CHAPTER 7

DOCSIS 1.1 for the Cisco CMTS

Revised: February 16, 2009, OL-1467-08

This document describes how to configure the Cisco CMTS router for Data-over-Cable Service Interface Specifications (DOCSIS) 1.1 operations.

Feature Specifications for DOCSIS 1.1 Operations

Feature History	
Release	**Modification**
12.1(4)CX	DOCSIS 1.1 support was introduced for Cisco uBR7200 series routers.
12.1(7)CX1	Several DOCSIS 1.1 MIBs were updated, reflecting changes in the DOCSIS 1.1 specification. The **cable submgmt default** command was also added, to set the default value of the attributes in DOCS-SUBMGT-MIB.
12.2(4)XF1 12.2(4)BC1	DOCSIS 1.1 support was introduced for the Cisco uBR7100 series, Cisco uBR7200 series, and Cisco uBR10012 routers on the Release 12.2 BC train.
12.2(4)BC1b	N+1 redundancy during DOCSIS 1.1 operations was supported on the Cisco uBR10012 router.
12.2(8)BC2	The **show cable modem mac** command was enhanced to show the DOCSIS capabilities and provisioned state of each cable modem.
12.2(11)BC1	N+1 redundancy during DOCSIS 1.1 operations was supported on the Cisco uBR7200 series router.
12.2(11)BC2	The **packetcable authorize vanilla-docsis-mta** command was supported to allow DOCSIS 1.1 cable modems to use UGS service flows when PacketCable operations have been enabled.
12.3(13a)BC	Added support for Enhanced Rate Bandwidth Allocation (ERBA) for DOCSIS 1.0 cable modems, to include the following new configuration command and **show** command enhancement: • **cable qos pro max-ds-burst** *burst-size* • **show cable qos profile** *n* **[verbose]** Refer to the "Using Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems" section on page 7-29.
12.3(21)BC	Added support for an enhanced version of ERBA on the Cisco uBR10012 router. Refer to the "Using Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems" section on page 7-29.
12.2(33)SCB	ERBA feature is enhanced with the *peak-rate* option of the **cable ds-max-burst** command for the Cisco uBR10012 router.

12.2(33)SCB1	Support for DOCSIS 3.0 Downstream Peak Traffic Rate TLV Support for ERBA was added.

Supported Platforms
Cisco uBR7100 series, Cisco uBR7200 series, Cisco uBR10012 universal broadband routers.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

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Prerequisites for DOCSIS 1.1 Operations

To support DOCSIS 1.1 operations, the CMTS must be running Cisco IOS Release 12.1(4)BC1 or later Cisco IOS 12.2 BC Release, and the cable modem must also support the DOCSIS 1.1 feature set. In addition, before you power on and configure the Cisco CMTS, check the following points:

- Ensure that 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 that your plant meets all DOCSIS downstream and upstream RF requirements.
- Ensure that your Cisco CMTS is installed according to the instructions provided in the appropriate *Hardware Installation Guide*. The chassis must contain at least one port adapter to provide backbone connectivity and one Cisco cable line card to serve as the RF cable TV interface.
- Ensure that all other required headend or distribution hub routing and network interface equipment is installed, configured, and operational, based on the services to support. This includes all routers, servers (DHCP, TFTP, and ToD), network management systems, and other configuration or billing systems. This includes IP telephony equipment including gatekeepers and gateways; backbone and other equipment if supporting virtual private networks (VPNs); and dialup access servers, telephone circuits and connections and other equipment if supporting telco return.
- Ensure that DHCP and DOCSIS configuration files have been created and pushed to appropriate servers such that each cable modem, when initialized, can transmit a DHCP request, receive an IP address, obtain TFTP and ToD server addresses, and download DOCSIS configuration files. Optionally, ensure that your servers can also download updated software images to DOCSIS 1.0 and DOCSIS 1.1 cable modems.

- Ensure that customer premises equipment (CPE)—cable modems or set-top boxes, PCs, telephones, or facsimile machines—meet the requirements for your network and service offerings.
- Familiarize yourself with your channel plan to ensure assigning of 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 cable modem configuration files. Obtain passwords, IP addresses, subnet masks, and device names, as appropriate.
- Ensure that the system clocks on the Cisco CMTS and on the time-of-day (ToD) servers are synchronized. If this does not occur, the clocks on the CMs will not match the clocks on the Cisco CMTS, which could interfere with BPI+ operations. In particular, this could prevent the proper verification of the digital certificates on the CM.

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

Caution If you plan to use service-class-based provisioning, the service classes must be configured at the Cisco CMTS before cable modems attempt to make a connection. Use the **cable service class** command to configure service classes.

Restrictions for DOCSIS 1.1 Operations

DOCSIS 1.1 operations includes the following restrictions:

Baseline Privacy Interface Plus Requirements

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

Also, ensure that the system clocks on the CMTS and on the time-of-day (ToD) servers are synchronized. If this does not occur, the clocks on the CMs will not match the clocks on the CMTS, which could interfere with BPI+ operations. In particular, this could prevent the proper verification of the digital certificates on the CM.

Note Ensure that the system clocks on the CMTS and on the time-of-day (ToD) servers are synchronized. If this does not occur, the clocks on the CMs will not match the clocks on the CMTS, which could interfere with BPI+ operations. In particular, this could prevent the proper verification of the digital certificates on the CM.

BPI+-Encrypted Multicast Not Supported with Bundled Subinterfaces on the Cisco uBR10012 Router

The current Cisco IOS releases do not support using BPI+ encrypted multicast on bundled cable subinterfaces on the Cisco uBR10012 router. Encrypted multicast is supported on bundled cable interfaces or on non-bundled cable subinterfaces, but not when a subinterface is bundled on the Cisco uBR10012 router. This restriction does not apply to Cisco uBR7200 series routers.

BPI+ Not Supported with High Availability Configurations

The current Cisco IOS releases do not support using BPI+ encrypted multicast on a cable interface when the interface has also been configured for N+1 (1:n) High Availability or Remote Processor Redundancy Plus (RPR+) High Availability redundancy.

In addition, BPI+ is not automatically supported after a switchover from the Working cable interface to the Protect cable interface, because the cable interface configurations that are required for BPI+ encryption are not automatically synchronized between the two interfaces. A workaround for this is to manually configure the Protect cable interfaces with the required configurations.

Cable Interface Cards

DOCSIS 1.1 traffic is supported on Cisco uBR-MC1XC and Cisco uBR-MC28C cable interface line cards. The Cisco uBR-MC11 (FPGA) and Cisco uBR-MC16B line cards do not support DOCSIS 1.1.

Cable Privacy Hotlist CLI Not Supported on Cisco uBR10012 Router

The **cable privacy hotlist** command is not supported on the Cisco uBR10012 router running Cisco IOS releases prior to Cisco IOS release 12.3(23)BC9, Cisco IOS release 12.2(33)SCB5, and Cisco IOS release12.2(33)SCC.

To add a manufacturer's or CM certificate to the hotlist on the Cisco uBR10012 router, use SNMP commands to set the appropriate attributes in DOCS-BPI-PLUS-MIB. See the "Adding a Certificate to the Hotlist Using SNMP Commands" section on page 7-26.

DOCSIS Root Certificates

The Cisco CMTS supports only one DOCSIS Root CA certificate.

Maximum Burst Size

Previously, the maximum concatenated burst size parameter could be set to zero to specify an unlimited value. In a DOCSIS 1.1 environment, this parameter should be set to a nonzero value, with a maximum value of 1522 bytes for DOCSIS 1.0 cable modems.

If a cable modem attempts to register with a maximum concatenation burst size of zero, the DOCSIS 1.1 CMTS refuses to allow the cable modem to come online. This avoids the possibility that a DOCSIS 1.0 cable modem could interfere with voice traffic on the upstream by sending extremely large data packets. Since DOCSIS 1.0 does not support fragmentation, transmitting such data packets could result in unwanted jitter in the voice traffic.

In addition, DOCSIS 1.1 requires that the maximum transmit burst size be set to either 1522 bytes or the maximum concatenated burst size, whichever is larger. Do not set the maximum concatenation burst size to values larger than 1522 bytes for DOCSIS 1.0 cable modems.

Note This change requires you to change any DOCSIS configuration files that specify a zero value for the maximum concatenation burst size. This limitation does not exist for DOCSIS 1.1 cable modems unless fragmentation has been disabled.

Performance

DOCSIS 1.0 cable modems lack the ability to explicitly request and provide scheduling parameters for advanced DOCSIS 1.1 scheduling mechanisms, such as unsolicited grants and real-time polling. DOCSIS 1.1 cable modems on the same upstream channel can benefit from the advanced scheduling mechanisms and a DOCSIS 1.1 CMTS can still adequately support voice traffic from DOCSIS 1.1 cable modems with DOCSIS 1.0 cable modems on the same upstream channel.

Provisioning

The format and content of the TFTP configuration file for a DOCSIS 1.1 cable modem are significantly different from the file for a DOCSIS 1.0 cable modem. A dual-mode configuration file editor is used to generate a DOCSIS 1.0 style configuration file for DOCSIS 1.0 cable modems and a DOCSIS 1.1 configuration file for DOCSIS 1.1 cable modems.

Registration

A DOCSIS 1.1 CMTS must handle the existing registration Type/Length/Value parameters from DOCSIS 1.0 cable modems as well as the new type TLVs from DOCSIS 1.1 cable modems. A DOCSIS 1.0 and DOCSIS 1.1 cable modem can successfully register with the same DOCSIS 1.1 CMTS.

A DOCSIS 1.1 cable modem can be configured to make an indirect reference to a service class that has been statically defined at the CMTS instead of explicitly asking for the service class parameters. When this registration request is received by a DOCSIS 1.1 CMTS, it encodes the actual parameters of the service class in the registration response and expects a DOCSIS 1.1-specific registration-acknowledge MAC message from the cable modem.

When a DOCSIS 1.0 cable modem registers with a DOCSIS 1.1 CMTS, the registration request explicitly requests all nondefault service-class parameters in the registration. The absence of an indirect service class reference eliminates the need for the DOCSIS 1.1 TLVs and eliminates the need to establish a local registration acknowledge wait state.

When a DOCSIS 1.1 CMTS receives a registration request from a DOCSIS 1.0 cable modem, it responds with the DOCSIS 1.0 style registration response and does not expect the cable modem to send the registration-acknowledge MAC message.

Information about DOCSIS 1.1

- Feature Overview, page 7-6
- DOCSIS 1.1 Quality of Service, page 7-8
- Benefits, page 7-14

Feature Overview

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

The DOCSIS 1.1 specification provides the following feature enhancements over DOCSIS 1.0 networks:

- Baseline Privacy Interface Plus, page 7-6
- Concatenation, page 7-7
- Dynamic MAC Messages, page 7-7
- Enhanced Quality of Service, page 7-7
- Fragmentation, page 7-8
- Interoperability, page 7-8
- Payload Header Suppression, page 7-8

Baseline Privacy Interface Plus

DOCSIS 1.0 introduced a Baseline Privacy Interface (BPI) to protect user data privacy across the shared-medium cable network and to prevent unauthorized access to DOCSIS-based data transport services across the cable network. BPI encrypts traffic across the RF interface between the cable modem and CMTS, and also includes authentication, authorization, and accounting (AAA) features.

BPI supports access control lists (ACLs), tunnels, filtering, protection against spoofing, and commands to configure source IP filtering on RF subnets to prevent subscribers from using source IP addresses that are not valid. DOCSIS 1.1 enhances these security features with BPI Plus (BPI+), which includes the following enhancements:

- X.509 Digital certificates provide secure user identification and authentication. The Cisco CMTS supports both self-signed manufacturer's certificates and certificates that are chained to the DOCSIS Root CA certificate.
- Key encryption uses 168-bit Triple DES (3DES) encryption that is suitable for the most sensitive applications.
- 1024-bit public key with Pkcs#1 Version 2.0 encryption.
- Support for encrypted multicast broadcasts, so that only authorized service flows receive a particular multicast broadcast.
- Secure software download allows a service provider to upgrade a cable modem's software remotely, without the risk of interception, interference, or alteration.

Note BPI+ is described in the DOCSIS Baseline Privacy Interface Plus Specification (SP-BPI+-I08-020301), available from the CableLabs DOCSIS web site (http://www.cablelabs.com/cablemodem).

Concatenation

Concatenation allows a cable modem to make a single time-slice request for multiple upstream packets, sending all of the packets in a single large burst on the upstream. Concatenation can send multiple upstream packets as part of one larger MAC data frame, allowing the cable modem to make only one time-slot request for the entire concatenated MAC frame, reducing the delay in transmitting the packets on the upstream channel. This avoids wasting upstream bandwidth when sending a number of very small packets, such as TCP acknowledgement packets.

Dynamic MAC Messages

Dynamic Service MAC messages allow the cable modem to dynamically create service flows on demand. These messages are DOCSIS link layer equivalents of the higher layer messages that create, tear down, and modify a service flow.

The DOCSIS 1.1 dynamic services state machine supports the following messages:

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

Note These messages are collectively known as DSX messages.

Enhanced Quality of Service

DOCSIS 1.1 provides enhanced quality of service (QoS) capabilities to give priority for real-time traffic such as voice and video:

- The DOCSIS 1.0 QoS model (a service ID (SID) associated with a QoS profile) has been replaced with a service flow and service class model that allows greater flexibility in assigning QoS parameters to different types of traffic and in responding to changing bandwidth conditions.
- Support for multiple service flows per cable modem allows a single cable modem to support a combination of data, voice, and video traffic.
- Greater granularity in QoS per cable modem in either direction, using unidirectional service flows.
- Upstream service flows can be assigned one of the following QoS scheduling types, depending on the type of traffic and application being used:
  - Best-effort—Data traffic sent on a non-guaranteed best-effort basis. This type of service flow is similar to the method used in DOCSIS 1.0 networks.
  - Real-time polling (rtPS)—Real-time service flows, such as video, that produce unicast, variable size packets at fixed intervals.
  - Non-real-time polling service (nrtPS)—Similar to the rtPS type, in that the cable modem is guaranteed regular opportunities to request data bursts of varying length, except that the CMTS can vary the time between its polling of the cable modem depending on the amount of traffic and congestion on the network.
  - Unsolicited grants (UGS)—Constant bit rate (CBR) or committed information rate (CIR) traffic, such as voice, that is characterized by fixed-size packets at fixed intervals, providing a guaranteed minimum data rate.

  - Unsolicited grants with activity detection (USG-AD)—Combination of UGS and rtPS, to accommodate real-time traffic that might have periods of inactivity (such as voice using silence suppression). The service flow uses UGS fixed grants while active, but switches to rtPS polling during periods of inactivity to avoid wasting unused bandwidth.

Fragmentation

DOCSIS fragmentation allows the upstream MAC scheduler to slice large data requests to fit into the scheduling gaps between UGS (voice slots). This prevents large data packets from affecting real-time traffic, such as voice and video.

Fragmentation reduces the run-time jitter experienced by the UGS slots when large data grants preempt the UGS slots. Disabling fragmentation increases the run-time jitter, but also reduces the fragmentation reassembly overhead for fragmented MAC frames.

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

Interoperability

DOCSIS 1.1 cable modems can coexist with DOCSIS 1.0 and 1.0+ cable modems in the same network. The Cisco CMTS provides the levels of service that are appropriate for each cable modem.

Payload Header Suppression

Payload header suppression (PHS) conserves link-layer bandwidth by suppressing repetitive or redundant packet headers on both upstream and downstream service flows. PHS is enabled or disabled per service flow, and each service flow can support a separate set of PHS rules that determine which parts of the header are suppressed. This ensures that PHS is done in the most efficient manner for each service flow and its particular type of application.

