsystems:

- High-speed fiber backbone—Carries Internet data, voice, and video between regional processing centers, headends, and hubs.
- Headend—Aggregates content at the national and regional level and sends it to the fiber backbone.
- Hub—Combines regional programming with local content and sends that combined content to the cable network.
- Interactive STBs with integrated EuroDOCSIS CMs—Connects subscribers to the cable network.

Video sources are Motion Picture Experts Group (MPEG) encoded and then fed into an MPEG multiplexer that packs the MPEG video streams into a single stream. This stream is uplinked to a satellite and then downlinked to multiple headends, which then distribute the MPEG stream directly onto the HFC plant.

The STB receives signals from the cable network and displays them on a television. An STB with EuroDOCSIS CM functionality supports two-way interactivity. Inside the EuroDOCSIS STB are two tuners:

- One handles MPEG-2 video, audio, broadcast control data, and broadcast service data.
- The other supports DOCSIS IP data. The return path is implemented with EuroDOCSIS.

EuroDOCSIS STB Support

Depending on the network configuration, servers that support Internet-enhanced video services—DTV application servers, user data servers, system management servers—and other tools and applications, are required to enable cable operators to deliver centrally managed services through STBs.

See the "Automatic Provisioning of Cable Modems" section on page 1-9. APIs need to be set up to allow EuroDOCSIS servers to communicate with the CSRC directory to obtain such information as IP addresses, user names, and subscription levels.

After registered subscribers receive a EuroDOCSIS-based STB, they can connect up the STB. Automatic configuration begins when the CM in the STB is detected and the CSRC DHCP server establishes IP connectivity and the basic IP configuration. As part of this initialization, the DHCP server transmits to the client STB, binding information for other resources such as TOD and TFTP servers.

When using this initial configuration, the DOCSIS CM uses TFTP to download its default DOCSIS configuration file, such as the DOCSIS options associated with the STB vendor subnet and CMTS. When minimally configured, the STB will register with the Cisco uBR7100 series router and create an associated object in the LDAP directory. The subscriber can then access the Cisco User Register web user interface to select one or more of the service packages the cable operator offers.

Configuring the Cisco CMTS for the First Time

This chapter describes how to start up and configure the Cisco uBR7100 series CMTS for the first time. The chapter contains the following sections:

Preparing for Configuration

Complete these prerequisite steps before you power on and configure the Cisco uBR7100 series router:

- Ensure your network supports reliable broadband data transmission. Your plant must be swept, balanced, and certified based on NTSC or appropriate international cable plant recommendations. Ensure your plant meets all DOCSIS or EuroDOCSIS downstream and upstream RF requirements.
- Ensure your Cisco uBR7100 series router is installed according to the instructions in the hardware installation guide that came with your CMTS. The chassis must contain at least one port adapter to provide backbone connectivity, and one Cisco cable modem card to serve as the RF cable TV interface.
- Ensure 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 (DHCP, TFTP, and ToD)
  - network management systems
  - other configuration or billing systems, depending on your applications, including gatekeepers and gateways; backbone and other equipment for VPN support; dial-up access servers, telephone circuits and connections.
  - other equipment if supporting telco return

- Ensure DHCP and DOCSIS configuration files have been created and pushed to appropriate servers so that each cable modem, 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 in your network)
- Ensure customer premises equipment (CPE)—cable modems or set top boxes, 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 or VPN solution sets if applicable to your headend or distribution hub. Know your dial plan if using H.323 for VoIP services and setting up VoIP-enabled CM configuration files.As appropriate, obtain:
  - passwords
  - IP addresses
  - subnet masks
  - device names

After these prerequisites are met, you are ready to configure the Cisco uBR7100 series CMTS. This includes, at a minimum, configuring a host name and password for the Cisco uBR7100 series router and configuring the CMTS to support IP over the cable plant and network backbone.

Understanding Configuration Fundamentals

This section describes the basic parameters of using passwords, and initial configuration utilities that the Cisco uBR7100 series routers support:

- "Using the Enable Secret and the Enable Password" section on page 2-3
- "Configuring the Cisco uBR7100 Series CMTS Using AutoInstall" section on page 2-7
- "Configuring Using the setup Facility" section on page 2-7
- "Configuring Using the Configuration Mode" section on page 2-15

Note These sections provide minimal configuration instructions. For additional configuration information, refer to subsequent chapters in this guide. For examples of Cisco uBR7100 series configuration files, refer to the Chapter 4, "Configuring Basic Broadband Internet Access."

Tip Be sure 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 Password

The Cisco uBR7100 series router is administered using the Cisco command interpreter, called the EXEC mode. You must boot and log in to the router before you can enter an EXEC command.

Step 1 Connect a terminal to the console port of the Cisco uBR7100 series 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 uBR7100 series router. The following prompt displays:

```
Would you like to enter the initial dialog?[yes]:no
```

Step 3 Enter **no** to choose the normal operating mode of the router. The user EXEC prompt displays:

```
Router>
```

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 privileged-level EXEC commands can change the configuration of the router, 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 will accept it, but you will 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 uBR7100 series 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 Procedure

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.

Details of the Password Recovery Procedure

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 uBR7100 series 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 uBR7100 series 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?" question and note the current configuration register settings.

Step 7 Initialize the router by entering the **reset** command as follows:

```
rommon 2> reset
```

The router will initialize, the configuration register will be set to 0x142, and the router will boot the system image from Flash memory and enter 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 displays:

```
Press RETURN to get started!
```

Step 9 Press **Return.** The user EXEC prompt displays as follows:

```
Router>
```

Step 10 Enter the **enable** command to enter the privileged EXEC mode. Then enter the **show startup-config** command to display the passwords in the configuration file as follows:

```
Router# show startup-config
```

Step 11 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
```

The enable secret password is encrypted and cannot be recovered; it must be replaced. The enable and console passwords can be encrypted 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 16.

Caution Do not perform the next step unless you have determined 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 12 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 13 Enter the **configure terminal** command for configuration mode:

```
Router# configure terminal
```

Step 14 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, enter the **no enable secret** command to remove the enable secret password.

Step 15 You must configure all interfaces to be *not* administratively shut down as follows:

```
Router(config)# interface fast ethernet 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 16 Use the **config-register** command to set the configuration register to the original value noted in Step 3 or Step 7.

Step 17 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 12 through Step 15 previously, then proceed now to Step 19. Failure to observe this sequence causes the system to erase your router configuration file.

Step 18 Enter the **copy running-config startup-config** command to save the new configuration to nonvolatile memory:

```
Router# copy running-config startup-config
```

Step 19 Enter the **reload** command to reboot the router:

```
Router# reload
```

Step 20 Log in to the router with the new or recovered passwords.

Configuring the Cisco uBR7100 Series CMTS Using AutoInstall

The AutoInstall process is designed to configure the Cisco uBR7100 series CMTS automatically after connection to your WAN. For AutoInstall to work properly, a Transmission Control Protocol/Internet Protocol (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 two conditions are maintained:

- Host must be on the LAN or WAN side of the router's port adapter connection to the WAN.
- User Datagram Protocol (UDP) broadcasts to and from the router and the TCP/IP host are 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. See the publications *Configuration Fundamentals Configuration Guide and Configuration Fundamentals Command Reference* for more information about AutoInstall.

Complete the following steps to prepare your Cisco uBR7100 series CMTS 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 Using the setup Facility

The Cisco uBR7100 series setup facility is a useful and efficient tool for configuring your CMTS. The setup facility supports the following functionalities so that cable interfaces and cable modem 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 up-converter 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/data service unit (CSU/DSU). If the WAN or LAN cable is connected to the CSU/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 (also called the System Configuration dialog). 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.

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) uBR7100 Software (uBR7100-I-M), Released Version 12.1(5)EC
Copyright (c) 1986-1998 by Cisco Systems, Inc.
Compiled Mon 09-Oct-98 04:10 by
Cisco 7100 (R4700) processor with 22528K/10240K bytes of memory.
R4700 processor, Implementation 33, Revision 1.0 (Level 2 Cache)
Last reset from power-on
Bridging software.

SuperLAT software copyright 1990 by Meridian Technology Corp).
X.25 software, Version 2.0, NET2, BFE and GOSIP compliant.
TN3270 Emulation software (copyright 1994 by TGV Inc).
4 Ethernet/IEEE 802.3 interfaces.
5 FastEthernet/IEEE 802.3 interfaces.
8 Serial network interfaces.
125K bytes of non-volatile configuration memory.

20480K bytes of Flash PCMCIA card at slot 0 (Sector size 128K).
4096K bytes of Flash internal SIMM (Sector size 256K).
Configuration register is 0x0
```

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** command facility, the script begins with the following prompt.

```
        --- System Configuration Dialog ---

At any point you may enter a questions mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

continue with configuration dialog? [yes/no]:
```

Step 3 When asked if you want to enter the System Configuration dialog and see the current interface summary, enter **yes** or press **Return**:

```
Continue with configuration dialog? [yes/no]:

First, would you like to see the current interface summary? [yes]:
```

In the following example, the summary shows a Cisco uBR7100 series router at first-time startup with nothing configured:

```
Any interface listed with OK? value "NO" does not have a valid configuration.

Interface   IP-Address OK  Method Status                Protocol
Ethernet1/0 9.2.22.3   YES NVRAM  up                    up
Ethernet1/1 unassigned YES unset  administratively down down
Ethernet1/2 unassigned YES unset  administratively down down
Ethernet1/3 unassigned YES unset  administratively down down
Ethernet1/4 unassigned YES unset  administratively down down
Ethernet1/5 unassigned YES unset  administratively down down
Ethernet1/6 unassigned YES unset  administratively down down
Ethernet1/7 unassigned YES unset  administratively down down
```

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 only one of two interior routing protocols to operate on your system using setup, 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 port adapter interface parameters. The following example shows how an 8-port Ethernet port adapter is installed in port adapter slot 3. The setup program 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 uBR71111 router with cable interface. The setup program will, for the most part, determine 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 1/0:
  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 Ethernet 1/0
ip address 19.2.22.4 255.255.0.0
!
interface Ethernet1/1
shutdown
no ip address
!
interface Ethernet1/2
shutdown
no ip address
!
interface Ethernet1/3
shutdown
no ip address
!
interface Ethernet1/4
shutdown
no ip address
!
interface Ethernet1/5
shutdown
no ip address
!
interface Ethernet1/6
shutdown
no ip address
!
interface Ethernet1/7
shutdown
no ip address
!

interface cable 1/0
ip address 19.2.22.5 255.255.0.0

interface cable 1/1
ip address 19.2.22.6 255.255.0.0

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 "Using the Setup Facility for Cable Interfaces" section on page 2-17.)

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 or between 5 to 65 MHz for PAL and SECAM channel plans (requires MC16E), 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 cable modems in set top boxes) which are DOCSIS- or EuroDOCSIS-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.

You can define individual modulation profiles. 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 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 uBR7100 series 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 uBR7100 series 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 the Cisco Cable Interface" for further information.

Configuring Non-Cable Interfaces

Follow the procedure in this section to configure WAN or LAN interfaces. To configure interface parameters, have your interface network addresses and subnet mask information ready.

Configuring Ethernet Interfaces

Step 1 In the following example, the system is being configured for an Ethernet LAN using IP. Respond to the prompts as follows, using your own addresses and mask at the setup prompts:

```
Configuring interface parameters:

Configuring interface Ethernet0/0:
  Is this interface in use? [no]: yes
  Configure IP on this interface? [no]: yes
    IP address for this interface: 1.1.1.10
    Number of bits in subnet field [0]:
    Class A network is 1.0.0.0, 0 subnet bits; mask is 255.0.0.0
```

Step 2 Do not enable Internetwork Package Exchange (IPX) on this interface; IPX is not supported on the Cisco uBR7100 series CMTS:

```
Configure IPX on this interface? [no]: no
```

Step 3 If additional Ethernet interfaces are available in your system, enter their configurations when you are prompted.

Step 4 Save your settings to NVRAM. (See the "Using the Setup Facility for Cable Interfaces" section on page 2-17.)

Note You must always manually save the configuration settings to NVRAM whenever they are modified.

Configuring Synchronous Serial Interfaces

The synchronous serial interfaces are configured to allow connection to WANs through a CSU/DSU. Complete the following steps to configure the serial ports:

Step 1 To configure serial port 0 enter **yes**:

```
Configuring interface Serial0/0:
  Is this interface in use? [no]: yes
```

Step 2 Determine which protocols you want on the synchronous serial interface and enter the appropriate responses:

```
Configure IP unnumbered on this interface? [no]:
    IP address for this interface: 10.1.1.20
    Number of bits in subnet field [0]:
    Class A network is 10.0.0.0, 0 subnet bits; mask is 255.0.0.0
```

Step 3 If additional synchronous serial interfaces are available in your system, enter their configurations when you are prompted.

Step 4 Save your settings to NVRAM. (See the "Using the Setup Facility for Cable Interfaces" section on page 2-17.)

Note You must always manually save the configuration settings to NVRAM whenever they are modified.

The following sample display includes a continuous listing of all interface configuration parameters selected for Ethernet and synchronous serial interfaces. These parameters are shown in the order in which they appear on your console terminal.

Note Only one Ethernet and one synchronous serial interface are configured for this example.

```
Configuring interface parameters:

Configuring interface Ethernet0/0:
  Is this interface in use? [no]: yes
  Configure IP on this interface? [no]: yes
    IP address for this interface: 10.1.1.10
    Number of bits in subnet field [0]:
    Class A network is 10.0.0.0, 0 subnet bits; mask is 255.0.0.0
  Configure IPX on this interface? [no]:
  Configure AppleTalk on this interface? [no]: no
Configuring interface Serial0/0:
  Is this interface in use? [no]: yes
  Configure IP on this interface? [no]: yes
  Configure IP unnumbered on this interface? [no]:
    IP address for this interface: 10.1.1.20
    Number of bits in subnet field [0]:
    Class A network is 10.0.0.0, 0 subnet bits; mask is 255.0.0.0
  Configure IPX on this interface? [no]:
  Configure AppleTalk on this interface? [no]:


The following configuration command script was created:

hostname Router
enable secret 5 $1$u8z3$PMYY8em./8sszhzk78p/Y0
enable password wilma
line vty 0 4
password s
snmp-server community public
!
ip routing
no vines routing
no ipx routing
no appletalk routing
no apollo routing
no decnet routing
no xns routing
no clns routing
no bridge 1

! Turn off IPX to prevent network conflicts.
interface Ethernet0/0
no ipx network
interface Ethernet0/1
```

```
no ipx network
!
interface Ethernet0/0
ip address 1.1.1.10 255.0.0.0
no mop enabled
!
interface serial0/0
ip address 1.1.1.20 255.0.0.0
ip route-cache cbus
no keepalive
!
!
router igrp 15
network 1.0.0.0
!
end

Use this configuration? [yes/no]: yes
[OK]
Use the enabled mode 'configure' command to modify this configuration.

Press RETURN to get started!
```

Your Cisco uBR7100 series CMTS is now minimally configured and is ready to use. You can use the **setup** command if you want to modify the parameters after the initial configuration. To perform more complex configurations, use the **configure** command.

Configuring Using the Configuration Mode

You can configure the Cisco uBR7100 series CMTS manually if you prefer not to use the setup facility or AutoInstall. Complete the following:

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>`) displays. Type **enable** to enter enable mode (configuration changes can only be made 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 modem card to support digital data transmission over the HFC network:

```
Router (config-int) # no shutdown
```

Step 8 Enter the fixed center frequency for your downstream RF carrier in Hz 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 modem 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 modem 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 the 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
```

Using the Setup Facility for Cable Interfaces

The setup facility creates an initial configuration. The basic management setup configures only enough connectivity for management of the system; the extended setup 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
```

Interface Slot Numbering

For Cisco uBR7100 series components, the slot number is the chassis slot in which a port adapter or a cable interface card is installed. The logical interface number is the physical location of the interface port on a port adapter.

Numbers on a Cisco uBR7100 series router begin with 0 and are as follows:

- Slot 0—Fixed Fast Ethernet LAN interface
- Slot 1—Fixed cable modem card interface
- Slot 2—Not used
- Slot 3—Modular single-slot port adapter
- Slot 4—Not used
- Slot 5—Not used

Configuring the Interfaces

To configure the system, define the Cisco uBR7100 series interfaces, using the **interface type slot/port** command, where:

- **type**—Cable, FastEthernet, and installed port adapter.
- **slot**—Slot number in chassis. Slot numbers begin with 0.
- **sort**—Port number on a cable modem card slot. Port numbers begin with 0.

Configuring the cable interface is particularly important because these components serve as the cable TV RF interfaces. Configuration involves the following for each interface:

- Setting the downstream center frequency for the card to reflect the digital carrier frequency of the downstream RF carrier (the channel) for that downstream port. To do this, enter the fixed center frequency for your downstream RF carrier in Hz:

  ```
  Router (config-int) # cable downstream frequency down-freq-hz
  ```

Note Make note of the correct value for the cable modem card. This provides useful information for troubleshooting.

The digital carrier frequency is specified to be the center of a 6 or 8 MHz channel based on your channel plan. For NTSC channel plans, EIA channel 95 spans 90.00 to 96.00 MHz. The center frequency is 93.000 MHz which is the digital carrier frequency that should be configured as the downstream frequency.

Tip The digital carrier frequency is not the same as the video carrier frequency. For EIA channel 95, the video carrier frequency is 91.250 MHz which is 1.75 MHz below the center frequency.

- Activating the downstream port on the cable modem card for data transmission over the HFC network, using the following command:

```
Router (config-int) # no shutdown
```

The particular downstream port LED should light.

- Setting the upstream frequency of your RF output to comply with the expected input frequency of your Cisco cable interface.

Tip The valid range for a fixed upstream frequency is 5,000,000 to 65,000,000 Hz for the cable modem card. The valid range for the Cisco uBR7100 series is 5,000,000 to 42,000,000 Hz.

The cable interface will not operate until you either set a fixed upstream frequency or create and configure a spectrum group. Enter the fixed center frequency for your upstream RF carrier in Hz and specify a port number from 0 to 5:

```
Router (config-int) # cable upstream port frequency up-freq-hz
```

Note Ensure that the selected upstream frequency does not interfere with the frequencies used for any other upstream applications in your cable plant.

- Enter an upstream RF carrier frequency for each upstream port on a cable modem.
- Activate the RF carrier on each upstream port to support data from cable modems or set top boxes on your network to the Cisco uBR7100 series CMTS. Enable upstream data traffic, using the following command:

```
Router (config-int) # no cable upstream port shutdown
```

The specified upstream port LED lights.

Enter the previous command for each upstream port that you wish to activate.

- Verify your settings using the following command:

```
Router# show running-config
```

- Save the configuration to nonvolatile random access memory (NVRAM) so that your settings are retained after a power cycle:

```
Router# copy running start
```

- Verify the upstream frequency, using the **show controllers cable** *slot/port* **upstream** command for the upstream port that you have just configured.
- Verify the downstream center frequency, using the **show controllers cable** *slot/port* **downstream** command for the downstream port that you have just configured.

Identifying the Cable Interface

The Cisco uBR7100 series routers feature a fixed cable interface at slot 1. On the Cisco uBR7111 and Cisco uBR7111E universal broadband routers, the cable interface supports one downstream modulator and one upstream demodulator. On the Cisco uBR7114 and Cisco uBR7114E universal broadband routers, the cable interface supports one downstream modulator and four upstream demodulators.

On all models, the cable interface has the following characteristics:

- The cable interface 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 IF output, which must be connected to an external upconverter.

Note The Cisco uBR7111 and Cisco uBR7114 default to transmitting downstream signals to the integrated upconverter using a 44 MHz frequency. The Cisco uBR7111E and Cisco uBR7114E default to transmitting downstream IF signals to the integrated upconverter using the 36.125 MHz frequency.

The cable interface cards can be configured in a number of different upstream combinations based on the card used, your cable network, and the anticipated subscription and service levels. Table 2-1 shows the DOCSIS and EuroDOCSIS data rates.

Table 2-1 DOCSIS and EuroDOCSIS Data Rates

Upstream Channel Width	Modulation Scheme	Baud Rate Sym/sec	Raw Bit Rate Mbit/sec
3.2 MHz	16 QAM QPSK	2.56 M	10.24 5.12
1.6 MHz	16 QAM QPSK	1.28 M	5.12 2.56
800 kHz	16 QAM QPSK	640 K	2.56 1.28
400 kHz	16 QAM QPSK	320 K	1.28 0.64
200 kHz	16 QAM QPSK	160 K	0.64 0.32

Cable Interface Card Slots

On Cisco uBR7100 series routers, the cable modem 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 uBR7100 series router.

```
Router# sh int c 1/0

Cable1/0: Upstream 0 is up
    Received 9972 broadcasts, 6096 multicasts, 370221275 unicasts
    0 discards, 36137535 errors, 0 unknown protocol
    370237908 packets input, 2064921 uncorrectable
    29354454 noise, 0 microreflections
    Total Modems On This Upstream Channel : 56 (55 active)
    Default MAC scheduler
    Queue[Rng Polls]  0/64, fifo queuing, 0 drops
    Queue[Cont Mslots]  0/53, fifo queuing, 7 drops
    Queue[CIR Grants]  0/64, fair queuing, 0 drops
    Queue[BE Grants] 1/64, fair queuing, 0 drops
    Queue[Grant Shpr]   0/64, calendar queuing, 0 drops
    Reserved slot table currently has 0 CBR entries
    Req IEs 114588350, Req/Data IEs 0
    Init Mtn IEs 241758, Stn Mtn IEs 208872
    Long Grant IEs 300445295, Short Grant IEs 1924354
    Avg upstream channel utilization : 78%
    Avg percent contention slots : 20%
    Avg percent initial ranging slots : 1%
    Avg percent minislots lost on late MAPs : 0%
    Total channel bw reserved 0 bps
    CIR admission control not enforced
    Admission requests rejected 0
    Current minislot count   : 9461304    Flag: 0
    Scheduled minislot count : 9462255    Flag: 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 uBR7100 series router that is turned up:

```
Router# sh int c 1/0 0

Cable1/0: Upstream 0 is up
    Received 3699 broadcasts, 0 multicasts, 28586 unicasts
    0 discards, 0 errors, 0 unknown protocol
    21817 packets error-free, 2371 corrected, 8097 uncorrectable
    0 noise, 0 microreflections
    CBR_queue_depth: [not implemented], ABR_queue_depth: [not implemented],
    UBR[1]_queue_depth: 0, UBR[2]_queue_depth: 0,
    UBR[3]_queue_depth: 0,  POLLS_queue_depth:  [not implemented]
    ADMIN_queue_depth: [not implemented]
    Last Minislot Stamp (current_time_base):190026    FLAG:1
    Last Minislot Stamp (scheduler_time_base):200706  FLAG:1
```

Mapping Interfaces and Physical Ports

Table 2-2 maps the cable interface card's interfaces and physical ports. The cards can be configured in a number of different upstream combinations.

Table 2-2 Interface to Port Mapping

Cisco uBR7100 Series	Cable Interface	Physical Ports
Cisco uBR7111	Cable 1/0	DS RF, DS IF, US0
Cisco uBR7111E	Cable 1/0	DS RF, DS IF, US0
Cisco uBR7114	Cable 1/0	DS RF, DS IF, US0, US1, US2, US3
Cisco uBR7114E	Cable 1/0	DS RF, DS IF, US0, US1, US2, US3

Identifying Port Adapter Slots

On the Cisco uBR7100 series universal broadband routers, two port adapter slots are available. Slot 0 is the fixed FastEthernet interface, and slot 3 is the modular port adapter. You can display information on a specific port adapter or all port adapters in the Cisco uBR7100 series router. To display information about all port adapter slots, use the **show interfaces** command. To display information about a specific port adapter slot, use the **show interfaces** command with the port adapter type and slot number in the format of **show interfaces** [*type slot/port*].

Tip If you abbreviate the command (**sh int**) and do not specify the port adapter type and slot number (or arguments), the system interprets the command as **show interfaces.** The system displays the status of all port adapters, all cable interface cards, and all ports.

Following is an example of how the **show interfaces** command displays status information (including the physical port adapter number) for each port adapter and cable interface card in the Cisco uBR7111:

```
FastEthernet0/0 is up, line protocol is up
   Hardware is DEC21140A, address is 0002.b9ff.7c00 (bia 0002.b9ff.7c00)
   Internet address is 1.7.35.1/16
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive not set
   Full-duplex, 100Mb/s, 100BaseTX/FX
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:01, output 00:00:04, output hang never
       (statistical information omitted)
 FastEthernet0/1 is administratively down, line protocol is down
   Hardware is DEC21140A, address is 0002.b9ff.7c01 (bia 0002.b9ff.7c01)
   Internet address is 1.1.1.2/24
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 252/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive set (10 sec)
   Full-duplex, 100Mb/s, 100BaseTX/FX
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input never, output 23:55:58, output hang never
       (statistical information omitted)
 Cable1/0 is up, line protocol is up
   Hardware is BCM3210 ASIC, address is 0002.b9ff.7c1c (bia 0002.b9ff.7c1c)
   Internet address is 2.35.1.1/16
```

```
   MTU 1500 bytes, BW 27000 Kbit, DLY 1000 usec,
      reliability 255/255, txload 19/255, rxload 24/255
   Encapsulation MCNS, loopback not set
   Keepalive not set
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:02, output 00:00:00, output hang never
       (statistical information omitted)
 Interface Cable1/0
 Hardware is IMC11
  BCM3210 revision=0x56B2
  Upconverter info: Config status 0x4E, Dynamic Status 0x0
   Upconverter output is Enabled
   IF ALC is Enabled, Threshold capability is Enabled
   RF ALC is Enabled, Threshold capability is Enabled

   Downstream Frequency 669.0000 MHz
       (statistical information omitted)

  Cable1/0 Downstream is up
   Frequency 669.0000 MHz, Channel Width 6 MHz, 256-QAM, Symbol Rate 5.360537 Msps
   FEC ITU-T J.83 Annex B, R/S Interleave I=32, J=4
   Downstream channel ID: 0
  Cable1/0 Upstream 0 is up
   Frequency 38.000 MHz, Channel Width 3.200 MHz, 16-QAM Symbol Rate 2.560 Msps
   Spectrum Group is overridden
   SNR 30.8820 dB
       (statistical information omitted)

FastEthernet1/0 is up, line protocol is up
   Hardware is DEC21140A, address is 0002.b9ff.7c28 (bia 0002.b9ff.7c28)
   Internet address is 192.100.68.100/24
   MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
      reliability 255/255, txload 1/255, rxload 1/255
   Encapsulation ARPA, loopback not set
   Keepalive not set
   Full-duplex, 100Mb/s, 100BaseTX/FX
   ARP type: ARPA, ARP Timeout 04:00:00
   Last input 00:00:01, output 00:00:01, output hang never
       (statistical information omitted)
```

You can also use arguments such as the interface type (Ethernet, Fast Ethernet, ATM, serial, HSSI, Packet-over-SONET, and so forth) and the port address (slot/port) to display information about a specific port adapter interface only. The following example shows such a display:

```
R7732-01-uBR7111_Router# sh int f0/0
FastEthernet 1/0 is up, line protocol is up
  Hardware is AmdFE, address is 0030.7bfa.a81c (bia 0030.7bfa.a81c)
  Internet address is 111.0.1.18/30
  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, 100BaseTX/FX
  ARP type:ARPA, ARP Timeout 04:00:00
  Last input 00:00:01, output 00:00:02, 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
     0 packets put, 230925 bytes
     Received 146107 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog
```

```
     0 input packets with dribble condition detected
     0 packets put, 284529 bytes, 0 underruns
     0 output errors, 0 collisions, 10 interface resets
     0 babbles, 0 late collision, 0 deferred
0 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
```

Note The interface type in the **show interfaces** command must match the actual interface type of the port adapter. For example, if you enter **sh int e 1/0** and a HSSI port adapter is actually in port adapter slot 1/0, the command returns an "invalid input" error.

