Cisco Systems

Cisco Cable Wideband Solution Design and Implementation Guide, Release 1.0

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Cisco IOS Releases 12.3(21)BC and 12.3(21a)BC3

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Preface

This preface describes the objectives and organization of this document and explains how to find additional information on related products and services. This preface contains the following sections:

Objectives

This document describes the Cisco Cable Wideband Solution, Release 1.0. It explains how to design and implement a cable network with that uses the DOCSIS 3.0 Downstream Channel Bonding feature.

Note This document describes release-specific functionality for Cisco IOS Releases 12.3(21)BC and 12.3(21a)BC3.

Document Revision History

Table 1 records technical changes to this document. The table shows Cisco IOS software release number and document revision number for the change, the date of the change, and a brief summary of the change.

Table 1 Document Revision History

Release No.	Revision	Date	Change Summary
12.3(21)BC	OL-10705-01	February 2007	First release
12.3(21a)BC3	OL-10705-02	July 2007	Added information on the Linksys WCM300-NA, WCM300-EURO, and WCM300-J modems.

Document Organization

This publication is organized as follows:

Chapter	Title	Description
Chapter 1	Solution Overview	Provides an overview of the Cisco Cable Wideband Solution, Release 1.0.
Chapter 2	Cisco Cable Wideband Components	Describes the components of the Cisco Cable Wideband Solution, Release 1.0.
Chapter 3	Cisco Cable Wideband Architecture	Explains the architecture used for the Cisco Cable Wideband Solution, Release 1.0.
Chapter 4	Implementing and Configuring the Solution	Provides implementation and configuration information for the Cisco Cable Wideband Solution, Release 1.0.
Chapter 5	Monitoring and Troubleshooting Wideband Components	Provides an introduction to monitoring and troubleshooting the wideband components of the Cisco Cable Wideband Solution, Release 1.0.

Related Documentation

The following is a list of documents and URLs for the Cisco uBR10012 router and the Cisco Wideband SIP and Wideband SPA:

Related Topic	Document Title
Documentation Roadmap	• *Cisco uBR7200 Series Routers and Cisco uBR10012 Universal Broadband Router Documentation Roadmap* http://www.cisco.com/en/US/partner/products/hw/cable/ps2209/products_documentation_roadmap09186a0080733a04.html
Cisco uBR10012 Hardware Installation	• *Cisco uBR10012 Universal Broadband Router SIP and SPA Hardware Installation Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/sipspa/hwsipspa/index.htm • *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/hig/ • *Regulatory Compliance and Safety Information for the Cisco uBR10012 Universal Broadband Router* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10rcsi.htm
Cisco uBR10012 Field Replaceable Units (FRUs) and Fiber-Optic Maintenance	• *Cisco uBR10012 Field Replaceable Units (FRUs)* Documentation Web Page http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/frus/index.htm • *Cisco uBR10012 Quick Start Guides Web Page* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/qsg/index.htm • For information about cleaning fiber-optic connections, go to the following URL: http://www.cisco.com/warp/public/127/cleanfiber2.html

Related Topic	Document Title
Cisco uBR10012 Software, Configuration, and Features	• *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/sipspa/swsipspa/index.htm • *Cisco Cable Wideband Solution Design and Implementation Guide, Release 1.0* (this document) http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/wbsolu/index.htm • *Release Notes for Cisco uBR10012 Universal Broadband Router for Cisco IOS Release 12.3 BC* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10krns/123bcu10.htm • *Cisco uBR10012 Universal Broadband Router Software Configuration Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/scg/index.htm • *Cisco uBR10012 Router Software Features* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/ub10ksw/index.htm • *Cisco Cable Modem Termination System Feature Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/cmtsfg/index.htm
Cisco IOS Command Reference and Related Information	• For Cisco Wideband SIP and SPA commands, see *Chapter 11, "SIP and SPA Commands"* in the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide.* • *Cisco Broadband Cable Command Reference Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/bbccmref/index.htm • *Cisco IOS Release 12.3 Web Page* http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/index.htm • *Cisco CMTS Error Messages* http://www.cisco.com/univercd/cc/td/doc/product/cable/cab_rout/ubrerrs.htm • *Cisco CMTS Universal Broadband Router MIB Specifications Guide* http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ubr10012/ubrmib5/index.htm
Additional Cable/Broadband Information Resources	• Cisco uBR10012 troubleshooting and alerts http://www.cisco.com/en/US/products/hw/cable/ps2209/tsd_products_support_troubleshoot_and_alerts.html • *Cisco Cable/Broadband Software Center Web page* http://www.cisco.com/public/sw-center/sw-cable.shtml • *Cisco Cable/Broadband Technical Support Web page* http://www.cisco.com/en/US/tech/tk86/tsd_technology_support_category_home.html • *Cisco Multiservice Broadband Cable Guide* http://www.cisco.com/application/pdf/en/us/guest/netsol/ns289/c643/ccmigration_09186a008014eeb0.pdf

Conventions

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

Table 2 Command Syntax and Emphasis Conventions

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

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

Tip This symbol means *the following are useful tips.*

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

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

Obtaining Documentation, Obtaining Support, and Cisco Security Guidelines

For information on obtaining documentation, providing documentation feedback, obtaining technical assistance, and Cisco product security guidelines, see the monthly *What's New in Cisco Product Documentation* at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

What's New in Cisco Product Documentation also lists all new and revised Cisco technical documentation.

