# Overview of Cisco uBR7100 Series Software

The Cisco uBR7100 series uses Cisco IOS® software to offer enhanced stability, features, performance and investment protection. This chapter summarizes system and software features of the Cisco uBR7200 series Cable Modem Termination System (CMTS). This chapter contains the following sections:

| Section | Purpose |
|---|---|
| Cisco IOS Releases and Images for the Cisco uBR7100 Series, page 1-2 | Describes the supported Cisco IOS release trains, associated features, and latest Cisco IOS images for each recently supported train. |
| | One early step in CMTS feature configuration is to verify your Cisco IOS release train, the associated image and feature set. This section guides you in determining such information. |
| "Cisco uBR7100 Series Router Configuration Tools," page 5 | Provides an overview of the configuration tools available when choosing your configuration method. |
| "Supported Software Features for the Cisco uBR7100 Series," page 6 | Describes the features and configuration utilities that are available on the Cisco uBR7100 series. |
| "DOCSIS and CMTS Interoperability," page 25 | Provides an overview of DOCSIS NTSC and EuroDOCSIS cable plants, DOCSIS-compliant signals, and traffic engineering. |

# Cisco IOS Releases and Images for the Cisco uBR7100 Series

The Cisco uBR7100 series router runs the IOS image that is located on the Type II Personal Computer Memory Card International Association (PCMCIA) Flash memory disks. These disks are located in the two PCMCIA slots in the primary Performance Routing Engine 1 (PRE1). A PCMCIA disk in either slot can store a Cisco IOS image or configuration file.

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

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

Each line card also contains onboard Flash memory that is used to store a boot loader, similar in function to that used on the PRE1 module. However, the line card loader executes following a system reset, line card reset, or line card insertion to reload and execute any code that must run on the line card for it to operate properly. Software images may also be stored on an external TFTP server. If the Cisco uBR7100 series router is so configured, it then downloads the proper image from the TFTP server and executes it.

This section describes the supported releases, latest images, memory requirements, and major software features for the following Cisco IOS software:

- Cisco IOS Software Location
- Determining Your Cisco IOS Software Release
- Upgrading to a New Software Release
- 12.2 BC Release Train and Images
- 12.1 EC Release Train and Images

## Cisco IOS Software Location

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

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

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

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

## Determining Your Cisco IOS Software Release

To determine the version of Cisco IOS software running on the Cisco uBR7100 series router, log in to the router and enter the **show version** command in privileged EXEC mode. For example:

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

# Upgrading to a New Software Release

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

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

# 12.2 BC Release Train and Images

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

Cisco IOS Release 12.2(4)BC1b, provides a migration path from the earlier 12.2 XF releases. Cisco IOS Release 12.2(4)BC1b supports the Cisco uBR7100 universal broadband router, which provides a high-capacity, high-throughput cable modem termination system (CMTS), optimized for aggregating traffic at the edge of the cable network. Designed for cable operators and service providers, the platform connects residential subscribers via cable modems, digital set-top boxes, or IP telephony cable modems for high-speed data, broadband entertainment, and IP telephony solutions.

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

## Cisco IOS 12.2(15)BC2b Images and Requirements

Table 1-1 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR7100 universal broadband router for Cisco IOS Release 12.2(4)BC1b. Cisco uBR7100 universal broadband routers are available with a 48-MB or 120-MB Type II PCMCIA Flash memory card.

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

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

The image subset legend for Table 5 is as follows:

- i = IP routing, MPLS-VPN support, and noncable interface bridging, including Network Address Translation (NAT)

- k8 = DOCSIS Baseline Privacy and MPLS-VPN support

- p = IP routing with Intermediate System-to-Intermediate System (IS-IS) and Border Gateway Protocol (BGP); MPLS-VPN support; no NAT

- s = "Plus" features: NAT and Inter-Switch Link (ISL)

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

http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html

# 12.1 EC Release Train and Images

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

## Cisco IOS 12.1 EC Images and Requirements

Table 1-2 displays the memory recommendations of the Cisco IOS feature sets for the Cisco uBR7100 universal broadband router for Cisco IOS Release 12.2(11)CY. Cisco uBR7100 universal broadband routers are available with a 48-MB or 120-MB Type II PCMCIA Flash memory card.

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

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

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

The image subset legend for Table 3 is as follows:

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

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

http://www.cisco.com/en/US/products/hw/cable/ps2211/prod_release_notes_list.html

# Cisco uBR7100 Series Router Configuration Tools

## Cisco Network Registrar (CNR)

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

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

For additional information about using CNR, refer to the latest CNR documentation at Cisco.com.

## DOCSIS CPE Configurator

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

## Cable Modem Configuration File Editor

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

# Supported Software Features for the Cisco uBR7100 Series

This section summarizes Cisco uBR7100 series router software features for all supported Cisco IOS Release trains, and directs you to additional configuration information for each feature.

## Cisco uBR7100 Series Features and Cisco IOS Releases

Table 1-3 summarizes the software-related features and related Cisco IOS releases that support the Cisco uBR7100 series router. Cisco IOS features indicate the first release in which the feature was introduced. Unless otherwise noted, feature support continues in later releases of the same or related Cisco IOS release train.

Features are organized in the following categories:

- Cisco Command-Line Enhancements, page 1-7
- Cisco Quality of Service Features, page 1-7
- DHCP Servers and Feature Support, page 1-9
- DOCSIS Feature Support, page 1-10
- High Availability Features, page 1-15
- Intercept Features, page 1-15
- IP Networking, page 1-16
- IP Routing, page 1-16
- Management Features, page 1-18
- PacketCable and Voice Support Features, page 1-20
- Security Features, page 1-20
- SNMP Features and Enhancements, page 1-22
- Spectrum Management Features, page 1-23
- Testing, Troubleshooting and Diagnostic Features, page 1-23
- VLAN Features, page 1-23
- VPN Features, page 1-24
- WAN Optimization and Service Features, page 1-24