DOCSIS 1.1 Quality of Service

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

- Service flow—A unidirectional sequence of packets on the DOCSIS link. Separate service flows are used for upstream and downstream traffic, and define the QoS parameters for that traffic.
- Service class—A collection of settings maintained by the CMTS that provide a specific QoS service tier to a cable modem that has been assigned a service flow associated with that service class.
- Packet classifier—A set of packet header fields used to classify packets onto a service flow to which the classifier belongs. The CMTS uses the packet classifiers to match the packet to the appropriate service flow.

- Payload header suppression (PHS) rule—A set of packet header fields that are suppressed by the sending entity before transmitting on the link, and are restored by the receiving entity after receiving a header-suppressed frame transmission. PHS increases the bandwidth efficiency by removing repeated packet headers before transmission.

See the following sections for more information on these components.

Service Flow

In DOCSIS 1.1, the basic unit of QoS is the service flow, which is a unidirectional sequence of packets transported across the RF interface between the cable modem and CMTS. A service flow defines a set of QoS parameters such as latency, jitter, and throughput assurances, and these parameters can be applied independently to the upstream and downstream traffic flows. This is a major difference from DOCSIS 1.0 networks, where the same QoS parameters were applied to both the downstream and upstream flows.

Note DOCSIS 1.0 networks used service IDs (SIDs) to identify the QoS parameter set for a particular flow. DOCSIS 1.1 networks use the service flow ID (SFID) to identify the service flows that have been assigned to a particular upstream or downstream. DOCSIS 1.1 networks still use the term SID, but it applies exclusively to upstream service flows.

Every cable modem establishes primary service flows for the upstream and downstream directions, with a separate SFID for the upstream and the downstream flows. The primary flows maintain connectivity between the cable modem and CMTS, allowing the CMTS to send MAC management messages at all times to the cable modem.

In addition, a DOCSIS 1.1 cable modem can establish multiple secondary service flows. The secondary service flows either can be permanently created (by configuring them in the DOCSIS configuration file that is downloaded to the cable modem), or the service flows can be created dynamically to meet the needs of the on-demand traffic, such as voice calls. Permanent service flows remain in effect, even if they are not being used, while dynamic service flows are deleted when they are no longer needed.

At any given time, a service flow might be in one of three states (provisioned, admitted, or active). Only active flows are allowed to pass traffic on the DOCSIS network. Every service flow is identified by an SFID, while upstream service flows in the admitted and active state have an extra Layer 2 SID associated with them. The SID is the identifier used by the MAC scheduler when specifying time-slot scheduling for different service flows.

Service Class

Each service flow is associated with a service class, which defines a particular class of service and its QoS characteristics, such as the maximum bandwidth for the service flow and the priority of its traffic. The service class attributes can be inherited from a preconfigured CMTS local service class (class-based flows), or they can be individually specified when a cable modem dynamically requests a service flow and the CMTS creates it.

The DOCSIS 1.1 service class also defines the MAC-layer scheduling type for the service flow. The schedule type defines the type of data burst requests that the cable modem can make, and how often it can make those requests. The following types of schedule types are supported:

- Best-effort (BE)—A cable modem competes with the other cable modems in making bandwidth requests and must wait for the CMTS to grant those requests before transmitting data. This type of service flow is similar to the method used in DOCSIS 1.0 networks.

- Real-time polling service (rtPS)—A cable modem is given a periodic time slot in which it can make bandwidth requests without competing with other cable modems. This allows real-time transmissions with data bursts of varying length.
- Non-real-time polling service (nrtPS)—A cable modem is given regular opportunities to make bandwidth requests for data bursts of varying size. This type of flow is similar to the rtPS type, in that the cable modem is guaranteed regular opportunities to request data bursts of varying length, except that the CMTS can vary the time between its polling of the cable modem, depending on the amount of traffic and congestion on the network.
- Unsolicited grant service (UGS)—A cable modem can transmit fixed data bursts at a guaranteed minimum data rate and with a guaranteed maximum level of jitter. This type of service flow is suitable for traffic that requires a Committed Information Rate (CIR), such as Voice-over-IP (VoIP) calls.
- Unsolicited grant service with activity detection (UGS-AD)—Similar to the UGS type, except that the CMTS monitors the traffic to detect when the cable modem is not using the service flow (such as voice calls when nobody is speaking). When the CMTS detects silence on the service flow, the CMTS temporarily switches the service flow to an rtPS type. When the cable modem begins using the flow again, the CMTS switches the flow back to the UGS type. This allows the CMTS to more efficiently support VoIP calls.

Each service flow is assigned a single service class, but the same service class can be assigned to multiple service flows. Also, a cable modem can be assigned multiple service flows, allowing it to have multiple traffic flows that use different service classes.

Packet Classifiers

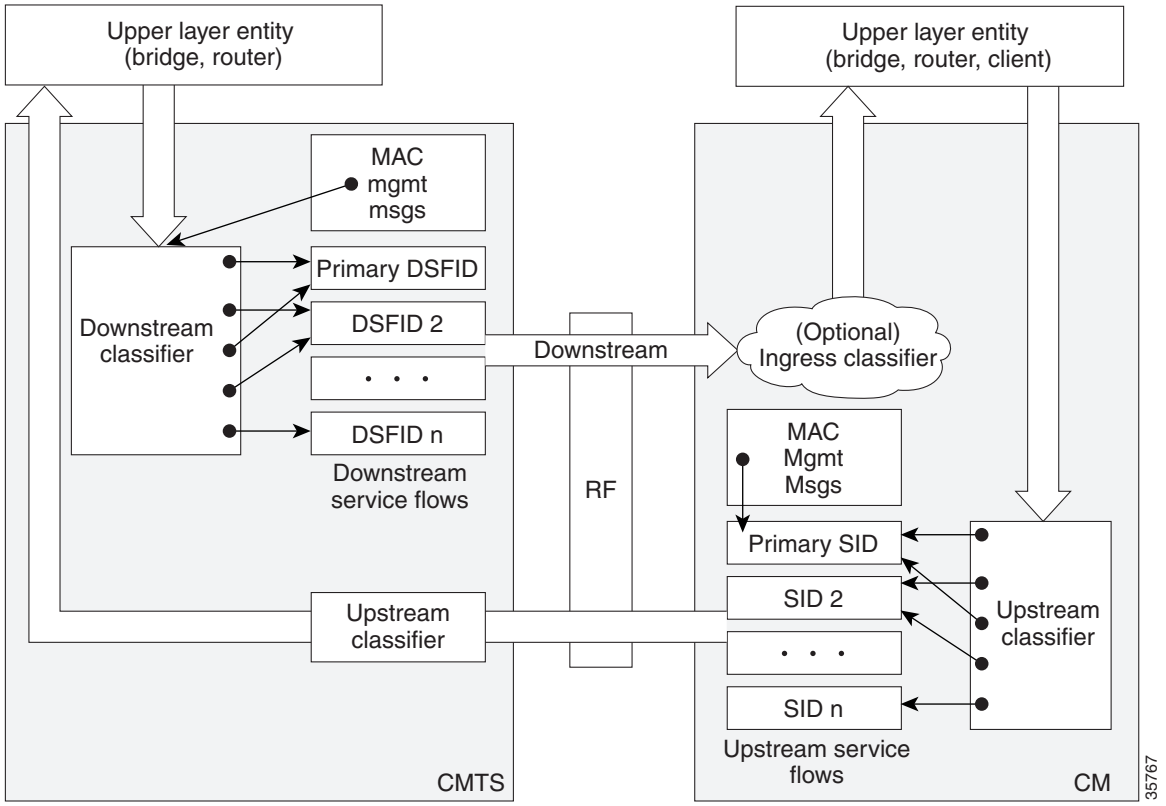
In DOCSIS 1.0 networks, a cable modem used only one set of QoS parameters for all of its traffic, so the CMTS simply had to route packets to and from the appropriate cable modems. In DOCSIS 1.1 networks, however, cable modems can be using multiple service flows, and each service flow can be given a different level of service. To quickly assign upstream and downstream packets to their proper service flows, the CMTS uses the concept of packet classifiers.

Each packet classifier specifies one or more packet header attributes, such as source MAC address, destination IP address, or protocol type. The classifier also specifies the service flow to be used when a packet matches this particular combination of headers. Separate classifiers are used for downstream and upstream service flows.

When the CMTS receives downstream and upstream packets, it compares each packet's headers to the contents of each packet classifier. When the CMTS matches the packet to a classifier, the CMTS then assigns the proper SFID to the packet and transmits the packet to or from the cable modem. This ensures that the packet is assigned its proper service flow, and thus its proper QoS parameters.

Figure 7-1 illustrates the mapping of packet classifiers.

Figure 7-1 Classification Within the MAC Layer



Packet Header Suppression Rules

Because many data and real-time applications may use fixed values in their packet header fields, DOCSIS 1.1 supports PHS to suppress the duplicate portions of the packet headers when a group of packets is transmitted during a session. Each service flow can support a separate set of PHS rules that determine which parts of the header are suppressed.

When PHS is being used, the transmitting CMTS suppresses the specified headers in all the packets for that service flow. The receiving CMTS then restores the missing headers before forwarding the packets on to their ultimate destination.

Proper use of PHS can increase the efficiency of packetized transmissions, especially for real-time data that is encapsulated by other protocols, such as VoIP traffic.

Quality of Service Comparison

This section summarizes the differences in QoS between DOCSIS 1.0, DOCSIS 1.0+, and DOCSIS 1.1 networks.

Note Cisco CMTS routers running Cisco IOS Release 12.1(4)CX or later can transparently interoperate with cable modems running DOCSIS 1.0, DOCSIS 1.0+ extensions, or DOCSIS 1.1. If a cable modem indicates at system initialization that it is DOCSIS 1.1-capable, the Cisco CMTS router uses the DOCSIS 1.1 features. If the cable modem is not DOCSIS 1.1-capable, but does support the DOCSIS 1.0+ QoS extensions (for example, a Cisco uBR924 cable access router running Cisco IOS Release 12.1(1)T or later release), the Cisco CMTS automatically supports the cable modem's requests for dynamic services. Otherwise, the cable modem is treated as a DOCSIS 1.0 device.

DOCSIS 1.0

DOCSIS1.0 uses a static QoS model that is based on a class of service (CoS) that is preprovisioned in the DOCSIS configuration file that is downloaded to the cable modem. The CoS is a bidirectional QoS profile that applies to both the upstream and downstream directions, and that has limited control, such as peak rate limits in either direction, and relative priority on the upstream.

DOCSIS 1.0 defines the concept of a service identifier (SID), which identifies the cable modems that are allowed to transmit on the network. In DOCSIS 1.0 networks, each cable modem is assigned only one SID for both the upstream and downstream directions, creating a one-to-one correspondence between a cable modem and its SID. All traffic originating from, or destined for, a cable modem is mapped to that particular SID.

Typically, a DOCSIS 1.0 cable modem has one CoS and treats all traffic the same, which means that data traffic on a cable modem can interfere with the quality of a voice call in progress. The CMTS, however, has a limited ability to prioritize downstream traffic based on IP precedent type-of-service (ToS) bits.

For example, voice calls using higher IP precedence bits receive a higher queueing priority (but without a guaranteed bandwidth or rate of service). A DOCSIS 1.0 cable modem could increase voice call quality by permanently reserving bandwidth for voice calls, but then that bandwidth would be wasted whenever a voice call is not in progress.

DOCSIS 1.0+

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

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

- Multiple SIDs per cable modem, creating separate service flows for voice and data traffic. This allows the CMTS and cable modem to give higher priority for voice traffic, preventing the data traffic from affecting the quality of the voice calls.
- Cable modem-initiated dynamic MAC messages—Dynamic Service Addition (DSA) and Dynamic Service Deletion (DSD). These messages allow dynamic SIDs to be created and deleted on demand, so that the bandwidth required for a voice call can be allocated at the time a call is placed and then freed up for other uses when the call is over.
- Unsolicited grant service (CBR-scheduling) on the upstream—This helps provide a higher-quality channel for upstream VoIP packets from an Integrated Telephony Cable Modem (ITCM) such as the Cisco uBR925 cable access router.

- Ability to provide separate downstream rates for any given cable modem, based on the IP-precedence value in the packet. This helps separate voice signaling and data traffic that goes to the same ITCM to address rate shaping purposes.
- Concatenation allows a cable modem to send several packets in one large burst, instead of having to make a separate grant request for each.

Caution All DOCSIS 1.0 extensions are available only when using a cable modem (such as the Cisco uBR924 cable access router) and CMTS (such as the Cisco uBR7200 series universal broadband router) that supports these extensions. The cable modem activates the use of the extensions by sending a dynamic MAC message. DOCSIS 1.0 cable modems continue to receive DOCSIS 1.0 treatment from the CMTS.

Interoperability with Different Versions of DOCSIS Networks

DOCSIS 1.1 cable modems have additional features and better performance than earlier DOCSIS 1.0 and 1.0+ models, but all three models can coexist in the same network. DOCSIS 1.0 and 1.0+ cable modems will not hamper the performance of a DOCSIS 1.1 CMTS, nor will they interfere with operation of DOCSIS 1.1 features.

Table 7-1 shows the interoperability of a DOCSIS 1.1 CMTS with different versions of cable modems.

Table 7-1 DOCSIS 1.1 Interoperability

For this configuration...	The result is...
DOCSIS 1.1 CMTS with DOCSIS 1.0 cable modems	DOCSIS 1.0 cable modems receive DOCSIS 1.0 features and capabilities. BPI is supported if available and enabled on the CMTS.
DOCSIS 1.1 CMTS with DOCSIS 1.0+ cable modems	DOCSIS 1.0+ cable modems receive basic DOCSIS 1.0 support. BPI is supported if available and enabled on the CMTS. In addition, DOCSIS 1.0+ cable modems also receive the following DOCSIS 1.1 features: • Multiple SIDs per cable modem • Dynamic service MAC messaging initiated by the cable modem • Unsolicited grant service (UGS, CBR-scheduling) on the upstream • Separate downstream rates for any given cable modem, based on the IP-precedence value • Concatenation
DOCSIS 1.1 CMTS with DOCSIS 1.1 cable modems	DOCSIS 1.1 cable modems receive all the DOCSIS 1.1 features listed in this document. BPI+ is supported if available and enabled on the CMTS.

Benefits

DOCSIS 1.1 includes a rich set of features that provide advanced and flexible QoS capabilities for various types of traffic (voice, data, and video) over the cable network. It also provides enhanced security and authentication features.

Baseline Privacy Interface Plus Enhancement

The Plus (+) version of the Baseline Privacy Interface (BPI+) in DOCSIS 1.1 provides a set of extended services within the MAC sublayer that increase performance and system security. Digital certificates provide secure authentication for each cable modem, to prevent identity theft on the basis of MAC and IP addresses. Advanced encryption provides a secure channel between the cable modem and CMTS, and secure software download allows a service provider to upgrade the software on cable modems, without the threat of interception, interference, or alteration of the software code.

Dynamic Service Flows

The dynamic creation, modification, and deletion of service flows allows for on-demand reservation on Layer 2 bandwidth resources. The CMTS can now provide special QoS to the cable modem dynamically for the duration of a voice call or video session, as opposed to the static provisioning and reservation of resources at the time of cable modem registration. This provides a more efficient use of the available bandwidth.

Concatenation

The cable modem concatenates multiple upstream packets into one larger MAC data frame, allowing the cable modem to make only one time-slot request for the entire concatenated MAC frame, as opposed to requesting a time slot for each packet. This reduces the delay in transferring the packet burst upstream.

Enhanced QoS

Extensive scheduling parameters allow the CMTS and the cable modem to communicate QoS requirements and achieve more sophisticated QoS on a per service-flow level.

Different new time-slot scheduling disciplines help in providing guaranteed delay and jitter bound on shared upstream. Activity detection helps to conserve link bandwidth by not issuing time slots for an inactive service flow. The conserved bandwidth can then be reused for other best-effort data slots.

Packet classification helps the CMTS and cable modem to isolate different types of traffic into different DOCSIS service flows. Each flow could be receiving a different QoS service from CMTS.