Tip At any time you can enter a question mark (?) for help. Use ctrl-c to abort the configuration dialog at any prompt. The default settings are enclosed in brackets '[]'.

```
Would you like to enter basic management setup? [yes/no]: no
First, would you like to see the current interface summary? [yes]:
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            10.20.133.2     YES NVRAM  up
up
FastEthernet1/0                1.11.1.1        YES NVRAM  up                    up
Cable1/0                   10.20.133.65    YES NVRAM  up                    up
```

Configuring Global Parameters

Step 1 Type this command: **Enter host name** [ishita-cmts]:

Next, the enable secret is a password used to protect access to privileged EXEC and configuration modes. This password, after entered, becomes encrypted in the configuration.

Step 2 Type this command: **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 Type this command: **Enter enable password** [rHoz]: bb

Next, the virtual terminal password is used to protect access to the router over a network interface.

Step 4 Type this command: **Enter virtual terminal password** [cc]:cc

The following system information displays.

```
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 Cable1/0  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 Cable1/0
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.

Checking Your Settings and Reviewing Your Configuration Changes

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 uBR7100 series CMTS, use **show** commands.

To verify the downstream center frequency:

```
Router# show controllers cable slot/port downstream
```

To verify the current value of an upstream port frequency:

```
Router# show controllers cable slot/port upstream
```

To check the value of the settings you entered, enter the **show running-config** command at the `Router#` prompt:

```
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.

Where to Go Next

After you have minimally configured the Cisco uBR7100 series CMTS, refer to Chapter 3, "Configuring the Cisco Cable Interface" for more advanced configuration instructions. Also refer to Chapter 5, "Troubleshooting the System" for information on troubleshooting your initial configuration.

The Cisco IOS software running the Cisco uBR7100 series CMTS contains extensive features and functionality. The effective use of these features is easier if you have more information at hand. For additional documentation about configuring the Cisco uBR7100 series CMTS and system capabilities, refer to resources cited in the "Preface". For instructions on configuration of port adapters, refer to the respective installation document that shipped with the port adapter.

Configuring the Cisco Cable Interface

The Cisco IOS software command-line interface (CLI) can be used to configure the Cisco cable modem interface for correct operation on the hybrid fiber coax cable (HFC) network. This chapter describes the following tasks required to configure the Cisco cable modem card.

Note For tasks marked optional below, default settings are typically adequate to configure the system. Change default settings only with careful prior analysis.

Configuring the Downstream Cable Interface

The first step in configuring the Cisco CM interface is to configure the downstream cable interface, which generally entails the downstream frequency, symbol rate, compression, and modulation. Configuring the downstream cable interface consists of the following specific tasks:

- "Setting the Downstream Modulation" section on page 3-6
- "Setting the Downstream Interleave Depth" section on page 3-6
- "Setting the Downstream Helper Address" section on page 3-7
- "Setting Downstream Rate Limiting" section on page 3-8

Note In most applications, default values for the commands used in these configuration steps are adequate to configure the Cisco uBR7100 series router. You do not need to specify individual parameters unless you want to deviate from system defaults.

For information on other configuration options, see the "Cisco Cable Modem Termination System Commands" chapter in the *Broadband Command Consolidation Guide*, available on Cisco.com and the Documentation CD-ROM.

Activating the Downstream Carrier

To activate a downstream port on a Cisco uBR7100 series cable interface card for digital data transmissions over the HFC network, complete the steps in the following table.

	Command	Purpose
Step 1	`CMTS01>` **`enable`**	Enter enable (privileged EXEC) mode.
	`Password:` *`password`*	Enter the password.
	`CMTS01#`	You have entered privileged EXEC mode when the prompt displays the pound symbol `(#)`.
Step 2	`CMTS01#` **`configure terminal`**	Enter global configuration mode. You have entered global configuration mode when the prompt displays `(config)#`.
	`Enter configuration commands, one per line. End with CNTL/Z.`	
	`CMTS01(config)#`	This command can be abbreviated to **config t**.
Step 3	`CMTS01(config)#` **interface cable1/0**	Enter cable interface configuration mode.
	`CMTS01(config-if)#`	In this example, the interface is downstream port 0 on the cable interface card installed in slot 1 of the Cisco uBR7100 series CMTS.
Step 4	`CMTS01(config-if)#` **cable downstream if-output**	Default. Activate downstream digital data from the Cisco uBR7100 series router.
	`CMTS01(config-if)#` **no cable downstream if-output**	Deactivate downstream digital data. This command mutes the IF output of the cable interface card and shuts down the interfaces.
Step 5	`CMTS01(config-if)#` **no shutdown**	Place the downstream port in the "admin up" state.
Step 6	`CMTS01(config-if)#` **`end`**	Return to privileged EXEC mode.
	`CMTS01#`	
	`%SYS-5-CONFIG_I: Configured from console by console`	This message is normal and does not indicate an error.

Verifying the Downstream Carrier

To determine if the downstream carrier is active (up), enter the **show controllers cable** command for the downstream port that you just configured. For NTSC 6 MHz operations, see the following example:

```
CMTS01# show controllers cable1/0 downstream
Cable1/0 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
```

Setting the Integrated Upconverter

The Cisco uBR7100 series router supports an integrated upconverter that outputs a DOCSIS RF signal on the DS0 RF downstream port. To enable the integrated upconverter, you must do the following:

- Set the downstream frequency—The integrated upconverter must be configured for the digital carrier frequency, which is the center frequency of the downstream RF carrier (the channel) for the downstream port. The cable downstream frequency command configures the downstream center frequency for the integrated upconverter.

Note The cable downstream frequency command has no effect on external upconverters. If you are using an external upconverter, this command is informational only and you must configure the external upconverter separately, using its own command procedures.

- Enable the integrated upconverter—The integrated upconverter is disabled by default and must be enabled with the **no cable downstream rf-shutdown** command.
- Enable the cable interface—The cable interface on the Cisco uBR7100 series router must be enabled before the integrated upconverter will output an RF signal.

To configure the integrated upconverter, use the following commands in cable interface configuration mode.

Command	Purpose
`ubr7100(config)# interface cable 1/0`	Enter interface configuration mode for the cable interface on the Cisco uBR7100 series router.
`ubr7100(config-if)# cable downstream frequency down-freq-hz`	Enter the fixed center frequency for your downstream RF carrier in Hz. Allowable DOCSIS center frequencies are 91,000,000 to 857,000,000 Hz (the default is 500,000,000 Hz).
`ubr7100(config-if)# no cable downstream rf-shutdown`	Enable the integrated upconverter.
`ubr7100(config-if)# no shutdown`	Enable the cable interface.

Verifying the Integrated Upconverter Configuration

To verify the configuration for the integrated upconverter, enter the show controllers cable downstream command. The following is a typical display with a correctly configured center frequency:

```
router# show controllers cable1/0 downstream
Cable1/0 Downstream is up
Frequency=525000000, 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
```

Then enter the show controllers cable command, which also displays the center frequency, along with the power levels and whether the integrated upconverter is enabled. The following is a typical display when these values have been correctly configured:

```
ubr7100# show controllers cable1/0
Interface Cable1/0
Hardware is IMC11
 BCM3210 revision=0x56B2
 Cable1/0 Upconverter is Enabled Output is Enabled
  Model: 74-2094-01 Serial Number: 0WAV04480010 CLEI Code:      CLEI#
  HW Rev:    PC2D0107 SW Rev: 007, NVRAM Rev: 006 ECI number 123456
  Downstream Frequency 525.0000 MHz
  IF Power 0.3 dBmv  RF Power 51.0 dBmv
...
```

If the center frequency has not been configured, the frequency is shown as “not set” as shown in the following example:

```
ubr7100# show controllers cable1/0 downstream
Cable1/0 Downstream is up
Frequency is not set. 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
```

If you are having trouble, make sure the cable connections are not loose or disconnected, and that you have calculated and entered the center frequency for your router accurately.

Setting the Downstream Channel ID

To assign a numeric channel ID to the downstream port on the Cisco cable modem card, use the following command in cable interface configuration mode. Acceptable range is 0 to 255.

```
CMTS01(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

The commands are used in instances where you want to send multiple downstream frequencies to a single region that contains CMs that can only connect to upstream ports on the same cable modem 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 when using this feature that you re-test each subsequent software release of CM code to verify correct operation, and 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 cable1/0 downstream
Cable1/0 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
```

For EuroDOCSIS operations, a sample appears below:

```
Router# show controllers cable 1/0 downstream
Cable1/0 Downstream is up
Frequency 669.0000MHz, Channel Width 8MHz, 64-QAM, Symbol Rate
6.952000 Msps
FEC ITU-T J.83 Annex A, R/S Interleave I=12, J=17
Downstream channel ID: 1
```

Setting the MPEG Framing Format

The MPEG framing format must be compatible with DOCSIS or EuroDOCSIS specifications and your local cable plant operations.

Tip Annex B is the DOCSIS MPEG framing format standard for North America, supported on the Cisco uBR7111 and Cisco uBR7114 routers. Annex A is the European standard, supported on the Cisco uBR7111E and Cisco uBR7114E routers.

Note Annex A or B framing format is automatically set when configuring the cable interface. The downstream ports and the connected CMs on the network must be set to the same MPEG framing format and support DOCSIS or EuroDOCSIS operations as appropriate.

The following command appears in the Cisco uBR7100 series router configuration file to designate Annex B or Annex A operation. This command sets the downstream MPEG framing format.

```
CMTS01(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 cable1/0 downstream
Cable1/0 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
```

A sample output appears below for EuroDOCSIS operations:

```
Router# show controllers cable 1/0 downstream
Cable3/0 Downstream is up
  Frequency 669.0000MHz, Channel Width 8MHz, 64-QAM, Symbol Rate
  6.952000 Msps
  FEC ITU-T J.83 Annex A, R/S Interleave I=12, J=17
  Downstream channel ID: 0
```

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. QPSK encodes 2 bits per symbol, 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.

Use the following command in cable interface configuration mode to set the downstream modulation. The standard DOCSIS modulation rate (and the Cisco default) is QAM-64.

```
CMTS01(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 cable1/0 downstream
Cable1/0 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:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers
5. Verify the downstream carrier is active using the **cable downstream if-output** command
6. Verify that you have selected the default if you are not certain about the modulation rate needed.

Setting the Downstream Interleave Depth

Set the interleave depth for the downstream port on the Cisco cable modem card. A higher interleave depth provides more protection from bursts of noise on the HFC network; however, it will increase 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:

```
CMTS01(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 cable1/0 downstream
Cable1/0 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:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that the downstream carrier is active using the **cable downstream if-output** command.

Setting the Downstream Helper Address

Specify an IP address of a DHCP server where UDP broadcast (DHCP) 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	`CMTS01(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	`CMTS01(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:

```
CMTS01# show running-config
Building configuration...

Current configuration:
!
interface Cable1/0
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:

1. Check the cables, upconverters, RF levels, and frequencies if the cable interfaces do not find a downstream signal.
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.
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.
4. Check DHCP options and the IP address of the TOD server, ping the TOD server using the source IP address option, check IP routing, verify that the TFTP filename is correct, verify the TFTP file is in the correct directory on the TFTP server, ensure 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 Downstream Rate Limiting

Downstream rate limiting enables you to use the token bucket policing algorithm with traffic shaping options or the weighted discard policing algorithm to buffer, shape, or discard packets that exceed a set bandwidth. Downstream rate limiting is disabled by default.

To enable downstream rate limiting for a downstream port on a Cisco cable modem card, use one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)#` **cable downstream rate-limit token-bucket**	Enable rate limiting on the downstream port using the token bucket policing algorithm. With this command, the Cisco uBR7100 series router automatically drops packets that are in violation of the allowable bandwidth.
`CMTS01(config-if)#` **cable downstream rate-limit token-bucket shaping**	Enable rate limiting on the downstream port using the token bucket policing algorithm with traffic shaping.
`CMTS01(config-if)#` **cable downstream rate-limit token-bucket shaping granularity 8**	Enable rate limiting 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.
`CMTS01(config-if)#` **cable downstream rate-limit token-bucket shaping max-delay 256**	Enable rate limiting 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.
`CMTS01(config-if)#` **cable downstream rate-limit weighted-discard 3**	Enable rate limiting on the downstream port using the weighted packet discard policing algorithm and assign a weight for exponential moving average of loss rate. Acceptable values are 1 to 4.
`CMTS01(config-if)# ^Z` `CMTS01#`	Exit back to EXEC mode so that you can verify the steps.

Verifying Downstream Rate Limiting

To determine if downstream rate limiting is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If downstream rate limiting is configured and enabled, a rate limiting entry displays in the output. If downstream rate limiting is disabled, no rate limiting entry displays.

```
CMTS01# show running-config
Building configuration...

Current configuration:
!
interface Cable1/0
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 rate-limit token-bucket shaping
 cable downstream annex B
 cable downstream modulation 64qam
```

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers
5. Verify that you selected the default if you are not certain about the modulation rate needed.
6. Verify the downstream carrier is active using the **cable downstream if-output** command.

Configuring the Upstream Cable Interface

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 to configure the upstream cable interface.

Note For some of these tasks, default values are adequate to configure the device.

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 modem card. To configure upstream channel frequencies, perform one of the following tasks:

- Configure a fixed frequency between 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
`CMTS01(config-if)# cable upstream` *usport* `frequency` *up-freq-hz*	Enter the fixed center frequency for your upstream RF carrier in Hz.
`CMTS01(config-if)# no cable upstream` *usport* `shutdown`	Place the upstream port in the "admin up" state.

Tip For 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 uBR7100 series software commands 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:

```
CMTS01# show controllers cable1/0 u0
Cable1/0 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 uBR7100 series CMTS might select an upstream frequency close to the frequency you entered that offers better performance. The Cisco uBR7100 series CMTS selects the closest frequency available.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you have selected a valid frequency for your router.

Setting the Upstream Channel Width

Enter the channel width in hertz (Hz). For NTSC operations, valid values are 200000 Hz (160 kilosymbols per second [ksps]), 400000 Hz (320 ksps), 800000 Hz (640 ksps), 1600000 Hz (1280 ksps), and 3200000 Hz (2560 ksps). The default is 1600000 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 channel(s). 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
`CMTS01(config-if)# cable upstream` *usport* **channel-width** *width*	Enter the channel width for your upstream RF carrier in Hz.
`CMTS01(config-if)# no cable upstream` *usport* **channel-width**	Return the channel width to its default setting of 1600000 Hz.

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 appears below:

```
CMTS01# show controllers cable1/0 u0
Cable1/0 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. Use a valid combination of modulation format (QPSK/QAM-16), minislot size, frequency, and **no shutdown**.
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.
3. Verify using IP ping packets of varying lengths (64 to 1500 bytes). Ping from the headend to the cable interface.
4. Verify with your cable interface vendor that CM software is fully certified or compatible with DOCSIS 1.0 or DOCSIS 1.0 extensions as appropriate.

Setting the Upstream Input Power Level

The Cisco uBR7100 series CMTS 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 will 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 is no longer reliable. 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. Default = 0 dBmV.

```
CMTS01(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:

```
CMTS01# show controllers cable1/0 u0
Cable1/0 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 modem 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 uBR7100 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, especially in marginal situations. Larger adjustments should be made in conjunction with spectrum analyzer-support at the headend or distribution hub.

Activating Upstream Admission Control

The admission control is set as a percentage of the specified upstream channel capacity. The acceptable range is from 10 to 1000 percent. Admission control is disabled by default.

To set the upstream admission control as a percentage of the upstream channel capacity, use the following command in cable interface configuration mode. Valid range is from 10 to 1000 percent.

```
CMTS01(config-if)# cable upstream usport admission-control percentage
```

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 displays in the **show running-config** output, indicating the user-defined percentage of upstream channel capacity allowable. If upstream admission control is disabled, no admission control entry displays in the output.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

Activating Upstream Forward Error Correction (FEC)

The Cisco uBR7100 series CMTS uses forward error correction (FEC) to attempt to correct any upstream data that might have been corrupted. FEC is activated by default and should not be disabled. When FEC is activated, all cable modems on the network also activate FEC.

Note Although upstream FEC is an option, Cisco recommends that you use upstream FEC.

To activate the upstream forward error correction and to enable FEC, use the following command in cable interface configuration mode. FEC is enabled by default.

```
CMTS01(config-if)# cable upstream usport fec
```

Verifying Upstream FEC

To verify if 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 displays in the **show running-config** output. If FEC is disabled, no FEC entry displays in the output.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

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. Default = 8.

```
CMTS01(config-if)# cable upstream usport minislot-size size
```

Verifying Upstream Minislot Size

To verify upstream minislot size, enter the **show controllers cable** command for the upstream port you have just configured:

```
CMTS01# show controllers cable1/0 u0
Cable1/0 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:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.

3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

Activating the Upstream Scrambler

The scrambler on the upstream RF carrier enables cable modems 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 modem 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.

```
CMTS01(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:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

Activating Upstream Differential Encoding

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.

```
CMTS01(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 displays in the **show running-config** output. If upstream differential encoding is disabled, no differential encoding entry displays in the output.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected.

2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

Activating Upstream Rate Limiting

Upstream rate limiting allows upstream bandwidth requests from rate-exceeding cable modems to be buffered without incurring TCP-related timeouts and retransmits. This enables the CMTS to enforce the peak upstream rate for each cable modem 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.

To enable upstream rate limiting for an upstream port on a Cisco cable modem card, use one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `rate-limit`	Enable rate limiting for the specified upstream cable interface.
`CMTS01(config-if)# cable upstream` *usport* `rate-limit token-bucket`	Enable rate limiting for the upstream cable interface employing the token bucket policing algorithm. With this command the Cisco uBR7100 series CMTS automatically drops packets in violation of allowable upstream bandwidth.
`CMTS01(config-if)# cable upstream` *usport* `rate-limit token-bucket shaping`	Default. Enable rate limiting for the upstream cable interface employing the token bucket policing algorithm with traffic shaping.
`CMTS01(config-if)# ^Z` `CMTS01#`	Exit back to the EXEC mode so that you can verify upstream rate limiting.

To disable upstream traffic shaping for an upstream port, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport rate-limit
```

Verifying Upstream Rate Limiting

To determine if upstream rate limiting is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream rate limiting is configured and enabled, a rate limiting entry displays in the **show running-config** output. If upstream rate limiting is disabled, **no cable upstream rate-limit** displays in the output.

You can also perform the following tasks to verify that rate limiting is enabled on the upstream channel:

Step 1 Configure a low-peak upstream rate limit for the cable modem in its QoS profile. Either use the command line interface to modify the modem's QoS profile, or edit the modem's TFTP config file.

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 cable modem when it exceeds its peak upstream rate.

Use the **show interface cx/y sid counters** 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 cx/y sid** 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 cable modem exceed its peak upstream rate by generating upstream traffic, and note the effect of grant buffering (shaping) at the CMTS. If you use cable modem-to-CMTS pings, you will see a perceivable slowing down of the pings.

Let the pings run for a period to let averages at the CMTS settle; then view the upstream rate received by this single modem. Use the **show interface cx/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 cable modem.

The bandwidth request drop count (from previous non-shaping 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.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected.
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers.
5. Verify that you selected a valid frequency for your router.

Activating Upstream Frequency Adjustment

To enable automatic upstream frequency adjustment for a specified cable interface, use the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable upstream` *usport* `frequency-adjust averaging` *percentage*	Set the minimum number of frequency adjustment packets required to justify changing the upstream frequency adjustment method as a percentage. Acceptable range is 10 to 100 percent. Default = 30 percent.
`CMTS01(config-if)# end` `CMTS01#`	Return to enable (privileged EXEC) mode.

To return the automatic upstream frequency adjustment percentage to the default value of 30 percent, enter the following command in cable interface configuration mode:

```
CMTS01(config-if)# no cable upstream usport frequency-adjust averaging
```

Verifying Upstream Frequency Adjustment

To determine if upstream frequency adjustment is configured and activated, enter the **show running-config** command and look for the cable interface configuration information. If upstream frequency adjustment is enabled, frequency adjustment entries are displayed in the **show running-config** output. If frequency adjustments are disabled, no frequency adjustment entry displays in the output.

Perform these steps if you are having difficulty with verification:

1. Ensure the cable connections are not loose or disconnected
2. Ensure the cable modem card is firmly seated in its chassis slot.
3. Ensure the captive installation screws are tight.
4. Verify that you have entered the correct slot and port numbers; you selected a valid frequency for your router.

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
`CMTS01(config-if)# cable upstream usport power-adjust continue db`	Set the minimum power adjustment in dB that allows continued ranging status. Valid values are 2 to 15 dB. Default = 2 dB.
`CMTS01(config-if)# cable upstream usport power-adjust noise percentage`	Set 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.
`CMTS01(config-if)# cable upstream 0 power-adjust threshold db`	Set the power adjustment threshold in dB. Valid values are 0 to 2 dB. Default = 1 dB.
`CMTS01(config-if)# end` `CMTS01#`	Return 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:

```
CMTS01(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:

```
CMTS01(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:

```
CMTS01(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 are displayed in the **show running-config** output. If all three **continue**, **noise**, and **threshold** upstream power adjustments are disabled, no power adjustment entry displays in the **show running-config** output.

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
`CMTS01(config-if)# cable upstream` *usport* `time-adjust continue` *seconds*	Set the minimum timing adjustment that allows continued ranging status. Valid values are 2 to 64 seconds. Default = 2 seconds.
`CMTS01(config-if)# cable upstream` *usport* `time-adjust threshold` *seconds*	Set the timing adjustment threshold value in seconds. Valid values are 1 to 32 seconds. Default = 1 second.
`CMTS01(config-if)# end` `CMTS01#`	Return 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:

```
CMTS01(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:

```
CMTS01(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 are displayed in the **show running-config** output. If both the **continue** and **threshold** upstream timing adjustments are disabled, no timing adjustment entry displays in the **show running-config** output.

Tip If you are having difficulty with verification, make sure the cable connections are not loose or disconnected; the cable modem card is firmly seated in its chassis slot; the captive installation screws are tight; you have entered the correct slot and port numbers.

Activating the Upstream Ports

Each upstream port must be activated to enable upstream data transmission from the cable modems on the HFC network to the Cisco uBR7100 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 3-10, or the "Creating Spectrum Groups" section on page 3-28 for details.

To activate the upstream ports, use the following commands in global configuration mode.

Command	Purpose
`CMTS01(config)# interface cable slot/port`	Specify a cable interface and enter cable interface configuration mode.
`CMTS01(config-if)# no cable upstream usport shutdown`	Enable 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 cable1/0
Cable1/0 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
     3 input errors, 3 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
```

Setting Upstream Backoff Values

The DOCSIS-specified method of contention resolution for cable modems wanting to transmit data or requests on the upstream channel is a truncated binary exponential backoff, with the initial backoff window and the maximum backoff window controlled by the CMTS. The Cisco uBR7100 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 uBR7100 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 you adjust default values, but enable the automatic dynamic backoff algorithm. Refer to the "Configuring Dynamic Contention Algorithms (Cable Insertion Interval, Range, and Data Backoffs)" section on page 5-4.

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
`CMTS01(config-if)# cable upstream` *usport* **`data-backoff`** *start end*	The **automatic** setting is optimized for as many as 250 cable interfaces per upstream port. Set manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.
or	
`CMTS01(config-if)# cable upstream` *usport* **`data-backoff automatic`**	This command configures the default backoff window values of 0 and 4.
`CMTS01(config-if)# cable upstream` *usport* **`range`** *start end*	The **automatic** setting is optimized for as many as 250 cable interfaces per upstream port. Set manual values for data backoff windows only when operating with more than 250 cable interfaces per upstream port.
or	
`CMTS01(config-if)# cable upstream` *usport* **`range automatic`**	This command configures the default backoff window values of 0 and 4.

When considering whether to adjust backoff values, keep the following in mind:

- The cable interface reconnection time after a power outage is related to the following factors:
  - DHCP, TOD, and TFTP server capacity. These servers often operate well below 1% load under normal situations, but can jump to over 100% after an outage.
  - Adjusting the backoffs to larger numbers slows cable interface reconnection and reduces server load.
  - Backoffs which 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 which 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 between approximately 0 to 10 minutes after all services are restored (Cisco uBR7100 series, RF transport, DHCP/TFTP/TOD servers). Cable modems taking longer than 10 minutes could indicate a problem in the cable modem, in CMTS settings, or 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 Automatic

To verify backoff window settings, enter the **show controllers cable** command for the upstream port you have just configured:

```
CMTS01# show controllers cable1/0 u0
Cable1/0 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
```

Enabling and Configuring Baseline Privacy

Introduction to the Baseline Privacy Interface (BPI)

BPI gives subscribers data privacy across the RF network, encrypting traffic flows between the CMTS and CM. 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 it is authorized to access.

Note Encryption/decryption is subject to export licensing controls.

Note Because DOCSIS 1.0 BPI does not authenticate CMs, it does not protect against users employing cloned CMs, masquerading as authorized CMs. Specific Cisco IOS releases provide protection against spoofing, and support commands that can be used to configure source IP filtering on RF subnets to prevent a user from using a source IP address that is not valid for the connected IP subnet.

BPI is defined as a set of extended services within the DOCSIS MAC sublayer. Refer to the *DOCSIS Baseline Privacy Interface Specification* for detailed requirements.

BPI extends the definition of the MAC sublayer's SID. The *DOCSIS RF Interface Specification* defines a SID as a mapping between CMTS and CM to allocate upstream bandwidth and class of service management. When BPI is activated, the SID also identifies a particular security association and has upstream and downstream significance. When BPI is operational, downstream multicast traffic flow that typically does not have a SID associated with it, now has a SID. The Privacy Extended Header Element includes the SID associated with the MAC Packet Data Physical Data Unit (PDU). The SID and other components of the extended header element identify to a CM the keying material required to decrypt the MAC PDU's packet data field.

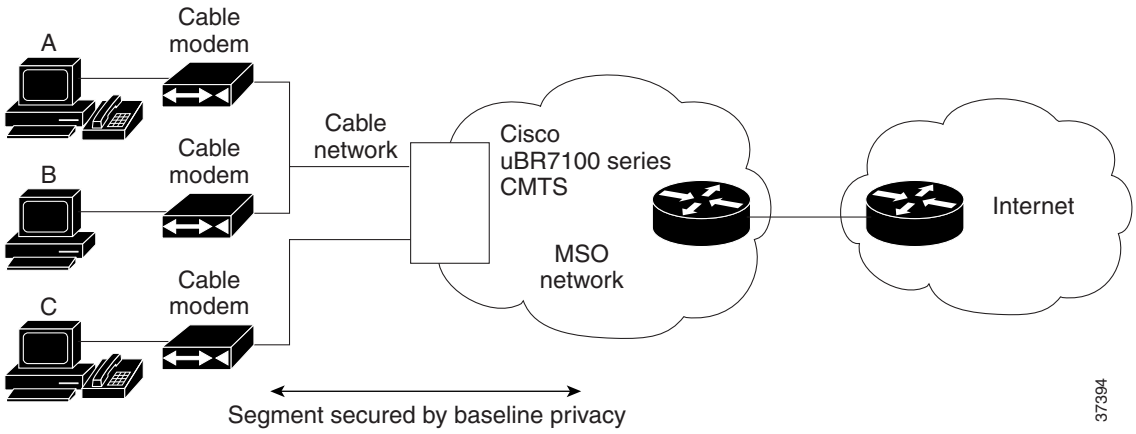
BPI's key management protocol runs between the CMTS and the CM. CMs use the protocol to obtain authorization and traffic keying material relevant to a particular SID from the CMTS, and to support periodic reauthorization and key refresh.

The key management protocol uses RSA—a public key encryption algorithm—and the electronic codebook (ECB) mode of DES to secure key exchanges between the CMTS and a CM. Privacy is in the form of 56-bit (the default) or 40-bit encryption between the CMTS and CM. Since BPI is part of DOCSIS, all DOCSIS-certified CMs and qualified CMTS are fully interoperable. Figure 3-1 shows a BPI architecture.

Note CMs must have factory-installed RSA private/public key pairs to support internal algorithms to generate key pairs prior to first BPI establishment.

A SID's keying material has a limited life span. When the CMTS delivers SID keying material to a CM, it also provides the CM with the lifetime value.

Figure 3-1 BPI Network Example



BPI Key Management

BPI initialization begins with the CM sending the CMTS an authorization request, containing data identifying:

- CM—48-bit IEEE MAC address
- CM's RSA public key
- List of zero or more assigned unicast SIDs that have been configured to run BPI

At that time, BPI provides basic protection against theft of service by ensuring the CM, identified by its MAC address, can obtain keying materials only it is authorized to access. The CMTS replies with a list of SIDs on which to run BPI. The reply also includes an authorization key from which the CM and CMTS derive the keys needed to secure a CM's subsequent requests for additional encryption keys. After obtaining the traffic encryption key, the CMs begin to transmit encrypted data.

Differentiating Traffic Streams

BPI only encrypts data on the cable network and only encrypts the user data itself, not cable MAC headers. BPI also does not encrypt MAC management messages.

After BPI is enabled, however, and encryption has been negotiated for a given SID, all user data sent using that SID is encrypted. BPI differentiates traffic, based on the SID alone.

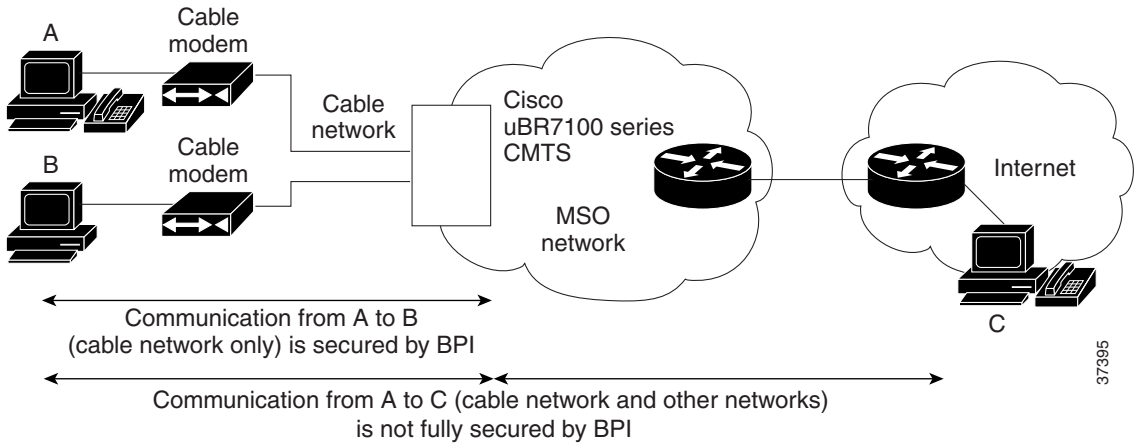
CM Communication with BPI

Figure 3-2 illustrates BPI communications. When user A sends packets to user B, the CM encrypts those packets using special keys specific to the user's CM. Packets are then transmitted to the CMTS where they are decrypted.

If user B is attached to the cable TV network, the CMTS then re-encrypts the information using a key specific to user B, and the encrypted data is passed to user B's CM where it is decrypted and sent to user B. In this manner, an unauthorized user is not able to see unencrypted traffic between user A and user B.

Caution Since BPI occurs only on the cable TV network, however, all traffic going upstream is decrypted as it passes the CMTS. If user A is attempting to communicate with someone beyond the cable network—user C—all traffic beyond the CMTS is not encrypted.

Figure 3-2 BPI Encrypted Data on the Cable TV Network



Enabling BPI

To enable BPI, choose software images at both the CMTS and CM that support the mode of operation. For the Cisco uBR7100 series software, choose an image with "k1" in its file name or BPI in the feature set description. For Cisco uBR924 cable access routers, all CM images from Cisco IOS Release 12.0(5)T1 or later support this by default. For earlier Cisco IOS release CM images, choose an image with "k1" in its file name or BPI in the feature set description.

Note For the CMTS, BPI is enabled by default when you select an image that supports BPI. For CMs, enable BPI using the DOCSIS configuration file using the instructions that follow in this section.

When baseline privacy is enabled, the Cisco uBR7100 series router generates traffic encryption keys (TEKs) for each applicable SID; 56-bit encryption/decryption is the default for Cisco uBR7100 series equipment.

The router uses the keys to encrypt downstream data and decrypt upstream traffic from two-way cable interfaces. The Cisco uBR7100 series router generates keys for unicast, broadcast, and multicast operation as appropriate. Keys are refreshed periodically and have a default lifetime of 12 hours.

Configuring Baseline Privacy

Note Both the CMTS and the CM must support baseline privacy and have BPI enabled.

To configure baseline privacy (deviating from default values), follow procedures in this section:

- "Configuring Key Encryption Key (KEK) Privacy" section on page 3-26
- "Configuring Traffic Encryption Key (TEK) Privacy" section on page 3-27
- "Activating Baseline Privacy" section on page 3-27

Configuring Key Encryption Key (KEK) Privacy

A gracetime KEK can be set from 300 to 1800 seconds. A lifetime KEK can be set from 86400 to 6048000 seconds. If you do not set a KEK value, the default values are used.

To configure KEK data privacy on the HFC network, enter one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable privacy kek grace-time` *seconds*	Set the cable privacy KEK gracetime in seconds. Valid values are from 300 to 1800 seconds. Default = 600.
or	
`CMTS01(config-if)# cable privacy kek life-time` *seconds*	Set the cable privacy KEK lifetime in seconds. Valid values are from 86400 to 6048000 seconds. Default = 604800.

Verifying KEK Privacy

To verify the KEK lifetime or gracetime values that are set, enter the **show cable privacy kek** command:

```
CMTS01# show cable privacy kek
Configured KEK life time value = 750000
Configured KEK grace time value = 800
```

Tip If you are having difficulty with verification, make sure you have entered a valid value for gracetime or lifetime.

Configuring Traffic Encryption Key (TEK) Privacy

A gracetime TEK can be set from 300 to 1800 seconds. A lifetime TEK can be set from 1800 to 604800 seconds. If you do not set a TEK value, the defaults are used.

To configure TEK data privacy on the HFC network, use the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable privacy tek grace-time` *seconds*	Set the cable privacy TEK grace time in seconds. Valid values are from 300 to 1800 seconds. Default = 600.
or	
`CMTS01(config-if)# cable privacy tek life-time` *seconds*	Set the cable privacy TEK life time in seconds. Valid values are from 1800 to 604800 seconds. Default = 43200 seconds.

Verifying TEK Privacy

To verify the TEK lifetime or gracetime values that are set, enter the **show cable privacy tek** command:

```
CMTS01# show cable privacy tek
Configured TEK life time value = 56000
Configured TEK grace time value = 900
```

Activating Baseline Privacy

BPI is activated by default when using an image that supports baseline privacy. Commands in the cable interface configuration mode are as follows:

Command	Purpose
`CMTS01(config-if)# cable privacy enable`	Activate cable privacy. This is the default.
`CMTS01(config-if)# cable privacy mandatory`	Activate cable privacy and do not allow access for any unencrypted cable modem connections.

Verifying Baseline Privacy

To determine if baseline privacy is activated, enter the **show interface privacy** command. When using a Cisco uBR7100 series "k1" image, cable privacy is enabled by default and can only be disabled with the **no cable privacy** command. The cable modem must also be configured to support baseline privacy.

Tip If you are having difficulty with verification, make sure you entered a valid value for gracetime or lifetime for KEK and TEK privacy.

Note If you entered the **cable privacy mandatory** command, then cable interfaces do not operate unless the cable interface configuration file specifies that privacy is on.

Configuring and Activating Frequency Agility

Set upstream port frequency to a fixed value during system installation and testing. Choose this value from your frequency allocation plan for the RF plant segment connected to the upstream.

When the system has reached sufficient stability, the RF domain topology can be entered into the configuration file to enable spectrum management. Spectrum management or frequency agility is configured and activated using spectrum groups.

Frequency-hopping policies supported on all Cisco cable modem cards include combined blind and scheduled specifications, as well as guided frequency hops.

Note The cable interface will not operate until you either create and configure a spectrum group or set a fixed upstream frequency. From the interface configuration prompt, an interface is assigned membership in a spectrum group. From the interface point of view, the spectrum group also represents the set of upstreams connected to the same group of fiber nodes. This allows the spectrum manager to know if upstream frequencies need to be managed together.

To configure and activate frequency agility, perform the following tasks:

- "Creating Spectrum Groups" section on page 3-28
- "Configuring and Activating Spectrum Groups" section on page 3-29
- "Configuring Spectrum Group Characteristics" section on page 3-32

Creating Spectrum Groups

To create a spectrum group, use one of the following general commands in global configuration mode.

Command	Purpose
`CMTS01(config)# cable spectrum-group` *group-number* **type scheduled daily**	Create a scheduled spectrum group that can change its frequency and power level at the same time every day.
`CMTS01(config)# cable spectrum-group` *group-number* **type scheduled periodic-sec** *seconds*	Create a scheduled spectrum group that can change its frequency and power level at a specified interval in seconds.

Frequency agility is configured and activated using spectrum groups. You can create from 1 to 32 spectrum groups for each cable interface card upstream port.

To create spectrum groups, specify a list of upstream frequencies and nominal power levels that each spectrum group can use when an upstream frequency change is necessary. Each spectrum group should have its own list of upstream frequencies.

After you have created one or more spectrum groups, you can add characteristics to them, providing more definitive control over frequency usage and frequency hopping. See the "Configuring and Activating Spectrum Groups" section on page 3-29.

Verifying Spectrum Groups

To verify that a spectrum group is created, enter the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
spectrum-group 1
spectrum-group 2
spectrum-group 3
```

Tip If you are having difficulty with verification, make sure you have entered a valid spectrum group number and type.

Configuring and Activating Spectrum Groups

After you create a spectrum group, configure a list of upstream frequencies and optional nominal power levels that each spectrum group can use when an upstream frequency change is necessary. Each spectrum group should have its own list of upstream frequencies.

Note Valid frequencies are 5,000,000 to 42,000,000 Hz for NTSC operations and 5,000,000 to 65,000,000 for EuroDOCSIS 8 MHz operations.

To configure and activate a spectrum group, use the following commands in global configuration mode.

Command	Purpose
CMTS01(config)# **cable spectrum-group** *group-number* [*time day hh:mm:ss*] [delete] **frequency** *ctr-freq-hz* [*power-level-dbmv*]	Add the upstream frequency to the list of valid frequencies with a default power level for a spectrum group. **Note** If the time parameter is configured, the frequency setting or band is either made available or deleted at the specified time.
CMTS01(config)# **cable spectrum-group** *group-number* [time day hh:mm:ss] [delete] **band** *start-freq-hz end-freq-hz* [*power-level-dbmv*]	The power level value should only be changed if you want to change the power level as part of spectrum management. The standard power level is 0 dBmV.

Note Configuring a spectrum group enables frequency agility and disables the fixed upstream frequency setting.

Tip You must repeat one of the previous command for each frequency or power level that you want to add to a spectrum group's list of valid values.

If your cable plant has an upstream noise characteristic on a weekly cycle, use time-scheduled spectrum allocation:

```
CMTS01(config)# cable spectrum-group 1 time Mon 08:00:00 frequency 21600000
```

Deletion is performed using the **delete** keyword:

```
CMTS01(config)# cable spectrum-group 1 time Mon 18:00:00 delete frequency 21600000
```

The following example displays a spectrum group configuration that is designed to perform minor equalization as a function of frequency.

```
CMTS01(config)# cable spectrum-group 1 frequency 21600000
CMTS01(config)# cable spectrum-group 1 frequency 24800000 1
CMTS01(config)# cable spectrum-group 1 frequency 28000000 2
```

In the previous example, the upstream port nominal receive power at 21.6 MHz is 0 dBmV, at 24.8 MHz is 1 dBmV, and at 28.0 MHz is 2 dBmV. At any time, the power level set in the interface configuration overrides the spectrum group power level.

The following example enables spectrum management for all upstream ports, assuming that all combiner groups use the frequency band from 20 to 26 MHz:

```
CMTS01(config)# cable spectrum-group 1 band 20000000 26000000
CMTS01(config)# cable spectrum-group 2 shared
CMTS01(config)# cable spectrum-group 2 band 20000000 26000000
CMTS01(config)# cable spectrum-group 3 shared
CMTS01(config)# cable spectrum-group 3 band 20000000 26000000
CMTS01(config)# interface Cable1/0
CMTS01(config-if)# cable spectrum-group 1
CMTS01(config-if)# cable upstream 2 spectrum-group 2
CMTS01(config-if)# cable upstream 3 spectrum-group 2
CMTS01(config-if)# exit
```

For the 20 to 26 MHz band of each RF domain, the spectrum is channelized according to the channel width settings of each member port. For example, if the ports U2 and U3 of Cable1/0 are set to 3.2 MHz and 1.6 MHz channel widths, respectively, then spectrum group 2 uses the following channelization:

```
> Channel Width Start Stop Center
>           (Mhz) (Mhz) (Mhz) (Mhz)
> 1         3.2    20.0 23.2 21.6
> 2*        1.6    20.0 21.6 20.8
> 3*        1.6    21.6 23.2 22.4
> 4         1.6    23.2 24.8 24.0
```

Note Channels 2 and 3 are not available when channel 1 is in use.

Because the group is shared, ports U2 and U3 will be assigned channels 1 and 4, respectively, to prevent overlap.

Note There are no alternate frequency assignments for either port and bandwidth is wasted from 24.8 to 26.0 MHz. To create alternate channels, increase the upper boundary from 26.0 to 28.0 MHz.

```
> Channel  Width  Start Stop  Center
>           (Mhz)  (Mhz) (Mhz) (Mhz)
>  1        3.2    20.0  23.2  21.6
>  2        3.2    23.2  26.4  24.8
>  3        1.6    20.0  21.6  20.8
>  4        1.6    21.6  23.2  22.4
>  5        1.6    23.2  24.8  24.0
>  6        1.6    24.8  26.4  25.6
>  7        1.6    26.4  28.0  27.4
```

Care should be taken to reduce the spectrum allocation when used with small channel widths. Otherwise, there will be a large number of upstream channel slots.

For example, if the allocation is from 20.0-to-28.0 MHz and an upstream port has its channel width set to 0.2 MHz, there are 40 possible slots for that channel width. Blind frequency hopping can require a long time to find the clean slot, because it tries each available slot, one at a time for several seconds during each try.

Verifying Spectrum Group Configuration

To verify if spectrum groups are configured and activated, enter the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
22:07:46: %SYS-5-CONFIG_I: Configured from console by console
Group  Frequency      Upstream     Weekly Scheduled            Power   Shared
No.    Band           Port         Availability                Level   Spectrum
       (Mhz)                       From Time:    To Time:      (dBmV)
1       5.000-15.000                                           0       Yes
1      12.000                                                  0       Yes
1      22.000                                                  7       Yes
2      29.000                                                  6       No
2      26.000                                                  0       No
3      35.000-41.000                                           0       No
3      16.000-19.000                                           5       No
5*      5.000-10.000               Thu 21:50:00  Thu 21:45:00  0       Yes
```

Verifying Frequency Hopping

To verify frequency hopping on the Cisco uBR7100 series CMTS, note the following:

- The controller must report being up.
- The comparison of the number of errors versus the number of error-free packets is a measure of the link quality. The percentage of errors should be less than 1%.

After you have established basic operation, inject a tone to the upstream port. For example, if the upstream frequency is currently 22.4 MHz, inject a 22.4 MHz tone at approximately the same power level as the modem. If the power level at the modem is 40 dBmV, set the tone power to 40 dBmV. The interfering carrier should shut down the channel and cause the frequency to change to the next configured value. In this example, it would be 24.0 MHz.

If you do not have an RF tone generator, use another cable modem card and modem that carries traffic. Connect the upstream to the same combiner group, and use the data carrier as an interfering signal by setting it to the same frequency. For example, to test frequency hopping on c1/0, install c1/0 and connect both upstreams together using a combiner. If the upstream frequency of c1/0 is currently 22.4 Mhz, set c1/0 to 22.4 MHz while c1/0 is carrying traffic. This should force c1/0 to change the frequency to the next configured value.

Tip If you are having difficulty with verification, make sure you entered a valid spectrum group number, time, frequency, and input power level.

When defining your spectrum, avoid frequencies with known ingress problems such as amateur radio bands or short-wave bands and spectrum below 20 MHz; allow extra bands for frequency hopping; place upstream ports in the same combiner group in a shared spectrum group; use the receive power level setting to perform slight equalization adjustments.

Configuring Spectrum Group Characteristics

After you have created one or more spectrum groups, add characteristics to them. As stated in the DOCSIS RFI specification, RF channel migration occurs by broadcasting a change in the upstream channel descriptor (UCD) message to all cable interfaces. The UCD message contains the upstream frequency and transmission parameters associated with an upstream channel.

The speed of channel migration via the UCD message is typically less than 20 milliseconds (ms). During this time, upstream transmission is interrupted until the cable interface transmitter adjusts to its new frequency. Data is stored in the cable interface's buffers during this time and is sent when the frequency hop is complete.

Also, per the DOCSIS RFI, station maintenance intervals are used to perform per-modem keepalive polling. The Cisco uBR7100 series poll each cable interface. When ingress noise causes loss of keepalive messages from a configurable percentage of all cable interfaces, resulting in those cable modems going offline, a new frequency is selected from the allocation table and a UCD update is performed.

Note Also see the "Polling Cable Modems" section on page 5-15.

The migration time is 10 seconds (maximum) for the decision and 20 ms for the frequency hop. The percentage threshold method prevents a single failing cable interface from affecting service to other good cable interfaces. The system will not hop endlessly because one cable interface is generating 90% of the errors and 90% of the traffic.

The minimum period between frequency hops is also configurable, with a default setting of 300 seconds. If the destination channel is expected to be impaired, the minimum period between frequency hops can be reduced to a small value such as 10 seconds. This allows the frequency hop to continue more rapidly until a clear channel is found. If excessive frequency hop is an issue, the minimum period between hops can be increased.

To adjust the frequency hop threshold percentage or the minimum period between frequency hops, use the following commands in global configuration mode.

Command	Purpose
`CMTS01(config)# cable spectrum-group` *groupnum* **hop threshold** *percent*	Set the percentage of all cable modems losing keepalive messages (going offline) that will cause a frequency hop.
`CMTS01(config)# cable spectrum-group` *groupnum* **hop period** *seconds*	Set the minimum time between frequency hops in seconds. Valid values are from 1 to 3600 seconds.

To specify that a particular spectrum group is a shared RF spectrum group, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)# cable spectrum-group` *groupnum* **shared**	Specifying a given spectrum group as "shared" tells the Cisco uBR7100 series CMTS that you want to be sure that upstream frequencies assigned to upstream interfaces are not assigned to additional upstream interfaces.

Table 3-1 describes the spectrum-group parameters.

Table 3-1 spectrum-group parameters

Syntax	Valid Values
group number	Specifies the spectrum group for which you are specifying a parameter value or specifies the number of the spectrum group you wish to remove from your router configuration. Valid range is from 1 to 32.
parameter	The spectrum group values that can be changed or added are: • Frequency—Specifies the center frequency for the given spectrum group. Entering additional **cable spectrum-group** *group number* **frequency** commands for the same spectrum group creates a collection of allowable center frequencies for spectrum group hopping. • Band—Specifies a range of center frequencies the Cisco uBR7100 series router can scan in order to find an acceptable channel to which the spectrum group can hop. • Time—Specifies a time of day that the Cisco uBR7100 series router should automatically perform a frequency hop for the given upstream spectrum group. **Note** The **time** command can be combined with the **frequency** and **band** commands. • Hop period—Specifies the minimum period (in seconds) before which a frequency hop can occur. • Hop threshold—The threshold value (expressed as a percentage) of the number of "offline" modems identified before the Cisco uBR7100 series router initiates an automatic frequency hop. • Shared—Specifies that a particular spectrum group is a shared RF spectrum group; upstream frequencies assigned to upstream interfaces are not to be assigned to additional upstream interfaces.
value	The corresponding parameter value for the parameter you are defining for a given spectrum group.

Examples are provided to configure differing spectrum groups:

- Use the following example to configure spectrum group 1 with an upstream frequency of 6,500,000 Hz and a default power level of 0 dBmV:

```
Router(config)# cable spectrum-group 1 frequency 6500000
```

- Use the following example to add the upstream frequency 7,000,000 Hz to the list of valid frequencies with a default power level of 0 dBmV for spectrum group 1:

```
Router(config)# cable spectrum-group 1 frequency 7000000
```

- Use the following example to configure spectrum group 2 with an upstream frequency 7,500,000 Hz and change the power level to 5 dBmV:

```
Router(config)# cable spectrum-group 2 frequency 7500000 5
```

- Use the following example to configure spectrum group 3 with an upstream band of 12,000,000 to 18,000,000 Hz and default power level of 0 dBmV:

```
Router(config)# cable spectrum-group 3 band 12000000 18000000
```

- Use the following example to add the upstream band 20,000,000 to 24,000,000 Hz to the list of valid bands with a change in the power level of 13 dBmV for spectrum group 3:

```
Router(config)# cable spectrum-group 3 band 20000000 24000000 13
```

- Use the following example to configure a continuous band between 5,000,004 and 40,000,000 Hz for scheduled spectrum group 4 with a default power level of 0 dBmV. The spectrum group will be available to the spectrum group starting at 12:00 p.m. local time each Monday:

```
Router(config)# cable spectrum-group 4 time Monday 12:00:00 band 5000004 40000000
```

- Use the following example to add the upstream frequency 9,500,000 Hz to the list of valid frequencies and change the nominal power level to 5 dBmV. The spectrum manager adjusts frequencies and power levels on this group at 2:00 a.m. local time each day:

```
Router(config)# cable spectrum-group 3 time 02:00:00 frequency 9500000 5
```

- Use the following example to configure the minimum period before which a frequency hop can occur in seconds:

```
Router(config)# cable spectrum-group 3 hop period 800
```

- Use the following example to configure the threshold value (expressed as a percentage) of the number of "offline" modems identified before the Cisco uBR7100 series router initiates an automatic frequency hop:

```
Router(config)# cable spectrum-group 3 hop threshold 40
```

- Use the following example to configure a particular spectrum group as a shared RF spectrum group. Specifying a given spectrum group as "shared" tells the Cisco uBR7100 series router that you want to be sure that upstream frequencies assigned to upstream interfaces are not assigned to additional upstream interfaces:

```
Router(config)# cable spectrum-group 3 shared
```

- Use the following example to remove a specified spectrum group from your configuration:

```
Router(config)# no cable spectrum-group 3
```

Verifying Spectrum Group Characteristics

To verify spectrum group characteristics and to determine if a spectrum group is shared, use the **show cable spectrum-group** command:

```
CMTS01# show cable spectrum-group
22:07:46: %SYS-5-CONFIG_I: Configured from console by console
Group  Frequency      Upstream     Weekly Scheduled            Power   Shared
No.    Band           Port         Availability                Level   Spectrum
       (Mhz)                       From Time:    To Time:      (dBmV)
1       5.000-15.000                                           0       Yes
1      12.000                                                  0       Yes
1      22.000                                                  7       Yes
2      29.000                                                  6       No
2      26.000                                                  0       No
3      35.000-41.000                                           0       No
3      16.000-19.000                                           5       No
5*      5.000-10.000               Thu 21:50:00  Thu 21:45:00  0       Yes
```

Tip If you are having difficulty with verification, make sure you entered a valid spectrum group number and type in global cable configuration mode.

Assigning the Spectrum Group and the Upstream Ports

After determining which upstream ports you want assigned to a combiner group, perform the following steps to configure a frequency hop table.

	Command	Purpose
Step 1	`CMTS01(config)# interface cable slot/port`	Enter cable interface configuration mode for the interface to which you wish to assign a spectrum group.
Step 2	`CMTS01(config-if)# cable spectrum-group usport`	Assign the spectrum group to the interface.
Step 3	`CMTS01(config-if)# cable upstream number spectrum-group usport`	Assign the upstream ports to the spectrum group for the interface.
Step 4	`CMTS01(config-if)# no cable upstream slot/port shutdown`	Place the upstream port in the "admin up" state.

Step 5	`CMTS01(config-if)# exit`
	`CMTS01# test cable hop c1/0`
	`CMTS01# test cable hop c1/0`
		Exit configuration mode and force the system to hop.

Verifying Spectrum Group and Upstream Port Assignments

Use the **show cable spectrum-group** command to display the current allocation table and frequency assignments.

Activating Cable Address Resolution Protocol Requests

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 need to activate ARP requests on the cable interface so that the Cisco uBR7100 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 uBR7100 series CMTS.

Activating Cable Address Resolution Protocol (ARP) Requests

To activate ARP requests, use the following command in cable interface configuration mode:

Command	Purpose
`CMTS01(config-if)# cable arp`	Enable ARP. This is the default.

Verifying ARP Requests

To verify if cable ARP is activated, enter the **more system:running-config** 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`.

```
CMTS01# more system:running-config
Building configuration...
```

```
Current configuration:
!
interface Cable1/0
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, make sure you entered the correct port and cable modem card slot number when you activated ARP and when you entered the **show interface cable** command.

Activating Host-to-Host Communication (Proxy ARP)

Cable proxy ARP allows the Cisco uBR7100 series CMTS to issue cable ARP requests on behalf of cable modems 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 uBR7100 series CMTS.

Activating Cable Proxy ARP Requests

To activate cable proxy ARP for host-to-host communications, use the following command in cable interface configuration mode.

Table 3-2 Instructions to Activate Cable Proxy ARP Requests

Command	Purpose
`CMTS01(config-if)# cable proxy-arp`	Enable 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** 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`.

```
CMTS01# more system:running-config
Building configuration...
```

```
Current configuration:
!
interface Cable1/0

 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 you entered the correct port and cable modem card slot number when you activated cable proxy ARP.

Configuring DHCP Options

Activating Cable Relay Agent

The cable relay agent is for use with DOCSIS-based DHCP servers that utilize option 82 to automatically map the Ethernet MAC address of a host (subscriber PC) with the cable interface to which it is connected.

With the cable relay agent activated, the Cisco uBR7100 series CMTS inserts the cable interface MAC address into a DHCP packet when the packet is received from a cable interface or another host. The Cisco uBR7100 series CMTS then forwards the packet to the DHCP server.

To activate the cable relay agent, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config)# cable relay-agent-option`	Activate the cable relay agent. This is the default.

Tip If you are having difficulty with verification, make sure you entered the correct port and cable interface card slot number when you activated the **cable relay-agent-option**.

Note A DOCSIS-based DHCP server is required. The DHCP server verifies that the defined IP address, if any, returned to the host is valid for the IP subnet on that downstream interface. The IP address must be unique and valid in the subnet for the subscriber to obtain connectivity.

Activating DHCP giaddr

Configure the Cisco uBR7100 series CMTS so it will either assign primary addresses to cable modems and remote hosts, or assign primary addresses to cable modems and secondary addresses to remote hosts.

To configure cable DHCP **giaddr** functionality, use one of the following commands in cable interface configuration mode.

Command	Purpose

`CMTS01(config)# cable dhcp-giaddr primary`
 	
or
 	
`CMTS01(config-if)# cable dhcp-giaddr policy`
	Enable cable DHCP giaddr functionality so that primary addresses are assigned to both cable modems and remote hosts.
	
	Enable cable DHCP giaddr functionality so that primary addresses are assigned to cable modems and secondary addresses are assigned to remote hosts.

To disable cable DHCP giaddr functionality (the default) after it has been enabled, enter the **no cable dhcp-giaddr** command in cable interface configuration mode.

Verifying DHCP giaddr Activation

To determine if DHCP **giaddr** is activated, enter the **show running-config** command and look for the cable interface configuration information. If DHCP **giaddr** is activated, a notation appears in this output. If DHCP **giaddr** is deactivated, no entry appears in this output.

Configuring Time-of-Day Service

Activating Time-of-Day Service

To activate Time-of-Day (ToD) service for the Cisco uBR7100 series CMTS, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)# cable time-server enable`	Enable Time-of-Day (ToD) service for the Cisco uBR7100 series CMTS

To disable ToD service (the default) after it has been enabled, enter the **no cable time-server** command or the **cable time-server disable** command in global configuration mode.

Verifying Time-of-Day Service

To determine if ToD service is activated, enter the **show running-config** command and look for the global cable configuration information. If ToD service is activated, an entry appears in this output. If ToD service is deactivated, no entry appears in this output.

Setting Optional IP Parameters

You can set additional IP parameters to enable downstream echoing of upstream data. To configure these optional IP parameters, perform the following tasks:

- "Activating IP Multicast Echo" section on page 3-39

- "Activating IP Broadcast Echo" section on page 3-39

Note The default values for the commands used in these configuration steps are adequate in most cases to configure the Cisco uBR7100 series CMTS.

Activating IP Multicast Echo

The Cisco uBR7100 series CMTS echos 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
`CMTS01(config-if)# cable ip-multicast-echo`	Enable 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 if 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:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable1/0

 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 have entered the correct slot and port numbers when you entered cable interface configuration mode.

Activating IP Broadcast Echo

By default, the Cisco uBR7100 series CMTS does not echo IP broadcast packets. To activate IP broadcast echo, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable ip-broadcast-echo`	Enable 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 if 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:

```
CMTS01# more system:running-config
Building configuration...