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| **Cisco Command-Line Enhancements** | | |
| Configurable registration timeout | 12.1 EC | Changes the CM registration value (the T9 timer); the **cable registration-timeout** *minutes* command sets the T9 timer to the new value (from 2 to 60 minutes). The **no cable registration-timeout** command resets the T9 timer to its default of 3 minutes. |
| Statistical values added to **show controller int cx/y upstream** command | 12.1 EC | Displays the following additional statistical counters in the output of the **show controller cx/0 upstream** *number* command: <br>• Average percent of upstream utilization in minislots <br>• Average percent of contention slots <br>• Average percent of initial ranging slots <br>• Average percent of minislots that were due because the MAP scheduler was not able to request them in time |
| WCCP and WCCPv2 | 12.1 EC | Identifies the web caching protocols supported. |
| Show Controllers Cable Enhancement | 12.2 BC | The Show Controllers Cables Extensions feature has been supported for Cisco IOS Release 12.2(15)BC2b. <br><br>In this feature, the mem-stats, memory, proc-cpu, and tech-support keywords execute the related command on the processor that runs on are added to obtain the relevant information from the onboard processor on Broadband Processing Engine (BPE) cable interface line cards, such as the Cisco uBR-MC16U/X, Cisco uBR-MC28U/X, and Cisco uBR-MC5X20S/U cards. This allows the user to obtain information that is specific for that particular cable interface card, as opposed to having to run these commands on the entire router. <br><br>Refer to *Cisco uBR7100 Series - Cisco IOS Release 12.2 BC*: <br>• http://www.cisco.com/en/US/docs/ios/12_2/12_2b/12_2bc/release/notes/u7108bc1.html |
| **Cisco Quality of Service Features** | | |
| Cisco express forwarding (CEF) | 12.1 EC | Supports Cisco's processing switching protocol to enable traffic decisions to be made quickly. |
| Committed access rate (CAR) | 12.1 EC | Provides the means to allocate and limit bandwidth to traffic sources and destinations, and specify policies to handle traffic exceeding the bandwidth allocation. CAR policies can be utilized at the ingress or egress of the network. The feature uses token bucket filters to measure traffic load and limit sources to bandwidth allocations. |
| DOCSIS 1.0 QoS extensions | 12.1 EC | Allows the Cisco uBR7100 series to specify priority service flows higher than those specified in DOCSIS 1.0. |
| Downstream rate shaping | 12.1 EC | Supports buffering downstream grants to rate-exceeding cable interfaces, without incurring TCP-related timeouts and retransmits. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Downstream rate shaping with ToS | 12.1 EC | Enables to be partitioned into multiple classes of service. Uses the three precedence bits in the ToS field in the IP header to specify class of service assignment for each packet.<br><br>Those packets with the IP precedence bit set in the IP packet are given higher priority. This allows the CMTS administrator to calculate the data rate for a given flow, in addition to the data rate configured on a per cable modem basis. |
| Multi-SID support | 12.1 EC | Allows the Cisco uBR7100 series to support the definition of multiple SIDs on the upstream. This includes multiple service classes per cable interface, enabling administrators to delegate higher priority as required. |
| QoS profile enforcement | 12.1 EC | Allows the Cisco uBR7100 series to override the provisioned service class of a cable interface at the time of registration with a CMTS-defined QoS profile. |
| Resource Reservation Protocol (RSVP) | 12.1 EC | Works in conjunction with WFQ; helps the router establish a weight for different types of packets that affect the order in which the packets enter the output queue and are placed on the cable network for transmission; that is, higher priority packets are routed through the interface with a QoS method that allows the packets to receive priority over standard data frames. A router that supports RSVP gives priority to packets that fall into a reservation within RSVP. |
| TAG/NetFlow switching | 12.1 EC | Provides high performance for network layer services, enabling per-flow application of network services such as security and traffic accounting. Data collected for each flow includes:<br><br>• Source and destination IP address<br>• Start of flow and end of flow timestamps<br>• Packet and byte counts<br>• Next hop router address<br>• Input and output physical port interfaces<br>• Source and Destination TCP/UDP port numbers<br>• IP protocol type<br>• Type of service (ToS) field<br>• TCP flags<br>• Source and destination autonomous system numbers<br>• Source and destination subnet masks |
| Upstream rate (traffic) shaping | 12.1 EC | Supports buffering upstream grants from rate-exceeding cable interfaces, without incurring Transmission Control Protocol (TCP)-related timeouts and retransmits. |
| Weighted fair drop (WFD) enhancements | 12.1 EC | In addition to other traffic shaping techniques, a new configuration field associates a maximum bandwidth in kbps with a particular setting of IP type of service (ToS) bits. This can be used to ensure that certain traffic, such as data, does not exceed a preset rate limit and thereby interfere with higher priority real time traffic. |

***Table 1-3      Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)***

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Weighted fair queuing (WFQ) | 12.1 EC | Performs priority output queuing and custom queuing to grant resources to important sessions when network bandwidth is saturated; typically used for digitized higher priority real time packets to help reduce delay. WFQ provides expeditious handling for high priority traffic, requiring low delay, while fairly sharing the remaining bandwidth between lower priority traffic. WFQ divides link traffic into high and low priority flows based on metrics including IP precedence and traffic volume. |
| Weighted random early detection (WRED) | 12.1 EC | Provides the ability to specify traffic handling policies to maximize throughput under congestion conditions. RED works in conjunction with TCP to intelligently avoid network congestion. WRED combines IP precedence and RED capabilities to provide differentiated performance characteristics for different classes of service, thus providing preferential traffic handling for higher priority traffic. Administrators can define minimum and maximum queue depth thresholds and drop probabilities for each class of service. |
| **DHCP Servers and Feature Support** | | |
| DHCP cable modem host ID (also known as cable modem and host subnet addressing) | 12.1 EC | (also known as cable modem and host subnet addressing)Allows the Cisco uBR7100 series to modify the giaddr field of DHCPDISCOVER packets, based on whether the source is a cable interface or a host. This helps automate provisioning. |
| Integrated DHCP server | 12.1 EC | Simplifies provisioning, offering an integrated Dynamic Host Configuration Protocol server. |
| Source Verify Lease-Query Throttling | 12.2 BC | When the cable source-verify dhcp and no cable arp commands are configured on a cable interface, problems can occur when viruses, denial of service (DoS) attacks, and theft-of-service attacks begin scanning a range of IP addresses, in an attempt to find unused addresses. When the Cisco CMTS router is verifying unknown IP addresses, this type of scanning generates a large volume of DHCP lease queries, which can result in a number of problems, such as dropped packets and high CPU utilization of both the Cisco CMTS router and DHCP server. To prevent these problems, you can enable filtering of these requests on upstream interfaces, downstream interfaces, or both. When this feature is enabled, the Cisco CMTS allows only a certain number of DHCP LEASEQUERY requests for each service ID (SID) on an interface within the configured interval time period. If a SID generates more lease queries than the maximum, the router drops the excess number of requests until the next interval period begins. For more information on this feature, see the document "Filtering Cable DHCP Lease Queries", at the following URL: • http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/cblsrcvy.htm |