Fragmentation

Fragmentation splits large data packets so that they fit into the smaller time slots inbetween UGS slots. This reduces the jitter experienced by voice packets when large data packets are transmitted on the shared upstream channel and preempt the UGS slots used for voice.

Multiple Subflows per SID

This feature allows the cable modem to have multiple calls on a single hardware queue. This approach scales much better than requiring a separate SID hardware queue on the cable modem for each voice call.

Payload Header Suppression

Payload Header Suppression (PHS) allows the CMTS and cable modem to suppress repetitive or redundant portions in packet headers before transmitting on the DOCSIS link. This conserves link bandwidth, especially with types of traffic such as voice, where the header size tends to be as large as the size of the actual packet.

Service Classes

The use of the service class provides the following benefits for a DOCSIS 1.1 network:

- It allows operators to move the burden of configuring service flows from the provisioning server to the CMTS. Operators provision the modems with the service class name; the implementation of the name is configured at the CMTS. This allows operators to modify the implementation of a given service to local circumstances without changing modem provisioning. For example, some scheduling parameters might need to be set differently for two different CMTSs to provide the same service. As another example, service profiles could be changed by time of day.
- It allows CMTS vendors to provide class-based-queuing if they choose, where service flows compete within their class and classes compete with each other for bandwidth.
- It allows higher-layer protocols to create a service flow by its service class name. For example, telephony signaling might direct the cable modem to instantiate any available provisioned service flow of class G.711.

Note The service class is optional. The flow scheduling specification may always be provided in full; a service flow may belong to no service class whatsoever. CMTS implementations *may* treat such unclassed flows differently from classed flows with equivalent parameters.

How to Configure the Cisco CMTS for DOCSIS 1.1 Operations

See the following sections for the configuration tasks for DOCSIS 1.1 operations. Each task in the list is identified as either required or optional.

- Configuring Baseline Privacy Interface (optional), page 7-16
- Downloading the DOCSIS Root Certificate to the CMTS (required), page 7-19
- Adding a Manufacturer's Certificate as a Trusted Certificate (optional), page 7-22
- Adding a Manufacturer's or CM Certificate to the Hotlist (required), page 7-24
- Enabling Concatenation (optional), page 7-27
- Enabling DOCSIS Fragmentation (optional), page 7-28
- "Using Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems" section on page 7-29

Note This section describes only the configuration tasks that are specific for DOCSIS 1.1 operations. For complete configuration information, see the software configuration documents listed in the "Additional References" section on page 7-59.

Configuring Baseline Privacy Interface (optional)

BPI+ encryption is by default enabled for 56-bit DES encryption on all cable interfaces. If BPI+ encryption has been previously disabled, or if you want to reconfigure BPI+ encryption on a cable interface on the CMTS, use the following procedure.

Note If you have disabled BPI+ encryption on a cable interface, and a cable modem attempts to register on that interface using BPI+ encryption, the CMTS will reject its registration request, displaying a %UBR7200-4-SERVICE_PERMANENTLY_UNAVAILABLE error message. The **show cable modem** command will also show that this cable modem has been rejected with a MAC status of reject(c).

Prerequisites

BPI+ encryption is supported on all Cisco CMTS images that include “k1”, “k8”, or “k9” in its file name or BPI in the feature set description. All BPI images support 40-bit and 56-bit DES encryption.

By default, BPI+ encryption is enabled for 56-bit DES encryption. Also, when a cable modem is running DOCSIS 1.1 software, BPI+ encryption is enabled by default, unless the service provider has disabled it by setting the Privacy Enable field (TLV 29) in the DOCSIS configuration file to 0. Therefore, both the CMTS and cable modem are set to use BPI+ encryption when using the default configurations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface cable** *x/y*
4. **cable privacy**
5. **cable privacy 40-bit-des**
6. **cable privacy accept-self-signed-certificate**

Caution Cisco strongly recommends that this above command remain unconfigured, as it bypasses DOCSIS BPI+ certificates. Otherwise, self-signed certificates provide workaround registration for cable modems that are not compliant with DOCSIS BPI+ certificates. This functionality is strictly intended for troubleshooting of a short duration or in the context of additional security measures.

7. **cable privacy authenticate-modem**
8. **cable privacy authorize-multicast**
9. **cable privacy mandatory**
10. **cable privacy oaep-support**
11. **cable privacy kek** {**life-time** *seconds*}
12. **cable privacy tek** {**life-time** *seconds*}
13. **exit**
14. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**enable**
	
	Example:
	`Router> enable`
	`Router#`
		Enables privileged EXEC mode. Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	**interface cable** *x/y*
	
	Example:
	`Router(config)# interface cable 6/0`
	`Router(config-if)#`
		Enters interface configuration mode for the cable interface line card at this particular slot.

Step 4	**cable privacy**
	
	Example:
	`Router(config-if)# cable privacy`
	`Router(config-if)#`
		(Optional) Enables BPI+ 56-bit DES encryption on the cable interface (default).

Step 5	**cable privacy 40-bit-des**
	
	Example:
	`Router(config-if)# cable privacy 48-bit-des`
	`Router(config-if)#`
		(Optional) Enables BPI+ 40-bit DES encryption on the cable interface. Cisco does not recommend this option for production systems because 40-bit encryption is not as secure as the 56-bit DES or 168-bit 3DES encryption algorithms.

Step 6	**cable privacy accept-self-signed-certificate**
	
	Example:
	`Router(config-if)# cable privacy`
	`accept-self-signed-certificate`
	`Router(config-if)#`
		(Optional) Allows cable modems to register using self-signed manufacturer certificates, as opposed to the default of allowing only manufacturer's certificates that are chained to the DOCSIS root certificate.
		
		Caution Cisco strongly recommends that this command remain unconfigured, as it bypasses DOCSIS BPI+ certificates. Otherwise, self-signed certificates provide workaround registration for cable modems that are not compliant with DOCSIS BPI+ certificates. This functionality is strictly intended for troubleshooting of a short duration or in the context of additional security measures.
		
		Note By default, the CMTS does not accept self-signed certificates. In the default configuration, if a cable modem attempts to register with self-signed certificates, the CMTS will refuse to allow the cable modem to register.

	Command	Purpose

Step 7	**cable privacy authenticate-modem**
	
	Example:
	`Router(config-if)# cable privacy authenticate-modem`
	`Router(config-if)#`
		(Optional) Enables BPI+ encryption on the cable interface and uses the Cisco IOS Authentication, Authorization and Accounting (AAA) service together with BPI to authenticate the CMs.

Step 8	**cable privacy authorize-multicast**
	
	Example:
	`Router(config-if)# cable privacy authorize-multicast`
	`Router(config-if)#`
		(Optional) Enables BPI+ encryption on the cable interface and uses AAA protocols to authorize all multicast stream (IGMP) join requests.
		
		Note If you use this command to authorize multicast streams, you must also use the **cable privacy authenticate-modem** command to enable AAA services on the cable interface.

Step 9	**cable privacy mandatory**
	
	Example:
	`Router(config-if)# cable privacy mandatory`
	`Router(config-if)#`
		(Optional) Requires baseline privacy be active for all CMs with BPI/BPI+ enabled in the DOCSIS configuration files, else the CMs are forced to go offline.
		
		If a CM does not have BPI enabled in its DOCSIS configuration file, it will be allowed to come online without BPI.

Step 10	**cable privacy oaep-support**
	
	Example:
	`Router(config-if)# cable privacy oaep-support`
	`Router(config-if)#`
		(Optional) Enables BPI+ encryption on the cable interface and enables Optimal Asymmetric Encryption Padding (OAEP). This option is enabled by default. Disabling this option could have a performance impact.

Step 11	**cable privacy kek** {**life-time** *seconds*}
	
	Example:
	`Router(config-if)# cable privacy kek life-time 302400`
	`Router(config-if)#`
		(Optional) Configures the life-time values for the key encryption keys (KEKs) for BPI+ operations on all cable interfaces.
		
		• **life-time** *seconds*—The maximum amount of time, in seconds, that a KEK key can be considered valid. The valid range is 300 to 604,8000, with a default of 604,800 seconds (7 days).

Step 12	**cable privacy tek** {**life-time** *seconds*}
	
	Example:
	`Router(config-if)# cable privacy tek life-time 86400`
	`Router(config-if)#`
		(Optional) Configures the life-time values for the traffic encryption keys (TEKs) for BPI+ operations on all cable interfaces.
		
		• **life-time** *seconds*—The maximum amount of time, in seconds, that a TEK key can be considered valid. The valid range is 180 to 604,8000, with a default of 43,200 seconds (12 hours).

	Command	Purpose

Step 13	`exit`
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits interface configuration mode.
		
		Note Repeat steps Step 3 through Step 13 for each cable interface.

Step 14	`exit`
	
	Example:
	`Router(config)# exit`
	`Router#`
		Exits global configuration mode.

You can also configure the following additional timers for BPI+ operations in the DOCSIS configuration file for each cable modem. As a general rule, you do not need to specify these timers in the DOCSIS configuration file unless you have a specific reason for changing them from their default values.

Table 7-2 Individual Cable Modem BPI+ Timer Values

Timer	Description
Authorize Wait Timeout	The amount of time a cable modem will wait for a response from a CMTS when negotiating a KEK for the first time.
Reauthorize Wait Timeout	The amount of time a cable modem will wait for a response from a CMTS when negotiating a new KEK because the Authorization Key (KEK) lifetime is about to expire.
Authorize Reject Wait Timeout	The amount of time a cable modem must wait before attempting to negotiate a new KEK if the CMTS rejects its first attempt to negotiate a KEK.
Operational Wait Timeout	The amount of time a cable modem will wait for a response from a CMTS when negotiating a TEK for the first time.
Rekey Wait Timeout	The amount of time a cable modem will wait for a response from a CMTS when negotiating a new TEK because the TEK lifetime is about to expire.

Downloading the DOCSIS Root Certificate to the CMTS (required)

DOCSIS 1.1 allows cable modems to identify themselves using a manufacturer's chained X.509 digital certificate that is chained to the DOCSIS root certificate. The DOCSIS root certificate is already installed on the bootflash of the CMTS router. However, if you want to install another root certificate, for example, the Euro-Docsis certificate, download the certificate and save it on the bootflash as "euro-root-cert".

Tip For more information about the DOCSIS root certificate provided by Verisign, see the information at the following URL:

http://www.verisign.com/products/cable/index.html

Note This document previously claimed that the Cisco CMTS supports only one root certificate. This information has changed effective with Cisco IOS Release 12.3(9a)BC. In this IOS release and later releases in the 12.3 BC train, you may load the DOCSIS root certificate and a EuroDOCSIS or PacketCable root certificate. Cisco recommends that the EuroDOCSIS PacketCable root certificates be copied into bootflash.

In prior Cisco IOS Releases, with the prior limitation, EuroDOCSIS or PacketCable devices could still come online, however, if they used self-signed manufacturer's digital certificates.

To download the DOCSIS root certificate to the Cisco CMTS, which is required if any cable modems on the network are using chained certificates, use the following procedure:

Step 1 Download the DOCSIS root certificate from the DOCSIS certificate signer, Verisign. At the time of this document's printing, the DOCSIS root certificate is available for download at the following URL:

http://www.verisign.com/products/cable/root.html

Step 2 Verisign distributes the DOCSIS root certificate in a compressed ZIP archive file. Extract the DOCSIS root certificate from the archive and copy the certificate to a TFTP server that the CMTS can access.

Tip To avoid possible confusion with other certificates, keep the file's original filename of "CableLabs_DOCSIS.509" when saving it to the TFTP server.

Step 3 Log in to the Cisco CMTS using either a serial port connection or a Telnet connection. Enter the **enable** command and password to enter Privileged EXEC mode:

```
Router> enable

Password: <password>

Router#
```

Step 4 Use the **dir bootflash** command to verify that the bootflash has sufficient space for the DOCSIS root certificate (approximately 1,000 bytes of disk space):

```
Router# dir bootflash:

Directory of bootflash:/

    1  -rw-     3229188   Dec 30 2002 15:53:23  ubr7200-boot-mz.122-11.BC2.bin

3407872 bytes total (250824 bytes free)
Router#
```

Tip If you delete files from the bootflash to make room for the DOCSIS root certificate, remember to use the **squeeze** command to reclaim the free space from the deleted files.

Step 5 Use the **copy tftp bootflash** command to copy the DOCSIS root certificate to the router's bootflash memory. (The file must be named "root-cert" on the bootflash for the CMTS to recognize it as the root certificate.)

```
Router# copy tftp bootflash:
```

```
Address or name of remote host []? tftp-server-ip-address
Source filename []? CableLabs_DOCSIS.509
Destination filename [CableLabs_DOCSIS.509]? root-cert
Loading CableLabs_DOCSIS.509 from tftp-server-ip-address (via FastEthernet0/0): !
[OK - 996/1024 bytes]

996 bytes copied in 4.104 secs (249 bytes/sec)
Router#
```

Tip If you are using Cisco IOS Release 12.2(4)BC1 or later software release, you can also copy the root certificate to a PCMCIA Flash Disk (disk0 or disk1). However, because Flash Disks are unsecure and easily removed from the router, we recommend that you keep the root certificate in the bootflash for both operational and security reasons.

Step 6 Verify that the DOCSIS root certificate has been successfully copied to the bootflash memory:

```
Router# dir bootflash:

Directory of bootflash:/

    1  -rw-     3229188   Dec 30 2002 15:53:23  ubr7200-boot-mz.122-11.BC2.bin
    2  -rw-         996   Mar 06 2002 16:03:46  root-cert

3408876 bytes total (248696 zxbytes free)
Router#
```

Step 7 (Optional) After the first cable modem has registered using BPI+, you can use the **show crypto ca trustpoints** command to display the Root certificate that the CMTS has learned:

Note The **show crypto ca trustpoints** command does not display the root certificate until after at least one cable modem has registered with the CMTS using BPI+ encryption. Alternatively, you can use the unsupported command **test cable generate** in privileged EXEC mode to force the CMTS to register the root certificate.

```
Router# show crypto ca trustpoints

Root certificate
  Status: Available
  Certificate Serial Number: D54BB68FE934324F6B8FD0E41A65D867
  Key Usage: General Purpose
  Issuer:
    CN = DOCSIS Cable Modem Root Certificate Authority
     OU = Cable Modems
     O = Data Over Cable Service Interface Specifications
     C = US
  Subject Name:
    CN = "BPI Cable Modem Root Certificate Authority "
     OU = DOCSIS
     O = BPI
     C = US
  Validity Date:
    start date: 07:00:00 UTC Mar 27 2001
    end   date: 06:59:59 UTC Jan 1 2007
```

Tip To display all certificates (Root, Manufacturers, CM) that the CMTS has learned, use the **show crypto ca certificates** command.

Adding a Manufacturer's Certificate as a Trusted Certificate (optional)

To DOCSIS specifications allow operators to control which manufacturer's and CM certificates are allowed on each CMTS by marking them as either trusted or untrusted. You can add a certificate to the list of trusted certificates on the Cisco CMTS using either CLI commands or SNMP commands, as described in the following sections:

- Adding a Certificate as a Trusted Certificate Using the Command Line Interface, page 7-22
- Adding a Certificate as a Trusted Certificate Using SNMP Commands, page 7-23

Note Unless you cannot use SNMP to configure the cable modem, or have a particular application that requires the use of CLI commands to add certificates, you should also use the SNMP method to add certificates to a cable modem.

Adding a Certificate as a Trusted Certificate Using the Command Line Interface

To add a manufacturer's certificate to the list of trusted certificates on the CMTS, use the following procedure:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable privacy add-certificate manufacturer** *serial-number*
4. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**enable**
	
	Example:
	`Router> enable`
	`Router#`
		Enables privileged EXEC mode. Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

	Command	Purpose

Step 3	**cable privacy add-certificate manufacturer** *serial-number*
	
	Example:
	`Router(config)# cable privacy add-certificate manufacturer 000102`
	
	`Router(config)#`
		(Optional) Specifies the serial number of the manufacturer CA certificate to be added as a trusted certificate.