Current configuration:
!
interface Cable1/0

 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
```

Activating Packet Intercept Capabilities

To activate packet intercept functionality, use the following commands in cable interface configuration mode.

Command	Purpose
CMTS01(config-if)# **cable intercept** ***xxxx.xxxx.xxxx***	Specify a MAC address on the cable network for which interception capabilities are to be activated. A limit of 10 MACs exist.
CMTS01(config-if)# **no cable intercept** ***xxxx.xxxx.xxxx***	Disable interception after it is enabled.

Configuring Cable Modulation Profiles

To configure cable profiles (deviating from defaults), perform the following as necessary:

Configuring Cable Modulation Profiles

In this step, you are defining the elements used in a cable modulation profile. The Cisco uBR7100 series CMTS supports as many as 8 cable modulation profiles. Profile 1 is the default.

Caution If you modify a cable modulation profile from default parameters, you are changing the physical layer. Changing physical layer characteristics affects router performance and function; therefore, only an expert should perform this task.

The following modulation profile values are configurable:

- Interval usage code (iuc)—Valid values are initial, long, reqdata, request, short, and station.
- Fec-tbytes—The number of bytes that can be corrected per FEC codeword. Valid range is 0 to 10 bytes, where 0 means no FEC. This is the number of bytes that the FEC decoder can correct within a codeword. A codeword consists of information bytes, called k-bytes and parity bytes for error correction. The number of parity bytes is equal to two times the number of correctable error (T). The size of T is dictated by channel impairments.
- Fec-len—FEC codeword length. Valid range is 16 to 254 bits. This value enables an efficiency mode wherein all codewords are fixed in size. In a fixed operation, all codewords are the same size with the last codeword padded with nulls if there are not enough information bytes to fill it entirely. The efficiency is gained by not having to transmit the nulls that pad the last codeword.
- Burst-len—Maximum burst length in bytes. 0 means no limit on burst length. This is used to determine the breakpoint between packets that use the short data grant burst profile and packets that use the long data grant burst profile. If the required upstream time to transmit a packet is greater than this value, the long data grant burst profile is used. If the time is less than or equal to this value, the short data grant burst profile is used.
- Guard-t—Guard time in symbols. This is the time between successive bursts. It is the blank time at the end of a burst transmission that exists to ensure that one burst ends before another burst starts.
- Mod—Modulation. Valid values are "16qam" and "qpsk". Modulation type is used to select between four bits per modulation symbol (QAM-16) or two bits per modulation symbol (QPSK). QAM-16 uses both phase and amplitude to carry information. QPSK carries information in the phase of the signal carrier. QAM-16 requires approximately 7 dB higher C/N to achieve the same BER as QPSK, but it transfers information at two times the rate of QPSK.

- Scrambler—Enable or disable scrambler. Valid values are scrambler and no-scrambler. Scrambler is used to create an almost random sequence of transmission symbols, which ensures an even spectral distribution of energy transmitted within the channel. The scrambler seed is an initial value that is used to start the pseudo-randomizer to scramble the bits. Because both the transmitter and receiver know the seed value, the scrambling can be reversed at the receiver, leaving only the original data.
- Seed—Scrambler seed in hexadecimal format. Valid range is 0x0000 to 0x7FFF.
- Diff—Enable or disable differential encoding. Valid values are diff and no-diff. Differential encoding is a technique wherein the information is transmitted by the phase change between two modulation symbols instead of by the absolute phase of a symbol. This technique makes the absolute phase of the received signal insignificant and has the effect of doubling the BER for the same C/N.
- Pre-len—Preamble length in bits. Valid range is 2 to 128 bits. Preamble length (and Preamble offset) are used to define a synchronizing string of modulation symbols used to let the receiver find the phase and timing of the transmitted burst.
- Last-cw—Handling of FEC for last codeword. Valid values are fixed for fixed codeword length, and shortened for shortened last code word.
- Uw-len—Upstream unique word length. Enter **uw8** for 8-bit unique words, or **uw16** for 16-bit unique code words.

To create or change a cable modulation profile, use the following command in global configuration mode.

Command	Purpose
CMTS01(config)# **cable modulation-profile** *profile iuc fec-tbytes fec-len burst-len guard-t mod scrambler seed diff pre-len last-cw uw-len*	Create a new cable modulation profile with a profile number or modify an existing profile.

In the following example, the request burst for cable modulation profile 2 is defined to have 0 fec-tbytes, 16 kbytes fec-len, a burst-len of 1, a guard time of 8, a mod value of qpsk, scrambler enabled with a seed value of 152, differential encoding disabled, a preamble length of 64 bits, a fixed code word length, and 8-bit unique words for upstream unique word length.

```
CMTS01(config)# cable modulation-profile 2 request 0 16 1 8 qpsk scrambler 152 no-diff 64
fixed uw8
```

To remove a cable modulation profile, use the **no cable modulation-profile** *profile* command in global configuration mode. You can use this command to remove all modulation profiles except for modulation profile 1.

Tip Entering **no cable modulation-profile 1** sets all parameters in profile 1 to the default values.

Verifying Cable Modulation Profiles

To determine if a cable modulation profile is created, enter the **show cable modulation-profile** command.

A sample output is shown in the following example:

```
CMTS01# show cable modulation-profile
Mo IUC     Type  Preamb Diff FEC err FEC   Scrambl Max  Guard Last Scrambl Preamb
                 length enco correct T     seed    B    time  CW           offset
                                       bytes          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
```

Note If you have CBR scheduling parameters and IP precedence rate limits defined in the QoS profile, the command output reveals this. Refer to the "Monitoring and Maintaining QoS for Higher Priority Traffic" section on page 3-47. The **show cable modulation-profile** and **show interface cable** commands are enhanced to reflect the state of the new MAC scheduler for the specified upstream port.

Tip If you are having difficulty with verification, ensure that the system is in global configuration mode, and that you typed the correct modulation profile number and elements when you entered the command.

The preamble offset is calculated from the modulation profile entries. The preamble offset is the distance the CMTS looks into the preamble to determine where the preamble starts. The CMTS does not need to look at the entire preamble in all instances. A shorter preamble has less overhead and time associated with that type of burst request. In general, you should use an offset of "0" for initial/station maintenance because you need to separate these packets as distinctly as possible.

The offset for QPSK is shorter because of the way DOCSIS specifies the preamble. For QPSK, it only takes a preamble length of 256 bits to separate frames, whereas with QAM-16, the date rate is much higher. Utilization of a larger preamble is necessary.

Configuring QoS Profiles

The Cisco uBR7100 series CMTS supports multiple QoS profiles. QoS profile 1 is used during cable interface registration and QoS profile 2 is the default QoS profile. Both of these profiles are preconfigured and cannot be removed. However, you can modify these profiles and create additional Q0S profiles for various traffic flows.

To create or change a QoS profile, use the first command below, plus as many of the additional commands as are necessary to make the changes you require. All of the QoS profile commands are global configuration commands.

Command	Purpose
CMTS01(config)# **cable qos-profile** *groupnum*	Create a new QoS profile with a profile number of *groupnum*, or modify an existing profile.
CMTS01(config)# **cable qos-profile** *groupnum* **ip-precedence** *bits*	Set the bits in the Type of Service (ToS) byte that enable you to configure individual data rate limits on a per-modem basis. Valid values are from 0 to 7.
CMTS01(config)# **cable qos-profile** *groupnum* **guaranteed-upstream** *rate*	Set the guaranteed minimum upstream rate in kbps. Valid values are from 0 to 100000 kbps. Default = 0 (no reserved rate).
CMTS01(config)# **cable qos-profile** *groupnum* **max-burst** *size*	Set the maximum upstream transmit burst size in minislots that the cable modem can send for any single transmit burst. Valid values are from 0 to 255 minislots. Default = 0 (no limit).

Command	Purpose
CMTS01(config)# **cable qos-profile** *groupnum* **max-upstream** *rate*	Set the maximum upstream data rate in kbps that a cable modem using this QoS profile will send. Valid values are from 0 to 100000 kbps. Default = 0 (no upstream rate limit.)
CMTS01(config)# **cable qos-profile** *groupnum* **max-downstream** *rate*	Set the maximum downstream data rate in kbps that a cable modem using this QoS profile will receive. Valid values are from 0 to 100000 kbps. Default = 0 (no downstream rate limit.)
CMTS01(config)# **cable qos-profile** *groupnum* **priority** ***number***	Assign a relative priority number for the upstream traffic associated with this QoS profile. Valid values are from 0 to 7, with 7 being the highest priority. Default = 0.
CMTS01(config)# **cable qos-profile** *groupnum* **tos-overwrite** *value*	Overwrite the ToS byte in the IP datagrams received on the upstream before forwarding them downstream. Set the mask bits to a hexadecimal value to help the CMTS identify datagrams for QoS on the backbone.

Note You can use a single **cable qos-profile** command to configure multiple parameters for the selected QoS profile number.

Tip Use the **no cable qos-profile** *groupnum* command to remove an optional QoS profile, or in the case of QoS profiles 1 and 2, to return the parameters to their default values.

Verifying QoS Profiles

To determine if a QoS profile has been created, and to see how it is configured, enter the **show cable qos profile** command:

```
CMTS01# show cable qos profile
Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create     B      IP
class       upstream  upstream  downstream burst  mask value by         priv    prec
            bandwidth bandwidth bandwidth                               enab   enab
1       0    0         0         0          0      0x0  0x0   cmts       no     no
2       0    64000     0         1000000    0      0x0  0x0   cmts       no     no
3       0    3120      31200              0              0      0x0  0x0   cmts       yes
          no
4       7    87200     87200      0                     0      0x0  0x0   cmts       yes
          yes
5                            0               256000        128000    1000000    0
0x0  0x0   cm         no     yes
```

Tip If you are having difficulty with verification, make sure you typed the correct QoS profile number and profile elements when you entered the command in global configuration mode.

Note Cable modems that register continuously and fail consume more resources than cable interfaces that stay registered. Assign customers who do not pay for service to QoS profile 3.

Caution DOCSIS 1.0-certified cable interfaces that are given a short max-burst size might be unable to transmit large packets to the headend.

Setting QoS Permission

The Cisco uBR7100 series CMTS supports the creation of QoS table entries by SNMP or by CM registration requests. You can also configure a Cisco uBR7100 series CMTS to dynamically update QoS table entries via SNMP.

To set QoS table access, use one or more of the following commands in global configuration mode.

Command	Purpose
`CMTS01(config)#` **cable qos permission create-snmp**	Enable SNMP access to create entries in the QoS tables.
`CMTS01(config)#` **cable qos permission update-snmp**	Enable SNMP access to dynamically update entries in the QoS tables.
`CMTS01(config)#` **cable qos permission modems**	Enable QoS table entries to be created using a CM registration requests.
`CMTS01(config)#` **no cable qos permission**	Disable both SNMP access and CM registration access to the QoS tables.

Verifying QoS Permission

To verify QoS permissions, enter the **show cable qos permission** command:

```
CMTS01# show cable qos permission
Create by SNMP  Update by SNMP  Create by modems
no              no              yes
```

Tip If you are having difficulty with verification, make sure you typed the correct QoS profile number and profile elements in global configuration mode.

Note QoS profiles can be changed dynamically, permitting service tiers that are time-sensitive. This provides more bandwidth during business hours than on weekends for telecommuter applications.

Enforcing a QoS Profile Assignment

To override the provisioned QoS profile of a CM and enforce a CMTS-specified QoS profile, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)#` **cable qos permission enforce** *index*	Assigns the QoS profile, specified by the index number, to all CMs attempting to connect to theCisco uBR7100 series CMTS.

Verifying a QoS Profile Assignment

Step 1 Load the Cisco uBR7100 series CMTS and wait for the CMs to come online as indicated by the **show cable modem** command.

Notice that the CMs are getting their provisioned class of service as indicated by the **show cable modem** and **show cable qos profile** commands.

Step 2 Configure any QoS profile at the CMTS with a specific index number (for example index 1) by using the SNMP/CLI.

Step 3 Enter the global command **cable qos permission enforce 1**.

Step 4 Enter the **clear cable modem all reset** global configuration command to force the CMs to reregister with the CMTS.

Notice that the CMs are assigned temporarily the CMTS-defined PRE_REGISTRATION QoS profile with index 2 until the CMs register with the CMTS.

Step 5 Use the **debug cable reg** command to see that the provisioned QoS parameters of the CMs are overwritten at the CMTS during registration. Notice that at the end of the registration, the CM gets the user-enforced QoS profile as indicated by the **show cable modem** and **show cable qos profile** commands.

Setting Quality of Service (QoS) for Higher Priority Traffic

This feature describes the software enhancements and procedures that support QoS for higher priority traffic. These enhancements include improved support for:

- Delay/jitter requirements of higher priority traffic
- Increase in per-modem data throughput
- New MAC scheduler
- MAC messaging enhancements to better support real time responses to high priority service requests

Refer to the following procedures for setting QoS for higher priority traffic:

- "Configuring a QoS Profile for Higher Priority Traffic" section on page 3-46
- "Monitoring and Maintaining QoS for Higher Priority Traffic" section on page 3-47

Configuring a QoS Profile for Higher Priority Traffic

Perform these steps to configure a QoS modulation profile:

	Command	Purpose
Step 1	`Router(config)# cable qos-profile` *n* **name**	Assigns a name to the QoS profile.
Step 2	`Router(config)# cable qos-profile` *n* **priority**	Sets the upstream traffic priority.
Step 3	`Router(config)# qos-profile` *n* **max-upstream**	Sets the maximum upstream traffic rate.
Step 4	`Router(config)# qos-profile` *n* **guaranteed-upstream**	Sets the guaranteed upstream traffic rate.

	Command	Purpose
Step 5	`Router(config)# qos-profile n grant-size`	Sets the size for unsolicited grants.
Step 6	`Router(config)# qos-profile n grant-interval`	Sets the interval for unsolicited grants.
Step 7	`Router(config)# qos-profile n max-burst`	Sets the maximum rate for upstream transmission bursts.
Step 8	`Router(config)# qos-profile n ToS-overwrite`	Sets the mask bits to overwrite the Type of Service byte.
Step 9	`Router(config)# qos-profile n max-downstream`	Sets the maximum downstream traffic rate.
Step 10	`Router(config)# qos-profile n privacy`	Enables baseline privacy.
Step 11	`Router(config)# qos-profile n ip-precedence`	Downstream settings are based on IP precedence.

Monitoring and Maintaining QoS for Higher Priority Traffic

Use the following commands to monitor and maintain QoS for higher priority traffic.

Command	Purpose
`Router# show cable qos profile n`	Displays the configuration for the specified profile.
`Router# show interface cable x/y sid`	Displays each QoS profile configured for the specified cable interface.
`Router# show interface cable x/y upstream`	Displays QoS statistics for the upstream channel.

The following example shows how the cable router (*mgmt*) creates a CM with a QoS profile 30:

```
Router(config)# cable qos profile 30 name qostest
Router(config)# cable qos profile 30 grant-int 55
Router(config)# cable qos profile 30 grant-size 100
Router(config)# cable qos profile 30 guaranteed 60000
Router(config)# cable qos profile 30 ip-prec 7
Router(config)# cable qos profile 30 max-bur 256
Router(config)# cable qos profile 30 max-down 3000
Router(config)# cable qos profile 30 max-up 6000
Router(config)# cable qos profile 30 prior 7
Router(config)# cable qos profile 30 privacy

router# show cable qos profile 30
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
30 7    6000000   60000000  100000000   256   0x0  0x0    mgmt    yes   no
```

To configure a QoS profile, enter the **cable qos profile** global configuration command. To set default values for profile group numbers 1 or 2, or to remove the QoS profile if no specific parameters remain, enter the **no** form of this command.

cable qos profile {*groupnum* | **grant-interval** {*interval*}| **grant-size** {*size*} | **guaranteed-upstream** {*rate*} | **ip-precedence** {*value*} | **max-burst** {*rate*} | **max-downstream** {*rate*} | **max-upstream** {*rate*} | **name** {*string*} | **priority** {*value*} | **privacy** | **ToS-overwrite** {*value*}}

no cable qos profile {*groupnum* | **grant-interval** {*interval*} | **grant-size** {*size*} | **guaranteed-upstream** {*rate*} | **ip-precedence** {*value*} | **max-burst** {*rate*} | **max-downstream** {*rate*} | **max-upstream** {*rate*} | **name** {*string*} | **priority** {*value*} | **privacy** | **ToS-overwrite** {*value*}}

The following table describes the syntax and values for these commands.

Syntax	Valid Values
groupnum	QoS profile group number. Qos profiles 1 and 2 are required by the system. QoS profile 1 is used during registration, and QoS profile 2 is the default QoS profile. Both profiles are preconfigured and cannot be removed. However, you can modify these profiles.
grant-interval	The periodic interval in microseconds at which the CM wants to send the fixed-sized upstream MAC frames. This value is used to compute the period between constant bit rate (CBR) slots for the CM. Valid range is 0 to 65535.
grant-size	The size of the DOCSIS MAC frame the CM wants periodically to send on the upstream transmission. This value in bytes does not include any PHY layer overhead. It includes the complete fixed MAC frame size starting from the frame control byte to the CRC of the protocol data unit (PDU). This parameter is used by the CMTS to set the size of the periodic CBR slot for the CM after adding the PHY overhead.
guaranteed-upstream	Guaranteed minimum upstream rate in kilobytes per second. Valid values are 0 through 100000. Default value is 0 (no reserved rate).
ip-precedence	Bits in the ToS byte that enable you to configure individual data rate limits on a per modem basis. Valid values are 0 to 7.
max-burst	Maximum upstream transmit burst size in bytes that the modem can send for any single transmit burst. Valid values are 0 to 65535 bytes. Default value is 0 (no limit).
max-downstream	Maximum downstream data rate in kilobytes per second that a modem using this QoS profile receives. Valid values are 0 to 100000. Default value is 0 (no downstream rate limit).
max-upstream	Maximum upstream data rate in kilobytes per second that a modem using this QoS profile receives. Valid values are 0 to 255. Default value is 0 (no upstream rate limit).
name	QoS name string.
priority	Relative priority number assigned to upstream traffic by this QoS profile. Valid values are 0 to 7, with 7 being the highest priority. Default value is 0.
privacy	Enables cable baseline privacy.
ToS-overwrite	Overwrite the ToS field in the IP datagrams received on the upstream before forwarding them downstream (or IP backbone). This parameter sets the hexadecimal mask bits to a hexadecimal value, thereby helping the CMTS identify datagrams for QoS on the backbone. Valid range is 0x0 to 0xFF.
value	The value substituted for the ToS value. See `ToS-overwrite`.

Refer to the following example to configure QoS profile 4 with guaranteed upstream of 2 kbps, maximum transmission burst of 2, an IP precedence of 7, a maximum downstream rate of 300 kbps, with a priority of 4, cable baseline privacy set, and a *ToS-overwrite* mask and value byte (in hex) of 0x7:

```
Router(config)# cable qos profile 4 name Mondayqos
Router(config)# cable qos profile 4 guaranteed-upstream 2
Router(config)# cable qos profile 4 max-burst 2
Router(config)# cable qos profile 4 ip-precedence 7 max-downstream 300
Router(config)# cable qos profile 4 priority 4
Router(config)# cable qos profile 4 ToS-overwrite 0x7
```

To display QoS profiles, use the **show cable qos profile** privileged EXEC configuration command.

Note An optional "**verbose**" parameter is added:
show cable qos profile *qos profile index* **verbose**
The *qos profile index* option displays the index of the specified QoS profile. The verbose option displays all details for the specified QoS profile index.

The following example shows the full QoS table for profile 30:

```
router# show cable qos profile 30 verbose
Profile Index                          30
Name                                   test
Upstream Traffic Priority              7
Upstream Maximum Rate (bps)            6000000
Upstream Guaranteed Rate (bps)         60000000
Unsolicited Grant Size (bytes)         100
Unsolicited Grant Interval (usecs)     55000
Upstream Maximum Transmit Burst (bytes) 256
IP Type of Service Overwrite Mask      0x0
IP Type of Service Overwrite Value     0x0
Downstream Maximum Rate (bps)          100000000
Created By                             mgmt
Baseline Privacy Enabled               yes
IP precedence rate limits
 IP precedence                                  2
 Rate Limit                            100000
```

Table 3-2 describes the fields shown in the **show cable qos profile** displays.

Field	Description
Profile Index	Profile number.
Name	The name string for this profile.
Upstream Traffic Priority	Priority level for upstream traffic.
Upstream Maximum Rate (bps)	Maximum upstream transmission rate in bits per second.
Upstream Guarantee Rate (bps)	Guaranteed minimum upstream rate in bits per second.
Unsolicited Grant Size (bytes)	Number of grant-size parameters in bytes. Grant size is used by the CMTS to set the size of the periodic CBR slot for the CM after adding the PHY overhead.
Unsolicited Grant Interval (usecs)	Number of unsolicited grant intervals in microseconds. The grant-interval parameter is used to compute the period between CBR slots for the CM.
Upstream Maximum Transmit Burst (bytes)	Maximum transmit burst size in bytes.

Field	Description
IP Type of Service Overwrite Mask	Hex value of the mask bits.
IP Type of Service Overwrite Value	Value of the mask byte. This is the value the CMTS will overwrite into the ToS field (after masking bits specified in the ToS-mask parameter) of the IP datagram before forwarding the datagram into IP backbone/downstream. The IP ToS overwrite feature helps to propagate cable access QoS onto the IP backbone.
Downstream Maximum Rate (bps)	Minimum upstream transmission rate in bits per second.
Created by	Identity of the profile creator.
Baseline Privacy Enabled	Reports yes if Baseline Privacy is enabled for this QoS profile. Reports no if Baseline Privacy is not enabled for this Qos profile.
IP Precedence rate limits	Value of the IP precedence and the transmission rate limit in bits per second.

Table 3-3 Related Commands

Command	Description
cable qos permission	Sets permissions for updating QoS tables.
cable qos profile	Configures QoS profiles.
show cable qos permission	Displays the status of permissions for updating QoS tables.

In the sample **show cable qos profile** output response, note the added IP precedence column:

```
CMTS01# show cable qos profile
Service Prio Max       Guarantee Max        Max tx TOS  TOS   Create     B      IP
class        upstream  upstream  downstream burst  mask value by         priv    prec
             bandwidth bandwidth bandwidth                               enab   enab
1       0    0         0         0          0      0x0  0x0   cmts       no     no
2       0    64000     0         1000000    0      0x0  0x0   cmts       no     no
3       0    3120      31200              0               0      0x0  0x0   cmts       yes
          no
4       7    87200     87200      0                       0       0x0  0x0   cmts       yes
          yes
5                            0               256000        128000    1000000    0
0x0  0x0   cm                  no                  yes
```

The software provides QoS based on the CM SID. Every QoS profile carries a parameter maximum downstream rate which is used to provide peak rate limiting and traffic shaping on the downstream. When the particular CM supports combined high priority and data traffic, rate exceeded data packets might shut out or delay higher priority packets, degrading quality. As a solution, IP precedence bits are used as a basic differentiator to provide independent rate limits for different traffic streams as desired.

The **show interface cable** *x/y* **upstream** *port #* command is also enhanced to reflect the current state of the new MAC scheduler for the specified upstream port as shown in the following example:

```
cmts# show interface cable 1/0 upstream 0
Cable1/0: Upstream 0 is up
     Received 68 broadcasts, 0 multicasts, 20811 unicasts
     0 discards, 99 errors, 0 unknown protocol
     20879 packets input, 0 corrected, 0 uncorrectable
     99 noise, 0 microreflections
     Total Modems On This Upstream Channel : 2 (2 active)
     Default MAC scheduler
     Queue[Cont Mslots]  1/104, fifo queuing, 0 drops
     Queue[Rng Polls]  0/20, fifo queuing, 0 drops
     Queue[CIR Grants]  0/20, fair queuing, 0 drops
     Queue[BE Grants]  0/30, fair queuing, 0 drops
     Queue[Grant Shpr]   0/30, calendar queuing, 0 drops
     Reserved slot table currently has 5 CBR entries
     Req IEs 176103, Req/Data IEs 0
     Init Mtn IEs 540, Stn Mtn IEs 101
     Long Grant IEs 10042, Short Grant IEs 405
     Total channel bw reserved 200000 bps
     CIR admission control not enforced
     Current minislot count   : 2099853    Flag: 1
     Scheduled minislot count : 2100020    Flag: 1
```

The **show interface sid** command is also enhanced to display the type of SID—whether it is “Static” versus “Dynamic”.

```
cmts# show interface cable x/y sid
```

Sid	Prim Sid	Type	Online State	Admin Status	QoS	Create Time	IP Address	MAC Address
2		stat	online	enable	4	12:10:25	1.11.51.37	0010.7b6b.722d
4	2	dyn	online	enable	5	12:10:30	1.11.51.37	0010.7b6b.722d

You can optimize the physical layer parameters on an upstream channel. An example is provided for physical layer parameters that can be used on the CMTS for upstream channels expected to support high priority traffic density. These parameters minimize the physical layer overhead encountered for each fixed sized (89 bytes) packet. The resulting fine tuning gives a direct improvement in the number of CBR high priority connections that can be admitted on a single upstream channel.

Configure the following settings for the upstream channel to maximize the number of CBR connections:

- Minislot size: 8
- Symbol rate: 1280 Ksymbols/sec
- Modulation type: QPSK
- Preamble length: 72 bits
- FEC (T bytes): 2 bytes
- FEC codeword length: 52 bytes
- Guard time: 8 symbols
- Last codeword: shortened last codeword

To configure the above modulation profile at the CMTS, use the following commands:

Create a new **qpsk modulation profile template** *m* with all default parameters, except the "short grant" profile which has special parameters as given below:

```
cmts(config)# cable modulation-profile m qpsk
cmts(config)# cable modulation-profile m short 2 52 16 8 qpsk scrambler 152 diff 72
shortened uw8
```

Configure **upstream port** *n* on a given interface to use minislot size of 8 ticks and above modulation profile template *m*:

```
cmts(config-if)# cable upstream n minislot-size 8
cmts(config-if)# cable upstream n modulation-profile m
```

Setting and Viewing Concatenation

To turn concatenation off or on from the CMTS, use the **cable upstream concatenation** interface configuration command. To turn off concatenation from the default state of on, use the **no** form of this command.

cable upstream *n* **concatenation**

no cable upstream *n* **concatenation**

Note Concatenation is part of DOCSIS 1.0 extension support. Concatenation must be supported at both the CMTS and the CM. When enabled on both the CMTS and the CM, the CMTS can receive a concatenated burst of multiple MAC frames from the CM.

Setting Concatenation

	Command	Purpose
Step 1	`Router(config-if)# no cable upstream n concatenation`	Turns off concatenation on the specified channel.
Step 2	`Router(config-if)# cable upstream n concatenation`	Turns on concatenation on the specified channel.

Tip Concatenation is enabled by default.

Caution Turning off concatenation instructs the CM that the CMTS does not want the CM to concatenate. It is actually up to the CM not to concatenate. If the CM concatenates even after the **no cable upstream** *number* **concatenation** interface command is issued, the CM might concatenate incorrectly. Such a CM is considered noncompliant.

Viewing Concatenation Status

Use the following command to monitor concatenation:

Command	Purpose
Router# **show controller cable** *slot/port*	Displays the current status of concatenation for the specified slot and port.

The following display indicates that concatenation is turned off.