*Table 1-3      Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
| --- | --- | --- |
| Support for dynamic/mobile hosts | 12.1 EC | Allows the CMTS administrator to bring up a PC behind one CM, then move it to another CM. Adds information for the hosts involved in host tables. To prevent security breaches, supports pinging the host using the old SID to verify that it has indeed been moved.<br><br>DHCP server is used to verify addresses and can be configured with the **cable source-verify dhcp** command; **no cable arp** should be configured in the CMTS to prevent it from sending ARP requests. |
| **DOCSIS Feature Support** | | |
| Concatenation support | 12.1 EC | Combines multiple upstream packets into one packet to reduce packet overhead and overall latency, as well as increase transmission efficiency. Using concatenation, a CM needs to make only one bandwidth request for a concatenated packet, as opposed to making a different bandwidth request for each individual packet. This technique is particularly effective for real time traffic. |
| DHCP Client ID/Remote ID options | 12.1 EC | Allows the Cisco uBR7100 series to report and limit the number of CPEs per cable interface through command-line interface (CLI) and Simple Network Management Protocol (SNMP).<br><br>**Note** This feature is also known as Customer Premises Equipment (CPE) Limitation. |
| DOCS-IF-MIB Update | 12.2(15)BC2 | The DOCS-IF-MIB (released as RFC 2670) has been updated to conform to the version 5 of the DOCSIS 2.0 RF MIB Specification (draft-ietf-ipcdn-docs-rfmibv2-05.txt). |
| DOCSIS 1.0 Concatenation Override | 12.3 BC | Cisco IOS release 12.3(13a)BC introduces support for the DOCSIS 1.0 concatenation override feature on the Cisco uBR10012 router. This feature provides the ability to disable concatenation on DOCSIS 1.0 cable modems, even in circumstances where concatenation is otherwise supported for the upstream channel.<br><br>DOCSIS 1.0 concatenation allows the cable modem to make a single-time slice request for multiple packets, and to send all packets in a single large burst on the upstream. Concatenation was introduced in the upstream receive driver in the previous Cisco IOS releases that supported DOCSIS 1.0 +. Per-SID counters were later added in Cisco IOS release 12.1(4)CX for debugging concatenation activity.<br><br>In some circumstances, overriding concatenation on DOCSIS 1.0 cable modems may be preferable, and Cisco IOS release 12.3(13a)BC supports either option.<br><br>To enable DOCSIS 1.0 concatenation override with Cisco IOS release 12.3(13a)BC and later releases, use the new **docsis10** keyword with the previously supported **cable upstream** *<n>* **concatenation** command in privileged EXEC mode:<br><br>**cable upstream** *<n>* **concatenation docsis10**<br><br>Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*:<br><br>• http://www.cisco.com/en/US/products/hw/cable/ps2211/prod_release_notes_list.html |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| DOCSIS 1.0 Constant Bit Rate (CBR)—DOCSIS 1.0 extension | 12.1 EC | Enables better processing of higher priority traffic; new fields in the DOCSIS configuration file can be used so that when a CM requests a voice SID, the MAC scheduler on the Cisco uBR7100 series schedules fixed periodic slots on the upstream for that traffic flow. The CM does not have to contend for these slots, and because the Cisco uBR7100 series controls the timing of slots, it has precise control over potential delay and jitter. |
| DOCSIS 1.0 Media Access Controller (MAC) driver | 12.1 EC | Supports CableLabs specifications for the MAC sublayer and associated interfaces. |
| DOCSIS 1.0 QoS enhancements | 12.1 EC | Supports definition of service class profiles according to DOCSIS 1.0:<br>• Traffic priority (7, 6, 5, 4, 3, 2, 1, 0) with 7 being the highest<br>• Maximum upstream rate in bps<br>• Maximum upstream channel burst in minislot<br>• Minimum upstream rate in bps<br>• Maximum downstream rate in bps |
| DOCSIS extensions MIB | 12.1 EC | Supports objects related to QoS support for scheduler of DOCSIS-compliant RF interfaces in the CMTS. |
| DOCSIS Set-Top Gateway (DSG) 1.0 | 12.2 BC | Cisco IOS Release 12.3(9a)BC introduces support for DOCSIS Set-Top Gateway (DSG) Issue 1.0 on the Cisco uBR7100 series universal broadband router. The DOCSIS Set-Top Gateway (DSG) feature allows the Cisco CMTS to provide a class of cable services known as out-of-band (OOB) messaging to set-top boxes (STBs) over existing DOCSIS networks. This allows MSOs and other service providers to combine both DOCSIS and STB operations over one, open, vendor-independent network, without any change to the existing network or cable modems.<br><br>DSG is a CableLabs® specification that allows the Cisco CMTS to provide a class of cable services known as out-of-band (OOB) messaging to set-top boxes (STBs) over existing Data-over-Cable Service Interface Specifications (DOCSIS) cable networks. DSG 1.0 allows cable Multi-System Operators (MSOs) and other service providers to combine both DOCSIS and STB operations over a single, open and vendor-independent network without requiring any changes to the existing DOCSIS network infrastructure.<br><br>At the time of this Cisco publication, the CableLabs® DOCSIS DSG specification is in the current status of "Issued" as characterized by stability, rigorous review in industry and cross-vendor interoperability.<br><br>For additional information about configuring and using DSG 1.0 on the Cisco uBR7100 Series routers, refer to the following document on Cisco.com:<br>• *DOCSIS Set-Top Gateway for the Cisco CMTS*<br>   http://www.cisco.com/en/US/netsol/ns457/networking_solutions_white_paper09186a00801b3f0f.shtml |