Step 4	**exit**
	
	Example:
	`Router(config)# exit`
	`Router#`
		Exits global configuration mode.

Adding a Certificate as a Trusted Certificate Using SNMP Commands

You can also use an SNMP manager to create and add certificates to the CMTS list of trusted certificates by manipulating the tables and attributes in the DOCS-BPI-PLUS-MIB. To add a manufacturer's certificate, add an entry to the docsBpi2CmtsCACertTable table. Specify the following attributes for each entry:

- docsBpi2CmtsCACertStatus—Set to 4 to create the row entry.
- docsBpi2CmtsCACert—The hexadecimal data, as an X509Certificate value, for the actual X.509 certificate.
- docsBpi2CmtsCACertTrust—An Integer value from 1 to 4 specifying the certificate's trust status: 1=trusted, 2=untrusted, 3= chained, 4=root. Specify 1 for certificates that should be trusted and 3 for chained certificates that should be verified with the root certificate.

Similarly, to add a CM certificate to the list of trusted certificates, add an entry to the docsBpi2CmtsProvisionedCmCertTable table. Specify the following attributes for each entry:

- docsBpi2CmtsProvisionedCmCertStatus—Set to 4 to create the row entry.
- docsBpi2CmtsProvisionedCmCert—The hexadecimal data, as an X509Certificate value, for the actual X.509 certificate.
- docsBpi2CmtsProvisionedCmCertTrust—An Integer value from 1 to 2 specifying the certificate's trust status: 1=trusted, 2=untrusted. Specify 1 for CM certificates that should be trusted.

Tip Always set the CertStatus attributes before loading the actual certificate data, because otherwise the CMTS will assume the certificate is chained and will immediately attempt to verify it with the manufacturers and root certificates.

For example, to use the Unix command-line SNMP utility to add a manufacturer's certificate to the list of trusted certificates on the CMTS at IP address 192.168.100.134, enter the following command (be sure to substitute a valid index pointer for the table entry for the <*index*> value).

```
% setany -v2c 192.168.100.134 private docsBpi2CmtsCACertStatus.<index> -i 4
docsBpi2CmtsCACert.<index> -o '<hex_data>' docsBpi2CmtsCACertTrust.<index> -i 1
```

To do the same thing for a CM certificate, use the following command:

```
% setany -v2c 192.168.100.134 private docsBpi2CmtsProvisionedCmCertStatus.<index> -i 4
docsBpi2CmtsProvisionedCmCert.<index> -o '<hex_data>'
docsBpi2CmtsProvisionedCmCertTrust.<index> -i 1
```

Tip Most operating systems cannot accept input lines that are as long as needed to input the hexadecimal decimal string that specifies a certificate. For this reason, you should use a graphical SNMP manager to set these attributes. For a number of certificates, you can also use a script file, if more convenient.

Note If you are adding self-signed certificates, you must also use the **cable privacy accept-self-signed-certificate** command before the CMTS will accept the certificates.

Adding a Manufacturer's or CM Certificate to the Hotlist (required)

The DOCSIS specifications allow operators to add a digital mnufacturer's or CM certificate to a hotlist (also known as the certificate revocation list, or CRL) on the CMTS, to indicate that this particular certificate should no longer be accepted. This might be done when a user reports that their cable modem has been stolen, or when the service provider decides not to support a particular manufacturer's brand of cable modems.

You can add a certificate to the hotlist on the Cisco CMTS using either CLI commands or SNMP commands, as described in the following sections:

- Adding a Certificate to the Hotlist Using the Command Line Interface, page 7-24
- Adding a Certificate to the Hotlist Using SNMP Commands, page 7-26

Note Unless you cannot use SNMP to configure the cable modem, or have a particular application that requires the use of CLI commands to add certificates, you should also use the SNMP method to add certificates to a cable modem.

Adding a Certificate to the Hotlist Using the Command Line Interface

To add a manufacturer's or CM certificate to the certificate hotlist on a Cisco uBR7100 series or Cisco uBR7200 series router, use the following procedure.

Note This procedure is not supported on the Cisco uBR10012 router running Cisco IOS releases prior to Cisco IOS release 12.3(23)BC9, Cisco IOS release 12.2(33)SCB5, and Cisco IOS release12.2(33)SCC.

Use the following section, Adding a Certificate to the Hotlist Using SNMP Commands, page 7-26, to add certificates to the hotlist on the Cisco uBR10012 router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cable privacy hotlist cm** *mac-address*

4. **cable privacy hotlist manufacturer** *certificate-serial-number*
5. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**enable**
	
	Example:
	`Router> enable`
	`Router#`
		Enables privileged EXEC mode. Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	**cable privacy hotlist cm** *mac-address*
	
	Example:
	`Router(config)# cable privacy hotlist cm 00C0.0102.0304`
	`Router(config)#`
		(Optional) Adds a CM certificate with the specified MAC address to the certificate hotlist. The *mac-address* is specified as a string of six hexadecimal digits.

Step 4	**cable privacy hotlist manufacturer** *certificate-serial-number*
	
	Example:
	`Router(config)# cable privacy hotlist manufacturer 010A0BC304DFEE1CA98371`
	`Router(config)#`
		Adds a manufacturer's certificate with the specified serial number to the certificate hotlist. The *certificate-serial-number* is specified as a string of hexadecimal digits. You can optionally use spaces between the digits as separators.

Step 5	**exit**
	
	Example:
	`Router(config)# exit`
	`Router#`
		Exits global configuration mode.

Cable modems that are using a MAC address or manufacturer's certificate that matches one in the hotlist will not be allowed to register. For example, the following command will put the CM with the MAC address of 0000.0C0A.0B0C in the hotlist and prevent it from registering on any cable interface:

```
Router# config terminal
Router(config)# cable privacy hotlist cm 00 00 0C 0a 0b 0c
Oct 31 13:06:29.112:  Successfully added CM hotlist 0000.0C0A.0B0C

Router#
```

The following command will put the manufacturer's certificate with the indicated serial number in the hotlist, preventing any cable modem that uses that manufacturer's certificate from registering:

```
Router(config)# cable privacy hotlist manufacturer 00 90 83 00 00 00 00 01
Oct 31 13:06:34.478:  Successfully added MFG hotlist 00 90 83 00 00 00 00 01

Router(config)# exit
```

```
Router#
```

To remove a cable modem or certificate from the hotlist, add the **no** prefix to the command. For example:

```
Router# config terminal
Router(config)# no cable privacy hotlist cm 00 00 0C 0a 0b 0c
Router(config)# no cable privacy hotlist manufacturer 00 90 83 00 00 00 00 01
Router(config)# exit
Router#
```

Adding a Certificate to the Hotlist Using SNMP Commands

You can also use an SNMP manager to create and add certificates to the hotlist by manipulating the tables and attributes in the DOCS-BPI-PLUS-MIB. To add a manufacturer's certificate, add an entry to the docsBpi2CmtsCACertTable table. Specify the following attributes for each entry:

- docsBpi2CmtsCACertStatus—Set to 4 to create the row entry.
- docsBpi2CmtsCACert—The hexadecimal data, as an X509Certificate value, for the actual X.509 certificate.
- docsBpi2CmtsCACertTrust—An Integer value from 1 to 4 specifying the certificate's trust status: 1=trusted, 2=untrusted, 3= chained, 4=root. When adding a certificate to the hotlist, set this attribute to 2 for untrusted.

Similarly, to add a CM certificate to the hotlist, add an entry to the docsBpi2CmtsProvisionedCmCertTable table. Specify the following attributes for each entry:

- docsBpi2CmtsProvisionedCmCertStatus—Set to 4 to create the row entry.
- docsBpi2CmtsProvisionedCmCert—The hexadecimal data, as an X509Certificate value, for the actual X.509 certificate.
- docsBpi2CmtsProvisionedCmCertTrust—An Integer value from 1 to 2 specifying the certificate's trust status: 1=trusted, 2=untrusted. When adding a certificate to the hotlist, set this attribute to 2 for untrusted.

Tip Always set the CertStatus attributes before loading the actual certificate data, because otherwise the CMTS will assume the certificate is chained and will immediately attempt to verify it with the manufacturers and root certificates.

Note This procedure is identical to the one given for adding a certificate as a trusted certificate in the "Adding a Certificate as a Trusted Certificate Using SNMP Commands" section on page 7-23, except that the docsBpi2CmtsProvisionedCmCertTrust attribute is set to 2 instead of 1.

For example, to use the Unix command-line SNMP utility to add a manufacturer's certificate to the hotlist on the CMTS at IP address 192.168.100.113, enter the following command (be sure to substitute a valid index pointer for the table entry for the <*index*> value).

```
% setany -v2c 192.168.100.113 private docsBpi2CmtsCACertStatus.<index> -i 4
docsBpi2CmtsCACert.<index> -o '<hex_data>' docsBpi2CmtsCACertTrust.<index> -i 2
```

To do the same thing for a CM certificate, use the following command:

```
% setany -v2c 192.168.100.113 private docsBpi2CmtsProvisionedCmCertStatus.<index> -i 4
docsBpi2CmtsProvisionedCmCert.<index> -o '<hex_data>'
docsBpi2CmtsProvisionedCmCertTrust.<index> -i 2
```

Tip Most operating systems cannot accept input lines that are as long as needed to input the hexadecimal decimal string that specifies a certificate. For this reason, you should use a graphical SNMP manager to set these attributes. For a number of certificates, you can also use a script file, if more convenient.

Enabling Concatenation (optional)

To enable concatenation for one or more upstreams on a cable interface (which is the default configuration), use the following procedure:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface cable** *x/y*
4. **cable upstream** *n* **concatenation**
5. **exit**
6. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**enable**
	
	Example:
	`Router> enable`
	`Router#`
		Enables privileged EXEC mode. Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	**interface cable** *x/y*
	
	Example:
	`Router(config)# interface cable 6/0`
	`Router(config-if)#`
		Enters interface configuration mode for the cable interface line card at this particular slot.

Step 4	**cable upstream** *n* **concatenation**
	
	Example:
	`Router(config-if)# cable upstream 0 concatenation`
	`Router(config-if)# cable upstream 1 concatenation`
	`Router(config-if)#`
		Enables concatenation for the specified upstream on the cable interface.
		Note Repeat this command for each upstream on the interface.

	Command	Purpose

Step 5	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits interface configuration mode.

Step 6	**exit**
	
	Example:
	`Router(config)# exit`
	`Router#`
		Exits global configuration mode.

Enabling DOCSIS Fragmentation (optional)

To enable DOCSIS fragmentation for one or more upstreams on a cable interface (which is the default configuration), use the following procedure:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface cable** *x/y*
4. **cable upstream** *n* **fragmentation**
5. **cable upstream** *n* **unfrag-slot-jitter** [**limit** *jitter* | **cac-enforce**]
6. **exit**
7. **exit**

DETAILED STEPS

	Command	Purpose

Step 1	**enable**
	
	Example:
	`Router> enable`
	`Router#`
		Enables privileged EXEC mode. Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	**interface cable** *x/y*
	
	Example:
	`Router(config)#`
	`Router(config-if)#`
		Enters interface configuration mode for the cable interface line card at this particular slot.

	Command	Purpose

Step 4	**cable upstream** *n* **fragmentation**
	
	Example:
	`Router(config-if)# cable upstream 2 fragmentation`
	`Router(config-if)# cable upstream 3 fragmentation`
	`Router(config-if)#`
		Enables fragmentation for the specified upstream on the cable interface.
		
		Note Repeat this command for each upstream on the interface.

Step 5	**cable upstream** *n* **unfrag-slot-jitter** [**limit** *jitter* | **cac-enforce**]
	
	Example:
	`Router(config-if)# cable upstream 0 unfrag-slot-jitter limit 2000 cac-enforce`
	`Router(config-if)#`
		(Optional) Specifies the amount of jitter that can be tolerated on the upstream due to unfragmentable slots. The **limit** option specifies the allowable *jitter* limit in microseconds (0 to 4,294,967,295. The **cac-enforce** option configures the upstream so that it rejects service flows requesting jitter less than the fragmentable slot jitter.
		
		Note By default, *jitter* is set to a limit of 0 microseconds, and the **cac-enforce** option is enabled.

Step 6	**exit**
	
	Example:
	`Router(config-if)# exit`
	`Router(config)#`
		Exits interface configuration mode.

Step 7	**exit**
	
	Example:
	`Router(config)# exit`
	`Router#`
		Exits global configuration mode.

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

This section contains the following procedures, and related commands:

- Configuring Downstream ERBA Settings for DOCSIS 1.0 Cable Modems, page 7-30

Cisco IOS release 12.3(13a)BC introduces Enhanced Rate Bandwidth Allocation (ERBA) support for DOCSIS 1.0 cable modems on the Cisco uBR7246VXR router. Cisco IOS release 12.3(21)BC extends this support to the Cisco uBR10012 router with Performance Routing Engine 2 modules.

Note Cisco IOS release 12.2(33)SCB modifies the ERBA support to the Cisco uBR10012 router with the DOCSIS WFQ Scheduler feature. For information on modification of this support, refer to *DOCSIS WFQ Scheduler on the Cisco CMTS Routers* at the following location: http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/ubr_docsis_wfq_sch.html#wp1085732

ERBA allows DOCSIS1.0 modems to burst their temporary transmission rate up to the full line rate for short durations of time. This capability provides higher bandwidth for instantaneous bandwidth requests, such as those in Internet downloads, without having to make changes to existing service levels in the QoS Profile.