```
Lab-CMTS# show controller cab 1/0
Interface Cable1/0
Hardware is BCM3210 FPGA
 idb 0x6182BE18 MAC regs 0x3D900000 PLX regs 0x3D800000
 rx ring entries 1024 tx ring entries 128 MAP tx ring entries 128
 Rx ring 0x4B09A400 shadow 0x61849408 head 359
 Tx ring 0x4B09C440 shadow 0x6184A478 head 85 tail 85 count 0
 MAP Tx ring 0x4B09C880 shadow 0x6184A8E8 head 7 tail 7 count 0

 MAP timer sourced from slot 4

 throttled 0 enabled 0 disabled 0
 Rx: spurious 341 framing_err 0 hcs_err 2 no_buffer 0 short_pkt 2
     no_enqueue 0 no_enp 1 miss_count 0 latency 16
     invalid_sid 0 invalid_mac 0 bad_ext_hdr_pdu 0 concat 0 bad-concat 0
 Tx:  full 0 drop 0 stuck 0 latency 1
 MTx: full 0 drop 0 stuck 0 latency 9
 Slots 68056 NoUWCollNoEngy 15 FECorHCS 2 HCS 0
 Req 1803579865 ReqColl 1 ReqNoise 276120 ReqNoEnergy 0
 ReqData 0 ReqDataColl 0 ReqDataNoise 0 ReqDataNoEnergy 0
 Rng 143099 RngColl 0 RngNoise 3891
 FECBlks 0 UnCorFECBlks 0 CorFECBlks 0
 MAP FIFO overflow 0, Rx FIFO overflow 0, No rx buf 0
 DS FIFO overflow 0, US FIFO overflow 0, US stuck 0
 Bandwidth Requests= 0xFFC9
 Piggyback Requests= 0xA1D
 Ranging Requests= 0x22039
 Timing Offset = 0x0


Bad bandwidth Requests= 0x31BC
 No MAP buffer= 0x0
 Cable1/0 Downstream is up
Frequency not set, 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
 Cable1/0 Upstream 0 is up
Frequency 20.208 MHz, Channel Width 1.600 MHz, QPSK Symbol Rate 1.280 Msps
  Spectrum Group is overridden
  SNR - Unknown
  Nominal Input Power Level 0 dBmV, Tx Timing Offset 4667
  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
concatenation is disabled
```

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

A Cisco uBR7100 series router and an intermediate frequency (IF)-to-RF upconverter are installed at the headend or distribution hub to transmit digital data. The Cisco uBR7100 series 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.

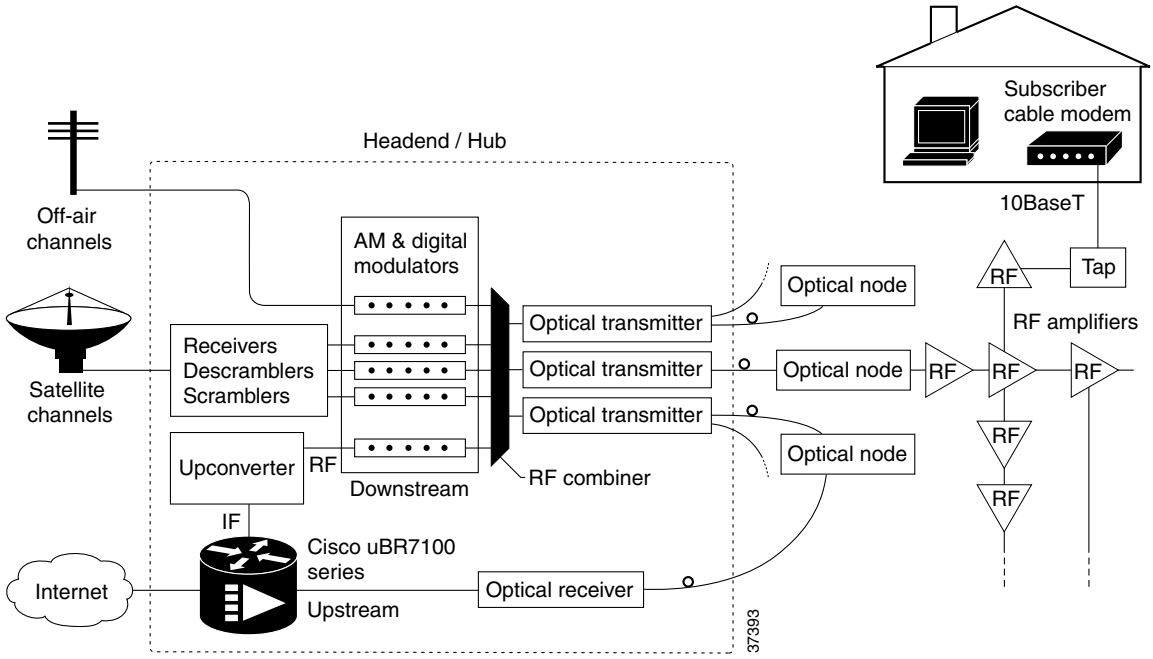
The analog and digital signals then pass through the RF combiner. The signals are broadcast from the headend through optical transmitters to fiber nodes.

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 STBs, TVs, and VCRs receive one-way analog signals.
- CMs, or tuners in EuroDOCSIS STBs that handle IP data, 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 uBR7100 series router where they are processed.
  - Telco return CMs transmit over the PSTN. Refer to *Telco Return for the Cisco CMTS* for additional information.

Figure 4-1 on page 4-2 illustrates this general signal flow and associated processes in the CMTS.

Figure 4-1 Two-Way Internet Access Network Example



Note The external upconverter shown in Figure 4-1 is needed only if you are not using the router's integrated upconverter.

Typical Routing Configuration For High Speed Internet Access

When running in routing mode, the Cisco uBR7100 series router is fully capable of self provisioning all cable modems and hosts to which it is attached. The router supports multiple IP subnets, including different subnets for hosts and cable modems. Configuration options are only limited by available configuration file length.

The Cisco uBR7100 series CMTS automatically connects DOCSIS-compliant cable modems 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 and the downstream port to a duplex filter.

Note Do not combine multiple ports as 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.

The following sample configuration file configures the Cisco uBR7111 router for typical routing operation with the following features:

- Basic DOCSIS Internet Access

- DHCP Address Pools—The Cisco uBR7111 router acts as a DHCP server, providing different address spaces on the basis of the cable modem'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 cable modems 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 Cable Modem Configuration Files—These configuration files provide several different service level options:
  - platinum.cm—Users are given a maximum upstream bandwidth of 128kbps, with a guaranteed minimum bandwidth of 10kbps. The downstream has a maximum bandwidth of 10Mbps. Up to 8 PCs are allowed on this connection.
  - gold.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 5Mbps. Up to 3 PCs are allowed on this connection.
  - silver.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 1Mbps. 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 ubr7100
!
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 FastEthernet0/0
   no ip address
   no ip mroute-cache
   shutdown
   duplex auto
   speed auto
!
interface FastEthernet0/1
   no ip address
   no ip mroute-cache
   shutdown
   duplex auto
   speed auto
!
interface Cable1/0
   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
no 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 string **cable modulation-profile** 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 utilizes both the spectrum management and the modulation profile configured in the sample.

cable upstream 0 spectrum-group 1

cable upstream 0 modulation-profile 3

EuroDOCSIS Operation

The Cisco uBR7111E and Cisco uBR7114E routers support the EuroDOCSIS channel plans that use an 8 MHz channel width. Key commands that appear in the Cisco uBR7100 series configuration file that denote EuroDOCSIS operation include:

- **cable downstream annex A**—Annex A is reserved for EuroDOCSIS operations (Annex B is used for DOCSIS NTSC operations). Annex A is chosen by default on the Cisco uBR7111E and Cisco uBR7114E routers.
- **cable upstream 0 frequency**—The EuroDOCSIS upstream valid range is from 5,000,000 to 65,000,000 Hz.

The following is a typical configuration file for EuroDOCSIS operation:

```
!
version 12.1
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname UBR7114
!
!
cable modulation-profile 1 request 0 16 1 8 16qam scrambler 152
no-diff 128 fixed uw16
cable modulation-profile 1 initial 5 34 0 48 16qam scrambler 152
no-diff 256 fixed uw16
cable modulation-profile 1 station 5 34 0 48 16qam scrambler 152
no-diff 256 fixed uw16
cable modulation-profile 1 short 6 75 6 8 16qam scrambler 152 no-diff
144 fixeduw8
cable modulation-profile 1 long 8 220 0 8 16qam scrambler 152 no-diff
160 fixeduw8
cable modulation-profile 2 request 0 16 1 8 qpsk scrambler 152 no-diff
64 fixeduw8
cable modulation-profile 2 initial 5 34 0 48 qpsk scrambler 152
no-diff 128 fixed uw16
cable modulation-profile 2 station 5 34 0 48 qpsk scrambler 152
no-diff 128 fixed uw16
cable modulation-profile 2 short 5 75 6 8 qpsk scrambler 152 no-diff
72 fixed uw8
cable modulation-profile 2 long 8 220 0 8 qpsk scrambler 152 no-diff
80 fixed uw8
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
!
```

```
!
!
!
interface Loopback0
 ip address 222.2.4.1 255.255.255.255
 no ip directed-broadcast
!
interface Loopback2
 ip address 111.0.4.2 255.255.255.255
 no ip directed-broadcast
!
interface FastEthernet0/0
 ip address 1.8.93.9 255.255.0.0
 no ip directed-broadcast
!
interface Cable1/0
 ip address 3.214.1.1 255.255.255.0
 no ip directed-broadcast
 load-interval 30
 no keepalive
 cable spectrum-group 1
 cable helper-address 1.8.93.100
cable downstream annex A
 cable downstream modulation 64qam
 cable downstream frequency 669000000
cable upstream 0 frequency 5008000
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 frequency 10000000
 cable upstream 1 power-level 0
 no cable upstream 1 shutdown
 cable upstream 2 frequency 15008000
 cable upstream 2 power-level 0
 no cable upstream 2 shutdown
 cable upstream 3 frequency 20000000
 cable upstream 3 power-level 0
 no cable upstream 3 shutdown
!
ip default-gateway 1.8.0.1
ip classless
ip route 223.255.254.254 255.255.255.255 1.8.0.1
!
alias exec scm show cable modem
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 password secret
 login
!
end
```

Transparent Bridging Configuration

Bridging operation between the cable interface and port adapter interfaces is typically not used in DOCSIS CMTS installations because of potential performance and security problems, but bridging operations is appropriate for certain MDU/MTU applications. For example, a hotel could offer Internet connectivity for customers who want to use a fixed IP address, as opposed to being assigned a temporary IP address from the local server's DHCP address pool.

Note Transparent bridging is supported only when using Cisco IOS Release 12.1(7)EC or greater. For complete details on transparent bridging and IRB operation, see the *Bridging* chapters in the *Cisco IOS Bridging and IBM Networking Configuration Guide, Release 12.1*, available on CCO and the Documentation CD-ROM.

The following sample configuration file configures the Cisco uBR7111 router for basic bridging operation with the following features:

- Basic DOCSIS Internet Access using bridging operations—This requires the following:
  - IP routing is disabled.
  - The FastEthernet and cable interfaces are assigned to the same bridge group.
  - Each interface receives the same IP address since they form one logical network.
  - The **subscriber-loop-control** bridging option is enabled on the cable interface to allow packets received on an upstream to be forwarded to another cable modem host on the downstream.

  Note The spanning-tree protocol is disabled, by default, on the cable interface, but this is not required.

- DOCSIS Cable Modem Configuration Files—These configuration files provide several different service level options:
  - platinum.cm—Users are given a maximum upstream bandwidth of 128kbps, with a guaranteed minimum bandwidth of 10kbps. The downstream has a maximum bandwidth of 10Mbps. Up to 8 PCs are allowed on this connection.
  - gold.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 5Mbps. Up to 3 PCs are allowed on this connection.
  - silver.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 1Mbps. 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.
- TFTP server provides access to the cable modem configuration files (but a DHCP server is not supported in bridging mode)

The following is a typical configuration file for transparent bridging operation:

```
!
version 12.1
no service pad
service timestamps debug datetime msec localtime
service timestamps log datetime
no service password-encryption
service udp-small-servers max-servers no-limit
service tcp-small-servers max-servers no-limit
```

```
!
hostname ubr7100
!
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
!
!
clock timezone PST -9
clock calendar-valid
ip subnet-zero
no ip routing
no ip finger
no ip domain-lookup
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 no keepalive
 duplex half
 speed auto
 no cdp enable
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface FastEthernet0/1
 ip address 10.1.1.1 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 duplex auto
 speed 10
 no cdp enable
```

```
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface Cable1/0
 ip address 10.1.1.1 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 no keepalive
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream frequency 525000000
 no cable downstream rf-shutdown
 cable upstream 0 frequency 17808000
 cable upstream 0 power-level 0
 cable upstream 0 timing-adjust threshold 0
 cable upstream 0 timing-adjust continue 0
 cable upstream 0 channel-width 3200000
 no cable upstream 0 shutdown
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
!
ip default-gateway 1.10.0.3
ip classless
no ip http server
!
no cdp run
tftp-server bootflash:platinum.cm alias platinum.cm
tftp-server bootflash:gold.cm alias gold.cm
tftp-server bootflash:silver.cm alias silver.cm
tftp-server bootflash:disable.cm alias disable.cm
!
line con 0
 exec-timeout 0 0
 privilege level 15
 length 0
 transport input none
line aux 0
line vty 0 4
 privilege level 15
 no login
!
end
```

Integrated Routing and Bridging Configuration

Integrated Routing and Bridging (IRB) operation allows bridging within a specific segment of networks or hosts, yet also allows those hosts to connect to devices on other, routed networks, without having to use a separate router to interconnect the two networks. IRB operation is typically not used in DOCSIS CMTS installations because of potential performance and security problems, but bridging operations is appropriate for certain MDU/MTU applications. For example, a hotel could offer Internet connectivity for customers who want to use a fixed IP address, as opposed to being assigned a temporary IP address from the local server's DHCP address pool.

Note IRB operation is supported only when using Cisco IOS Release 12.1(7)EC or greater. For complete details on transparent bridging and IRB operation, see the *Bridging* chapters in the *Cisco IOS Bridging and IBM Networking Configuration Guide, Release 12.1*, available on CCO and the Documentation CD-ROM.

The following sample configuration file configures the Cisco uBR7111 router for basic IRB operation with the following features:

- Basic DOCSIS Internet Access using IRB operations—This requires the following:
  - IRB bridging is enabled.
  - The FastEthernet and cable interfaces are assigned to the same bridge group.
  - An IP address is configured only on the virtual BVI interface. No IP address is configured on any physical interface.
  - The **subscriber-loop-control** bridging option is enabled on the cable interface to allow packets received on an upstream to be forwarded to another cable modem host on the downstream.
  - The virtual BVI interface is configured with an IP address.

  Note The spanning-tree protocol is disabled, by default, on the cable interface, but this is not required.

- DOCSIS Cable Modem Configuration Files—These configuration files provide several different service level options:
  - platinum.cm—Users are given a maximum upstream bandwidth of 128kbps, with a guaranteed minimum bandwidth of 10kbps. The downstream has a maximum bandwidth of 10Mbps. Up to 8 PCs are allowed on this connection.
  - gold.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 5Mbps. Up to 3 PCs are allowed on this connection.
  - silver.cm—Users are given a maximum upstream bandwidth of 64kbps and a maximum downstream bandwidth of 1Mbps. 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.
- TFTP server provides access to the cable modem configuration files (but a DHCP server is not supported in bridging mode)

The following is a typical configuration file for IRB operation:

```
!
version 12.1
no service pad
service timestamps debug datetime msec localtime
service timestamps log datetime
no service password-encryption
service udp-small-servers max-servers no-limit
service tcp-small-servers max-servers no-limit
!
hostname ubr7100
!
logging buffered 409600 debugging
no logging console
!
```

```
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
!
!
clock timezone PST -9
clock calendar-valid
ip subnet-zero
no ip finger
no ip domain-lookup
!
bridge irb
!
interface FastEthernet0/0
 no ip address
 no ip mroute-cache
 no keepalive
 duplex half
 speed auto
 no cdp enable
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface FastEthernet0/1
 no ip address
 no ip mroute-cache
 duplex auto
 speed 10
 no cdp enable
 bridge-group 1
 bridge-group 1 spanning-disabled
!
interface Cable1/0
```

```
 no ip address
 no ip mroute-cache
 load-interval 30
 no keepalive
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream frequency 525000000
 no cable downstream rf-shutdown
 cable upstream 0 frequency 17808000
 cable upstream 0 power-level 0
 cable upstream 0 timing-adjust threshold 0
 cable upstream 0 timing-adjust continue 0
 cable upstream 0 channel-width 3200000
 no cable upstream 0 shutdown
 bridge-group 1
 bridge-group 1 subscriber-loop-control
 bridge-group 1 spanning-disabled
!
interface BVI1
 ip address 100.1.1.1 255.255.255.0
!
ip default-gateway 1.10.0.3
ip classless
no ip http server
!
no cdp run
tftp-server bootflash:platinum.cm alias platinum.cm
tftp-server bootflash:gold.cm alias gold.cm
tftp-server bootflash:silver.cm alias silver.cm
tftp-server bootflash:disable.cm alias disable.cm

bridge 1 protocol ieee
 bridge 1 route ip
alias exec scm show cable modem
alias exec sib show ip int brief
!
line con 0
 exec-timeout 0 0
 privilege level 15
 length 0
 transport input none
line aux 0
line vty 0 4
 privilege level 15
 no login
!
end
```

Baseline Privacy Interface

The Cisco uBR7100 series CMTS supports 56-bit and 40-bit encryption/decryption; 56 bit is the default. After you choose a CMTS image that supports BPI, BPI is enabled by default for the Cisco uBR7100 series routers.

When baseline privacy is enabled, the Cisco uBR7100 series router routes encrypted/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 cable modem based on the cable modem's service

identifier (SID), and permits the cable modem to connect to the Cisco uBR7100 series router when baseline privacy is activated. The TEK is assigned to a cable modem when its KEK has been established. The TEK is used to encrypt data traffic between the cable modem and the Cisco uBR7100 series CMTS.

Keks and TEKs can be set to expire based on a gracetime or a lifetime value. A gracetime key is used to assign a temporary key to a cable modem to access the network. A lifetime key is used to assign a more permanent key to a cable modem. Each cable modem that has a lifetime key assigned will request a new lifetime key from the Cisco uBR7100 series CMTS before the current one expires.

Tip Use the **show cable modem** command to identify a cable modem with encryption/decryption enabled. The *online(pk)* output of this command reveals a cable modem that is registered with BPI enabled and a KEK assigned. The *online(pt)* output reveals a cable modem that is registered with BPI enabled and a TEK assigned.

Commands that enable, disable, and configure BPI encryption/decryption include:

- 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

To change the Cisco uBR7100 series default of 56-bit encryption/decryption to 40-bit, use the "40 bit des" option:

```
CMTS(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/decryption after changing to 40-bit, enter the **no** command in front of the "40 bit des" option.

Caution Cisco uBR7100 series telco return images that support BPI do not support encryption/decryption in the telco return path.

Troubleshooting the System

This chapter contains troubleshooting information for various functions of your Cisco uBR7100 series CMTS, and includes the following sections:

Using a Cable Modem at the Headend to Verify Downstream Signals

You can use a Cisco uBR924 cable access router to verify the downstream signal originating from a Cisco uBR7100 series universal broadband router. Be sure you configure the Cisco uBR924 according to DOCSIS cable modem practices. To verify the downstream signal from a Cisco uBR7100 series universal broadband 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, enter 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 cable modem installed at a headend should be between 35 and 39 dB. Although the exact value displayed will vary from cable modem to cable modem, values collected on the same cable modem from measurement to measurement will be consistent. Maximizing SNR optimizes cable modem reliability and service quality.

Managing Cable Modems on the HFC Network

To manage cable modems connected to the network, perform the following tasks as appropriate:

Caution Cisco recommends using default values for most commands. Default settings are adequate for most systems.

Configuring Sync Message Interval

To specify the sync message interval between successive sync message transmissions from the Cisco uBR7100 series CMTS, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable sync-interval` *msec*	Specify the interval in milliseconds between successive sync message transmissions from the Cisco uBR7100 series CMTS. Valid values are from 1 to 200 msec. Default = 10 msec.
`CMTS01(config-if)# no cable sync-interval`	Return 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.

Activating Cable Modem Authentication

The Cisco uBR7100 series CMTS can be configured to require all cable modems 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 cable modem authentication, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable shared-secret [0|7] authorization-key`	Enable cable modem authentication: • `0` specifies an unencrypted authentication key; • `7` specifies an encrypted authentication key.
`CMTS01(config-if)# no cable shared-secret`	Disable cable modem authentication.

Tip Be sure you enter the correct slot and port number in the cable interface configuration mode. Verify that the cable modem is using BPI and that it is assigned to a QoS with privacy active. Verify that the cable interface configuration file contains a matching key.

Verifying Cable Modem Authentication

To determine if cable modem authentication is activated or deactivated, enter the **more system:running-config** command and look for the cable interface configuration information. If cable modem authentication is deactivated, it appears in this output as `no cable secret-shared`.

Activating Cable Modem Upstream Address Verification

Cable modem upstream address verification ensures that only cable modems that have received DHCP leases through the Cisco uBR7100 series CMTS can access the HFC network. The Cisco uBR7100 series CMTS discards all packets received from or for hosts that have not received DHCP-assigned addresses.

To activate cable modem upstream address verification, use the following cable interface configuration command.

Command	Purpose
`CMTS01(config-if)# cable source-verify [dhcp]`	Activate cable modem upstream verification. The **dhcp** option specifies that queries be sent to verify unknown IP addresses in upstream data packets.
`CMTS01(config-if)# no cable source-verify`	Return to the default upstream verification state.

Verifying Cable Modem Upstream Address Verification

To determine if cable modem upstream verification is activated or deactivated, enter the **more system:running-config** command and look for the `no cable source-verify` notation in the cable interface configuration information.

Tip Be sure you enter the correct slot and port number when you enter the cable interface configuration mode.

Note If the Cisco uBR7100 series router is reloaded or the ARP table is cleared, all hosts on the network will be 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.

Configuring Dynamic Contention Algorithms (Cable Insertion Interval, Range, and Data Backoffs)

The Cisco uBR7100 series software includes:

- Algorithm that dynamically controls the rate of upstream contention slots —initial ranging and bandwidth requests.
- Algorithm that varies backoff parameters CMs use within each of the initial ranging and bandwidth request upstream contention subchannels.

These algorithms control the capacity of the contention subchannel and how efficiently a given contention subchannel capacity is utilized.

In high contention mode, the Cisco uBR7100 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 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*]

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` enables the dynamic backoff algorithm.

To deviate from system defaults when modifying the dynamic contention algorithm, use one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# [no] cable insertion-interval automatic`	Disable or enable the dynamic ranging interval algorithm. If lower and upper bounds for varying the period are not specified, the system uses default values of 50 msecs and 2 secs respectively.
`CMTS01(config-if)# cable insertion-interval automatic min 25-2000`	Set the lower bound on the initial ranging period for the auto ranging algorithm.
`CMTS01(config-if)# cable insertion-interval max 500-2000`	Set the upper bound on initial ranging period for the auto ranging algorithm.
`CMTS01(config-if)# no cable insertion-interval`	Reset fixed initial ranging period to default value of 500 msecs. Also invokes fixed initial ranging algorithm.
`CMTS01(config-if)# cable insertion-interval 100-2000`	Enable fixed initial ranging period algorithm with specified fixed period (msecs).

Configuring the Dynamic Map Advance Algorithm

A CMTS administrator can enhance the upstream throughput from a cable modem connected to the Cisco uBR7100 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/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
`CMTS01(config-if)# cable map-advance dynamic [n]|static`	Specify a value to enhance the upstream throughput from a cable modem connected to the Cisco uBR7100 series router. The `n` parameter provides the safety factor for the dynamic map advance algorithm. This parameter 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 between 500 to 1500 usecs. This parameter is a delta value added to the dynamic map-advance 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 map advance command. The Cisco uBR7100 series router will use a fixed lookahead time in MAPs, regardless of the real propagation delay of the farthest cable modem 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 Cisco recommends if you are adjusting the dynamic map advance algorithm that you 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 Per Modem Filters

You can configure the Cisco uBR7100 series router to filter incoming packets from individual hosts or cable modems 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.

To configure per modem filters, use the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(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 modems and individual hosts are filtered based on the cable modem or the host the packets are received from. Use *modem* if the device is a cable modem. Use *host* if the device is a CPE device attached to a cable modem. Define the filter to be applied to the device and a given address. The *macaddr* specifies the cable modem'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 cable modem 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. This is a typical registration and login procedure:

1. The CM registers with the Cisco uBR7100 series CMTS.
2. The Cisco uBR7100 series CMTS 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 uBR7100 series CMTS.
6. The login server sets per-CPE filter in the Cisco uBR7100 series CMTS. The per-CPE filter overrides the per modem filter settings.
7. If the CM goes offline for less than 24 hours, filters that have been defined using the Cisco uBR7100 series CMTS remain active. If a CM stays offline for more than 24 hours, the 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 the Maximum Number of Hosts Attached to a Cable Modem

To specify the maximum number of hosts that can be attached to a subscriber's cable modem, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable max-hosts n`	Specify the maximum number of hosts that can be attached to a cable modem on this interface. Valid range is from 0 to 255 hosts. Default = 0.
`CMTS01(config-if)# no cable max-hosts`	Reset the allowable number of hosts attached to a cable modem to the default value of 0 hosts.

Configuring Cable Modem Registration Timeout

By default, registered cable modems that have no upstream activity for three minutes are timed out and disconnected from the Cisco uBR7100 series CMTS. This timeout interval can be decreased to 2 minutes or increased up to 60 minutes.

To specify the registration timeout interval for cable modems connected to the Cisco uBR7100 series CMTS, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# cable registration-timeout n`	Specify 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.

Clearing Cable Modem Reset

To remove a single cable modem (or all cable modems) from the station maintenance list and reset the cable modem (or all cable modems) on the network, use one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# clear cable modem mac-addr reset`	Remove the CM with a specific MAC address from the station maintenance list and reset it.
`CMTS01(config-if)# clear cable modem ip-addr reset`	Remove the CM with a specific IP address from the station maintenance list and reset it.
`CMTS01(config-if)# clear cable modem all reset`	Remove all CMs from the station maintenance list and reset them.

Verifying Clear Cable Modem Reset

To determine if the **clear cable modem reset** command has removed a cable modem from the station maintenance list and forced it to start a reset sequence, enter the **show cable modem** command.

Tip Be sure you entered the correct cable modem IP address or MAC address when you typed the **clear cable modem reset** command. It might take up to 30 seconds for the cable modem to start the reset sequence.

Note The **clear cable modem reset** command is useful if an SNMP manager is not available, or if the cable modem is unable to obtain an IP address or respond to SNMP messages.

Clearing Cable Modem Counters

To clear the counters for the cable modem(s) in the station maintenance list, use one of the following commands in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# clear cable modem mac-addr counters`	Clear the counters in the station maintenance list for the CM with a specific MAC address.
`CMTS01(config-if)# clear cable modem ip-addr counters`	Clear the counters in the station maintenance list for the CM with a specific IP address.
`CMTS01(config-if)# clear cable modem all counters`	Clear the counters in the station maintenance list for all CMs.

Verifying Clear Cable Modem 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 cable modem identified by its IP address.
show cable modem *mac-address*	Displays the status of a cable modem identified by its MAC address.
show cable modem *interface-address*	Displays the status of all cable modems on a particular upstream.

Configuring Traffic Shaping

Configuring Downstream Rate Limiting and Shaping

To configure downstream rate limiting or shape downstream traffic, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# [no] cable downstream rate-limit token-bucket [shaping] weighted-discard [expwt n]`	Enables or disables rate limiting and traffic shaping on the downstream of a cable interface.