*Table 1-3     Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| DOCSIS software infrastructure | 12.1 EC | Supports CableLabs specifications for high-speed data-over-cable systems involving the following categories:<br><br>• RF interfaces between the Cisco uBR7100 series and the cable network—Downstream and upstream traffic.<br><br>• Data interfaces for cable interfaces and CPE devices, as well as the CMTS network-side interface between the Cisco uBR7100 series routers and the data network.<br><br>• Operations support interfaces—Network element management layer interfaces between the network elements and the operations support systems. Telco return interfaces—Interfaces between third-party DOCSIS-compliant cable interfaces and the telco return path(s) when the return path is not provided by the cable network. |
| Downstream channel ID | 12.1 EC | Allows all cable interfaces on the cable network to have unique downstream channel IDs. CMs communicate their downstream ID when making a connection, and not the downstream frequency. |
| Downstream frequency override | 12.1 EC | Allows the Cisco uBR7100 series to change the downstream frequency for a cable interface, overriding the DOCSIS configuration file setting. |
| Downstream signal test commands | 12.1 EC | Provides the following test capabilities: the **cable downstream if-output** command is enhanced with the following options to generate test signals on the downstream interface:<br><br>• **cable downstream if-output prbs** shuts down the downstream interface and outputs a PRBS test signal<br><br>• **cable downstream if-output continuous wave** shuts down the downstream interface and outputs an unmodulated carrier signal<br><br>The previous **cable downstream if-output** command has not changed and continues to output a standard modulated signal.<br><br>The **no cable downstream if-output** command has not changed; it stops all signal output and shuts down the interface. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---------|------------------------|-------------|
| Enhanced Rate Bandwidth Allocation (ERBA) Support for DOCSIS 1.0 Cable Modems | | Cisco IOS release 12.3(13a)BC introduces Enhanced Rate Bandwidth Allocation (ERBA) support for DOCSIS 1.0 cable modems and the Cisco uBR7100 router. ERBA allows DOCSIS1.0 modems to burst their temporary transmission rate up to the full line rate for short durations of time. This capability provides higher bandwidth for instantaneous bandwidth requests, such as those in Internet downloads, without having to make changes to existing service levels in the QoS Profile. |
| | | This feature enables MSOs to set the DOCSIS 1.0 cable modems burst transmissions, with mapping to overriding DOCSIS 1.1 QoS profile parameters on the Cisco CMTS. DOCSIS 1.0 cable modems require DOCSIS 1.0 parameters when registering to a matching QoS profile. This feature enables maximum downstream line rates, and the ERBA setting applies to all cable modems that register to the corresponding QoS profile. |
| | | **Note**    QoS definitions must previously exist on the Cisco CMTS headend to support this feature. |
| | | DOCSIS 1.0 cable modems require DOCSIS 1.0 parameters when registering to a matching QoS profile. This feature enables the maximum downstream burst to be set in global configuration mode. The **max-ds-burst** setting applies to all cable modems that register to the corresponding QoS profile. |
| | | ERBA for DOCSIS 1.0 cable modems is supported with these new or enhanced commands or keywords in Cisco IOS release 12.3(13a)BC: |
| | | • **cable qos pro max-ds-burst** *burst-size* |
| | | • **show cable qos profile** *n* **[verbose]** |
| | | Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*: |
| | | • http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html |
| Enhanced source address verification | 12.1 EC | Prevents the spoofing of IP addresses by verifying that each upstream data packet comes from the CM known to be associated with the source IP address in the packet. The **cable source-verify** [**dhcp**] cable interface command specifies that DHCP lease query requests are sent to verify any unknown source IP address found in upstream data packets. |
| | | **Note**    This feature requires a DHCP server that supports the new LEASEQUERY message type such as Cisco Network Registrar (CNR) Version 3.01(T). |
| EuroDOCSIS Support | 12.1 EC | The Cisco uBR7111E and Cisco uBR7114E routers support the EuroDOCSIS Annex A standard with 8 MHz PAL or SECAM channel plan operation (similar to DAVIC/DVB ITU J.83 standard). |
| | | The EuroDOCSIS standard specifies a downstream 36.125 MHz interface, with a 8 MHz channel width and interleave factor of I=12, J=17. The card supports a downstream symbol rate of 6.592 Msymbols/sec at 64 QAM and 256 QAM. The downstream channel range supported is 85 to 860 MHz; the upstream channel range supported is 5 to 65 MHz. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Extended Upstream Frequency Ranges | 12.2 BC | Cisco IOS Release 12.2(15)BC2 adds support for the extended upstream frequency range that is used in cable networks in Japan and other areas. This feature also clarifies the configuration of DOCSIS and EuroDOCSIS networks, so that the router shows only those upstream and downstream frequencies that are valid for each mode of operation.<br><br>A new CLI command, **cable freq-range**, was also added to support this feature on the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cards. For more information, see the *Support for Extended Upstream Frequency Ranges*, at the following URL:<br><br>http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/mclcjfm.htm |
| Integrated Time of Day (ToD) server | 12.1 EC | Allows the Cisco uBR7100 series to respond to ToD (RFC 868) queries from cable interfaces during the registration process. |
| Modem power enhancement adjustments for low SNR failures | 12.1 EC | Allows Cisco uBR7100 series to better adjust when a CM seems to bounce—the CM requires frequent power adjustments in opposite directions. When this occurs, instead of making large power adjustments for each correction, the administrator can configure the Cisco uBR7100 series to calculate the average value of the power corrections before making power adjustments:<br><br>• **cable upstream power-adjust threshold** now accepts a range of 0 to 10 dB (the previous range was 0 to 2 dB).<br><br>• **cable upstream power-adjust noise** *% of power adjustment* sets the threshold value (in percent) for a particular upstream, switching between regular power adjustments and the noise power adjustment method.<br><br>The noise power adjustment method uses an averaging algorithm before sending any correction. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Vendor-Specific Information Field to Authorize Dynamic Service Requests | | DOCSIS 1.1 cable modems can request additional bandwidth via the DOCSIS 1.1 dynamic services mechanism, by sending dynamic service add (DSA) and dynamic service change (DSC) messages (known collectively as DSX messages). By default, the CMTS grants these requests because a DOCSIS-compliant cable modem does not request services that would violate their provisioned service flows. |
| | | However, a cable modem that is using software that is not DOCSIS-compliant, or that is using software that has been hacked to include unauthorized changes that violate the DOCSIS specifications, could use dynamic services requests to obtain bandwidth that the user is not authorized to use. Users could also use dynamic services requests as part of a denial-of-service attack on the cable network. |
| | | To prevent this, Cisco IOS Release 12.2(15)BC2 supports including an optional vendor-specific information field (VSIF) in the DOCSIS configuration file to enable or disable DSX requests by the cable modem: |
| | | TLV = 43 (VSIF) |
| | | SubTLV 12, Length = 1 |
| | | Value = 0, denies all DSX requests |
| | | Value = 1, allows all DSX requests |
| | | Refer to *Cisco uBR7100 Series - Cisco IOS Release 12.2 BC*: |
| | | • http://www.cisco.com/en/US/docs/ios/12_2/12_2b/12_2bc/release/notes/u7108bc1.html |
| **High Availability Features** | | |
| N+1 HCCP Redundancy with Load Balancing | 12.2 BC | Cisco IOS Release 12.2(15)BC2 supports configuring a cable interface for both load balancing and N+1 HCCP redundancy. |
| **Intercept Features** | | |
| Access List Support for COPS Intercept | 12.3 BC | Cisco IOS Release 12.3(13a)BC introduces enhanced command-line interface for the Common Open Policy Service (COPS) feature. |
| | | To configure access control lists (ACLs) for inbound connections to all COPS listener applications on the Cisco CMTS, user the **cops listeners access-list** command in global configuration mode. To remove this setting from the Cisco CMTS, us the **no** forZzm of this command. |
| | | Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*: |
| | | • http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
| --- | --- | --- |
| SII—Service Independent Intercept | 12.3 BC | Cisco CMTS supports the Communications Assistance for Law Enforcement Act (CALEA) for voice and data. Cisco IOS Release 12.3(13a)BC introduces support for Service Independent Intercept (SII) on the Cisco uBR7100 CMTS. Cisco SII provides a more robust level of the lawful intercept (LI) options offered in the Packet Intercept feature. Cisco SII is the next level of support for judicially authorized electronic intercept, to include dial access, mobile wireless, tunneled traffic, and Resilient Transport Protocol (RTP) for voice and data traffic on the Cisco CMTS. SII on the Cisco CMTS includes these functions: <br><br> Packet intercept on specified or unspecified interfaces or ports, including port lists <br><br> Packet intercept on virtual interface bundles <br><br> Corresponding SNMP MIB enhancements for each of these functions, as intercept requests are initiated by a mediation device (MD) using SNMPv3 <br><br> No new CLI commands are provided for this feature in Cisco IOS release 12.3(13a)BC. <br><br> Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*: <br><br> • http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html |
| **IP Networking** | | |
| ARP Filtering | 12.2 BC | Cisco IOS Release 12.2(15)BC2 adds support for the **cable arp filter** command, which enables service providers to filter ARP request and reply packets, to prevent a large volume of such packets from interfering with the other traffic on the cable network. For more information, see the *Cable ARP Filtering* document, at the following URL: <br><br> http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/cblarpfl.htm <br><br> Cisco IOS Release 12.2(15)BC2b introduces support for the ip-requests-filtered option, which was added to the **show cable arp-filter** command to display the specific Service IDs (SIDs) that are generating or forwarding a minimum number of ARP packets. <br><br> Refer to *Cisco uBR7100 Series - Cisco IOS Release 12.2 BC*: <br><br> • http://www.cisco.com/en/US/docs/ios/12_2/12_2b/12_2bc/release/notes/u7108bc1.html |
| LLQ—Low Latency Queuing | 12.3 BC | See "Upstream Schedule Modes (Optional)." |
| **IP Routing** | | |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Basic wiretap support | 12.1 EC | Provides support for a basic wiretap facility that the United States Federal Communications Assistance for Law Enforcement Act (CALEA) requires. This provides a mechanism such that user-to-user traffic can be captured. |
| | | The wiretap facility is based on the MAC address of the RF CPE device, so the wiretap facility can be used for either data or digitized higher priority connections. The feature is controlled by the new interface command—**cable intercept**—which requires a MAC address, an IP address, and a UDP port number as its parameters: |
| | | **cable intercept**[*mac-address*] ip-address udp-port |
| | | When activated, the Cisco uBR7100 series examines each packet for the desired MAC address. When a matching MAC address is found (for either the origination or destination endpoint), a copy of the packet is encapsulated into a UDP packet, which is then sent to the specified server at the given IP address and port. |
| Bridging Operation | 12.1 EC | Performs forwarding of traffic on the basis of the MAC address between the cable and port adapter interfaces. |
| Cable modem multicast authentication (RADIUS) | 12.1 EC | Permits RADIUS to be used to authenticate subscribers. |
| Cisco IOS router operating system | 12.1 EC | Performs enhanced route filtering and translation to save network resources and prevent data from being broadcast to nodes that do not require it. |
| Integrated Routing and Bridging (IRB) | 12.1 EC | Allows the Cisco uBR7100 series to use bridging on the cable and port adapter interfaces, while still providing access to routed networks, without having to use a separate external router. |
| Nonstop Forwarding (NSF) Awareness | 12.2 BC | The Nonstop Forwarding (NSF) Awareness feature, introduced in Cisco IOS Release 12.2(15)T and inherited by Cisco IOS Release 12.2(15)BC1, allows customer premises equipment (CPE) routers that are NSF-aware to assist NSF-capable routers perform nonstop forwarding of packets. |
| | | The NSF Awareness feature is supported on three IP routing protocols—Border Gateway Protocol (BGP), Open Shortest Path First (OSPF), and Integrated Intermediate System-to-Intermediate System (IS-IS). |
| | | Refer to *Cisco uBR7100 Series - Cisco IOS Release 12.2 BC*: |
| | | • http://www.cisco.com/en/US/docs/ios/12_2/12_2b/12_2bc/release/notes/u7108bc1.html |
| Per modem filters (also known as per modem and per host access lists) | 12.1 EC | Allows the Cisco uBR7100 series to filter incoming packets from individual hosts or cable interfaces based on the source Media Access Control (MAC) or Internet Protocol (IP) address. This allows access lists to be specified on a per-interface and per-direction basis. The packets received from cable interfaces and individual hosts are filtered based on the cable interface or the host from which the packets are received. |
| Telco return | 12.1 EC | Allows the Cisco uBR7100 series to register third-party DOCSIS-compliant telco return cable interfaces, based on the DOCSIS telco return specification. This allows the network to support two-way and telco return cable interfaces. |
| Transparent and IRB Bridging Operation | 12.1 EC | Performs forwarding of traffic on the basis of the MAC address between the cable and port adapter interfaces. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Upstream Schedule Modes (Optional) | 12.3 BC | With this feature, the user is able to select either Unsolicited Grant Services (UGS) or Real Time Polling Service (rtPS) scheduling types, as well as packet-based or TDM-based scheduling. Low latency queueing (LLQ) emulates a packet-mode-like operation over the Time Division Multiplex (TDM) infrastructure of DOCSIS. As such, the feature provides the typical tradeoff between packets and TDM: with LLQ, the user has more flexibility in defining service parameters for UGS or rtPS, but with no guarantee (other than statistical distribution) regarding parameters such as delay and jitter. Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*: <br>• http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html |
| **Management Features** | | |
| Cable monitor | 12.1 EC | Provides upstream and downstream sniffer capabilities. |
| Downstream Load Balancing Distribution with Upstream Load Balancing | 12.3 BC | Cisco IOS Release 12.3(17b)BC4 introduces further enhancements to downstream load balancing, resulting in equalized upstream load balancing group members. This enhancement synchronizes the pending statistic between different cable interface line cards in the load balancing group. <br>This enhancement performs downstream load balancing that accounts for loads on upstream channels in the same upstream load balancing group, rather than on the basis of the entire downstream channel load. Prior Cisco IOS releases may not have distributed cable modems evenly over individual upstream channels, nor in a way that accounted for downstream and upstream segment loads that account for one another. <br>This enhancement applies when downstream load balancing occurs on a headend system with separate upstream load balancing segments; the upstream segments are spread over multiple downstreams segments. This enhancement provides an alternative downstream load balancing scheme that accounts and makes use of per-upstream loads rather than total downstream loads. <br>For additional information about Load Balancing on the Cisco CMTS, refer to the following documents on Cisco.com: <br>• *Load Balancing and Dynamic Channel Change on the Cisco CMTS* <br>http://www.cisco.com/en/US/docs/cable/cmts/troubleshooting_batch9/cmtslbg.html <br>• *Cisco Broadband Cable Command Reference Guide* <br>http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Modem status display enhancements | 12.1 EC | Enhancements support polling of CMs to obtain parameter and status information on an ongoing basis. Two new Cisco IOS commands are added to support the feature:<br><br>• **cable modem remote** configures the router for the polling interval; the **no** version of this command disables the status polling.<br><br>• **show cable modem remote-query** displays the collected information:<br>  – downstream receive power level<br>  – downstream signal to noise ratio<br>  – upstream power level<br>  – micro reflection in dB<br><br>Additional or changed show commands include:<br><br>• **show cable qos** shows **cable qos-profile** *n* command, where the optional argument *n* can be used to display a specific profile.<br><br>• **show int cx/y sid** displays more complete Service ID (SID) status information.<br><br>• **show cable modem** displays a list of options for a single modem to be specified by entering either the RF CPE device's IP address or MAC address: SNR information for each CM on each interface, summary display of the total number of modems connected for each upstream channel, total number of registered and unregistered modems for the specified interface or upstream, total number of offline modems for the specified interface or upstream and status for each offline modem before it went offline.<br><br>• **show cable burst-profile** has been removed. Its functions have been incorporated into the **show cable modulation-profile** command, which now includes an added option number that displays the modulation profile number.<br><br>• **show cable flap-list** and **show cable modem** now indicate when the Cisco uBR7100 series has detected an unstable return path for a particular modem and has compensated with a power adjustment. An asterisk appears in the power adjustment field for a modem when a power adjustment has been made; an exclamation point appears when the modem has reached its maximum power transmit level and cannot increase its power level any further. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---------|------------------------|-------------|
| Subscriber Traffic Management 1.1 | 12.3 BC | Cisco IOS Release 12.3(9a)BC introduces support for Subscriber Traffic Management (STM) through Version 1.1 on the Cisco uBR7100 series universal broadband routers. STM 1.1 supports DOCSIS 1.1-compliant cable modems. The STM feature enables service providers to identify and control subscribers who exceed the maximum bandwidth allowed under their registered quality of service (QoS) profiles. STM 1.1 works with Network-Based Application Recognition (NBAR) and Access control lists (ACLs) to ensure full network performance to other network subscribers that abide by their service agreements. STM 1.1 also works in conjunction with the Cisco Broadband Troubleshooter 3.2 to support additional network management and troubleshooting functions in the Cisco CMTS. <br><br> STM 1.1 extends earlier STM functions to monitor a subscriber's traffic on DOCSIS 1.1 primary service flows and supports these additional features: <br><br> • Cisco Broadband Troubleshooter (CBT) 3.2 supports STM 1.1. <br> • DOCSIS 1.0-compliant and DOCSIS 1.1-compliant cable modem are supported. <br> • Monitoring and application of traffic management policies are applied on a service-flow basis. <br> • Monitoring window duration increased from seven to 30 days. <br><br> For additional information about STM 1.1 and Cisco CBT 3.2, refer to the following document on Cisco.com: <br><br> • *Release Notes for Cisco Broadband Troubleshooter Release 3.2* <br> http://www.cisco.com/en/US/products/sw/netmgtsw/ps530/prod_release_notes_list.html |
| **PacketCable and Voice Support Features** | | |
| PacketCable | 12.2 BC | Cisco IOS Release 12.2(15)BC2 supports PacketCable operations on the Cisco uBR-MC5X20S/U cable interface line cards on the Cisco uBR10012 router, and on the Cisco uBR-MC16U/X and Cisco uBR-MC28U/X cards on the Cisco uBR7246VXR router. <br><br> In addition, cable interfaces can be configured for both PacketCable operations and for N+1 HCCP redundancy. The debug packetcable hccp and show packetcable event commands have been added as part of this support. <br><br> Refer to *Cisco uBR7100 Series - Cisco IOS Release 12.2 BC*: <br><br> • http://www.cisco.com/en/US/docs/ios/12_2/12_2b/12_2bc/release/notes/u7108bc1.html |
| **Security Features** | | |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Dynamic Shared Secret | 12.2 BC | The Dynamic Shared Secret feature provides service providers a way of providing higher levels of security for their Data-over-Cable Service Interface Specifications (DOCSIS) cable networks, by using randomized, single-use shared secrets to verify the DOCSIS configuration files that are downloaded to each cable modem. The Dynamic Shared Secret feature is enabled using the **cable dynamic-secret** interface configuration command.<br><br>The Dynamic Shared Secret feature automatically creates a unique DOCSIS shared secret on a per-modem basis, creating a one-time use DOCSIS configuration file that is valid only for the current session. This ensures that a DOCSIS configuration file that has been downloaded for one cable modem can never be used by any other modem, nor can the same modem reuse this configuration file at a later time.<br><br>This patent-pending feature is designed to guarantee that all registered modems are using only the quality of service (QoS) parameters that have been specified by the DOCSIS provisioning system for that particular modem at the time of its registration.<br><br>For information on the Dynamic Shared Secret feature, see the *Configuring a Dynamic Shared Secret for the Cisco CMTS* document, at the following URL:<br><br>http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_15/ubrdmic.htm |
| Encrypted Baseline Privacy key exchange | 12.1 EC | Supports full DOCSIS 1.0 BPI specifications |
| 40-bit and 56-bit Baseline Privacy Data Encryption Standard (DES) | 12.1 EC | The Cisco uBR7100 series supports 40-bit and 56-bit encryption/decryption. When encryption/decryption is enabled, 56-bit is the default. If necessary, administrators can force the Cisco uBR7100 series to generate a 40-bit DES key, where the DES key that is generated and returned masks the first 16-bits of the 56-bit key to zero in software.<br><br>**Note** Requires software images that support the BPI feature to be set at the CMTS and CM. |
| Telco return RADIUS enhancements | 12.1 EC | Enhancements provide additional authentication information, allowing an administrator to determine if a subscriber dialed a number that requires special billing arrangements (such as a toll-free number). If a telco return customer is being authenticated by a Terminal Access Controller Access Control System Plus (TACACS+) or RADIUS server, and if the number dialed by the CM is being redirected to another number for authentication, the system can include the original number in the information sent to the authentication server. The original number can be sent as a Cisco Vendor Specific Attribute (VSA) for TACACS+ servers and as RADIUS Attribute 93 (Ascend-Redirect-Number) for RADIUS servers. |