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

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

ERBA for DOCSIS 1.0 cable modems is supported with these new or enhanced commands or keywords:

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

Configuring Downstream ERBA Settings for DOCSIS 1.0 Cable Modems

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

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

no cable qos pro max-ds-burst

Syntax Description

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

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

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

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

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

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

```
50  0    0         0         96000      0     0xFF 0x0   mgmt    no    no
51  0    0         0         97000      0     0xFF 0x0   mgmt    no    no
```

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

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

Usage Guidelines

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

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

```
03 (Net Access Control)         = 1

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

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

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

To change these settings, two or more traffic profiles are defined, with differing downstream QoS settings as desired. Table 7-3 provides two examples of such QoS profiles for illustration:

Table 7-3 Sample QoS Profiles with Differing ERBA (Maximum Downstream) Settings

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

In this scenario, both QoS profiles are identical except for the max-ds-burst size, which is set to 4000 in QoS profile 101 and 5000 in QoS profile 102.

Optimal Settings for DOCSIS 1.0 Downstream Powerburst

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

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

For individual flows, a larger burst size is likely to be better. As long as the system is not congested, a large burst size reduces the chances of two flows transmitting at the same time, because each burst is likely to take less time to transmit.

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

- *Cisco Broadband Cable Command Reference Guide*

  http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html

Enabling DOCSIS 1.1 Downstream Maximum Transmit Burst on the Cisco uBR10012 Router

Cisco IOS Release 12.3(21)BC introduces the ERBA feature on the Cisco uBR10012 CMTS with Performance Routing Engine 2 (PRE2) modules. The ERBA feature in Cisco IOS release 12.3(21)BC is characterized by the following enhancements:

- Enables support for the DOCSIS1.1 *Downstream Maximum Transmit Burst* parameter on the Cisco CMTS by using th e **cable ds-max-burst** configuration command. This command is not required on the Cisco uBR7225VXR, Cisco uBR7246VXR and the Cisco uBR7100 Series routers, as this parameter is supported by default.
- Allows DOCSIS1.0 modems to support the DOCSIS1.1 *Downstream Maximum Transmit Burst* parameter by mapping DOCSIS1.0 modems to overriding DOCSIS 1.1 QoS profile parameters on the Cisco CMTS.

For command reference information for the **cable ds-max-burst** commands on the Cisco CMTS, refer to the *Cisco Broadband Cable Command Reference Guide* on Cisco.com:

- **cable ds-max-burst**

  http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_03_cable_d.html#wp1061392

In Cisco IOS Release 12.3(33)SCB1, the peak rate option through the named service class was added for DOCSIS 1.1 compliant modems. The peak rate value is added to all the service flows that are created after the **cable ds-max burst** command is configured. The default value is zero and it represents the line card.

If the DOCSIS 3.0 TLV 25.27 is specified for a service flow, the peak-rate value is set as the TLV value.

The peak-rate value can also be configured through **cable service class** command which forms part of the service class template. During modem registration or Dynamic Service Addition (DSA) operation, the service class name TLV 25.4 is sent to create the static or dynamic downstream service flow that matches the service class template. These downstream service flows are created with a specific peak-rate. If the peak-rate is not specified, then the value specified by the cable ds-max-burst command is used.

If a service flow has both service class and TLV 25.27 defined peak-rate, then the peak-rate value specified in the TLV is used.

Perform the following steps to configure ERBA on the Cisco uBR10012 router with PRE2 or PRE4 modules and Cisco IOS Release 12.3(21)BC or Cisco IOS Release 12.2(33)SCB or later releases. This procedure and the associated commands are subject to the guidelines and restrictions cited in this document.

Restrictions

The **cable ds-max-burst** and related commands are supported strictly on the Cisco uBR10012 router with PRE2 or PRE4 modules and Cisco IOS Release 12.3(21)BC or Cisco IOS Release 12.2(33)SCB or later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. [**no**] **cable ds-max-burst** [**burst-threshold** *threshold*] [**peak-rate** *peak-rate*]
4. **Ctrl^Z**
5. **show cr10k-rp cable** *slot/subslot/port* **sid service-flow ds**

DETAILED STEPS

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

Step 2	**configure terminal**
	Example:
	`Router# configure terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	[**no**] **cable ds-max-burst** [**burst-threshold** *threshold*][**peak-rate** *peak-rate*] **Example:** `Router(config)# cable ds-max-burst burst-threshold 2048 peak-rate 1000`	Enables the support for DOCSIS 1.1 downstream max burst. To remove this configuration, use the **no** form of this command. • **burst-threshold** *threshold*—Optional keyword and value defines the burst threshold in Kbytes, with a valid range from 64 Kbyte to 2 GB. By default, this setting is 1MB. This value is used to compare with the per-service flow maximum traffic burst value as defined in DOCSIS 2.0. • **peak-rate** *peak-rate*—Peak rate in kbps. The default value of peak-rate is zero, which represents the line rate. The peak-rate value is a global value and is applied to all the service flows created after the configuration of **cable ds-max-burst** command.

	Command or Action	Purpose

Step 4	**Ctrl^Z**
	
	Example:
	`Router(config)# Ctrl^Z`
	`Router#`
		Returns to privileged EXEC mode.

Step 5	**show cr10k-rp cable** *slot/subslot/port* **sid service-flow ds** **Example:** `Router(config)# show cr10k-rp cable 6/1/0 sid service-flow ds`	Displays service flows on the Cisco uBR10012 router with PRE2 or PRE4, and identifies which service flows have maximum burst enabled. • *slot* = 5 to 8 • *subslot* = 0 or 1 • *port* = 0 to 4 (depending on the cable interface)

Examples

When this feature is enabled, new service flows with burst size larger than the burst threshold are supported. However, the existing service flows are not affected.

When this feature is disabled, no new service flows are configured with the *Downstream Maximum Transmit Burst* parameter—the **cable ds-max-burst** command settings. However, the existing service flows are not affected.

The following example illustrates the **cable ds max-burst** command on the Cisco uBR10012 router in Cisco IOS Release 12.3(21)BC:

```
Router(config)# cable ds-max-burst burst-threshold 2048
```

The following example illustrates configuration of the ERBA maximum burst for the specified service flow:

```
Router# sh cr10k-rp c7/0/0 1 service-flow ds
RP SFID  LC SFID   Conform   Conform    Exceed    Exceed    Total   Total   QID
Bytes    Pkts      Bytes     Pkts       Bytes     Pkts

32781    4         538       1        0           0          538    1       279    #
32782    4         0         0        0           0          0      0       0
#: DS max burst enabled
```

The following example illustrates the **cable ds max-burst** command on the Cisco uBR10012 router in Cisco IOS Release 12.2(33)SCB:

```
Router(config)# cable ds-max-burst burst-threshold 2048 peak-rate 1000
```

The following example illustrates configuration of the ERBA maximum burst for the specified service flow:

```
Router# sh cr10k-rp c7/0/0 1 service-flow ds
RP SFID  LC SFID  Conform    Exceed     Conform    Exceed     Total      QID
                  Xmit Pkts  Xmit Pkts  Drop Pkts  Drop Pkts  Pkts
32930    10       41         0          0          0          41         131349
Forwarding interface: Modular-Cable1/0/0:0
32931    13       0          0          0          0          0          131350
Forwarding interface: Modular-Cable1/0/0:0
```

Monitoring DOCSIS Operations

The following sections describe the commands that provide information about the DOCSIS network and its cable modems, the RF network and cable interfaces on the CMTS, and BPI+ operations.

- Monitoring the DOCSIS Network, page 7-35
- Monitoring the RF Network and Cable Interfaces, page 7-40
- Monitoring BPI+ Operations, page 7-44

Monitoring the DOCSIS Network

The **show cable modem** command is the primary command to display the current state of cable modems and the DOCSIS network. This command has many options that provide information on different aspects of DOCSIS operations.

- Displaying the Status of Cable Modems, page 7-35
- Displaying a Summary Report for the Cable Modems, page 7-38
- Displaying the Capabilities of the Cable Modems, page 7-39
- Displaying Detailed Information About a Particular Cable Modem, page 7-39

Tip For a complete description of the **show cable modem** command and its options, see the "Cisco Cable Modem Termination System Commands" chapter in the *Cisco Broadband Cable Command Reference Guide* (see "Additional References" section on page 7-59).

Displaying the Status of Cable Modems

The following sample output from the **show cable modem** command shows a list of known cable modems and their current status.

```
Router# show cable modems
MAC Address    IP Address      I/F       MAC         Prim RxPwr  Timing  Num BPI
                                         State       Sid  (db)   Offset  CPE Enb
0010.9507.01db 144.205.151.130 C5/1/0/U5 online(pt)  1     0.25    938   1    Y
0080.37b8.e99b 144.205.151.131 C5/1/0/U5 online      2    -0.25   1268   0    N
0002.fdfa.12ef 144.205.151.232 C6/1/0/U0 online(pt)  13   -0.25   1920   1    Y
0002.fdfa.137d 144.205.151.160 C6/1/0/U0 online      16   -0.50   1920   1    N
0003.e38f.e9ab 144.205.151.237 C6/1/0/U0 online      3    -0.50   1926   1    N
0003.e3a6.8173 144.205.151.179 C6/1/1/U2 offline     4     0.50   1929   0    N
0003.e3a6.8195 144.205.151.219 C6/1/1/U2 online(pt)  22   -0.50   1929   1    Y
0006.28dc.37fd 144.205.151.244 C6/1/1/U2 online(pt)  61    0.00   1925   2    Y
0006.28e9.81c9 144.205.151.138 C6/1/1/U2 online(pt)  2    !0.75   1925   1    Y
0006.28f9.8bbd 144.205.151.134 C6/1/1/U2 #online     25   -0.25   1924   1    N
0002.fdfa.12db 144.205.151.234 C7/0/0/U0 online      15   -0.75   1914   1    N
0002.fdfa.138d 144.205.151.140 C7/0/0/U5 online      4     0.00   1917   1    N
0003.e38f.e85b 144.205.151.214 C7/0/0/U5 online      17   *0.25   1919   1    N

Router#
```

You can also display a particular cable modem by specifying its MAC address or IP address with the **show cable modem** command. If you specify the MAC address or IP address for a CPE device, the command will display the information for the cable modem that is associated with that device.

Note If the CPE IP address is no longer associated with a cable modem, the **show cable modem** command might not display information about the cable modem. To display the IP address of the CPE device for the cable modem, use the **clear cable host ip-address** command to clear the IP address of the modem from the router database, and then enter the **ping docsis mac-address** command, which resolves the MAC address by sending the DOCSIS ping to the CM.

```
Router# show cable modem 0010.7bb3.fcd1

MAC Address    IP Address      I/F     MAC         Prim RxPwr Timing Num  BPI
                                       State       Sid  (db)  Offset CPEs Enbld
0010.7bb3.fcd1 10.20.113.2     C5/0/U5 online      1    0.00  1624   0    yes

Router#
```

To display a list of cable modems sorted by their manufacturer, use the **vendor** option.

```
Router# show cable modem vendor

Vendor     MAC Address    I/F       MAC         Prim  RxPwr  Timing  Num BPI
                                    State       Sid   (db)   Offset  CPE Enb
Thomson    0010.9507.01db C5/1/0/U5 online      1     0.00    938   1    N
Ericsson   0080.37b8.e99b C5/1/0/U5 online      2     -0.25   1268  0    N
Cisco      0002.fdfa.12ef C6/1/0/U0 online      13    0.00    1920  1    N
Cisco      0002.fdfa.137d C6/1/0/U0 online      16    -0.50   1920  1    N
Cisco      0003.e38f.e9ab C6/1/0/U0 online      3     -0.25   1926  1    N
Cisco      0003.e3a6.7f69 C6/1/0/U0 online      15    0.50    1927  1    N
Cisco      0003.e3a6.816d C6/1/0/U0 online      4     0.00    1929  1    N
Cisco      0006.28f9.8be5 C6/1/0/U0 online      12    0.75    1922  1    N
Cisco      0001.9659.519f C6/1/1/U2 online      26    0.25    1930  1    N
Cisco      0002.b96f.fdbb C6/1/1/U2 online      29    -0.75   1929  1    N
Cisco      0002.b96f.fdf9 C6/1/1/U2 online      39    -0.50   1931  1    N
Cisco      0002.fdfa.12e9 C6/1/1/U2 online      5     -0.25   1925  1    N
Motorola   0020.4005.3f06 C7/0/0/U0 online      2     0.00    1901  1    N
Motorola   0020.4006.b010 C7/0/0/U5 online      3     0.25    1901  1    N
Cisco      0050.7302.3d83 C7/0/0/U0 online      18    -0.25   1543  1    N
Cisco      00b0.6478.ae8d C7/0/0/U5 online      44    0.50    1920  21   N
Cisco      00d0.bad3.c0cd C7/0/0/U5 online      19    0.00    1543  1    N

Router#
```

The MAC state field in each of these displays shows the current state of the cable modem:

Table 7-4 Descriptions for the MAC State Field

MAC State Value	Description
Registration and Provisioning Status Conditions	
init(r1)	The CM sent initial ranging.
init(r2)	The CM is ranging. The CMTS received initial ranging from the Cm and has sent RF power, timing offset, and frequency adjustments to the CM.
init(rc)	Ranging has completed.
init(d)	The DHCP request was received. This also indicates that the first IP broadcast packet has been received from the CM.
init(i)	The DHCP reply was received and the IP address has been assigned, but the CM has not yet replied with an IP packet.

Table 7-4 Descriptions for the MAC State Field (continued)

MAC State Value	Description
init(o)	The CM has begun to download the option file (DOCSIS configuration file) using the Trivial File Transfer Protocol (TFTP), as specified in the DHCP response. If the CM remains in this state, it indicates that the download has failed.
init(t)	Time-of-day (TOD) exchange has started.
resetting	The CM is being reset and will shortly restart the registration process.
Non-error Status Conditions	
offline	The CM is considered offline (disconnected or powered down).
online	The CM has registered and is enabled to pass data on the network.
online(d)	The CM registered, but network access for the CM has been disabled through the DOCSIS configuration file.
online(pk)	The CM registered, BPI is enabled and KEK is assigned.
online(pt)	The CM registered, BPI is enabled and TEK is assigned. BPI encryption is now being performed.
expire(pk)	The Cm registered, BPI is enabled, KEK was assigned but has since expired.
expire(pt)	The Cm registered, BPI is enabled, TEK was assigned but has since expired.
Error Status Conditions	
reject(m)	The CM attempted to register but registration was refused due to a bad Message Integrity Check (MIC) value. This also could indicate that the shared secret in the DOCSIS configuration file does not match the value configured on the CMTS with the **cable shared-secret** command. In Cisco IOS Release 12.1(11b)EC1 and Cisco IOS Release 12.2(8)BC2 or later releases, this could also indicate that the **cable tftp-enforce** command has been used to require that a CM attempt a TFTP download of the DOCSIS configuration file before registering, but the CM did not do so.
reject(c)	The CM attempted to register, but registration was refused due to a a number of possible errors: • The CM attempted to register with a minimum guaranteed upstream bandwidth that would exceed the limits imposed by the **cable upstream admission-control** command. • The CM has been disabled because of a security violation. • A bad class of service (COS) value in the DOCSIS configuration file. • The CM attempted to create a new COS configuration but the CMTS is configured to not permit such changes.
reject(pk)	KEK key assignment is rejected, BPI encryption has not been established.
reject(pt)	TEK key assignment is rejected, BPI encryption has not been established.
reject(ts)	The CM attempted to register, but registration failed because the TFTP server timestamp in the CM registration request did not match the timestamp maintained by the CMTS. This might indicate that the CM attempted to register by replaying an old DOCSIS configuration file used during a prior registration attempt.

Table 7-4 Descriptions for the MAC State Field (continued)

MAC State Value	Description
reject(ip)	The CM attempted to register, but registration failed because the IP address in the CM request did not match the IP address that the TFTP server recorded when it sent the DOCSIS configuration file to the CM. IP spoofing could be occurring.
reject(na)	The CM attempted to register, but registration failed because the CM did not send a Registration-Acknowledgement (REG-ACK) message in reply to the Registration-Response (REG-RSP) message sent by the CMTS. A Registration-NonAcknowledgement (REG-NACK) is assumed.

Displaying a Summary Report for the Cable Modems

The **show cable modem** command also can provide a summary report of the cable modems by using the **summary** and **total** options.

```
Router# show cable modem summary
Interface                     Cable Modem
                    Total Registered Unregistered Offline
Cable5/1/0/U5       2     2          0            0
Cable6/1/0/U0       14    13         1            0
Cable6/1/1/U2       14    14         0            0
Cable7/0/0/U0       2     2          0            0
Cable7/0/0/U5       4     3          1            1

Router# show cable modem summary total
Interface                     Cable Modem
                    Total Registered Unregistered Offline
Cable5/1/0/U5       2     2          0            0
Cable6/1/0/U0       14    13         1            0
Cable6/1/1/U2       14    14         0            0
Cable7/0/0/U0       2     2          0            0
Cable7/0/0/U5       4     3          1            1

Total:              36    34         2            1

Router#
```

You can also use the **summary** and **total** options to display information for a single interface or a range of interfaces.

```
Router# show cable modem summary c5/0 total

Interface     Total      Active      Registered
              Modems     Modems      Modems
Cable5/0/U0   294         272         271
Cable5/0/U1   256         248         246
Cable5/0/U2   196         194         194

Total:        746         714         711
```

```
Router# show cable modem summary c6/1/1 c7/0/0 total

Interface                      Cable Modem
                    Total Registered Unregistered Offline
Cable6/1/1/U2       14    14         0            0
Cable7/0/0/U0       2     2          0            0
Cable7/0/0/U5       4     3          1            1

Total:              20    19         1            1
```

Displaying the Capabilities of the Cable Modems

To display the capabilities and current DOCSIS provisioning for cable modems, use the **mac** option.