You can use this command in the following ways:

- To enable rate limiting on the given downstream port using the token bucket policing algorithm, enter the **cable downstream rate-limit token-bucket** command.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with traffic shaping, enter the **cable downstream rate-limit token-bucket shaping** command.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with a specific traffic shaping time granularity, enter the **cable downstream rate-limit token-bucket shaping granularity 8** command. Acceptable values are 1, 2, 4, 8, or 16 msecs.
- To enable rate limiting on the given downstream port using the token bucket policing algorithm with a specific maximum traffic shaping buffering delay, enter the **cable downstream rate-limit token-bucket shaping granularity 8** command. Acceptable values are 128, 256, 512, or 1028 msecs.
- To remove rate limiting on the given downstream port, enter the **cable downstream rate-limit token-bucket** command.
- To enable rate limiting on the given downstream port using a weighted packet discard policing algorithm, and to assign a weight for the exponential moving average of loss rate value, enter the **cable downstream rate-limit weighted-discard 3** command. Acceptable values are 1, 2, 3, or 4.

Configuring Upstream Rate Limiting and Shaping

You can rate limit and shape traffic on a DOCSIS upstream channel. This 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's TCP/IP stack to pace the application traffic appropriately and approach throughput commensurate with the subscriber's defined QoS levels.

To configure upstream rate limiting and shaping, use the following command in cable interface configuration mode.

Command	Purpose
`CMTS01(config-if)# [no] cable upstream n1 rate-limit [token-bucket]`	Enables or disables DOCSIS rate limiting or shaping on an upstream channel. The *n1* argument depends on the number of upstream channels on the specific cable modem card.

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 (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 SMTP. 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.

```
CMTS01# show interface c1/0 sid 1 counters
Sid   Inpackets  Inoctets   Outpackets Outoctets  Ratelimit  Ratelimit
                                                  BWReqDrop  DSPktDrop
1     67859      99158800   67570      98734862   2579       0
```

Configuring Spectrum Management

Combining Blind Strategies and Time Scheduled Spectrum Management

Cisco uBR7100 series software supports combined blind and time scheduled spectrum management:

- Using blind spectrum management, the number of lost station management messages exceeding a configured threshold (default = 10) initiates an upstream channel frequency reassignment. The Cisco uBR7100 series software moves all CMs on the upstream port by sending UCD messages that contain the next frequency and input power level defined in the spectrum management group. The frequency change occurs rapidly without data loss and with minimal latency.
- Using time scheduled spectrum management, the upstream channel frequency reassignment process is initiated at a configured time of day or week.

With combined blind and time scheduled strategies, blind hop tables are given the capability for time-variant configuration. The frequency or subband list can change with time. Blind frequency hop is performed within the spectrum specified to be currently available. An example follows:

```
uBR(config)# cable spectrum-group 2 time Mon 09:00:00 frequency 10000000
uBR(config)# cable spectrum-group 2 time Tue 09:05:00 delete frequency 10000000
uBR(config)# cable spectrum-group 2 time Tue 09:00:00 frequency 5000000
uBR(config)# cable spectrum-group 4 time Fri 09:00:00 band 15000000 25000000
uBR(config)# cable spectrum-group 4 time Sat 09:00:00 delete band 15000000 25000000
```

Using Guided Frequency Hop

Using guided frequency hop, the upstream channel frequency is reassigned if a threshold number or percentage of CMs suddenly go offline. You can adjust the thresholds and assign explicit frequencies or frequency subbands and associated input power levels in the unified spectrum group table. The Cisco uBR7100 series CMTS locates the defined channel or a suitable channel and moves all CMs on the upstream port.

The following example shows that the Cisco uBR7100 series can force the CTMS to change the upstream to another frequency before the CMTS sends a message to increase output power levels. You can configure the frequency hop table so that the next entry has the same frequency, but a different power level:

```
uBR(config)# cable spectrum-group 2 frequency 20000000
uBR(config)# cable spectrum-group 2 frequency 20000000 2
uBR(config)# cable spectrum-group 2 frequency 20000000 -2
uBR(config)# cable spectrum-group 2 frequency 22000000
uBR(config)# cable spectrum-group 2 frequency 22000000 2
```

```
uBR(config)# cable spectrum-group 2 frequency 22000000 3
```

The order of the configuration commands defines the order which frequency or power level is changed. There is always a single allocation set per spectrum group, listing the currently available bands. In the case of a shared spectrum group, there is also a single free set and "in-use" set because there is a single RF domain. Otherwise, there are free and in-use sets for each upstream port because each upstream port has its own RF domain.

Sample output:

```
noisy1# show cable spec
Group  Frequency      Upstream     Weekly Scheduled            Power   Shared
No.    Band           Port         Availability                Level   Spectrum
       (Mhz)                       From Time:   To Time:       (dBmV)

1      10.000- 0.000                                           1       No
1      11.000- 0.000                                           1       No
1      12.000- 0.000                                           1       No
1      13.000- 0.000                                           1       No
1      14.000- 0.000                                           1       No
2      10.000-15.000                                           2       No
2      10.208 [0.40]  Cable1/0 U1                              2
3      20.000- 0.000                                           3       Yes
3      21.000- 0.000                                           3       Yes
3      22.000- 0.000                                           3       Yes
3      23.000- 0.000                                           3       Yes
3      24.000- 0.000                                           3       Yes
3       0.400 [0.80]  Cable1/0 U2                              3
4      20.000-25.000                                           4       Yes
4      20.800 [1.60]  Cable1/0 U3                              4
5      10.000- 0.000                                           5       No
5      11.000- 0.000                                           5       No
5      12.000- 0.000                                           5       No
5      13.000- 0.000              Mon 17:06:00  --- --:--:--  5       No
5      14.000- 0.000              Mon 17:08:00  --- --:--:--  5       No
5      13.000- 0.000              Mon 17:10:00  --- --:--:--  5       No
```

To display information about a specific interface or upstream port, enter the **show cable hop** *cable-if* [**upstream** *portnum*] command. Information lines describe the frequency hop status of an upstream port.

Table 5-1 show cable hop Command Parameters

Field	Description
Upstream Port	The upstream port for this information line
Port Status	Show "down" if frequency is unassigned, "admindown" if the port is shutdown, or the center frequency of the channel if the port is up
Poll Rate	The rate station maintenance polls are generated (msec)
Missed Poll Count	The number of missing polls
Min Poll Sample	The number of polls in the sample
Missed Poll Pcnt	The ratio of missing polls to the number of polls displayed as a percentage
Hop Thres Pcnt	The level that the missed poll percentage must exceed to trigger a frequency hop expressed as a percentage
Hop Period	The maximum rate which frequency hopping will occur (seconds)

Table 5-1 show cable hop Command Parameters (continued)

Field	Description
Corr FEC Errors	The number of correctable FEC errors on this upstream port
Uncorr FEC Errors	The number of uncorrectable FEC errors on this upstream port

Sample output:

```
noisy1# show cable hop
Upstream    Port       Poll Missed Min    Missed Hop   Hop     Corr    Uncorr
Port        Status     Rate Poll   Poll   Poll   Thres Period  FEC     FEC
                       (ms) Count  Sample Pcnt   Pcnt  (sec)   Errors  Errors
Cable1/0/U0 down       1000 * * *   frequency not set    * * * 0       0
Cable1/0/U1 admindown  1000 * * *   interface is down    * * * 0       0
Cable1/0/U2 admindown  1000 * * *   interface is down    * * * 0       0
Cable1/0/U3 admindown  1000 * * *   interface is down    * * * 0       0
Cable1/0/U0 10.800 Mhz 1000 0      0       -----  100%  300    0       0
Cable1/0/U0 down       1000 * * *   frequency not set    * * * 0       0
```

Spectrum Management Debug and Test Commands

To enable display of frequency hopping debugging messages, enter:

```
debug cable freqhop
```

To enable display of spectrum management debugging messages, enter:

```
debug cable specmgmt
```

This command also enables display of channel width list and offer list for the **show cable spectrum-group** command.

To force a frequency hop decision on the port or ports, enter:

test cable hop *cable-if* [*upstream portnum*]

show cable hop Command

You can use the following command to obtain specific upstream interface information:

show cable hop *cable-if* [**upstream** *portnum*]

Table 5-2 show cable hop Command Parameter Descriptions

Field	Description
`Upstream Port`	Upstream port for this information line
`Port Status`	Shows “down” if frequency is unassigned, “admindown” if the port is shutdown, or the center frequency of the channel if the port is up
`Poll Rate`	Rate that station maintenance polls are generated (msec)
`Missed Poll Count`	Number of missing polls
`Min Poll Sample`	Number of polls in the sample
`Missed Poll Pcnt`	Ratio of missing polls to the number of polls expressed as a percentage

Table 5-2 show cable hop Command Parameter Descriptions

Field	Description
Hop Thres Pcnt	Level that the missed poll percentage must exceed to trigger a frequency hop expressed as a percentage
Hop Period	Maximum rate which frequency hopping will occur (seconds)
Corr FEC Errors	Number of correctable FEC errors on this upstream port
Uncorr FEC Errors	Number of uncorrectable FEC errors on this upstream port

```
noisy1# show cable hop
Upstream    Port       Poll Missed Min    Missed Hop   Hop     Corr    Uncorr
Port        Status     Rate Poll   Poll   Poll   Thres Period  FEC     FEC
                       (ms) Count  Sample Pcnt   Pcnt  (sec)   Errors  Errors
Cable1/0/U0 down       1000 * * *   frequency not set     * * * 0       0
Cable1/0/U1 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U2 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U3 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U0 10.800 Mhz 1000 0      0       -----  100%  300    0       0
Cable1/0/U0 down       1000 * * *   frequency not set     * * * 0       0
```

You can use the following command to obtain specific upstream interface information:

show cable hop *cable-if* [**upstream** *portnum*]

Table 5-3 Upstream Port Field Parameter Descriptions

Field	Description
Upstream Port	Upstream port for this information line
Port Status	Shows “down” if frequency is unassigned, “admindown” if the port is shutdown, or the center frequency of the channel if the port is up
Poll Rate	Rate that station maintenance polls are generated (msec)
Missed Poll Count	Number of missing polls
Min Poll Sample	Number of polls in the sample
Missed Poll Pcnt	Ratio of missing polls to the number of polls expressed as a percentage
Hop Thres Pcnt	Level that the missed poll percentage must exceed to trigger a frequency hop expressed as a percentage
Hop Period	Maximum rate at which frequency hopping will occur (seconds)
Corr FEC Errors	Number of correctable FEC errors on this upstream port
Uncorr FEC Errors	Number of uncorrectable FEC errors on this upstream port

Sample output:

```
noisy1# show cable hop
Upstream    Port       Poll Missed Min    Missed Hop   Hop     Corr    Uncorr
Port        Status     Rate Poll   Poll   Poll   Thres Period  FEC     FEC
                       (ms) Count  Sample Pcnt   Pcnt  (sec)   Errors  Errors
Cable1/0/U0 down       1000 * * *   frequency not set     * * * 0       0
Cable1/0/U1 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U2 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U3 admindown  1000 * * *   interface is down     * * * 0       0
Cable1/0/U0 10.800 Mhz 1000 0      0       -----  100%  300    0       0
Cable1/0/U0 down       1000 * * *   frequency not set     * * * 0       0
```

Debug and Test Commands

To enable display of frequency hopping debugging messages, enter:

```
debug cable freqhop
```

To enable display of spectrum management debugging messages, enter:

```
debug cable specmgmt
```

To force a frequency hop decision on the port or ports, enter:

test cable hop *cable-if I portnum*

Polling Cable Modems

You can obtain operating statistics and determine the state of CMs on the network. The Cisco uBR7100 series CMTS supports polling of CMs to obtain parameter and status information on an ongoing basis. The following Cisco IOS commands have been added to support the feature:

- **cable modem remote** configures the router for the polling interval; the **no** version of this command disables the status polling.
- **show cable modem remote-query** displays the collected information: downstream receive power level, downstream signal to noise ratio, upstream power level, micro reflection in dB.

The Cisco uBR7100 series CMTS polls CMs on the network and caches the state information on the CMTS, allowing administrators to use SNMP to manage the system.

This section describes how you can enable this. See the following configuration tasks:

- "Enabling SNMP" section on page 5-15 (required)
- "Configuring Remote Modem Monitoring" section on page 5-15 (required)

Enabling SNMP

Command	Purpose
Router(config)# **snmp-server manager**	Opens the SNMP manager.
Router(config)# **snmp-server community** [Community String] [Permissions]	Defines user permissions.

Configuring Remote Modem Monitoring

Command	Purpose
Router(config)# **cable modem remote-query** [*polling interval*] [Community string]	Specifies how often SNMP polls the modem and allows you to configure access.

Verifying Remote Query Information

To display information from a queried modem, enter the **show cable modem remote-query** command.

```
R7732-01-uBR7246# show cable modem remote-query
IP address      MAC address     S/N    US     DS    Tx Time Micro (dB) Modem
                                Ratio  Power  Power Offset  Reflection State
5.108.1.2       0010.4bd7.ccf2   0.0    0.0    0.0  0       0  offline
5.109.1.2       0000.0000.0022   0.0    0.0    0.0  0       0  offline
```

```
5.110.1.2       0000.0000.0023   0.0    0.0    0.0  0       0  offline
5.108.1.5       0000.0000.0026   0.0    0.0    0.0  0       0  offline
5.108.1.4       0000.0000.0024   0.0    0.0    0.0  0       0  offline
5.108.1.3       0000.0000.0025   0.0    0.0    0.0  0       0  offline
```

Tip To display debugging information, enter the **debug cable remote-query** command.

See the following for an example **debug** message of a successful poll of a CM:

```
Router# debug cable remote-query

remote-query debugging is on
.
For IP address 209.165.200.223
Nov 10 15:56:50.241: docsIfSignalQualityEntry.5.4 = 380
Nov 10 15:56:50.241: docsIfMibObjects.2.2.1.3.2 = 360
Nov 10 15:56:50.245: docsIfDownstreamChannelEntry.6.4 = -30
Nov 10 15:56:50.245: docsIfUpstreamChannelEntry.6.3 = 12422
Nov 10 15:56:50.249: docsIfSignalQualityEntry.6.4 = 0
Nov 10 15:56:50.477:
```

See the following for an example **debug** message when the waiting queue at the CMTS is empty:

```
SNMP proxy exec got event, but queue is empty
```

See the following for an example **debug** message when you try to modify the polling interval or community string while polling in is progress:

```
Community string if modified will not be reflected
```

Note The polling interval is changed. To change the community string, you must reconfigure the **snmp-server community** command with the new `community` string.

Monitoring and Maintaining Remote Querying

Use the following **show** commands to gather status information about the specified modems.

Command	Purpose
Router# **show cable flap-list**	Displays statistics on the quality of the modem connection.
Router# **show cable modem**	Displays statistics on modem states.
Router# **show cable modem remote-query**	Displays statistics gathered by SNMP agents on modem states.
Router# **show interface cable**	Displays statistics on the quality of the cable interface.
Router# **show interface cable sid**	Displays statistics on the service IDs of the specified modems.

Understanding Show Command Responses

General show Commands

Key **show** commands include:

- **show cable modem**
- **show interface cable**
- **show cable qos profile**
- **show cable modulation profile**
- **show cable spectrum-group**

Additional or changed **show** commands include the following:

- The **show cable qos** command shows **cable qos-profile** *n* command, where the optional argument *n* can be used to display a specific profile.
- The **show int cx/y sid** command displays more complete Service ID (SID) status information.
- The **show cable modem** command displays a list of options for a single modem to be specified by entering either the RF CPE device IP address or MAC address:
  - 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
- The **show cable burst-profile** command has been removed. Its functions have been incorporated into the **show cable modulation-profile** command, which now includes an added option number that displays the modulation profile number.
- The **show cable flap-list** and **show cable modem** commands indicate when the Cisco uBR7100 series CMTS 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.
- The **show controller upstream** command is enhanced to display the following information on cable interfaces:
  - Upstream channel utilization in minislots
  - Contention slots
  - Initial ranging slots
  - Minislots lost due to the MAP interrupt being too late

  You can also limit your search for modem status to specific cable interfaces.

show cable modem Command

The **show cable modem** command includes all DOCSIS states, and other useful troubleshooting information such as last received upstream RF power level and maximum number of provisioned customer premises equipment.

Note DOCSIS CMs are required to pass through successive states during registration and provisioning. Using this information, you can isolate why a CM is offline or unavailable.

Specific added information includes the downstream receive power ratio, downstream SNR, upstream and downstream power levels, transmit timing offset, and micro reflections in decibels.

For each upstream channel, you can obtain the following information:

- Total number of modem(s)
- Number of active modem(s)
- Number of registered modem(s)
- Number of unregistered modem(s)
- Number of offline modem(s)
- Time the modem(s) went offline
- Status before the modem(s) went offline
- Receive power before the modem(s) went offline

Sample **show cable modem** command output follows:

```
Router# show cable modem

 Interface   Prim Online     Timing Rec    QoS CPE IP address      MAC address
             Sid  State      Offset Power
 Cable1/0/U0 1    online     2257    0.00  3   0   10.30.128.142   0090.8330.0217
 Cable1/0/U0 2    online     2262  *-0.50  3   0   10.30.128.145   0090.8330.020f
 Cable1/0/U0 3    online     2260    0.25  3   0   10.30.128.146   0090.8330.0211
 Cable1/0/U0 4    online     2256   *0.75  3   0   10.30.128.143   0090.8330.0216
 Cable1/0/U0 5    online     2265   *0.50  3   0   10.30.128.140   0090.8330.0214
 Cable1/0/U0 6    online     2256    0.00  3   0   10.30.128.141   0090.8330.0215
 Cable1/0/U0 7    online     4138  !-1.00  3   1   10.30.128.182   0050.7366.124d
 Cable1/0/U0 8    online     4142  !-3.25  3   1   10.30.128.164   0050.7366.1245
 Cable1/0/U0 9    online     4141  !-3.00  3   1   10.30.128.185   0050.7366.17e3
 Cable1/0/U0 10   online     4142  !-2.75  3   0   10.30.128.181   0050.7366.17ab
 Cable1/0/U0 11   online     4142  !-3.25  3   1   10.30.128.169   0050.7366.17ef
```

The output from the **show cable modem** command indicates when the Cisco uBR7100 series CMTS has detected an unstable return path for a particular CM and has compensated with a power adjustment. An asterisk (*) in the power adjustment field for a CM indicates that a power adjustment has been made. An exclamation point (!) indicates that the CM has reached its maximum power transmit level and cannot increase its power level any further.

Columns are described below:

- prim Sid column reveals the primary (lifeline) service identifier assigned to the CM.
- SID column is the service identifier.
- Online State column reveals the state of the modem; values include:
  - offline—CM considered offline.

  - offline time—the time the CM went offline; the format is the same as other **show cable modem** commands (month, day, time, and year).
  - init (r1)—CM sent initial ranging.
  - init (r2)—CM is ranging.
  - init (rc)—CM ranging complete.
  - init (d)—Dhcp request received.
  - init (i)—Dhcp reply received; IP address assigned.
  - init (o)—Option file transfer started.
  - init (t)—TOD exchange started.
  - online—CM registered, enabled for data.
  - online(d)—CM registered, but network access for the cable modem is disabled.
  - online(pk)—CM registered, BPI enabled and KEK assigned.
  - online(pt)—CM registered, BPI enabled and TEK assigned.
  - reject (m)—CM did attempt to register; registration was refused due to bad MIC.
  - reject (c)—CM did attempt to register; registration was refused due to bad COS.
  - reject (pk)—KEK modem key assignment rejected.
  - reject (pt)—TEK modem key assignment rejected.
- Rec Power column contains the nominal receive power in decibels for this SID.

Note An asterisk (*) means that the noise power adjustment method is active for this modem. An exclamation point (!) means that the modem has reached its maximum transmit power.

- The QoS column contains the service class assigned to the modem.
- The CPE column identifies the number of devices behind the modem.
- The Max CPE column identifies the maximum number of devices configured for the modem.
- The IP address reveals the modem's IP address.
- The MAC address reveals the modem's MAC address.
- The Concatenation column reveals if concatenation is enabled (yes) or disabled (no).
- The Rx SNR column reveals the SNR ratio level in dBmV as perceived by the CM.

Note This parameter is only meaningful for CMs. A CMTS returns a zero.

- The S/N Ratio column provides values for remote-queried modems.
- The US Power column reveals the transmit power level for the upstream channel in dBmV.
- The DS Power column reveals the received power level at the downstream modem in dBmV.

Note If the power level measurement is not supported, set this parameter to zero. Also, if the interface is down, this value will be the CMTS-configured value, the most current CM value, or zero.

- The Tx Timing Offset shows the current round trip time at the CM. The value is used to synchronize upstream transmission to the CMTS and is measured in units of 6.25 microseconds.
- The Micro (dB) Reflection column is the total microreflections including in-channel response as perceived on this interface, measured in Dbc below the signal level.

Note The value is not assumed to return an absolutely accurate value, but gives a rough indication of microreflections received on this interface.

- The Offline Time column reveals when a modem went offline.
- The Previous State column reveals the modem's status prior to going offline.
- The Rx Power column reveals the last receive power measurement for a modem that is offline before it went offline.
- SM Exhaust Count reveals the number of times the CMTS declared that modem offline. The modem can be marked offline for various reasons. Refer to the "show cable modem maintenance Command" section on page 5-21.

See the following sample for detailed output of the **show cable modem** command:

```
Router# show cable modem detail

Interface   SID  MAC address    Max CPE  Concatenation Rx SNR
Cable1/0/U0 1    0090.8330.0215 3        yes
Cable1/0/U0 2    0090.8330.0213 3        yes
Cable1/0/U0 3    0090.8330.0214 3        yes
Cable1/0/U0 4    0090.8330.0217 3        yes
Cable1/0/U0 5    0090.8330.020f 3        yes
Cable1/0/U0 6    0050.7366.17e3 3        no
Cable1/0/U0 7    0090.8330.0211 3        yes
Cable1/0/U0 8    0050.7366.17af 3        no
Cable1/0/U0 9    0090.8330.0216 3        yes
Cable1/0/U0 10   0050.7366.1801 3        no
Cable1/0/U0 11   0050.7366.124d 3        no
Cable1/0/U0 12   0050.7366.1241 3        no
Cable1/0/U0 13   0050.7366.17db 3        no
Cable1/0/U0 14   0050.7366.1239 3        no
Cable1/0/U0 15   0050.7366.17ab 3        no
Cable1/0/U0 1    0050.7366.1db1 3        no             26.50
Cable1/0/U1 2    0050.7318.e97f 3        no             23.87
Cable1/0/U1 3    0050.7318.e965 3        no             23.85
Cable1/0/U0 4    0050.7318.e931 3        no             26.72
Cable1/0/U1 5    0050.7318.e92d 3        no             23.31
Cable1/0/U1 6    0050.7318.e97b 3        no             23.85
Cable1/0/U0 7    0050.7366.1d8d 3        no             26.88
Cable1/0/U0 8    0050.7318.e953 3        no             26.54
Cable1/0/U1 9    0050.7366.1d9d 3        no             23.72
Cable1/0/U1 10   0050.7318.e96b 3        no             23.79
Cable1/0/U1 11   0050.7366.1d95 3        no             23.82
Cable1/0/U0 12   0050.7318.e93f 3        no             26.26
Cable1/0/U1 13   0050.7318.e96d 3        no             23.51
Cable1/0/U0 14   0050.7318.e941 3        no             26.69
Cable1/0/U0 15   0050.7366.1dcd 3        no             26.94
Cable1/0/U1 16   0050.7318.e939 3        no             23.98
Cable1/0/U0 17   0050.7366.1d8f 3        no             27.13
Cable1/0/U0 18   0050.7302.3da3 3        no             26.58
Cable1/0/U0 19   0050.7318.e93b 3        no             26.49
Cable1/0/U0 20   0050.7318.e901 3        no             26.68
Cable1/0/U1 21   0050.7366.1dbb 3        no             23.45
Cable1/0/U0 22   0050.7318.e957 3        no             26.35
```

```
Cable1/0/U0 23   0050.7318.e985 3        no             26.40
Cable1/0/U0 24   0050.7366.1dbd 3        no             26.69

Router# show cable modem cable 1/0 upstream 0

Interface   Prim Online     Timing Rec    QoS CPE IP address        MAC address
            Sid  State      Offset Power
Cable1/0/U0 1    offline    2264   -0.50  2   0   209.165.200.2     0090.8330.0214
Cable1/0/U0 2    offline    4137  !-3.50  2   0   209.165.200.9     0050.7366.17d3
Cable1/0/U0 3    init(d)    4136  !-2.50  2   0   209.165.200.0     0050.7366.17ab
Cable1/0/U0 4    init(d)    4138  !-4.75  2   0   209.165.200.0     0050.7366.1803
Cable1/0/U0 5    init(d)    4137  !-2.25  2   0   209.165.200.0     0050.7366.1801
Cable1/0/U0 6    init(o)    2251   -0.25  2   0   209.165.200.3     0090.8330.0213
Cable1/0/U0 7    offline    2264    0.75  2   0   209.165.200.4     0090.8330.020f
Cable1/0/U0 8    offline    2266   -0.50  2   0   209.165.200.5     0090.8330.0211
Cable1/0/U0 9    init(rc)   4662    1.00  2   0   209.165.200.0     00d0.bad3.c459

Router# show cable modem cable 1/0 upstream 0 unregistered

Interface   Prim Online     Timing Rec    QoS CPE IP address        MAC address
            Sid  State      Offset Power
Cable1/0/U0 1    offline    2264   -0.50  2   0   209.165.200.2     0090.8330.0214
Cable1/0/U0 2    offline    4137  !-3.50  2   0   209.165.200.9     0050.7366.17d3
Cable1/0/U0 3    init(d)    4136  !-2.75  2   0   209.165.200.0     0050.7366.17ab
Cable1/0/U0 4    init(d)    4137  !-3.25  2   0   209.165.200.0     0050.7366.1803
Cable1/0/U0 5    init(d)    4141  !-2.75  2   0   209.165.200.0     0050.7366.1801
Cable1/0/U0 6    offline    2251   -0.25  2   0   209.165.200.3     0090.8330.0213
Cable1/0/U0 7    offline    2254   -1.00  2   0   209.165.200.4     0090.8330.020f
Cable1/0/U0 8    offline    2248    0.00  2   0   209.165.200.5     0090.8330.0211
Cable1/0/U0 9    init(rc)   4665   -0.50  2   0   209.165.200.0     00d0.bad3.c459

Router# show cable modem cable 1/0 upstream 0 offline

Interface   MAC address    Prim Previous  Offline          Rx     Rx    SM
                           Sid  State     Time             Power  SNR   Exhaust
                                                                       Count
Cable1/0/U0 0050.7366.17d3 2    init(o)   Jan 16 20:30:26 !-3.50  ----- 1
Cable1/0/U0 0090.8330.0213 6    init(o)   Jan 16 20:30:55  -0.25  ----- 181
Cable1/0/U0 0090.8330.020f 7    init(o)   Jan 16 20:31:07  -1.00  ----- 181
Cable1/0/U0 0090.8330.0211 8    init(o)   Jan 16 20:31:23   0.00  ----- 181
```

show cable modem maintenance Command

When a cable modem is detected to be offline by the CMTS—no reply after 16 retries of station maintenance requests—the cable modem is marked offline. Besides marking the cable modem and SID state offline, the SID is removed immediately from the CMTS ranging list, and an aging timer is started to cleanup the SID completely if the cable modem 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 cable modem 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.