*Table 1-3      Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Upstream address verification | 12.1 EC | Supports verification of cable interface and PC addresses to ensure cable interface SID and MAC addresses are consistent; this helps ensure IP addresses are not spoofed. A PC behind a cable interface is assigned an IP address from the DHCP server. If a user on a second PC/cable interface statically assigns the same IP address to a PC, the Cisco uBR7100 series finds this case to help block the spoofing user. Using the CLI, administrators can determine the IP and MAC address of a given cable interface, and the SID number that shows the IP and MAC addresses of all devices learned in the cable interface MAC table. Using the service provider customer databases, administrators can cross reference the spoofing cable interface and PC and prevent usage. |
| **SNMP Features and Enhancements** | | |
| CISCO-NBAR-PROTOCOL-DISCOVERY-MIB | 12.2(15)BC2 | Cisco IOS Release 12.2(15)BC2 adds support for the CISCO-NBAR-PROTOCOL-DISCOVERY-MIB to the Cisco uBR7100 series and Cisco uBR7246VXR universal broadband routers. This allows service providers to use SNMP requests to configure and monitor the Network-Based Application Recognition (NBAR) feature. For more information about NBAR, see the *Network-Based Application Recognition and Distributed Network-Based Application Recognition* document, at the following URL: http://www.cisco.mn/en/US/products/ps6616/products_ios_protocol_group_home.html For more information about the CISCO-NBAR-PROTOCOL-DISCOVERY-MIB, see the *Network-Based Application Recognition Protocol Discovery Management Information Base* document, at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t15/ftpdmib.htm |
| RF Interface Management Information Base (MIB) | 12.1 EC | Improves object support for SNMP traps; traps are the mechanisms used to automatically send alarms for certain network events. |
| Service Class Setting Using SNMP | 12.1 EC | Supports objects related to class of service. |
| Simple Network Management Protocol (SNMP) v3 | 12.1 EC | SNMP version 3 offers enhanced security features and increases interoperability. The implementation set of MIBs allows the SNMP manager to gather data such as system card descriptions, serial numbers, hardware and software revision levels, and slot location. |
| Support for RFC 2233 (RF Interface MIB) | 12.1 EC | Support DOCSIS OSSI Required Objects in RFC 2233 for the Cisco uBR7100 series. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Support for RFC 2665 for Cisco uBR7100 Series | 12.1 EC | Support DOCSIS OSSI Required Objects in RFC 2665 for the Cisco uBR7100 series. |
| **Spectrum Management Features** | | |
| Dynamic upstream modulation | 12.1 EC | Provides improved performance using proactive spectrum management functions. |
| Spectrum management phases 1 and 2 | 12.1 EC | Supports the following spectrum management capabilities to specify the rules the system uses when hopping to another frequency when no clean frequency band is available:<br><br>• Combined blind and time scheduled reassignment:<br><br>  – Blind hop—No "look ahead" capabilities, but some specifications on frequency reassignment based on the number of lost station management messages exceeding a threshold (default=10).<br><br>  – Time scheduled—Frequency reassignment based on time of day or week.<br><br>• Guided frequency hop—Assigning explicit frequency subbands and associated input power levels in a spectrum group. |
| **Testing, Troubleshooting and Diagnostic Features** | | |
| Cisco Broadband Troubleshooter | 12.3 BC | Cisco IOS Release 12.3(9a)BC introduces support for the Cisco Broadband Troubleshooter (CBT) Version 3.2 on the Cisco uBR7100 series universal broadband router. Multiple Service Operators (MSO) provide a variety of services such as TV, video on demand, data, and voice telephony to subscribers. Network Administrators and radio frequency (RF) technicians need specialized tools to resolve RF problems in the MSO's cable plant. Cisco Broadband Troubleshooter 3.2 (CBT 3.2) is a simple, easy-to-use tool designed to accurately recognize and resolve such issues.<br><br>The user can select up to three different cable modems (CMs) under the same CMTS or three different upstreams under the same CMTS. In addition, CBT 3.2 introduces the ability to display upstreams and cable modems combined (mixed) on the same trace window for monitoring and for playback.<br><br>**Note**    CBT 3.2 resolves the former CBT 3.1 caveat CSCee03388. With CBT 3.1, trace windows did not support the *mixing* of upstreams or cable modems.<br><br>Refer to *Release Notes for Cisco Broadband Troubleshooter Release 3.2*:<br><br>• http://www.cisco.com/en/US/products/sw/netmgtsw/ps530/prod_release_notes_list.html |
| **VLAN Features** | | |
| Interswitch Link (ISL) bridging (noncable interfaces) | 12.1 EC | Provides support for the ISL feature—Cisco protocol used to interconnect multiple routers and switches and maintain Virtual Local Area Network (VLAN) information as traffic is conveyed between the routers and switches. |