```
Router# show cable modem mac

MAC Address    MAC          Prim  Ver     Prov    Frag  Concat PHS   Priv  DS    US
               State        Sid                                             Saids Sids
0010.64ff.e4ad online       1     DOC1.1  DOC1.0 yes   yes    yes   BPI+  0     4
0010.f025.1bd9 init(rc)     2     DOC1.0  DOC1.0 no    no     no    BPI   0     0
0010.9659.4447 online(pt)   3     DOC1.0  DOC1.0 no    yes    no    BPI   0     0
0010.9659.4461 online(pt)   4     DOC1.0  DOC1.0 no    yes    no    BPI   0     0
0010.64ff.e459 online       5     DOC1.0  DOC1.0 no    yes    no    BPI   0     0
0020.4089.7ed6 online       6     DOC1.0  DOC1.0 no    no     no    BPI   0     0
0090.9607.3831 online(pt)   7     DOC1.0  DOC1.0 no    no     no    BPI   0     0
0090.9607.3830 online(pt)   1     DOC1.0  DOC1.0 no    no     no    BPI   0     0
0050.7366.12fb init(i)      2     DOC1.0  DOC1.0 no    no     no    BPI   0     0
0010.fdfa.0a35 online(pt)   3     DOC1.1  DOC1.1 yes   yes    yes   BPI+  0     4

Router#
```

To get a summary report of the cable modems and their capabilities, use the **mac** option with the **summary** and **total** options.

```
Router# show cable modem mac summary total

                          Cable Modem Summary
                          -------------------
                      Mac Version                    Provision Mode
Interface       Total   DOC1.1  DOC1.0   Reg/Online   DOC1.1       DOC1.0
Cable5/1/0/U5   1       0       1        1            0            1
Cable6/1/0/U0   11      0       11       8            0            8
Cable6/1/1/U2   17      1       16       15           0            15
Cable7/0/0/U0   2       0       2        1            0            1
Cable7/0/0/U5   1       0       1        0            0            0

Total:          32      1       31       25           0            25

Router#
```

Displaying Detailed Information About a Particular Cable Modem

Several options for the show cable modem command display detailed information about a particular cable modem (as identified by its MAC address). The **verbose** option displays the most comprehensive output.

```
Router# show cable modem 0010.7bb3.fcd1 verbose

MAC Address                     : 0010.7bb3.fcd1
IP Address                      : 10.20.113.2
Prim Sid                        : 1
```

```
Interface                          : C5/0/U5
Upstream Power                     : 0 dBmV (SNR = 33.25 dBmV)
Downstream Power                   : 0 dBmV (SNR = ----- dBmV)
Timing Offset                      : 1624
Received Power                     :   0.25
MAC Version                        : DOC1.0
Capabilities                       : {Frag=N, Concat=N, PHS=N, Priv=BPI}
Sid/Said Limit                     : {Max Us Sids=0, Max Ds Saids=0}
Optional Filtering Support         : {802.1P=N, 802.1Q=N}
Transmit Equalizer Support         : {Taps/Symbol= 0, Num of Taps= 0}
Number of CPEs                     : 0(Max CPEs = 0)
Flaps                              : 373(Jun 1  13:11:01)
Errors                             : 0 CRCs, 0 HCSes
Stn Mtn Failures                   : 0 aborts, 3 exhausted
Total US Flows                     : 1(1 active)
Total DS Flows                     : 1(1 active)
Total US Data                      : 1452082 packets, 171344434 bytes
Total US Throughput                : 0 bits/sec, 0 packets/sec
Total DS Data                      : 1452073 packets, 171343858 bytes
Total DS Throughput                : 0 bits/sec, 0 packets/sec

Router#
```

The **connectivity** and **maintenance** options also provide information that can be useful in troubleshooting problems with a particular cable modem.

The following example shows sample output for the **maintenance** option for a particular CM:

```
Router# show cable modem 0010.7bb3.fcd1 connectivity

Prim  1st time    Times  %online     Online time            Offline time
Sid   online      Online           min     avg     max     min     avg     max
1     May 30 2000 4      99.85    48:20   11h34m  1d2h23m 00:01   00:59   03:00

Router# show cable modem 0010.7bb3.fcd1 maintenance

MAC Address    I/F         Prim  SM Exhausted          SM Aborted
                           Sid   Count Time            Count Time
0010.7bb3.fcd1 C5/0/U5     1     3     Jun 1  10:24:52 0     Jan 1  00:00:00

Router#
```

Monitoring the RF Network and Cable Interfaces

You can use the **show interface cable** command to display information about the operation of the RF network and the cable interfaces on the CMTS.

- Displaying Information About the Mac Scheduler, page 7-41
- Displaying Information About QoS Parameter Sets, page 7-41
- Displaying Information About Service Flows, page 7-42
- Displaying Information About Service IDs, page 7-43

Tip For a complete description of the **show cable interface** command and its options, see the "Cisco Cable Modem Termination System Commands" chapter in the *Cisco Broadband Cable Command Reference Guide* (see "Additional References" section on page 7-59).

Displaying Information About the Mac Scheduler

To display information about the DOCSIS MAC layer scheduler that is operating on each cable interface, use the **mac-scheduler** option with the **show cable interface** command. You can display information for all of the upstreams on an interface, or you can display information for a single upstream on an interface.

The following example shows how to display information for the second upstream (U1) on a particular cable interface:

```
Router# show interface cable 3/0 mac-scheduler 1

     DOCSIS 1.1 MAC scheduler for Cable3/0/U1
     Queue[Rng Polls] 0/64, 0 drops
     Queue[CIR Grants] 0/64, 0 drops
     Queue[BE(7) Grants] 0/64, 0 drops
     Queue[BE(6) Grants] 0/64, 0 drops
     Queue[BE(5) Grants] 0/64, 0 drops
     Queue[BE(4) Grants] 0/64, 0 drops
     Queue[BE(3) Grants] 0/64, 0 drops
     Queue[BE(2) Grants] 0/64, 0 drops
     Queue[BE(1) Grants] 0/64, 0 drops
     Queue[BE(0) Grants] 0/64, 0 drops
     Req Slots 81256509, Req/Data Slots 0
     Init Mtn Slots 568433, Stn Mtn Slots 68664
     Short Grant Slots 2261, Long Grant Slots 2064698
     Awacs Slots 0
     Fragmentation count 6
     Fragmentation test disabled
     Avg upstream channel utilization : 1%
     Avg percent contention slots : 97%
     Avg percent initial ranging slots : 2%
     Avg percent minislots lost on late MAPs : 0%
     Sched Table Adm-State: Grants 1, Reqpolls 1, Util 20%
     UGS    : 0 SIDs, Reservation-level in bps 0
     UGS-AD : 1 SIDs, Reservation-level in bps 412800
     RTPS   : 0 SIDs, Reservation-level in bps 0
     NRTPS  : Not Supported
     BE     : 8 SIDs, Reservation-level in bps 0

Router#
```

Displaying Information About QoS Parameter Sets

To display information about the DOCSIS 1.1 QoS parameter sets that have been defined on a cable interface, use the **qos paramset** option with the **show cable interface** command.

```
Router# show interface cable 3/0 qos paramset

Index Name              Dir   Sched  Prio MaxSusRate  MaxBurst    MinRsvRate
1                       US    BE     0    64000       0           0
2                       DS    BE     0    1000000     0           0
3                       US    BE     0    200000      1600        0
4                       DS    BE     0    1500000     1522        0
5                       US    BE     0    500000      1522        0
6                       US    UGS_AD
7                       DS    BE     0    2000000     1522        0
8                       US    BE     0    128000      1600        0
9                       DS    BE     0    1000000     1522        0
10                      DS    BE     0    100000      1522        50000

Router#
```

You can also display detailed information for a particular parameter set by specifying the index number for its Class of Service along with the **verbose** option.

```
Router# show interface cable 3/0 qos paramset 8 verbose

Index:                                  8
Name:
Direction:                              Upstream
Minimum Packet Size                     64 bytes
Admitted QoS Timeout                    200 seconds
Active QoS Timeout                      0 seconds
Scheduling Type:                        Unsolicited Grant Service(AD)
Request/Transmission Policy:            0x1FF
Nominal Polling Interval:               10000 usecs
Tolerated Poll Jitter:                  2000 usecs
Unsolicited Grant Size:                 500 bytes
Nominal Grant Interval:                 10000 usecs
Tolerated Grant Jitter:                 2000 usecs
Grants per Interval:                    1
IP ToS Overwrite [AND-mask,OR-mask]:    0xFF,0x0
Parameter Presence Bitfield:            {0x0, 0x3FC000}

Router#
```

Displaying Information About Service Flows

To display the service flows and their QoS parameter sets that are configured on a cable interface, use the **service-flow** option with the **show interface cable** command.

```
Router# show interface cable 3/0 service-flow

Sfid  Sid   Mac Address     QoS Param Index   Type    Dir    Curr   Active
                           Prov  Adm  Act                  State  Time
4     N/A   0001.9659.4447   4     4    4     prim    DS     act    1d0h39m
3     1     0001.9659.4447   3     3    3     prim    US     act    1d0h39m
6     N/A   0001.64ff.e4ad   6     6    6     prim    DS     act    1d0h39m
14    N/A   0006.2854.7319   9     9    9     prim    DS     act    1d0h2m
457   N/A   0006.2854.7319   10    10   0     sec(S)  DS     adm    00:00
13    6     0006.2854.7319   7     7    7     prim    US     act    1d0h2m
456   155   0006.2854.7319   8     8    8     sec(S)  US    act    21h31m
458   156   0006.2854.7319   0     11   11    dyn(S)  US     act    00:10
16    N/A   0050.7366.12fb   4     4    4     prim    DS     act    1d0h39m
15    7     0050.7366.12fb   3     3    3     prim    US     act    1d0h39m
19    N/A   0090.9607.3831   4     4    4     prim    DS     act    1d0h39m
23    10    0090.9607.3831   3     3    3     prim    US     act    1d0h39m

Router#
```

To display the major QoS parameters for each service flow, add the **qos** option to this command.

```
Router# show interface cable 3/0 service-flow qos

Sfid  Dir Curr  Sid   Sched  Prio MaxSusRate  MaxBrst   MinRsvRate  Throughput
          State       Type

14    DS  act   N/A   BE     0    2000000     1522      0           8124
457   DS  adm   N/A   BE     0    100000      1522      50000       0
13    US  act   6     BE     0    500000      1522      0           0
456   US  act   155   UGS_A  0    0           1522      0           57643
19    DS  act   N/A   UGS    0    100000      1522      50000       68715

Router#
```

To display the complete QoS parameters for a particular service flow, use the **qos** and **verbose** options. You can use these options separately or together.

```
Router# show interface cable 3/0 service-flow 19 verbose

Sfid                                    : 4
Mac Address                             : 0090.9607.3831
Type                                    : Primary
Direction                               : Downstream
Current State                           : Active
Current QoS Indexes [Prov, Adm, Act]    : [4, 4, 4]
Active Time                             : 21h04m
Sid                                     : N/A
Traffic Priority                        : 0
Maximum Sustained rate                  : 100000 bits/sec
Maximum Burst                           : 1522 bytes
Minimum Reserved Rate                   : 0 bits/sec
Admitted QoS Timeout                    : 200 seconds
Active QoS Timeout                      : 0 seconds
Packets                                 : 130
Bytes                                   : 123096
Rate Limit Delayed Grants               : 0
Rate Limit Dropped Grants               : 0
Current Throughput                      : 68715 bits/sec, 9 packets/sec
Classifiers: NONE

Router# show interface cable 3/0 service-flow 19 qos verbose

Sfid                                    : 19
Current State                           : Active
Sid                                     : N/A
Traffic Priority                        : 0
Maximum Sustained rate                  : 100000 bits/sec
Maximum Burst                           : 1522 bytes
Mimimum Reserved rate                   : 50000 bits/sec
Minimum Packet Size                     : 100 bytes
Admitted QoS Timeout                    : 200 seconds
Active QoS Timeout                      : 0 seconds
Maximum Latency                         : 20000 usecs
Current Throughput                      : 68715 bits/sec, 9 packets/sec

Router#
```

Displaying Information About Service IDs

To display information about Service IDs (SIDs), which are assigned to only upstreams in DOCSIS 1.1 networks, use the **sid** option with the **show interface cable** command.

```
Router# show interface cable 3/0 sid

Sid  Prim  MAC Address    IP Address      Type Age      Admin   Sched  Sfid
                                                        State   Type
1          0090.9607.3831 10.1.1.35       stat 22h26m   enable  BE     3
2          0001.9659.4447 10.1.1.36       stat 22h26m   enable  BE     5
3          0000.f025.1bd9 0.0.0.0         stat 22h26m   enable  BE     7
4          0001.64ff.e4ad 10.1.1.39       stat 22h26m   enable  BE     9
5          0006.2854.7319 10.1.1.41       stat 22h26m   enable  BE     11
6          0001.9659.4461 10.1.1.33       stat 22h26m   enable  BE     13
7          0001.64ff.e459 10.1.1.42       stat 22h26m   enable  BE     15
8    5                                    stat 22h26m   enable  UGS_AD 17
9    5                                    stat 22h26m   enable  BE     18
10         0050.7366.12fb 10.1.1.43       stat 22h26m   enable  BE     20
11         0020.4089.7ed6 10.1.1.40       stat 22h26m   enable  BE     22
```

```
12   5                                      dyn  22h26m   enable  UGS     24
13   5                                      dyn  22h26m   enable  BE      25

Router#
```

Add the **qos** option to display the major QoS parameters associated with each SID.

```
Router# show interface cable 3/0 sid qos

Sid  Pr MaxSusRate MinRsvRate Sched  Grant Grant  GPI Poll   Thrput
                              Type   Size  Intvl      Intvl
1    0  200000     0          BE     100   100000 1   100000 848
2    0  200000     0          BE     100   100000 1   100000 0
3    0  64000      0          BE     0     0      0   0      0
4    0  128000     0          BE     100   100000 1   100000 0
5    0  500000     0          BE     100   100000 1   100000 0
6    0  200000     0          BE     100   100000 1   100000 848
7    0  128000     0          BE     100   100000 1   100000 0
8    0  0          0          UGS_AD 500   10000  1   10000  3468
9    0  100000     0          BE     100   100000 1   100000 0
10   0  200000     0          BE     100   100000 1   100000 848
11   0  200000     0          BE     100   100000 1   100000 848
12   0  0          0          UGS    150   100000 1   100000 0
13   0  7000       0          BE     100   100000 1   100000 0

Router#
```

To display detailed information about a particular SID and its QoS parameters, use both the **qos** and **verbose** options.