Following is a response to the **show cable modem maintenance** command:

```
uBR7100# show cable modem maintenance

Interface    SID   MAC Address       SM Exhausted           SM Aborted
                                    Count       Time       Count      Time
Cable1/0/U1  1     0010.7b6b.5e27    4     Apr 29 19:33:19   0
Cable1/0/U0  2     0010.7b6b.5e15    8     Apr 29 19:34:55   0
Cable1/0/U2  11    0050.731c.b025    1     Apr 29 16:43:39   0
Cable1/0/U0  13    0050.731c.b021    1     Apr 29 15:58:43   0
Cable1/0/U0  16    0050.731c.b009    1     Apr 29 15:58:28   0
Cable1/0/U0  20    0050.731c.bfed    1     Apr 28 14:36:22   0
Cable1/0/U2  24    0050.731c.b023    1     Apr 27 10:30:36   0
Cable1/0/U1  27    0050.731c.bfeb    1     Apr 28 14:54:53   0
Cable1/0/U2  28    0050.731c.bfdf    1     Apr 28 14:50:55   0
Cable1/0/U1  30    0050.7366.1a71    2     Apr 29 17:49:00   0
Cable1/0/U1  31    0050.7366.1bab    3     Apr 29 16:21:47   0
Cable1/0/U1  32    0050.731c.bfe7    0                       2    Jan 1  09:00:00
Cable1/0/U1  33    0050.731c.bfd3    4     Apr 29 15:09:28   0
Cable1/0/U2  35    0050.731c.b041    1     Apr 29 16:17:41   0
Cable1/0/U1  36    0050.7366.1ab9    2     Apr 29 16:53:26   0
```

show interface cable Command

To display cable interface information, use the **show interface cable** privileged EXEC command:

show interface cable *slot/port* [*downstream* | *upstream*]

See the following sample **show interface cable** command output for a cable modem located in slot 1/port 0:

```
Router# show interface cable 1/0

Cable1/0 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
```

Note The **show interface upstream** command is enhanced to display details on the MAC scheduler state for an upstream port. Refer to the "Enhanced show interface upstream output Command" section on page 5-27.

Table 5-4 show interface cable Command Field Descriptions

Field	Description
Cable slot/port is up/...administratively down	Indicates whether the interface hardware is currently active or taken down by the administrator.
line protocol is up/...administratively down	Indicates whether the software processes that handle the line protocol believe the interface is usable or if it has been taken down by the administrator.
hardware	Hardware type and address.
Internet address	Internet address followed by subnet mask.
MTU	Maximum Transmission Unit (MTU) of the interface.
BW	Bandwidth of the interface in kilobits per second.
DLY	Delay of the interface in microseconds.
rely	Reliability of the interface as a fraction of 255, calculated as an exponential average over 5 minutes. (For example, 255/255 is 100% reliability).
load	Load on the interface as a fraction of 255, calculated as an exponential average over 5 minutes. (For example, 255/255 is complete saturation.)
Encapsulation	Encapsulation method assigned to this interface.
ARP type	Type of Address Resolution Protocol (ARP) and timeout value assigned.
Last input	Number of hours, minutes, and seconds since the last packet was successfully received by an interface.
output	Number of hours, minutes, and seconds since the last packet was successfully transmitted by an interface.
Last clearing of "show interface" counters	Time when the counters that measure cumulative statistics, such as number of bytes transmitted and received, were last reset to zero.
Queuing strategy	Displays the type of queuing configured for this interface. In the example output, the type of queuing configured is First In First Out (FIFO).
Output queue	Number of packets in the output queue. The format of this number is A/B where A indicates the number of packets in the queue, and B indicates the maximum number of packets allowed in the queue.
drops	Indicates the number of packets dropped due to a full queue.
input queue/drops	Number of packets in the input queue. The format of this number is A/B where A indicates the number of packets in the queue, and B indicates the maximum number of packets allowed in the queue.
drops	Indicates the number of packets dropped due to a full queue.
Five minute input rate Five minute output rate	Average number of bits and packets transmitted per second in the last five minutes.
packets input	Total number of error-free packets received by the system.
bytes input	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.

Table 5-4 show interface cable Command Field Descriptions (continued)

Field	Description
no buffer	Number of received packets discarded because there was no buffer space in the main system.
Received broadcast	Total number of broadcast or multicast packets received by the interface.
runts	Number of packets that are discarded because they are smaller than the medium's minimum packet size.
giants	Number of packets that are discarded because they exceed the medium's maximum packet size.
input errors	Includes runts, giants, no buffers, CRC, frame, overrun, and ignored counts.
CRC	Indicates the number of times the cyclic redundancy checksum generated by the originating LAN station or far-end device does not match the checksum calculated from the data received.
frame	Number of packets received incorrectly (with a CRC error and a non-integer number of octets).
overrun	Number of times the receiver hardware was unable to forward received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers.
packets output	Total number of messages transmitted by the system.
bytes	Total number of bytes, including data and MAC encapsulation, transmitted by the system.
underruns	Number of times the transmitter ran faster than the receiving device could handle.
output errors	Sum of all errors that prevented the final transmission of packets out of the interface being examined.
interface resets	Number of times an interface has been completely reset.
output buffer failures	Number of times the output buffer has failed.
output buffer swapped out	Number of times the output buffer has been swapped out.

See the following sample output for the downstream cable interface from the **show interface cable downstream** command:

```
Router# show interface cable 1/0 downstream

Cable1/0: Downstream is up
    111947771 packets output, 1579682655 bytes, 0 discarded
    0 output errors
```

Table 5-5 show interface cable downstream Command Field Descriptions

Field	Description
Cable	Indicates the location of the downstream interface.
Downstream is up/...administratively down	Indicates the administrative state of the interface.
packets output	Total number of packets transmitted out of this interface.
bytes	Total number of bytes transmitted out of this interface.
discarded	Total number of packets discarded.
output errors	Sum of all errors that prevented downstream transmission of packets out of this interface.

See the following sample output for the upstream cable interface for upstream cable interface 0 from the **show interface cable upstream** command:

```
Router# show interface cable 1/0 upstream 0

Cable1/0: Upstream 0 is up
    Received 16873 broadcasts, 0 multicasts, 73310 unicasts
    0 discards, 89053 errors, 0 unknown protocol
    90183 packets input, 1 uncorrectable
    89042 noise, 0 microreflections
    Total Modems On This Upstream Channel : 8 (4 active)
    Default MAC scheduler
    Queue[Rng Polls]  0/20, fifo queuing, 0 drops
    Queue[Cont Mslots]  0/104, fifo queuing, 0 drops
    Queue[CIR Grants]  0/20, fair queuing, 0 drops
    Queue[BE Grants]  0/30, fair queuing, 0 drops
    Queue[Grant Shpr]   0/30, calendar queuing, 0 drops
    Reserved slot table currently has 0 CBR entries
    Req IEs 134469315, Req/Data IEs 0
    Init Mtn IEs 385879, Stn Mtn IEs 131059
    Long Grant IEs 10766, Short Grant IEs 15895
    Avg upstream channel utilization : 1%
    Avg percent contention slots : 97%
    Avg percent initial ranging slots : 0%
    Avg percent minislots lost on late MAPs : 0%
    Total channel bw reserved 0 bps
    CIR admission control not enforced
    Current minislot count   : 6676390    Flag: 0
    Scheduled minislot count : 6676545    Flag: 0
```

Table 5-6 describes the fields shown in the **show interface cable upstream** display.

Table 5-6 show interface cable upstream Command Field Descriptions

Field	Description
Cable	Indicates the location of the upstream interface.
Upstream is up/...administratively down	Indicates the administrative state of the upstream interface.
Received broadcasts	Number of broadcast packets received through this upstream interface.
multicasts	Number of multicast packets received through this upstream interface.

Table 5-6 show interface cable upstream Command Field Descriptions (continued)

Field	Description
unicasts	Number of unicast packets received through this interface.
discards	Number of packets discarded by this interface.
errors	Sum of all errors that prevented upstream transmission of packets through this interface.
unknown protocol	Number of packets received that were generated using a protocol unknown to the Cisco uBR7100 series.
packets input	Number of packets received through this upstream interface that were free from errors.
corrected	Number of error packets received through this upstream interface that were corrected.
uncorrectable	Number of error packets received through this upstream interface that could not be corrected.
noise	Number of upstream packets corrupted by line noise.
microreflections	Number of upstream packets corrupted by microreflections.
Guaranteed-rate service queue depth	Number of bandwidth requests queued up in the Guarantee-rate queue. This queue is only available to modems that have a reserved minimum upstream rate in their class of service.
Best-effort service queue depth	Number of bandwidth requests queued up in the Best-effort queue. This queue is available to all modems that do not have any reserved rate on the upstream.
Total Modems On This Upstream Channel	Number of cable modems currently sharing this upstream channel. This field also shows how many of these modems are active.
Current Total Bandwidth Reserved	Total amount of bandwidth reserved by all modems sharing this upstream channel that require bandwidth reservation. The class of service for these modems specifies some nonzero value for the guaranteed-upstream rate. When one of these modems is admitted on the upstream, this field value is incremented by this guaranteed-upstream rate value.
CIR admission control (formerly: Current Admission Control Status)	Indicates the status of admission control on the upstream channel ENFORCED status allows users to enable admission control on a per port basis. This controls how limited bandwidth is allocated. NOT ENFORCED status indicates that there is no admission control. Every modem that registers with a class of service specifying a minimum upstream rate is admitted by the CMTS regardless of how much aggregate bandwidth is actually available. Users enable admission control by using the admission control CLI.
Default MAC scheduler	Indicates the status of the MAC scheduler as being in default mode as opposed to Automated Test Procedure (ATP).
Queue[Rng Polls]	The MAC scheduler queue showing the number of ranging polls.
Queue[Cont Mslos]	The MAC scheduler queue showing the number of forced contention request slots in MAPS.

Table 5-6 show interface cable upstream Command Field Descriptions (continued)

Field	Description
Queue[CIR Grants]	The MAC scheduler queue showing the number of CIR grants pending.
Queue[BE Grants]	The MAC scheduler queue showing the number of BE grants pending.
Queue[Grant Shpr]	The MAC scheduler queue showing the number of grants that have been buffered for traffic shaping.
drops	Number of packets dropped.
Reserved slot table currently has 0 CBR entries	Number of CBR sessions active on an upstream channel at any given time.
Req IEs	The running counter of request IEs sent in MAPS.
Req/Data IEs	The counter of request/data IEs sent in MAPS.
Init Mtn IEs	The counter of Initial Maintenance IEs.
Stn Mtn IEs	Number of station maintenance (ranging poll) IEs.
Long Grant IEs	Number of long grant IEs.
Short Grant IEs	Number of short grant IEs.
Avg upstream channel utilization	Indicates on average what percent of the upstream channel bandwidth is being used.
Avg percent contention slots	Indicates on average what percent of slots are in contention state.
Avg percent initial ranging slots	Indicates on average what percent of slots are in initial ranging state.
Avg percent minislots lost on late MAPs	Indicates on average what percent of slots are lost because a MAP interrupt was too late.
Current minislot count (formerly: Last Minislot Stamp [current_time_base])	Indicates the current minislot count at the CMTS. FLAG indicates the timebase reference. This field is used only by developers.
Scheduled minislot count (formerly: Last Minislot Stamp [scheduler_time_base])	Indicates the furthest minislot count allocated at the indicated time. FLAG indicates the timebase reference. This field is used only by developers.

Enhanced show interface upstream output Command

The **show interface cable upstream** command displays detailed MAC scheduler state information for the upstream port. The example below illustrates the new display:

```
cmts# show interface cable 1/0 upstream 0

Cable1/0:Upstream 0 is up
    Received 13 broadcasts, 0 multicasts, 110 unicasts
    0 discards, 106 errors, 0 unknown protocol
    123 packets input, 0 uncorrectable
    106 noise, 0 microreflections
    Total Modems On This Upstream Channel :3 (3 active)
    Default MAC scheduler
    Queue[Rng Polls]  0/20, fifo queuing, 0 drops
    Queue[Cont Mslots]  0/104, fifo queuing, 0 drops
```

```
Queue[CIR Grants]  0/20, fair queuing, 0 drops
Queue[BE Grants]  0/30, fair queuing, 0 drops
Queue[Grant Shpr]   0/30, calendar queuing, 0 drops
Reserved slot table currently has 2 CBR entries
Req IEs 280185, Req/Data IEs 0
Init Mtn IEs 800, Stn Mtn IEs 49
Long Grant IEs 26, Short Grant IEs 15
Avg upstream channel utilization :1%
Avg percent contention slots :97%
Avg percent initial ranging slots :1%
Avg percent minislots lost on late MAPs :0%
Total channel bw reserved 192000 bps
CIR admission control not enforced
Current minislot count   :1165412    Flag:1
Scheduled minislot count :1176227    Flag:1
```

New items in the display include:

- Detailed slot queue statistics—Queue [CIR Grants] 0/20, fair queuing, 0 drops in the previous example, meaning that the queue for CIR-service grants has a current depth of 0, and a maximum depth of 20. Weighted fair queuing shows grants in this queue.
- CBR slot scheduling table state—The reserved slot table in the previous example has 2 CBR entries. This shows that at the time the command was issued, the MAC scheduler had admitted 2 CBR slots in the reserved slot table.
- Counters for each type of upstream slot scheduled in the MAPs for this upstream channel—The "Init Mtn IEs 800" means that the MAC scheduler has added 800 initial maintenance information elements (slots) at the time the **show** command was issued.
- MAC scheduling statistics—Display what percentage of the upstream bandwidth is utilized for each type of slot on an average.

show interface cable sid Command

To display per-SID counters for bandwidth requests, use the **show interface cable** privileged EXEC command:

show interface cable *interface* **sid** [*sid*] **counters verbose**

Data transport over the RF link uses the registered SID address, rather than the Ethernet address. This allows multiple hosts to access the network by using a single cable modem.

Note Use the **verbose** option to provide SID details.

See the following display output for the **verbose** keyword extension for SID 1:

```
Router# show interface c1/0 sid 1 counters verbose

   Sid                           : 1
   Input packets                 : 39
   Input octets                  : 15964
   Output packets                : 30
   Output octets                 : 8796
   BW requests received          : 40
   Grants issued                 : 40
   Rate exceeded BW request drops : 0
   Rate exceeded DS packet drops  : 0
```

See the following display output for the **verbose** keyword extension for all SIDs on the specified interface:

```
Router# show interface c1/0 sid counters verbose

    Sid                           : 1
    Input packets                 : 39
    Input octets                  : 15964
    Output packets                : 30
    Output octets                 : 8796
    BW requests received          : 40
    Grants issued                 : 40
    Rate exceeded BW request drops : 0
    Rate exceeded DS packet drops  : 0
    Sid                           : 2
    Input packets                 : 0
    Input octets                  : 0
    Output packets                : 0
    Output octets                 : 0
    BW requests received          : 0
    Grants issued                 : 0
    Rate exceeded BW request drops : 0
    Rate exceeded DS packet drops  : 0
    Sid                           : 3
    Input packets                 : 0
    Input octets                  : 0
    Output packets                : 0
    Output octets                 : 0
    BW requests received          : 0
    Grants issued                 : 0
    Rate exceeded BW request drops : 0
    Rate exceeded DS packet drops  : 0
```

See the following display for the SIDs connected to the specified interface:

```
    Lab-CMTS# show inter cab 1/0 sid

    Sid  Prim Type Online     Admin   QoS Create      IP Address        MAC Address
         Sid       State      Status      Time
    23        stat init(d)    enable  2   04:00:54    209.165.200.0     0050.7366.17ab
    24        stat init(d)    enable  2   04:00:58    209.165.200.0     0050.7366.1803
    25        stat init(rc)   enable  2   04:01:05    209.165.200.0     00d0.bad3.c459
    26        stat init(d)    enable  2   04:01:10    209.165.200.0     0050.7366.1801
    27        stat offline    enable  2   04:01:31    209.165.200.225   0090.8330.0213
    28        stat offline    enable  2   04:01:59    209.165.200.226   0090.8330.0211
    29        stat offline    enable  2   04:02:07    209.165.200.227   0090.8330.0214
    30        dyn  init(o)    enable  2   04:03:09    209.165.200.228   0090.833
```

See the following connection information for all SIDs on the specified interface:

```
Router# show interface c1/0 sid connectivity

    Sid   1st time    Times  %online     Online time            Offline time
           online      Online           min     avg     max     min     avg     max
    1     15:37:24    1      99.73   00:00   1h45m   1h45m   00:17   00:17   00:17
    2     15:37:24    1      99.73   00:00   1h45m   1h45m   00:17   00:17   00:17
    3     15:37:24    1      99.73   00:00   1h45m   1h45m   00:17   00:17   00:17
```

See the following connection information for SID 1 on the specified interface:

```
Router# show interface c1/0 sid 1 connectivity

    Sid   1st time    Times  %online     Online time            Offline time
          online      Online           min     avg     max     min     avg     max
    1     15:37:24    1      99.72   00:00   1h41m   1h41m   00:17   00:17   00:17
```

See the following display for the counters of the SIDs connected to the specified interface:

```
Router# show interface c1/0 sid counters

    Sid   Inpackets  Inoctets   Outpackets Outoctets  Ratelimit  Ratelimit
                                                       BWReqDrop  DSPktDrop
    1     40         16586      31         9160       0          0
    2     0          0          0          0          0          0
    3     0          0          0          0          0          0
```

See the following display for the counters of SID 1 on the specified interface:

```
Router# show interface c1/0 sid 1 counters

    Sid   Inpackets  Inoctets   Outpackets Outoctets  Ratelimit  Ratelimit
                                                       BWReqDrop  DSPktDrop
    1     39         15964      30         8796       0          0
```

Table 5-7 describes the fields shown in the output for the **show interface cable sid** displays.

Table 5-7 show interface cable sid Command Field Descriptions

Field	Description
Sid	Service identification number.
Prim Sid	The primary service identifier assigned to the modem.
Type	Indicates this SID was created statically at the time of registration or dynamically by the exchange of dynamic service messages between the CM and CMTS.
Online State	“Online” means the modem owning this SID is processing traffic. “Offline” means the modem owning this SID is not processing traffic.
Admin Status	“Disable” means that the SID has been turned off. “Enable” is the normal state.
QoS	Quality of service.
Create time	When the SID was created, number of seconds since the system booted.
Input octets (Inoctets)	Number of octets received by using this SID.
Input packets (Inpackets)	Number of packets received by using this SID.
Output octets (Outoctets)	Number of octets sent from this SID.
Output packets (Outpackets)	Number of packets sent from this SID.
IP address	IP address of the modem owning this SID.
MAC address	MAC address of the modem owning this SID.
BW requests received	Number of bandwidth requests received by this SID.
Grants issued	Number of bandwidth requests granted by this SID.
Rate exceeded BW request drops	Number of bandwidth requests not granted by this SID.
Rate exceeded DS packet drops	Number of downstream packets lost by this SID.
Ratelimit BWReqDrop	Number of bandwidth requests not granted by this SID.
Ratelimit DSPktDrop	Number of downstream packets lost by this SID.

Table 5-7 show interface cable sid Command Field Descriptions (continued)

Field	Description
1st time online	Time at which the modem with this SID connected.
Times online	Number of times the modem with this SID has connected.
% online	Percentage of time the modem with this SID has been connected.
Online time	Minimum, average, and maximum number of hours and minutes the modem with this SID has been connected.
Offline time	Minimum, average, and maximum number of hours and minutes the modem with this SID has been disconnected.

show cable qos profile Command

Following is a response to the **show cable qos profile** command. The display shows ToS specifications:

```
uBR7100# 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(r)    no
2       0    64000     0         1000000    0      0x0  0x0   cmts(r)    no
3       0    1000      0         1000       0      0x0  0x0   cmts       no
4       3    256000    0         512000     0      0x0  0x0   cm         no
5       5    1000000   0         10000000   0      0x0  0x0   cm         no
6       3    256000    0         512000     0      0x0  0x0   cm         yes
```

Note The “r” in the “Create by” column means the first two classes of service the CMTS creates are reserved for CMs that are not online.

Displays upstream packet discards, errors, error-free packets, correctable and uncorrectable errors, noise and micro-reflection statistics:

```
show  interface slot/downstream-port upstream
```

Troubleshooting Cable Flap Lists

The Cisco uBR7100 series maintains a database of flapping cable modems to assist in locating cable plant problems. The flapping cable interface detector tracks the upstream and downstream performance of all cable modems on the network, without impacting throughput and performance, or creating additional packet overhead on the broadband network. The cable interface flap list keeps track of:

- the cable interface MAC address
- up and down transitions
- registration events
- missed periodic ranging packets
- upstream power adjustments
- the physical interface on the Cisco uBR7100 series CMTS

Note Although this is a Cisco proprietary CMTS feature, it is compatible with all DOCSIS-compliant cable modems. Unlike SNMP, the flap list uses zero bandwidth.

The flap list collects the following station maintenance statistics:

- Detects interface up/down flap; the reinsertion counter counts the number of times a cable interface comes up and inserts into the network. This helps identify potential problems in the downstream because improperly provisioned cable modems tend to try to reestablish a link repeatedly.
- Detects intermittent upstream; the keepalive hits versus misses is the number of times cable modems do not respond or do not respond to the MAC layer keepalive messages. If there are a number of misses, this points to a potential problem in the upstream.
- Lists cable interface MAC addresses sorted by flap rate or most recent flap time.
- Shows power adjustment statistics during station maintenance polling; this represents the number of times the CMTS tells a cable interface to adjust the transmit power more than 3 dB. If constant power adjustments are detected, this usually indicates a problem with an amplifier. By looking at the cable modems in front and behind various amplifiers, you can find the source of failure.

The cable system administrator typically:

- Sets up a script to periodically poll the flap list, for example, every 15 minutes
- Uses the resulting data to perform trend analysis to identify the cable modems that are consistently in the flap list
- Queries the billing and administrative database for cable interface MAC address-to-street address translation and generates a report

These reports can be given to the Customer Service Department or the cable plant's Operations and Maintenance Department. Using these reports, maintenance personnel can quickly discern how characteristic patterns of flapping cable modems, street addresses, and flap statistics can indicate which amplifier or feeder lines are faulty. The reports also help you quickly discern whether problems exist in your downstream or upstream path, and whether the problem is ingress noise or equipment related.

Default values for the following flap-list configuration commands are:

- **cable flap-list miss-threshold**—6 seconds
- **cable flap-list power-adjust**—2 dB
- **cable flap-list insertion-time**—180 seconds

Note Since the cable flap list was originally developed, polling mechanisms have been enhanced to have an increased rate of 1/sec when polls are missed. Cable modems go offline faster than the frequency hop period. This can cause the frequency to stay fixed while cable modems go offline. To compensate for this, as appropriate, you can reduce the hop period to 10 seconds.

Tip The system supports automatic power adjustments. The **show cable flap-list** and **show cable modem** commands indicate when the Cisco uBR7100 series CMTS 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.

The following tips and scenarios allow you to use the flap list in the most effective way:

- If a subscriber's cable interface shows a lot of flap list activity, it is having communication problems.
- If a subscriber's cable interface shows little or no flap list activity, it is communicating reliably; the problem is probably in the subscriber's computer equipment or in the connection to the cable interface.
- The top 10% most active cable interfaces in the flap list are most likely to have difficulties communicating with the headend.
- Cable modems with more than 50 power adjustments per day have a suspect upstream path.
- Cable modems with approximately the same number of hits and misses and with a lot of insertions have a suspect downstream path (for example, low level into the cable interface).
- All cable interfaces incrementing the insertion at the same time indicates a provisioning server failure.
- Cable modems with high CRC errors have bad upstream paths or in-home wiring problems.
- Correlating cable interfaces on the same physical upstream port with similar flap list statistics can quickly resolve outside plant problems to a particular node or geography.
- Monitoring the flap list cannot affect cable interface communications.
- The flap list should be saved to a database computer and cleared at least once each day.
- Important upstream performance data can be obtained by tracking flap list trend data.
- Important installation quality control and performance data is directly available from the flap list.

Following is a sample response to the **show cable flap** command:

```
uBR7100# show cable flap

Mac Addr       CableIF Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.9500.461f C1/0 U1 56  18857    887      0      1    116 Jun 1  14:09:12
0010.9500.446e C1/0 U1 38  18686   2935      0      1     80 Jun 2  19:03:57
0010.9500.38ec C1/0 U2 63  18932   1040      0      8    138 Jun 2  23:50:53
0010.9500.4474 C1/0 U2 65  18913   1053      0      3    137 Jun 2  09:30:09
0010.9500.4672 C1/0 U2 56  18990   2327      0      6    124 Jun 2  10:44:14
0010.9500.38f0 C1/0 U2 50  18964   2083      0      5    111 Jun 2  20:46:56
0010.9500.e8cb C1/0 U2  0   6537    183      0      1      5 Jun 2  22:35:48
0010.9500.38f6 C1/0 U3 50  19016   2511      0      2    104 Jun 2  07:46:31
0010.9500.4671 C1/0 U3 43  18755   3212      1      1     89 Jun 1  19:36:20
0010.9500.38eb C1/0 U0 57  36133   1608      0      6    126 Jun 2  20:04:58
0010.9500.3ce2 C1/0 U0 44  35315   1907      0      4     99 Jun 2  16:42:47
0010.9500.e8d0 C1/0 U2  0  13213    246      0      1      5 Jun 3  04:15:30
0010.9500.4674 C1/0 U2 56  36037   2379      0      4    121 Jun 3  00:34:12
0010.9500.4677 C1/0 U2 40  35781   2381      0      4     91 Jun 2  12:14:38
0010.9500.4614 C1/0 U2 40  21810   2362      0    502    586 Jun 2  21:43:02
0010.9500.3be9 C1/0 U2 63  22862    969      0      0    128 Jun 1  14:09:03
0010.9500.4609 C1/0 U2 55  22723   2127      0      0    112 Jun 1  14:08:02
0010.9500.3cb8 C1/0 U2 49  22607   1378      0      0    102 Jun 1  14:08:58
0010.9500.460d C1/0 U3 46  22477   2967      0      2     96 Jun 2  17:03:48
0010.9500.3cba C1/0 U3 39  22343   3058      0      0     81 Jun 1  14:13:16
0010.9500.3cb4 C1/0 U3 38  22238   2936      0      0     79 Jun 1  14:09:26
0010.9500.4612 C1/0 U3 38  22306   2928      0      0     79 Jun 1  14:09:29
```

The command line with an arrow next to it reveals a cable interface that is continuously flapping. A high flap rate indicates that the cable interface is power adjusting frequently. This can indicate a problem with an amplifier. The number reveals the number of times the CMTS instructed the cable interface to adjust the transmit power more than 3 dB.

Cable modems are automatically added to the flap list when any of the following conditions are detected:

- When the cable modem re-registers more frequently than the user-specified insertion time.
- When intermittent keepalive messages are detected between the CMTS and the cable modem.
- When the cable modem's upstream transmit power is adjusted beyond the user-specified power threshold.

Displaying the Flap List

The flap list can be queried either using the standard Simple Network Management (SNMP) API or the CLI. Using any third party SNMP Management Information Base (MIB) browser, you can query the ***ccsFlapTable*** in the CISCO-CABLE-SPECTRUM-MIB, a proprietary extension to the DOCSIS MIBs.

Using the **show cable flap list** command, the flap list statistics are accessed. Refer to the following example. Each of the columns in the display are described in Table 5-8:

```
        MAC ID     CableIF     Ins  Hit     Miss    CRC  P-Adj    Flap    Time
0010.7b6b.60ad C1/0 U0         0   14386   1390      1     38       41    Nov 24 21:34:24
0010.7b6b.65a3 C1/0 U0         0   14503   1264      1     33       37    Nov 24 21:28:09
0010.7b6b.6b9d C1/0 U0         0   14060   1726      3     40       43    Nov 24 21:18:36
```

Table 5-8 Flap List Statistics Description

Statistic	Description
MAC ID	MAC-layer address of a cable modem. The first six digits indicate the vendor ID of the cable modem manufacturer, followed by six digits indicating a unique host address. Each cable modem's MAC address is unique.
Cable IF	The physical upstream interface on the Cisco uBR7100 series CMTS. It denotes the cable modem card slot number, the downstream port number on the RF line card and the upstream port number on the same cable modem card. The flap list data can be sorted based on the upstream port number which is useful when isolating reverse path problems unique to certain combining groups.