*Table 1-3    Cisco uBR7100 Series Feature List with First Supporting Release Train (continued)*

| Feature | First Cisco IOS Release | Description |
|---|---|---|
| Transparent LAN Service | 12.2 BC | Cisco IOS Release 12.2(15)BC2 enhanced the existing support for Transparent Lan Services (TLS), which allows the Cisco CMTS to create Layer 2 tunnels for traffic to and from cable modems. This allows customers to create their own virtual local area network (VLAN) using any number of cable modems in multiple sites. |
| | | In addition to the ATM PVC Mapping, which was previously supported, Cisco IOS Release 12.2(15)BC2 added the ability to map a cable modem's MAC address to an IEEE 802.1Q VLAN on a specific Ethernet interface, so that all traffic from the cable modem is tagged with the specified VLAN ID. Service providers can now map cable modem traffic onto an ATM PVC or onto an Ethernet IEEE 802.1Q VLAN, depending on their customer's specific needs. |
| | | For more information on this service, see the *Transparent LAN service over Cable* document, at the following URL: |
| | | http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122limit/122bc/122bc_11/sidatmpv.htm |
| **VPN Features** | | |
| TAG Switching Support on Cable Interfaces | 12.1 EC | Supports enhancements made to tags placed on the fronts of packets that contain forwarding information used for making switching decisions for cable interfaces. A tag switching infrastructure combines advanced routing protocol capabilities to define IP VPNs by selectively advertising IP reachability information to just those subscribers within the same VPN or extranet on a cable interface. |
| **WAN Optimization and Service Features** | | |
| MLPPP Support | 12.3 BC | The Cisco IOS Multilink Point-to-Point Protocol (MLPPP) feature is now supported for selected line cards and port adapters on the Cisco uBR7100 series, which share the same MLPPP code as the Cisco 7200 series. There is no new hardware or software for MLPPP in this release. |
| | | MLPPP combines one or more physical interfaces into a virtual "bundle" interface. The bandwidth of the bundle interface is equal to the sum of the component links' bandwidth. This allows service providers to make the step from T1 and E1 lines to affordable T3 and E3 speeds. |
| | | MLPPP is configured not on a cable interface, but on the T1/E1 link. |
| | | Refer to *Release Notes for Cisco uBR7100 Series for Cisco IOS Release 12.3 BC*: |
| | | • http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/release/notes/12_3bc/123BCu71.html |
| Per SID bandwidth request/grant counters | 12.1 EC | Promotes better control of higher priority traffic, permitting per-SID bandwidth requests and grants. Profiles can be customized for scheduling parameters required at subscriber sites for the service offering. The **show interface cx/0 upstream** *number* command now supports a **verbose** option that displays: |
| | | • Number of bandwidth requests successfully received by the Cisco uBR7100 series from the specified SID on the specified cable interface |
| | | • Number of grants issued by the Cisco uBR7100 series to the specified SID |

**Note**    Refer to the Cisco IOS command reference master index for a detailed listing of all Cisco IOS releases and supported features.