```
Router# show interface cable 3/0 sid 1 qos verbose

Sid                                    : 1
Traffic Priority                       : 0
Maximum Sustained Rate                 : 200000 bits/sec
Maximum Burst                          : 1600 bytes
Minimum Reserved Rate                  : 0 bits/sec
Minimum Packet Size                    : 64 bytes
Admitted QoS Timeout                   : 200 seconds
Active QoS Timeout                     : 0 seconds
Maximum Concatenated Burst             : 1600 bytes
Scheduling Type                        : Best Effort
Nominal Grant Interval                 : 100000 usecs
Tolerated Grant Jitter                 : 2000 usecs
Nominal Polling Interval               : 100000 usecs
Tolerated Polling Jitter               : 2000 usecs
Unsolicited Grant Size                 : 100 bytes
Grants per Interval                    : 1
Request/Transmission Policy            : 0x0
IP ToS Overwrite [AND-mask, OR-mask]   : 0xFF, 0x0
Current Throughput                     : 863 bits/sec, 0 packets/sec

Router#
```

Monitoring BPI+ Operations

See the following sections to monitor the state of BPI operations on the CMTS and its connected cable modems:

- Displaying the Current BPI+ State of Cable Modems, page 7-45
- Displaying the BPI+ Timer Values on the CMTS, page 7-46

- Displaying the Certificate List on the CMTS, page 7-46

Displaying the Current BPI+ State of Cable Modems

To display the current BPI+ state of cable modems, use the **show cable modem** command. If used without any options, this command displays the status for cable modems on all interfaces. You can also specify a particular cable interface on the CMTS, or the IP address or MAC address for a specific cable modem:

```
Router# show cable modem [ip-address | interface | mac-address]
```

The following display shows a typical display for cable modems on all interfaces:

```
Router# show cable modem

MAC Address    IP Address      I/F     MAC          Prim RxPwr Timing Num  BPI
                                       State        Sid  (db)  Offset CPEs Enbld
0010.7b6b.58c1 0.0.0.0         C4/0/U5 offline      5   -0.25  2285   0    yes
0010.7bed.9dc9 0.0.0.0         C4/0/U5 offline      6   -0.75  2290   0    yes
0010.7bed.9dbb 0.0.0.0         C4/0/U5 online(pt)   7    0.50  2289   0    yes
0010.7b6b.58bb 0.0.0.0         C4/0/U5 reject(pk)   8    0.00  2290   0    yes
0010.7bb3.fcd1 10.20.113.2     C5/0/U5 online(pt)   1    0.00  1624   0    yes
0010.7bb3.fcdd 0.0.0.0         C5/0/U5 online(pk)   2   -20.00 1624   0    yes
0010.7b43.aa7f 0.0.0.0         C5/0/U5 reject(pt)   3    7.25  1623   0    yes

Router#
```

The following shows a typical display for a Cisco uBR10012 router for a specific interface:

```
Router# show cable modems c7/0/0

MAC Address    IP Address      I/F       MAC          Prim RxPwr  Timing  Num BPI
                                         State        Sid  (db)   Offset  CPE Enb
0002.fdfa.12db 144.205.151.234 C7/0/0/U0 offline      15    -0.75   1914  1    Y
0002.fdfa.138d 144.205.151.140 C7/0/0/U5 online(pk)   4     0.00    1917  1    Y
0003.e38f.e85b 144.205.151.214 C7/0/0/U5 reject(pk)   17   *0.25    1919  1    Y
0003.e38f.f4cb 144.205.151.238 C7/0/0/U5 online(pt)   16    0.00   !2750  1    Y
0003.e3a6.7fd9 144.205.151.151 C7/0/0/U5 online(pt)   1     0.25    1922  0    Y
0020.4005.3f06 144.205.151.145 C7/0/0/U0 online(pt)   2     0.00    1901  1    Y
0020.4006.b010 144.205.151.164 C7/0/0/U5 online(pt)   3     0.00    1901  1    Y
0050.7302.3d83 144.205.151.240 C7/0/0/U0 online(pt)   18    -0.25   1543  1    Y
00b0.6478.ae8d 144.205.151.254 C7/0/0/U5 online(pt)   44    0.25    1920  21   Y
00d0.bad3.c0cd 144.205.151.149 C7/0/0/U5 online(pk)   19    0.25    1543  1    Y
00d0.bad3.c0cf 144.205.151.194 C7/0/0/U0 online(pt)   13    0.00    1546  1    Y
00d0.bad3.c0d5 144.205.151.133 C7/0/0/U0 reject(pt)   12   *0.50    1546  1    Y

Router#
```

The following shows a typical display for a particular cable modem:

```
Router# show cable modem 00C0.abcd.ef01

MAC Address    IP Address      I/F     MAC          Prim RxPwr Timing Num  BPI
                                       State        Sid  (db)  Offset CPEs Enbld
00c0.abcd.ef01 10.20.113.2     C5/0/U5 online(pt)   1    0.00  1624   0    yes

Router#
```

The MAC State column displays the current status of each cable modem. The following are the possible BPI-related values for this field:

Table 7-5 Possible show cable modem BPI+ States

State	Description
online	A cable modem has come online and, if configured to use BPI+, is negotiating its privacy parameters for the session. If the modem remains in this state for more than a couple of minutes, it is online but not using BPI+. Check that the cable modem is running DOCSIS-certified software and is using a DOCSIS configuration file that enables BPI+.
online(pk)	The cable modem is online and has negotiated a Key Encryption Key(KEK) with the CMTS. If BPI+ negotiation is successful, this state will be shortly followed by online(pt).
online(pt)	The cable modem is online and has negotiated a Traffic Encryption Key (TEK) with the CMTS. The BPI+ session has been established, and the cable modem is encrypting all user traffic with the CMTS using the specified privacy parameters.
reject(pk)	The cable modem failed to negotiate a KEK with the CMTS, typically because the cable modem failed authentication. Check that the cable modem is properly configured for BPI+ and is using valid digital certificates. If the CMTS requires BPI+ for registration, the cable modem will go offline and have to reregister. Check that the cable modem is properly registered in the CMTS provisioning system. **Note** If a cable modem fails BPI+ authentication, a message similar to the following appears in the CMTS log: `%UBR7200-5-UNAUTHSIDTIMEOUT: CMTS deleted BPI unauthorized Cable Modem 00c0.abcd.ef01`
reject(pt)	The cable modem failed to successfully negotiate a TEK with the CMTS. If the CMTS requires BPI+ for registration, the cable modem will have to reregister.

Tip Other MAC states are possible. See Table 7-4 on page 7-36 for a complete list.

Displaying the BPI+ Timer Values on the CMTS

To display the values for the KEK and TEK lifetime timers on a particular cable interface, use the **show interface cable** *x/y* **privacy** [**kek** | **tek**] command. For example:

```
Router# show interface cable 4/0 privacy kek

Configured KEK lifetime value = 604800

Router# show interface cable 4/0 privacy tek

Configured TEK lifetime value = 60480

Router#
```

Displaying the Certificate List on the CMTS

Use the **show crypt ca certificates** command to display the list of known certificates on the CMTS. For example:

```
Router# show crypto ca certificates
```

```
Certificate
  Status: Available
  Certificate Serial Number: 7DBF85DDDD8358546BB1C67A16B3D832
  Key Usage: General Purpose
  Subject Name
    Name: Cisco Systems
  Validity Date:
    start date: 00:00:00 UTC Sep 12 2001
    end   date: 23:59:59 UTC Sep 11 2021

Root certificate
  Status: Available
  Certificate Serial Number: 5853648728A44DC0335F0CDB33849C19
  Key Usage: General Purpose
    CN = DOCSIS Cable Modem Root Certificate Authority
     OU = Cable Modems
     O = Data Over Cable Service Interface Specifications
     C = US
  Validity Date:
    start date: 00:00:00 UTC Feb 1 2001
    end   date: 23:59:59 UTC Jan 31 2031

Router#
```

Command Summary

Table 7-6 summarizes the commands that are used to configure and monitor the Cisco CMTS for DOCSIS 1.1 operations.

Table 7-6 New or Modified Commands for DOCSIS 1.1 Operation

Command	Description
cable dci-response	Configures how a cable interface responds to DCI-REQ messages for cable modems on that interface.
cable dci-upstream-disable	Configures a cable interface so that it transmits a DOCSIS 1.1 Upstream Transmitter Disable (UP-DIS) message to a particular cable modem (CM).
cable service class	Sets parameters for a cable service class.
cable service flow inactivity-threshold	Sets the inactivity threshold value for service flows using Unsolicited Grant Service with Activity Detection (UGS-AD).
cable submgmt default	Sets the default values for attributes in the Subscriber Management MIB (DOCS-SUBMGT-MIB), so that those default values persist over restarts.
cable upstream fragmentation	Enables DOCSIS 1.1 fragmentation on a cable interface.
cable upstream unfrag-slot-jitter	Controls how much jitter can be tolerated on the corresponding upstream due to unfragmentable slots.
debug cable dci	Displays information about DOCSIS 1.1 Device Class Identification (DCI) messages.
debug cable mac-scheduler	Displays information about the MAC scheduler's admission control activities.
debug cable phs	Displays the activities of the payload header suppression (PHS) driver.
debug cable tlvs	Displays the TLVs parsed by the DOCSIS 1.1 TLV parser/encoder, including the TLVs for service flow encodings, classifier encodings, and PHS rules.
show cable modem	Displays information for the registered and unregistered cable modems.
show cable service-class	Displays the parameters for a DOCSIS 1.1 cable service class.
show interface cable downstream	Displays the downstream packet queuing and the scheduling state.
show interface cable mac-scheduler	Displays the current time-slot scheduling state and statistics.
show interface cable qos paramset	Displays the attributes of the service flow QoS parameter set.
show interface cable service-flow	Displays the attributes of DOCSIS service flows on a given cable interface.

The following commands have been obsoleted and not used for DOCSIS 1.1 operations:

- **cable qos** [**profile** | **permission**]
- **cable service-flow inactivity-timeout**
- **show cable qos profile**

Configuration Examples for DOCSIS 1.1 Operations

This section lists the following sample configurations for DOCSIS 1.1 operations on the Cisco CMTS:

- DOCSIS 1.1 Configuration for Cisco uBR7246VXR Router (without BPI+), page 7-49
- DOCSIS 1.1 Configuration for Cisco uBR7246VXR Router (with BPI+), page 7-51
- DOCSIS 1.1 Configuration for Cisco uBR10012 Router (with BPI+), page 7-55

DOCSIS 1.1 Configuration for Cisco uBR7246VXR Router (without BPI+)

```
version 12.2
no service pad
service timestamps log datetime localtime
service password-encryption
service udp-small-servers max-servers no-limit
!
hostname 7246VXR
!
enable password 7 030A69CE09
!
cable qos profile 8
cable qos profile 10
cable qos profile 10 grant-size 1500
cable qos profile 12 guaranteed-upstream 100000
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable timeserver
!
cable config-file disable.cm
 access-denied
 service-class 1 max-upstream 1
 service-class 1 max-downstream 1600
 cpe max 1
 timestamp
!
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 10
 timestamp
!
clock timezone PDT -8
clock summer-time PDT recurring
clock calendar-valid
ip subnet-zero
ip cef
ip cef accounting per-prefix
no ip finger
ip tcp synwait-time 5
no ip domain-lookup
ip host vxr 192.100.168.103
ip domain-name cisco.com
ip name-server 192.100.168.70
ip name-server 192.100.168.132
ip name-server 192.100.168.250
no ip dhcp relay information check
```

```
!
!
!
ip dhcp pool cm-platinum
network 10.10.4.0 255.255.255.0
   bootfile platinum.cm
   next-server 10.10.4.1
   default-router 10.10.4.1
   option 7 ip 10.10.4.1
   option 4 ip 10.10.4.1
   option 2 hex ffff.8f80
   lease 7 0 10
!
ip dhcp pool pcs-c4
   network 192.100.168.0 255.255.255.224
   next-server 192.100.168.1
   default-router 192.100.168.1
   dns-server 192.100.168.2
   domain-name cisco.com
   lease 7 0 10
!
!
interface Ethernet2/0
 ip address 192.100.168.4 255.255.255.192
 no ip mroute-cache
 half-duplex
!
interface Cable4/0
 ip address 192.100.168.1 255.255.255.224 secondary
 ip address 10.10.4.1 255.255.255.0
 no ip route-cache cef
 no keepalive
 cable downstream rate-limit token-bucket shaping
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 555000000
 cable upstream 0 frequency 40000000
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable upstream 4 shutdown
 cable upstream 5 shutdown
 cable dhcp-giaddr policy
!
!
router eigrp 202
 redistribute connected
 redistribute static
 network 10.0.0.0
 network 192.100.168.0
 no auto-summary
 no eigrp log-neighbor-changes
!
router rip
 version 2
 redistribute connected
 redistribute static
 network 10.0.0.0
 network 192.100.168.0
 no auto-summary
!
```

```
ip default-gateway 192.100.168.1
ip classless
ip route 0.0.0.0 0.0.0.0 192.100.168.1
ip route 192.100.168.0 255.255.255.0 Ethernet2/0
ip http server
ip http authentication local
!
snmp-server engineID local 00000009020000E01ED77E40
snmp-server community public RO
snmp-server community private RW
tftp-server server
 tftp-server slot0:silver.cm alias silver.cm
 !
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
 speed 19200
line vty 0 4
 session-timeout 60
 login
!
ntp clock-period 17179977
ntp server 192.100.168.51
end
```

DOCSIS 1.1 Configuration for Cisco uBR7246VXR Router (with BPI+)

```
version 12.2
no service pad
service password-encryption
service compress-config
!
hostname uBR7246VXR
!
logging queue-limit 100
enable password 7 03085A09
!
clock summer-time EDT recurring
clock calendar-valid
cable flap-list insertion-time 120
cable flap-list power-adjust threshold 5
cable flap-list aging 1440
cable modem max-cpe 2
cable modulation-profile 2 request 0 16 2 8 qpsk scrambler 152 no-diff 64 fixed uw8
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 91 14 8 qpsk scrambler 152 no-diff 72 shortened uw8
cable modulation-profile 2 long 8 239 0 8 qpsk scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 3 request 0 16 2 8 qpsk scrambler 152 no-diff 64 fixed uw8
cable modulation-profile 3 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 3 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 3 short 8 85 14 8 qpsk scrambler 152 no-diff 72 shortened uw8
cable modulation-profile 3 long 10 235 0 8 qpsk scrambler 152 no-diff 80 shortened uw8
cable modulation-profile 4 request 0 16 2 8 qpsk scrambler 152 no-diff 64 fixed uw8
cable modulation-profile 4 initial 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 4 station 5 34 0 48 qpsk scrambler 152 no-diff 128 fixed uw16
cable modulation-profile 4 short 10 8 6 8 8 16qam scrambler 152 no-diff 144 shortened uw16
cable modulation-profile 4 long 10 235 0 8 16qam scrambler 152 no-diff 160 shortened uw16
no cable qos permission create
no cable qos permission update
cable qos permission modems
```

```
cable logging badipsource 2000000
cable time-server
!
!
ip subnet-zero
no ip source-route
!
!
ip cef
ip domain name sampleclient.com
ip dhcp smart-relay
ip dhcp relay information option
no ip dhcp relay information check
!
crypto ca trustpoint DOCSIS-ROOT-CERT
!
crypto ca certificate chain DOCSIS-ROOT-CERT
 certificate ca 00A0730000000002
  308202B7 30820220 A0030201 02020800 A0730000 00000230 0D06092A 864886F7
  0D010105 05003081 9D310B30 09060355 04061302 5553310E 300C0603 55040A13
  05436F6D 3231310F 300D0603 55040B13 06444F43 53495331 36303406 0355040B
  132D4C4F 43303030 332C2037 35302054 61736D61 6E204472 6976652C 204D696C
  70697461 732C2043 41203935 30333531 35303306 03550403 132C436F 6D323120
  4361626C 65204D6F 64656D20 526F6F74 20436572 74696669 63617465 20417574
  686F7269 7479301E 170D3030 30353038 30373030 30305A17 0D323530 35303830
  37303030 305A3081 9D310B30 09060355 04061302 5553310E 300C0603 55040A13
  05436F6D 3231310F 300D0603 55040B13 06444F43 53495331 36303406 0355040B
  132D4C4F 43303030 332C2037 35302054 61736D61 6E204472 6976652C 204D696C
  70697461 732C2043 41203935 30333531 35303306 03550403 132C436F 6D323120
  4361626C 65204D6F 64656D20 526F6F74 20436572 74696669 63617465 20417574
  686F7269 74793081 9F300D06 092A8648 86F70D01 01010500 03818D00 30818902
  818100D9 C1A4199A 47D4FFAD B43F573C D1232742 748D2C91 B89E9FE9 94277008
  FBA544C8 5CC4FE3F 754BA64B AEE5A362 32A41BFE B9FD03C2 99242D95 0508DC45
  1A007021 FEC688F9 E57D9161 DE43E4EC 29379E9E 3AEB3563 455AF3B6 2C345A31
  70F4FCF6 FB39FC6E 815F05CF EC6E618A 52562F26 098C5BE1 48FD46DE E07078A9
  DD962902 03010001 300D0609 2A864886 F70D0101 05050003 8181001B DFAF32FD
  38FF13E8 CD5063C6 4663D00A 2F3132FB 25D9F6DF 1CC67C1B 5CDB5F02 825F2DD2
  72C07A3C 7EB0B138 F217E0BA CCBCF712 19AB117E 76193E86 3E7C8532 B44228A1
  0E19643A B44D66B6 15F8F142 9ECF54F6 AFCA093E A6D59067 E3F9306C 5696BF5F
  C34999A5 5F36F368 EAFAA8DD BAD93942 8620C59C 879EB625 88C3A1
  quit
!
!
!
 key chain ubr7246-rip
 key 1
  key-string 7 0600066C594C1B4F0E574345460133
!
!
interface FastEthernet0/0
ip address 192.168.10.130 255.255.255.0
 duplex half
 tag-switching ip
 no cdp enable
!
interface Ethernet1/0
 ip address 10.10.0.1 255.255.0.0
 no ip redirects
 no ip proxy-arp
 ip pim dense-mode
 no ip mroute-cache
 duplex half
 no keepalive
 no cdp enable
```