Table 5-8 Flap List Statistics Description (continued)

Statistic	Description
Insertions	Link insertion is the process whereby a modem performs an initial maintenance procedure to establish link with the CMTS. The **Ins** column is the flapping modem's insertion count and indicates the number of times the RF link was abnormally re-established. An abnormality is detected when the time between link re-establishment attempts is less than the user-configurable parameter. Normal modem activity uses the following sequence below. • Initial link insertion is followed by a keepalive loop between the CMTS and cable modem and is called station maintenance. • Power-on • Initial maintenance • Station maintenance • Power-off When the link is broken, initial maintenance is repeated to re-establish the link. • Initial maintenance @ Time T1 • Station maintenance • Init maintenance @ Time T2 The ***Ins*** and ***Flap*** counters in the flap list are incremented whenever T2 – T1 < N where N is the insertion-time parameter configured in <*cable flap-list insertion-time*>. A high **Ins** number indicates: • Intermittent downstream sync loss • DHCP or modem registration problems

Table 5-8 Flap List Statistics Description (continued)

Statistic	Description
Hit and Miss	The **HIT** and **MISS** columns are keepalive polling statistics between the Cisco uBR7100 series and the cable modem. The station maintenance process occurs for every modem approximately every 25 seconds. When the CMTS receives a response from the modem, the event is counted as a **Hit**. If the CMTS does not receive a response from the cable modem, the event is counted as a **Miss.** A cable modem will fail to respond either because of noise or if it is down. Modems which only log **Misses** and zero **Hits** are assumed to be powered off. **Misses** are not desirable since this is usually an indication of a return path problem; however, having a small number of misses is normal. The flap count is incremented if there are *M* consecutive misses where *M* is configured in the *cable flap miss-threshold* parameter. The parameter value ranges from 1 to 12 with a default of 6. Ideally, the **HIT** count should be much greater than the **Miss** counts. If a modem has a **HIT** count much less than its **MISS** count, then registration is failing. Noisy links cause the **MISS/HIT** ratio to deviate from a nominal 1% or less. High **Miss** counts can indicate: • Intermittent upstream possibly due to noise • Laser clipping • Common-path distortion • Ingress or interference • Too much or too little upstream attenuation
Cyclical Redundancy Check (CRC)	This statistic tracks the **CRC** error counter per modem. **CRC** errors are usually an indication of noise on a plant. A low count can be always be expected but a high **CRC** number calls for some the plant troubleshooting. The **CRC** counter indicates: • Intermittent upstream • Laser clipping • Common-path distortion • Impulsive noise or interference

Table 5-8 Flap List Statistics Description (continued)

Statistic	Description
Power Adjustments (P-Adj)	The station maintenance poll in the CMTS constantly adjusts the modem transmit power, frequency, and timing. The **P-Adj** column indicates the number of times the modem's power adjustment exceeded the threshold value. The power adjustment threshold may be set using the <*cable flap power threshold* > parameter with a value range of 0 to 10 dB and a default value of 2 dB. Tuning this threshold is recommended to decrease irrelevant entries in the flap list. Power Adjustment values of 2 dB and below will continuously increment the **P-Adj** counter. The modem transmitter step size is 1.5 dB, whereas the headend may command 0.25 dB step sizes. Power adjustment flap strongly suggests upstream plant problems such as: • Amplifier degradation • Poor connections • Thermal sensitivity • Attenuation problem
Flap	The **Flap** counter indicates the number of times the modem has flapped. This counter is incremented when one of the following events is detected: • Unusual modem insertion or reregistration attempts. The **Flap** and the **Ins** counters are incremented when the modem tries to reestablish the RF link with the CMTS within a period of time that is less than the user-configurable insertion interval value. • Abnormal Miss/Hit ratio. The **Flap** counter is incremented when *N* consecutive Misses are detected after a Hit where *N* can be user-configurable with a default value of 6. • Unusual power adjustment. The **Flap** and **P-adj** counters are incremented when the modem's upstream power is adjusted beyond a user-configurable power level.
Time	**Time** is the timestamp indicating the last time the modem flapped. The value is based on the clock configured on the local Cisco uBR7100 series CMTS. If no time is configured, this value is based on the current uptime of the Cisco uBR7100 series CMTS. When a cable modem meets one of the three flap list criteria, the **Flap** counter is incremental and **Time** is set to the current time.

Troubleshooting with the Flap List

This section includes suggestions on how to interpret different network conditions based on the flap list statistics:

- **Condition 1:** Low miss/hit ratio (< 2% for MC16 card), low insertion, low P-adj, low flap counter and old timestamp.
  Analysis: This exhibits an optimal network situation.
- **Condition 2:** High ratio of misses over hits (> 10%).
  Analysis: Hit/miss analysis should be done after the "Ins" count stops incrementing. In general, if the hit and miss counts are about the same order of magnitude, the upstream can be experiencing noise. If the miss count is greater, then the modem is probably dropping out frequently and not

completing registration. The upstream or downstream might not be stable enough for reliable link establishment. Very low hits and miss counters and high insertion counters indicate provisioning problems.

- **Condition 3:** Relatively high power adjustment counter.
  Analysis: Indicates the power adjustment threshold is probably set at default value of 2 dB adjustment. The modem transmitter step size is 1.5 dB, but the headend can command 0.25 dB step sizes. Tuning your power threshold to 6 dB is recommended to decrease irrelevant entries in the flap list. The power adjustment threshold can be set using *cable flap power threshold <0-10 dB>* from the Cisco IOS global configuration mode. A properly operating HFC network with short amplifier cascades can use a 2 to 3 dB threshold.
- **Condition 4:** High P-Adj and CRC errors.
  Analysis: This condition can indicate that the fiber node is clipping the upstream return laser. Evaluate the modems with the highest CRC count first. If the modems are not going offline (Ins = 0), this will not be noticed by subscribers. However, they could receive slower service due to dropped IP packets in the upstream. This condition also results in input errors on the Cisco uBR7100 series router cable interface.
- **Condition 5:** High insertion rate.
  Analysis: If link re-establishment happens too frequently, the modem is usually having a registration problem. This is indicated by a high Ins counter which tracks the **Flap** counter.

Setting Cable Flap List Aging

You can specify the number of days to record and retain flapping activity on cable interfaces currently in the flap list table. This value is known as the age of the flap list. The valid range is from 1 to 60 days.

To set the age of the cable flap list, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)# cable flap-list aging days`	Specifies the number of days to record and retain flapping activity for the cable modems connected to this Cisco uBR7100 series CMTS.

Verifying Cable Flap List Aging

To verify that cable flap list aging is set, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C1/0 U0      0    688    169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C1/0 U0      1    707    185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C1/0 U0      1    707    198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C1/0 U0      1    709    205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C1/0 U0      1    710    204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Insertion Time

You can set the cable flap list insertion time. When a cable interface makes an insertion request more frequently than the amount of insertion time defined by this command, the cable interface is placed in the flap list for activity recording. The valid range is from 60 to 86400 seconds.

To set the cable flap list insertion time, use the following command in global configuration mode.

Command	Purpose
CMTS01(config)# **cable flap-list insertion-time** *seconds*	Specifies the insertion time in seconds. Any cable modem that makes an insertion request more frequently than this period of time is placed in the flap list.

Verifying Cable Flap List Insertion Time

To verify cable flap list insertion time, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C1/0 U0      0    688    169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C1/0 U0      1    707    185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C1/0 U0      1    707    198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C1/0 U0      1    709    205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C1/0 U0      1    710    204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Power Adjustment Threshold

You can specify the power adjustment threshold that will cause a flap list event to be recorded. When the power adjustment of a cable interface meets or exceeds the threshold, the cable interface is placed in the flap list. The valid range is from 1 to 10 dBmV.

Note A power adjustment threshold of less than 2 dBmV might cause excessive flap list event recording. Cisco recommends setting this threshold value to 3 dBmV or higher.

To set the power adjustment threshold for flap-list events, use the following command in global configuration mode.

Command	Purpose
CMTS01(config)# **cable flap-list power-adjust threshold** *dbmv*	Specifies the minimum power adjustment that will constitute a flap-list event.

Verifying Cable Flap List Power Adjustment Threshold

To verify the cable flap list power adjustment threshold, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C1/0 U0      0    688    169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C1/0 U0      1    707    185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C1/0 U0      1    707    198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C1/0 U0      1    709    205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C1/0 U0      1    710    204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Miss Threshold

You can specify the miss threshold for recording a flap-list event. A miss is the number of times a cable modem does not acknowledge a MAC layer keepalive message from a cable interface card. An 8% miss rate is normal for the Cisco cable interface cards. When the number of misses exceeds the threshold, the cable interface is placed in the flap list.

Note A high miss rate can indicate intermittent upstream problems, fiber laser clipping, or common-path distortion.

To set the miss threshold for recording a flap-list event, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)# cable flap-list miss-threshold` *misses*	Specifies the number of MAC layer keepalive misses that will result in the cable modems being place in the flap list.

Verifying Cable Flap List Miss Threshold

To verify the cable flap list miss threshold, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C1/0 U0      0    688    169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C1/0 U0      1    707    185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C1/0 U0      1    707    198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C1/0 U0      1    709    205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C1/0 U0      1    710    204      0      0      7 Nov 5  12:30:16
```

Setting Cable Flap List Size

You can specify the maximum number of cable interfaces that can be listed in the cable flap list tables. The valid range is from 1 to 8192 cable interfaces. The default is 8192 cable interfaces.

To specify the maximum number of cable modems that can be recorded in the flap list, use the following command in global configuration mode.

Command	Purpose
`CMTS01(config)# cable flap-list size` *number*	Specifies the maximum size of the flap list.

Verifying Cable Flap List Size

To verify the cable flap list size, enter the **show cable flap list** command:

```
CMTS01# show cable flap list
Mac Addr       CableIF    Ins    Hit   Miss    CRC  P-Adj   Flap    Time
0010.7b6b.5d1d C1/0 U0      0    688    169      0      0      3 Nov 5  12:28:50
0010.7b6b.5e15 C1/0 U0      1    707    185      0      0      5 Nov 5  12:29:52
0010.7b6b.5e27 C1/0 U0      1    707    198      0      0      5 Nov 5  12:29:55
0010.7b6b.5d29 C1/0 U0      1    709    205      0      0      5 Nov 5  12:29:52
0010.7b6b.5e2b C1/0 U0      1    710    204      0      0      7 Nov 5  12:30:16
```

Clearing Cable Flap List

To remove a single cable modem from the flap list or to remove all cable modems from the flap list, use one of the following commands in global configuration mode.

Command	Purpose
`CMTS01(config)# clear cable flap-list mac-addr`	Clears the entries in the cable flap list for the cable modem with this MAC address.
`CMTS01(config)# clear cable flap-list all`	Clears the entries for all cable modems in the flap list.

Customizing Other Flap List Values and Related Commands

The following displays flap list with different sorting options:

show cable modem flap-list [*cable n* | *sort-flap* | *sort-time* | *sort-interface*]
The following sets the threshold value for link establishment:

[**no**] **cable flap-list insertion-time** *sec*

Note A modem is tagged as flapping if the insertion time exceeds this value. Its value can be set from 60 to 86400 seconds with a default of 180 seconds.

The following sets the number of consecutive missed station maintenance (RNG-RSP) messages that must be missed for a flap event to occur. Value ranges from 1 to 2 with a default of 6 seconds. The hits and miss counters are not affected:

[**no**] **cable flap-list miss-threshold** *miss-threshold*

The following clears the counters for a cable modem (or all cable modems) in the station maintenance list:

clear cable modem *{mac-addr | ip-addr | all}* **counters**

The following displays the QoS, modem status, In and Out octets, IP and MAC addresses per SID:

show int cable slot/port **sid**

The following drops the modem's RF link by removing a modem from the keep-alive polling list. This forces the modem to reset:

clear cable-modem *{mac-addr | ip-addr | all}* **reset**

The following uses a MAC layer ping to determine if the cable modem is online. It uses smaller data units on the wire than a standard IP ping, resulting in lower overhead. This command works even if the IP layer in the modem is down or has not completed registration:

ping DOCSIS cable-modem *mac-addr | IP address*

The following displays the timing offset, receive power, and QoS values by cable interface, SID, and MAC address:

show cable modem *[ip-address | MAC-address]*

The following displays the current allocation table and frequency assignments:

show cable spectrum-group *[spectrum group number]*

The following displays maximum, average, and minimum% online time and offline times for a given SID on a given Cisco uBR7100 series router interface:

show int *slot/port* **sid connectivity**

The following command displays input and output rates, input errors, CRC, frames, overruns, underruns, collisions, interface resets. High input errors in the CMTS retrieved from this query suggests noisy upstream. In older versions of the chassis, loose midplane and line card screws caused a similar problem:

show interface *slot/downstream-port*

Performing Amplitude Averaging

The Cisco uBR7100 series CMTS uses an averaging algorithm to determine the optimum power level for a cable modem with low carrier-to-noise ratio that is making excessive power adjustments—known as flapping. To avoid dropping flapping cable modems, the Cisco uBR7100 series CMTS averages a configurable number of RNG-REQ messages before it makes power adjustments. By compensating for a potentially unstable return path, the Cisco uBR7100 series CMTS maintains connectivity with affected cable modems. 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 which paths the Cisco uBR7100 series CMTS is making power adjustments and which modems 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  Cable1/0/U1  0     2792  281   0     *45    58    Jul 27 16:54:50
 0010.7bb3.fcfc  Cable1/0/U1  0     19    4     0     !43    43    Jul 27 16:55:01
 0010.7bb3.fcdd  Cable1/0/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

 Interface   Prim Online     Timing Rec    QoS CPE IP address      MAC address
             Sid  State      Offset Power
 Cable1/0/U0 1    online     2257    0.00  3   0   10.30.128.142   0090.8330.0217
 Cable1/0/U0 2    online     2262  *-0.50  3   0   10.30.128.145   0090.8330.020f
 Cable1/0/U0 3    online     2260    0.25  3   0   10.30.128.146   0090.8330.0211
 Cable1/0/U0 4    online     2256   *0.75  3   0   10.30.128.143   0090.8330.0216
 Cable1/0/U0 5    online     2265   *0.50  3   0   10.30.128.140   0090.8330.0214
 Cable1/0/U0 6    online     2256    0.00  3   0   10.30.128.141   0090.8330.0215
 Cable1/0/U0 7    online     4138  !-1.00  3   1   10.30.128.182   0050.7366.124d
 Cable1/0/U0 8    online     4142  !-3.25  3   1   10.30.128.164   0050.7366.1245
 Cable1/0/U0 9    online     4141  !-3.00  3   1   10.30.128.185   0050.7366.17e3
 Cable1/0/U0 10   online     4142  !-2.75  3   0   10.30.128.181   0050.7366.17ab
 Cable1/0/U0 11   online     4142  !-3.25  3   1   10.30.128.169   0050.7366.17ef
```

Similar to the **show cable flap-list** display, the * symbol in the **show cable modem** 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 or disable the power adjustment capability, use the following commands:

cable upstream *n* **power-adjust** {**threshold** [*threshold #*] | **continue** [*tolerable value*] | **noise** [*% of power adjustment*]}

no cable upstream power-adjust

Table 5-9 Cable Upstream Power Adjust Syntax Descriptions

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 you adjust values. Cisco does recommend, however, that you clean up your cable plant should you encounter flapping cable modems.

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 modem 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 too many CMs are unnecessarily detected as “noisy,” you might try to increase it.

Setting Frequency Threshold to Affect Power Adjustment

To control power adjustment methods by setting the frequency threshold, use the **cable upstream freq-adj averaging** interface configuration command. 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

Table 5-10 Cable Upstream Freq-adj Averaging Syntax Descriptions

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 required tasks to create PRBS and unmodulated carrier test signals:

- "Configuring Unmodulated Test Signals" section on page 5-45
- "Configuring PRBS Test Signals" section on page 5-45
- "Verifying Test Signal Output" section on page 5-45

Configuring Unmodulated Test Signals

Table 5-11 Instructions to Configure 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 re-enable the interface to resume normal operations.

Configuring PRBS Test Signals

Table 5-12

	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 re-enable 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 Cable Modems

Pinging a Cable Modem

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 uBR7100 series and the cable interface. The technology uses 1/64—the bandwidth of IP ping—and works with cable modems that do not have an IP address. This allows cable operators to ping cable modems that are unable to complete registration, 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.

Table 5-13 Instructions to Ping a Cable Modem

Command	Purpose
`CMTS01# ping docsis addr`	Pings the cable modem 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 cable modem 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 you are using a valid MAC or IP address for the cable interface you want to ping.

Using the Cable Monitor Feature

The Cable Monitor feature configures the cable interface so that it forwards copies of certain packets to a specified interface (typically one of the fixed Fast Ethernet ports on the Cisco uBR7100 series router). By attaching a network analyzer on that interface, you can monitor inbound or outbound packets for specific types of traffic. This can provide invaluable information about the type of traffic being sent or received, and whether that traffic contains any errors or unusual characteristics.

Note Do not confuse the Cable Monitor feature that is available on the Cisco uBR7100 series router with the Cable Monitor feature available on Cisco cable CPE devices, such as the Cisco uBR924 cable access router. The CMTS feature allows the analysis of traffic over the cable interface, while the cable CPE version of this command provides a way for customers to obtain current configuration information when the CPE cable interface goes down.

The **cable monitor** cable interface command has the following syntax:

```
Router(config-if)# cable monitor [outbound | incoming] [timestamp] interface interface
{access-list <name | number> | sid <n> | mac-addr <address> | upstream <n>}[packet-type
{mac [type {map-req | map-grant | dsa | dsc | dsd ... }] | data packet-header {ethernet |
docsis}}]
```

Enter configuration commands, one per line. Then press **ctrl+z**.

```
Router# conf t

Router(config)# int c1/0
Router(config-if)# cable monitor ?

incoming Monitor incoming packets
outbound       Monitor outbound packets
timestamp Enable packet timestamping
interface Interface to forward monitored packets

Router(config-if)# cable monitor incoming ?

timestamp Enable packet timestamping
interface Interface to forward monitored packets

Router(config-if)# cable monitor incoming timestamp ?

interface Interface to forward monitored packets

Router(config-if)# cable monitor incoming timestamp interface e1/0 ?

access-list IP access list name
mac-addrMAC address of the device monitored
sid Service ID to be monitored
upstreamUpstream port to monitor

Router(config-if)# cable monitor incoming timestamp interface e1/0 sid 2 packet-type ?

mac Monitor mac packets
dataMonitor data packets
<cr>
Router(config-if)# cable monitor incoming timestamp interface e1/0 sid 2 packet-type mac ?

typeMonitor selected mac packets
<cr>
Router(config-if)# cable monitor incoming timestamp interface e1/0 sid 2 packet-type mac
type ?

map-req Monitor Requests
map-grantMonitor Grants
dsa Monitor dynamic service addition
dsc Monitor dynamic service change
dsd Monitor dynamic service deletion
Router(config-if)# cable monitor incoming timestamp interface e1/0 sid 2 packet-type mac
type map-req

Show CLI :
Router# show interface cable 1/0 monitor

US/ Time Outbound  Flow     Flow Type      Flow  Packet MAC   MAC       Encap
DS  Stmp Interface Type     Identifier     Extn. Type   Extn. Type      Type
all  yes   Et1/0   mac-addr 0050.5462.008c yes   data   no     -        Ethernet
us   yes   Et1/0   acc-list 300            no     -     no     -          -
us   no    Et1/0   sid      2              yes   mac    yes   map-grant   -
all  no    Et1/0   acc-list rrr            no      -    no     -          -
all  no    Et1/0   mac-addr 0042.b013.008c yes   data   no     -        Ethernet
all  no    Et1/0   upstream 0              yes   data   no     -        docsis
```

Note See the *Broadband Command Consolidation* manual, available on Cisco.com and the documentation CD-ROM, for more information on this feature and its commands.

Using Cable Interface debug Commands

To troubleshoot cable interfaces, use the following **debug** commands in enable (privileged EXEC) mode.

Table 5-14 Instructions to Use Debug Command

Command	Purpose
`CMTS01#` **debug cable ?**	View all debug cable commands that are available.
`CMTS01#` **undebug all**	Turn off all debugging information to the console and choose 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 cable modems, these commands can dramatically affect router performance.

debug cable arp Command

This command activates debugging of arp requests on the cable interfaces. When this command is activated, all cable arp request messages are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable arp
```

To deactivate debugging of arp requests, use the following command:

```
CMTS01# no debug cable arp
```

debug cable envm Command (Environmental Monitor Messages)

This command activates debugging of the Cisco uBR7100 series environmental monitor. When this command is activated, all environmental monitor messages are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable envm
```

To deactivate debugging of the environmental monitor, use the following command:

```
CMTS01# no debug cable envm
```

debug cable err Command (MAC Protocol Errors)

This command activates debugging of cable MAC protocol errors. When this command is activated, any errors that occur in the cable MAC protocol are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable err
```

To deactivate debugging of MAC protocol errors, use the following command:

```
CMTS01# no debug cable err
```

debug cable privacy Command (Baseline Privacy)

This command activates debugging of baseline privacy. The format for the command follows:

```
CMTS01# debug cable privacy
```

To deactivate debugging of baseline privacy, use the following command:

```
CMTS01# no debug cable privacy
```

debug cable keyman Command (Baseline Privacy Activity)

This command activates debugging of the TEK and KEK baseline privacy key activity. When this command is activated, all activity related to KEK and TEK keys displays on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable keyman
```

To deactivate debugging of the keys, use the following command:

```
CMTS01# no debug cable keyman
```

debug cable mac-messages Command

This command activates debugging of messages generated in the cable MAC that frames and encrypts downstream RF signals. When this command is activated, messages generated by the cable MAC are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable mac-messages
```

To deactivate debugging of cable MAC messages, use the following command:

```
CMTS01# no debug cable mac-messages
```

debug cable map Command

This command activates debugging of cable maps that identify data on cable interfaces. When this command is activated, messages related to cable maps are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable map
```

To deactivate debugging of cable maps, use the following command:

```
CMTS01# no debug cable map
```

debug cable modems Command

This command activates debugging of cable modems. When this command is activated, messages from cable modems on the HFC network are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable modems
```

To deactivate debugging of cable MAC messages, use the following command:

```
CMTS01# no debug cable modems
```

debug cable phy Command (Messages)

This command activates debugging of messages generated in the cable PHY—the physical layer where upstream and downstream activity between the Cisco uBR7100 series router and the HFC network is controlled. When this command is activated, messages generated in the cable PHY are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable phy
```

To deactivate debugging of the cable PHY, use the following command:

```
CMTS01# no debug cable phy
```

debug cable qos Command

This command activates debugging of QoS. When this command is activated, messages related to QoS parameters are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable qos
```

To deactivate debugging of QoS, use the following command:

```
CMTS01# no debug cable qos
```

debug cable range Command (Ranging Messages)

This command activates debugging of ranging messages from cable interfaces on the HFC network. When this command is activated, ranging messages generated when cable interfaces request or change their upstream frequencies are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable range
```

To deactivate debugging of cable interface ranging, use the following command:

```
CMTS01# no debug cable range
```

debug cable receive Command (Upstream Messages)

This command activates debugging of upstream messages from cable interfaces. When this command is activated, any messages generated by cable interfaces and sent to the Cisco uBR7100 series router will be displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable receive
```

To deactivate debugging of upstream messages, use the following command:

```
CMTS01# no debug cable receive
```

debug cable reg Command (Modem Registration Requests)

This command activates debugging of registration requests from cable interfaces on the HFC network. When this command is activated, messages generated by cable interfaces as they make requests to connect to the network are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable reg
```

To deactivate debugging of cable registration, use the following command:

```
CMTS01# no debug cable reg
```

debug cable reset Command (Messages)

This command activates debugging of reset messages from cable interfaces on the HFC network. When this command is activated, reset messages generated by cable interfaces are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable reset
```

To deactivate debugging of cable reset messages, use the following command:

```
CMTS01# no debug cable reset
```

debug cable specmgmt Command (Spectrum Management)

This command activates debugging of spectrum management (frequency agility) on the HFC network. When this command is activated, messages generated because of spectrum group activity are displayed on the Cisco uBR7100 series router console. Spectrum group activity can be additions or changes to spectrum groups, or frequency and power level changes controlled by spectrum groups. The format for the command follows:

```
CMTS01# debug cable specmgmt
```

To deactivate debugging of cable spectrum management, use the following command:

```
CMTS01# no debug cable specmgmt
```

debug cable startalloc Command (Channel Allocations)

This command activates debugging of channel allocations on the HFC network. When this command is activated, messages generated when channels are allocated to cable interfaces on the HFC network are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable startalloc
```

To deactivate debugging of cable channel allocations, use the following command:

```
CMTS01# no debug cable startalloc
```

debug cable transmit Command (CMTS Transmissions)

This command activates debugging of transmissions from the Cisco uBR7100 series router across the HFC network. When this command is activated, messages generated at the headend are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable transmit
```

To deactivate debugging of cable transmissions, use the following command:

```
CMTS01# no debug cable transmit
```

debug cable ucc Command (Upstream Channel Change Messages)

This command activates debugging of upstream channel change (UCC) messages generated when cable interfaces request or are assigned a new channel. When this command is activated, messages related to upstream channel changes are displayed on the Cisco uBR7100 series router console. The format for the command follows:

```
CMTS01# debug cable ucc
```

To deactivate debugging of cable upstream channel changes, use the following command:

```
CMTS01# no debug cable ucc
```

debug cable ucd Command (Upstream Channel Description Messages)

This command activates debugging of upstream channel descriptor (UCD) messages. UCD messages contain information about upstream channel characteristics and are sent to the cable modems on the HFC network. Cable modems 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 uBR7100 series router console. The format for the command is as follows:

```
CMTS01# debug cable ucd
```

To deactivate debugging of cable upstream channel descriptor, use the following command:

```
CMTS01# no debug cable ucd
```

Configuration Register Information for the Cisco uBR7100 Series Universal Broadband Routers

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 A-1 lists the meaning of each of the configuration memory bits. Following the table is a more in-depth description of each setting.

Table A-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 A-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 A-2 provides information about the bits settings.

Table A-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 A-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 A-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 A-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 A-4 shows the combined effect of bit 10 and bit 14.

Table A-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:

- "Configuring the CMTS for the First Time" in the *Cisco uBR7100 Series Software Configuration Guide*:

  http://www.cisco.com/en/US/products/hw/cable/ps2211/products_configuration_guide_chapter09186a00801b3506.html

Bit 11 and Bit 12

Bit 11 and Bit 12 in the configuration register determine the baud rate of the console terminal. Table A-5 shows the bit settings for the four available baud rates. (The factory set default baud rate is 9600.)

Table A-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:

- Chapter 2, "Configuring the Cisco CMTS for the First Time," in the *Cisco uBR7100 Series Software Configuration Guide* (this document):

  http://www.cisco.com/en/US/products/hw/cable/ps2211/products_configuration_guide_chapter09186a00801b3506.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** commandusing a Cisco uBR7100 series router:

```
Router# show version

 Cisco Internetwork Operating System Software
 IOS (tm) EGR Software (UBR7100-P-M), Released Version 12.1(5)EC
 Copyright (c) 1986-2001 by cisco Systems, Inc.
 Compiled Thu 10-Aug-01 00:56 by
 Image text-base: 0x60008968, data-base: 0x60F84000

 ROM: System Bootstrap, Version 12.1(5r)EC, RELEASE SOFTWARE (fc1e)
 BOOTFLASH: EGR Software (UBR7100-BOOT-M), Released Version 12.1(5)EC

 RACK7522_uBR7114 uptime is 21 hours, 45 minutes
 System returned to ROM by reload at 05:53:22 PST Wed Aug 17 2001
 System image file is "ubr7100-p-mz"

 cisco uBR7114 (EGR) processor (revision A) with 57344K/73728K bytes of memory.
 Processor board ID 15495273
 R527x CPU at 225Mhz, Implementation 40, Rev 10.0, 2048KB L2 Cache
 Last reset from power-on
 X.25 software, Version 3.0.0.
```

```
National clock card with T1 controller
2 FastEthernet/IEEE 802.3 interface(s)
1 Cable Modem network interface(s)
125K bytes of non-volatile configuration memory.

46976K bytes of ATA PCMCIA card at slot 0 (Sector size 512 bytes).
8192K bytes of Flash internal SIMM (Sector size 256K).
Configuration register is 0x0
```

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 >
```

A

B

C

D

E

F

G

H

I

M

N

P

Q

R

S

T

U

W