# DOCSIS and CMTS Interoperability

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

## DOCSIS Cable Plants

When using the DOCSIS specification, a cable plant modulates and demodulates data using 6-MHz downstream channels in the 54 to 860-MHz range and upstream channels in the 5 to 42 MHz range. The cable interface supports NTSC channel operation, using standard (STD), Harmonic Related Carrier (HRC), or Incremental Related Carrier (IRC) frequency plans conforming to EIA-S542.

NTSC uses a 6 MHz-wide modulated signal with an interlaced format of 25 frames per second and 525 lines per frame. NTSC is compatible with CCIR Standard M. PAL, used in West Germany, England, Holland, Australia, and several other countries.

**Note**    Cisco 6-MHz products can be used in Cisco 8-MHz cable plants. The products, however, operate at a maximum downstream bandwidth of 27 Mbps, ignoring 2 MHz of available channel width, and limiting upstream channel choices to the range below 42 MHz.

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

*Figure 1-1    DOCSIS Two-Way and Telco-Return Architecture*
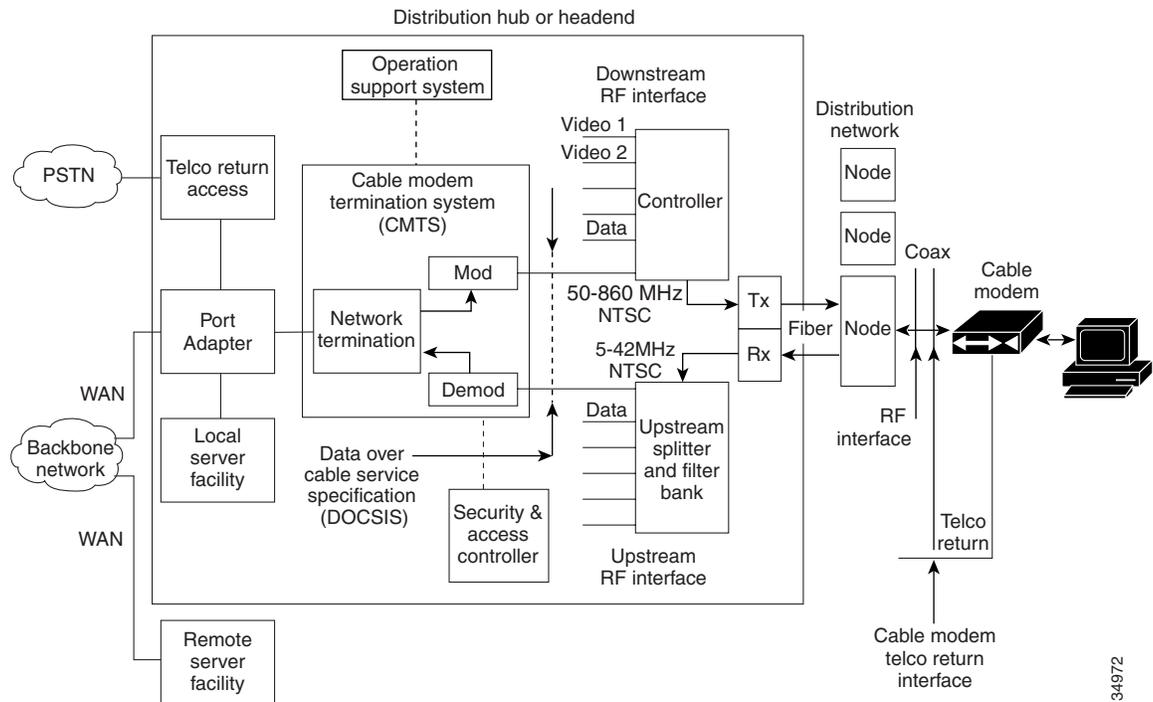


Larger cable companies typically have high-speed fiber backbones that carry Internet data, voice, and video between the following cable company facilities:

- Regional processing centers
- Headends
- Hubs

The fiber backbone can be made up of OC-3 (155 Mbps) to OC-48 (2488 Mbps) Synchronous Optical Network (SONET) or Asynchronous Transfer Mode (ATM) rings. The backbone network can connect to other networks, including the Public Switched Telephone Network (PSTN), other cable system backbones, or to public Internet interconnect points that multiple ISPs use.

The CMTS Media Access Control (MAC) domain typically includes one or more downstream paths and one or more upstream paths. Depending on the CMTS configuration, the CMTS MAC domain can be defined to have its downstreams on one cable modem card with its upstreams on another card, or one or more CMTS MAC domains per cable modem card.

Cisco provides high-speed routers to route interactive traffic between the backbone and Ethernet in the headend internal network. Signaling protocols maintain the network intelligence needed to route traffic optimally, automatically building and maintaining routing tables to direct traffic and signal failures for rerouting in the network.

Border Gateway Protocol (BPG) typically operates between the cable operator's regional network and external networks, providing routing information exchange between different networks. The Open Shortest Path First (OSPF) protocol is used in regional networks usually. Cisco routers incorporate Cisco IOS software, which offers advanced software features, including quality of service (QoS), Weighted Fair Queuing (WFQ), and IP multicast.

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

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

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

## Downstream Signals

Downstream signals are modulated using QAM-64 or QAM-256 quadrature amplitude modulation, based on the cable interface card used, your cable plant, and the significance of the data. DOCSIS defines the messages and data types for CMTS to CM (or CM in an STB) communications. All CMs listen to all frames transmitted on the downstream channel on which they are registered and accept those where the destinations match the units themselves or the devices that each CM supports.

The Cisco uBR7100 series CMTS supports multicast groups using standard protocols such as Protocol Independent Multicast (PIM), Distance Vector Multicast Routing Protocol (DVMRP), and Internet Group Management Protocol (IGMP) to determine if multicast streams are to be forwarded to a prescribed downstream CM or STB, or a multicast routing peer.

The Cisco uBR7100 series software periodically sends MAC (Media Access Control) allocation and management messages—known as MAPs—to all CMs on the network, defining the transmission availability of channels for specific periods of time. The MAP rate is fixed—every 2 milliseconds.

Different transmission intervals are defined that associate an interval with a Service Identifier (SID). SIDs define the devices allowed to transmit, and provide device identification and class of service management. Software defines what type of transmission is allowed during the interval.

The CMTS system administrator typically assigns one or more SIDs to each CM, corresponding to the classes of service the CM requires. Each MAP is associated with a particular upstream channel. The SID concept supports multiple data flows and use of protocols such as Resource Reservation Protocol (RSVP) that allows IP backbone QoS features to be extended to the CMTS. The CMTS schedules the times granted for sending and receiving packets, and if defined, manipulates the type of service (ToS) field in the IP packet header to accommodate QoS.

**Note** Cisco uBR7100 series software supports extensions to DOCSIS 1.0 to operate with DOCSIS 1.0-based CMs or cable RF CPE devices (such as Cisco uBR924 cable access routers or Cisco uBR910 cable data service units) that also support DOCSIS 1.0 extensions.

**Tip** DOCSIS 1.0 extensions address the problem of QoS for VoIP until the DOCSIS 1.1 specification is finalized. Currently, only certain vendors offer products that support DOCSIS 1.0 extensions.