```
!
interface Ethernet1/1
 ip address 10.11.0.1 255.255.0.0
 no ip redirects
 no ip proxy-arp
 ip pim dense-mode
 duplex half
 no keepalive
 no cdp enable
!
interface Ethernet2/0
 ip address 192.168.10.2 255.255.0.0
 shutdown
 duplex half
 no cdp enable
!
interface Ethernet2/1
 ip address 192.168.10.1 255.255.0.0
 duplex half
 no cdp enable
!
interface Cable3/0
 ip address 192.168.10.77 255.255.255.0
 ip mask-reply
 no ip redirects
 no ip proxy-arp
 ip pim sparse-dense-mode
 ip route-cache flow
 ip igmp access-group 96
 no ip mroute-cache
 cable map-advance dynamic 400 1000
 cable insertion-interval automatic 25 500
 cable bundle 1 master
 cable downstream annex B
 cable downstream modulation 256qam
 cable downstream interleave-depth 32
 cable downstream channel-id 0
 cable upstream 0 frequency 5008000
 cable upstream 0 power-level 0
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 modulation-profile 2
 no cable upstream 0 shutdown
 cable upstream 1 frequency 7008000
 cable upstream 1 power-level 0
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 modulation-profile 2
 no cable upstream 1 shutdown
 cable upstream 2 frequency 10000000
 cable upstream 2 power-level 0
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 modulation-profile 2
 no cable upstream 2 shutdown
 cable upstream 3 frequency 13008000
 cable upstream 3 power-level 0
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 modulation-profile 2
 no cable upstream 3 shutdown
 cable upstream 4 frequency 16000000
 cable upstream 4 power-level 0
 cable upstream 4 channel-width 1600000 1600000
```

```
 cable upstream 4 minislot-size 4
 cable upstream 4 modulation-profile 2
 no cable upstream 4 shutdown
 cable upstream 5 frequency 20000000
 cable upstream 5 power-level 0
 cable upstream 5 channel-width 1600000 1600000
 cable upstream 5 minislot-size 4
 cable upstream 5 modulation-profile 2
 no cable upstream 5 shutdown
 cable dhcp-giaddr policy
 cable privacy accept-self-signed-certificate
 cable privacy authenticate-modem
 cable privacy authorize-multicast
 cable privacy kek life-time 300
 cable privacy tek life-time 180
 no keepalive
!
interface Cable4/0
 ip address 192.168.10.55 255.255.255.0
 ip mask-reply
 no ip redirects
 no ip proxy-arp
 ip multicast ttl-threshold 5
 ip multicast boundary 15
 ip route-cache flow
 no ip mroute-cache
 cable map-advance dynamic 400 1000
 cable insertion-interval automatic 25 500
 cable bundle 1
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream channel-id 1
 cable upstream 0 frequency 30000000
 cable upstream 0 power-level 0
 cable upstream 0 channel-width 1600000 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 modulation-profile 3
 no cable upstream 0 shutdown
 cable upstream 1 frequency 31008000
 cable upstream 1 power-level 0
 cable upstream 1 channel-width 1600000 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 modulation-profile 3
 no cable upstream 1 shutdown
 cable upstream 2 frequency 32000000
 cable upstream 2 power-level 0
 cable upstream 2 channel-width 1600000 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 modulation-profile 3
 no cable upstream 2 shutdown
 cable upstream 3 frequency 33008000
 cable upstream 3 power-level 0
 cable upstream 3 channel-width 1600000 1600000
 cable upstream 3 minislot-size 4
 no cable upstream 3 shutdown
 cable upstream 4 frequency 34000000
 cable upstream 4 power-level 0
 cable upstream 4 channel-width 1600000 1600000
 cable upstream 4 minislot-size 4
 cable upstream 4 modulation-profile 3
 no cable upstream 4 shutdown
 cable upstream 5 frequency 35008000
 cable upstream 5 power-level 0
```

```
 cable upstream 5 channel-width 1600000 1600000
 cable upstream 5 minislot-size 4
 cable upstream 5 modulation-profile 3
 no cable upstream 5 shutdown
 cable source-verify leasetimer 5
 cable dhcp-giaddr policy
 cable privacy accept-self-signed-certificate
 cable privacy authenticate-modem
 cable privacy authorize-multicast
 cable privacy kek life-time 300
 cable privacy tek life-time 180
 no keepalive
!
!
router rip
 version 2
 redistribute bgp 222 metric transparent
 network 10.10.0.0
 no auto-summary
!
!
ip default-gateway 192.168.100.1
ip classless
no ip forward-protocol udp netbios-ns
no ip forward-protocol udp netbios-dgm
 no ip http server
no ip http secure-server
!
!
!
!
snmp-server community private RW
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps config
snmp-server enable traps cable
snmp-server enable traps docsis-cmts
snmp-server enable traps syslog
!
line con 0
 exec-timeout 0 0
 password 7 070C285F4D06
 stopbits 1
line vty 0 4
 session-timeout 60
 exec-timeout 0 0
 password 7 0703204E
line vty 5 15
!
scheduler allocate 4000 200
end
```

DOCSIS 1.1 Configuration for Cisco uBR10012 Router (with BPI+)

```
version 12.2
service timestamps log datetime msec localtime
service password-encryption
!
hostname uBR10012
!
redundancy
 main-cpu
  auto-sync standard
```

```
logging queue-limit 100
no logging buffered
no logging rate-limit
enable password my-enable-password
!
ipc cache 5000
card 1/1 2cable-tccplus
card 2/0 1gigethernet-1
card 2/1 2cable-tccplus
card 3/0 1gigethernet-1
card 4/0 1oc12pos-1
card 8/0 5cable-mc520s
card 8/1 5cable-mc520s
cable flap-list insertion-time 60
cable flap-list power-adjust threshold 4
cable flap-list aging 86400
cable modem vendor 00.50.F1 TI
cable spectrum-group 2 band 11000000 16000000
cable spectrum-group 21 band 17000000 25000000
cable spectrum-group 32 shared
cable spectrum-group 32 band 5000000 42000000
cable modulation-profile 2 request 0 16 0 8 qpsk scrambler 152 no-diff 64 fixed uw16
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 6 75 6 8 16qam scrambler 152 no-diff 144 shortened uw8
cable modulation-profile 2 long 8 220 0 8 16qam scrambler 152 no-diff 160 shortened uw8
cable modulation-profile 21 request 0 16 0 22 qpsk scrambler 152 no-diff 32 fixed
cable modulation-profile 21 initial 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 21 station 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 21 short 3 76 12 22 qpsk scrambler 152 no-diff 64 shortened
cable modulation-profile 21 long 7 231 0 22 qpsk scrambler 152 no-diff 64 shortened
cable modulation-profile 22 request 0 16 0 22 qpsk scrambler 152 no-diff 32 fixed
cable modulation-profile 22 initial 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 22 station 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 22 short 4 76 7 22 16qam scrambler 152 no-diff 128 shortened
cable modulation-profile 22 long 7 231 0 22 16qam scrambler 152 no-diff 128 shortened
cable modulation-profile 23 request 0 16 0 22 qpsk scrambler 152 no-diff 32 fixed
cable modulation-profile 23 initial 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 23 station 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 23 short 4 76 7 22 16qam scrambler 152 no-diff 128 shortened
cable modulation-profile 23 long 7 231 0 22 16qam scrambler 152 no-diff 128 shortened
cable qos profile 5 max-downstream 10000
cable qos profile 5 max-upstream 1000
cable qos profile 5 priority 7
cable qos profile 5 tos-overwrite 0x3  0x0
cable qos profile 5 name cm_no_priority
cable qos profile 6 max-downstream 10000
cable qos profile 6 max-upstream 5000
cable qos profile 6 priority 7
cable qos profile 6 tos-overwrite 0x3  0x0
cable qos profile 6 name qos6
cable qos profile 7 max-downstream 128
cable qos profile 7 max-upstream 128
cable qos profile 7 priority 7
cable qos profile 8 max-downstream 10000
cable qos profile 8 max-upstream 1000
cable qos profile 8 priority 3
cable qos profile 8 tos-overwrite 0x3  0x0
cable qos profile 8 name qos8
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable event syslog-server 10.10.10.131
ip subnet-zero
```

```
!
!
interface FastEthernet0/0/0
 ip address 10.10.32.21 255.255.0.0
 no cdp enable
!
interface GigabitEthernet2/0/0
 ip address 10.10.31.2 255.0.0.0
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 load-interval 30
 negotiation auto
 no cdp enable
!
interface GigabitEthernet3/0/0
 no ip address
 ip pim sparse-mode
 no ip route-cache cef
 load-interval 30
 shutdown
 negotiation auto
 no cdp enable
!
interface POS4/0/0
 no ip address
 crc 32
 no cdp enable
 pos ais-shut
!
!
interface Cable8/0/0
 ip address 10.10.10.28 255.255.255.0
 ip helper-address 1.10.10.133
 cable bundle 2 master
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 669000000
 cable downstream channel-id 0
 no cable downstream rf-shutdown
 cable downstream rf-power 45
 cable upstream 0 connector 0
 cable upstream 0 spectrum-group 32
 cable upstream 0 power-level 0
 cable upstream 0 channel-width 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 data-backoff 0 6
 cable upstream 0 modulation-profile 23
 no cable upstream 0 rate-limit
 no cable upstream 0 shutdown
 cable upstream 1 connector 1
 cable upstream 1 spectrum-group 32
 cable upstream 1 power-level 0
 cable upstream 1 channel-width 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 data-backoff 0 6
 cable upstream 1 modulation-profile 23
 no cable upstream 1 shutdown
 cable upstream 2 connector 2
 cable upstream 2 spectrum-group 32
 cable upstream 2 power-level 0
 cable upstream 2 channel-width 1600000
```

```
 cable upstream 2 minislot-size 4
 cable upstream 2 data-backoff 3 6
 cable upstream 2 modulation-profile 23
 no cable upstream 2 shutdown
 cable upstream 3 connector 3
 cable upstream 3 spectrum-group 32
 cable upstream 3 channel-width 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 modulation-profile 21
 no cable upstream 3 shutdown
 cable source-verify
 cable privacy kek life-time 300
 cable privacy tek life-time 180
 no keepalive
!
interface Cable8/0/1
 ip address 10.10.11.121
 cable bundle 2
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
 cable downstream channel-id 0
 no cable downstream rf-shutdown
 cable upstream max-ports 6
 cable upstream 0 connector 4
 cable upstream 0 spectrum-group 2
 cable upstream 0 power-level 0
 cable upstream 0 channel-width 1600000
 cable upstream 0 minislot-size 4
 cable upstream 0 range-backoff 3 6
 cable upstream 0 data-backoff 0 6
 cable upstream 0 modulation-profile 23 21
 no cable upstream 0 rate-limit
 cable upstream 0 shutdown
 cable upstream 1 connector 5
 cable upstream 1 channel-width 1600000
 cable upstream 1 minislot-size 4
 cable upstream 1 modulation-profile 21
 cable upstream 1 shutdown
 cable upstream 2 connector 6
 cable upstream 2 channel-width 1600000
 cable upstream 2 minislot-size 4
 cable upstream 2 modulation-profile 21
 cable upstream 2 shutdown
 cable upstream 3 connector 7
 cable upstream 3 channel-width 1600000
 cable upstream 3 minislot-size 4
 cable upstream 3 modulation-profile 21
 cable upstream 3 shutdown
 cable upstream 4 channel-width 1600000
 cable upstream 4 minislot-size 4
 cable upstream 4 modulation-profile 21
 cable upstream 4 shutdown
 cable upstream 5 channel-width 1600000
 cable upstream 5 minislot-size 4
 cable upstream 5 modulation-profile 21
 cable upstream 5 shutdown
 cable source-verify
 cable privacy kek life-time 300
 cable privacy tek life-time 180
 no keepalive
!
!
```

```
ip classless
ip http server
no ip http secure-server
!
!
no cdp run
snmp-server community public RW
snmp-server community private RW
snmp-server enable traps cable
!
line con 0
 exec-timeout 0 0
line aux 0
line vty 0 4
 exec-timeout 0 0
 password my-telnet-password
 login
 length 0
!
end
```

Additional References

For additional information related to DOCSIS 1.1 operations, refer to the following references:

Related Documents

Related Topic	Document Title
Cable Command Reference Guide	For syntax and usage information on the cable-specific commands used in this chapter, see the "Cisco Cable Modem Termination System Commands" chapter of the *Cisco Broadband Cable Command Reference Guide* at the following URL: http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html
DHCP Configuration	To configure the DHCP server onboard the Cisco CMTS, see the "Configuring DHCP" chapter in the "IP Addressing and Services" section of the *Cisco IOS IP and IP Routing Configuration Guide*, Release 12.2T at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fipr_c/index.htm For information on all DHCP commands, see the "DHCP Commands" chapter in the *Cisco IOS IP Command Reference, Volume 1 of 3: Addressing and Services,* Release 12.2T at the following URL: http://www.cisco.com/en/US/docs/ios/12_2/ipaddr/command/reference/fipras_r.html

Related Topic	Document Title
HCCP N+1 Configuration	To configure the Cisco CMTS for N+1 redundancy, see the *N+1 Redundancy for the Cisco Cable Modem Termination System* chapter in the Cisco CMTS Feature Guide at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/ufgnpls1.htm
NTP or SNTP Configuration	For information on configuring the Cisco CMTS to use Network Time Protocol (NTP) or Simple Network Time Protocol (SNTP) to set its system clock, see the "Performing Basic System Management" chapter in the "System Management" section of the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2T, at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/ffun_c/fcfprt3/fcf012.htm
Software Configuration Guides	For information on configuring the CMTS router for cable operations, see the appropriate software configuration guide for your router. These guides are available for each router at the following URL: http://www.cisco.com/web/techdoc/cable/Config/Sw_conf.html

Standards

Standards[1]	Title
SP-RFIv1.1-I08-020301	*Data-over-Cable Service Interface Specifications Radio Frequency Interface Specification*
SP-BPI+-I08-020301	*DOCSIS Baseline Privacy Interface Plus Specification*

1. Not all supported standards are listed.

MIBs

MIBs[1]	MIBs Link
• DOCS-BPI-PLUS-MIB • DOCS-CABLE-DEVICE-MIB (RFC 2669) • DOCS-CABLE-DEVICE-TRAP-MIB • DOCS-IF-EXT-MIB • DOCS-IF-MIB (RFC 2670) • DOCS-QOS-MIB • DOCS-SUBMGT-MIB • IGMP-STD-MIB (RFC 2933)	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

1. Not all supported MIBs are listed.

RFCs

RFCs[1]	Title
RFC 2669	DOCS-CABLE-DEVICE-MIB
RFC 2670	DOCS-IF-MIB
RFC 2933	IGMP-STD-MIB

1. Not all supported RFCs are listed.

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/cisco/web/support/index.html

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