DOCSIS 1.0 extensions build intelligence into the MAP file, which the CMTS sends to voice-enabled CMs to address jitter and delay. The extensions support unsolicited grants which are used to create a constant bit rate-like stream between the CMTS and the CM, in contrast to typical data applications where CMs request grants from the CMTS before they can transmit upstream.

## Upstream Signals

The upstream channel is characterized by many CMs (or CMs in STBs) transmitting to the CMTS. These signals typically operate in a burst mode of transmission. Time in the upstream channel is slotted.

The CMTS provides time slots and controls the usage for each upstream interval. The CMTS sends regular mappings of minislot structure in downstream broadcast MAP messages. The CMTS allocates contention broadcast slots that all CMs can use, and also allocates upstream minislots for unicast or noncontention data from specific CMs.

The CMTS allocates two basic types of contention slots on the upstream:

- Initial ranging slots that CMs use during their initialization phase to join the network. When the CMTS receives an initial ranging request from a CM using this kind of slot, the CMTS subsequently polls the CM, and other operational CMs, in unicast, noncontention station maintenance slots. Refer to the"Automatic Provisioning of Cable Modems" section on page 1-29 for CM provisioning and initialization processes.

- Bandwidth-request minislots that CMs use to request data grants from the CMTS to send data upstream in noncontention mode. Any CM can use this type of minislot to request a data grant from the CMTS.

The stream of initial ranging slots and bandwidth request minislots comprise two separate contention subchannels on the upstream. Cisco uBR7100 series software uses a "dynamic bandwidth-request minislots-per-MAP" algorithm to dynamically control the rate of contention slots for initial ranging and bandwidth-requests. The CMTS uses a common algorithm to vary backoff parameters that CMs use within each of the two upstream contention subchannels. The CMTS uses these algorithms to dynamically determine the initial ranging slots and bandwidth-request minislots to allocate on the slotted upstream.

When power is restored after a catastrophic power failure, a large number of CMs attempt to join the network simultaneously. This represents an impulse load on the initial ranging subchannel. The CMTS increases the frequency of initial ranging slots so that CMs can quickly join the network.

During high upstream data loads, the CMTS conserves the scarce upstream channel bandwidth resource and is more frugal in introducing upstream initial ranging slots. The CMTS schedules bandwidth-request minislots at low loads to provide low access delay. At high upstream loads, the CMTS reduces the number of contention-based request minislots in favor of data grants, while maintaining a minimum number of request slots.

> **Note**  The system default is to have the automatic dynamic ranging interval algorithm enabled, automatic dynamic ranging backoff enabled, and data backoffs for each upstream on a cable interface. Commands to configure the dynamic contention algorithms include:
> [**no**] **cable insertion-interval** [*automatic* [*Imin* [*Imax*]] *in msecs*
> [**no**] **cable upstream** *port number* **range backoff** [*automatic*] | [*start* | *end*]
> [**no**] **cable upstream** *port number* **data-backoff** [*automatic*] | [*start* | *end*]

> **Caution**  In general, Cisco discourages adjusting default settings. Only personnel who have received the necessary training should attempt to adjust values.

The Cisco uBR7100 series equipment periodically broadcasts upstream channel descriptor (UCD) messages to all CMs. These messages define upstream channel characteristics that include upstream frequencies, symbol rates and modulation schemes, forward error correction (FEC) parameters, and other physical layer values.

Upstream signals are demodulated using quadrature phase shift keying (QPSK) or quadrature amplitude modulation (QAM). QPSK carries information in the phase of the signal carrier, whereas QAM uses both phase and amplitude to carry information.

**Tip**   If your cable plant is susceptible to ingress or noise, QPSK is recommended based on the importance of the data. Frequencies below 20 MHz are more susceptible to noise and might require lower symbol rates. Higher frequencies might be able to support higher rates and use QAM modulation instead.

## Automatic Provisioning of Cable Modems

A key component of DOCSIS networks is the ability to automatically provision each CM or STB as it comes online. To allow for this, the systems administrator creates DHCP and DOCSIS configuration files on the appropriate servers such that each CM or CM in an STB on the network, when initialized, can transmit a DHCP request, receive its IP address, obtain its TFTP and TOD server addresses, and download its DOCSIS configuration file (and updated software image, if needed).

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

- DHCP server—The CM must contact a DHCP server through the cable interface to obtain its IP address and other information, such as the default gateway and TFTP server from which to download its DOCSIS configuration file. If the CM cannot contact the DHCP server, it refuses to come online and restarts the registration process.

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

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

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

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

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

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

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

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

- The CM initializes and ranges through available frequencies until it finds the first frequency that it can use to communicate to the CMTS—known as scanning for a downstream channel.

- The CM obtains upstream parameters and performs ranging.

- The CM goes through the DHCP server process and establishes IP connectivity, time of day (TOD, optional), and security (optional). At this point, the CM cannot determine if it is communicating on the correct channel.

- The CM receives a DOCSIS configuration file from the Trivial File Transfer Protocol (TFTP) server. One of the parameters in the DOCSIS configuration file tells the CM which channel it can use.

- The CM registers with the CMTS.

- If the network supports DOCSIS baseline privacy interface (BPI) or other secure data sets, encryption/decryption processes are initialized.

- The CM is ready for normal operations. Once initialized and operational, CMs send requests to initiate data transmission to the CMTS.

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

Initial and station maintenance management messages are sent to maintain communications between CMs and the CMTS. The following is a typical sequence of messages:

1. An offline CM powers up and brings up its cable interface.

2. The CM begins searching on the cable interface for an available downstream frequency.

3. The CM continues searching the downstream frequencies until it finds an active and available frequency and locks on to that frequency.

4. The CMTS sends one or more Upstream Channel Description (UCD) messages to the CM containing information about the upstream channel it should use.

5. The CM scans each upstream channel identified in the UCD messages, and if a usable channel is found, it obtains the bandwidth allocation map for the channel. If no usable channel is found, the CM attempts to lock on another downstream.

6. The CM begins its initial ranging, using a temporary identifier on the upstream, to obtain its permanent Service ID (SID) and initial upstream frequency and power levels.

7. When ranging is successful, the CM transmits a DHCP request on the cable interface.

8. The DHCP server receives the DHCP request and replies with a DHCP reply that contains the information appropriate for this particular CM (IP address, default gateway, ToD server address, TFTP server address, and so forth).

9. The CM then contacts the ToD server to obtain a current timestamp. This step is optional but is recommended because it allows the CM to timestamp its log and other messages, which can be helpful in troubleshooting problems and managing the network.

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

10. The CM also contacts the designated TFTP server to obtain its DOCSIS configuration file. If a valid DOCSIS configuration file is received, the CM configures itself accordingly.

11. If specified in the DOCSIS configuration file, the CM enables BPI encryption and negotiates with the CMTS for the proper key values.

12. The CM also performs any other steps specified by the DOCSIS configuration file, such as downloading a new software image or downloading a secondary configuration file (for example, downloading a Cisco IOS configuration file).

13. The CM then goes online and enters the maintenance state, passing traffic to and from its connected CPE devices.

# EuroDOCSIS Cable Plants

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

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

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

A typical EuroDOCSIS architecture has four subsystems:

- High-speed fiber backbone—Carries Internet data, voice, and video between regional processing centers, headends, and hubs.

- Headend—Aggregates content at the national and regional level and sends it to the fiber backbone.

- Hub—Combines regional programming with local content and sends that combined content to the cable network.

- Interactive STBs with integrated EuroDOCSIS CMs—Connects subscribers to the cable network.

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

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

- One handles MPEG-2 video, audio, broadcast control data, and broadcast service data.

- The other supports DOCSIS IP data. The return path is implemented with EuroDOCSIS.

## EuroDOCSIS STB Support

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

See the . APIs need to be set up to allow EuroDOCSIS servers to communicate with the CSRC directory to obtain such information as IP addresses, user names, and subscription levels.

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

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