Solution Overview

This chapter provides an overview of the Cisco Cable Wideband Solution, Release 1.0, and contains the following major topics:

In this document, the terms *wideband channel*, *bonded channel*, and *bonding group* have the same meaning: a logical grouping of one or more physical radio frequency (RF) channels over which MPEG-TS packets are carried.

Solution Description and Scope

Cisco IOS Release 12.3(21)BC and 12.3(21a)BC3 support the DOCSIS 3.0 Downstream Channel Bonding feature, which is the key feature of the Cisco Cable Wideband Solution, Release 1.0.

In the Cisco Cable Wideband Solution, Release 1.0, the DOCSIS 3.0 Downstream Channel Bonding feature supports downstream wideband channels consisting of multiple bonded RF channels. The solution provides wideband data services over existing hybrid fiber coax (HFC) networks. With wideband data services, multiple RF channels are aggregated into a single logical wideband channel (bonding group) that delivers higher bandwidth to the wideband cable modem than was previously possible with DOCSIS 2.0 technology. This aggregation of RF channels is referred to as "channel bonding."

The maximum bandwidth supported depends on the number of RF channels that can be aggregated into a wideband channel. For example:

- The Linksys WCM300-NA wideband cable modem supports downstream throughput of up to approximately 292 Mbps (with a wideband channel consisting of eight RF channels at 6 MHz and 256 QAM).
- The Scientific Atlanta DPC2505 wideband cable modem supports downstream throughput of up to approximately 74 Mbps (with a wideband channel consisting two RF channels at 6 MHz and 256 QAM).

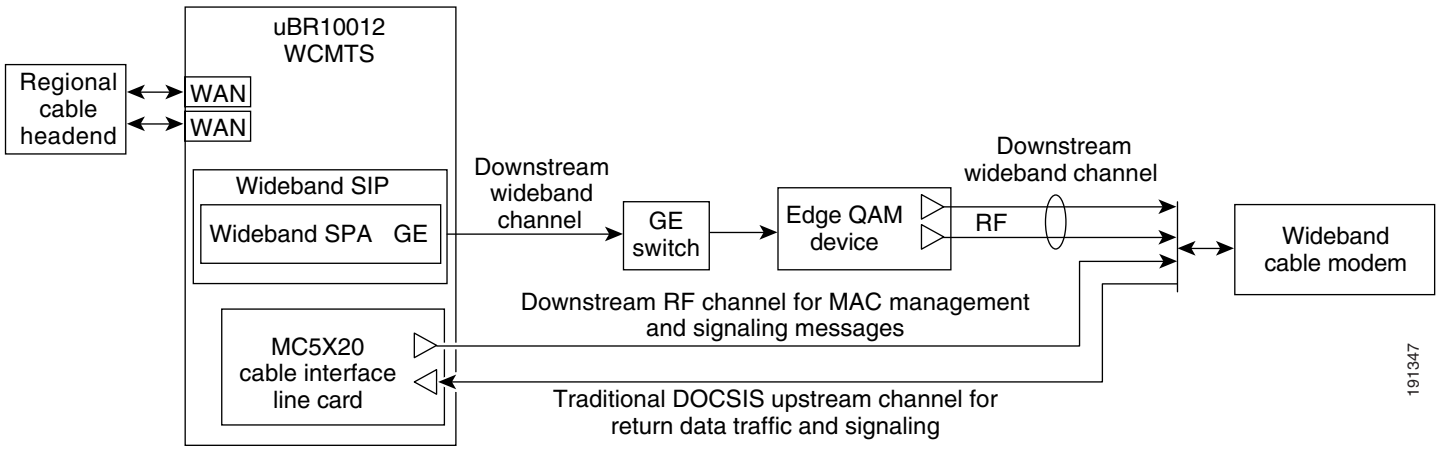
The Cisco Cable Wideband Solution, Release 1.0, can be deployed in parallel with DOCSIS 1.X/2.0 technology. The CMTS supports DOCSIS 1.X/ 2.0 modems on non-wideband ports while wideband cable modems deliver higher-speed throughput on the wideband ports.

Architecture and Scope

Figure 1-1 presents a simplified view of the Cisco Cable Wideband Solution, Release 1.0. In Figure 1-1, two RF channels are bonded into a wideband channel (bonding group). The Cisco Cable Wideband Solution includes these major components:

- Wideband cable modem termination system (WCMTS)—Cisco uBR10012 router
- Cisco Wideband SPA (Shared Port Adapter) and Cisco Wideband SIP (SPA Interface Processor)
- Edge QAM (EQAM) device
- Wideband cable modem (WCM)

Figure 1-1 Cisco Wideband Cable System



In Scope

The scope of the Cisco Cable Wideband Solution, Release 1.0, comprises fully tested and supported Cisco and Scientific Atlanta components, as well as selected third-party components tested for interoperability by Cisco. The following aspects of the solution are in scope:

- DOCSIS 3.0 Downstream Channel Bonding software
- One or more downstream wideband channels with RF channel bonding
- Wideband CMTS (Cisco uBR10012 router) including cable interface and network uplink line cards
- Cisco Wideband SIP and Cisco Wideband SPA
- Edge QAM device
- Wideband cable modem
- Wideband-related cable modem configuration file parameters
- Cisco IOS command set for wideband-channel configuration, provisioning, and maintenance
- Cisco IOS command set for wideband hardware monitoring, troubleshooting, and debugging
- MIBs for the wideband CMTS, wideband cable modem, and wideband channel and service statistics

Device configuration that is in scope for this document is limited to the Wideband SIP and Wideband SPA. Comprehensive documentation for other CMTS components is provided in the existing Cisco uBR10012 documentation set, which is accessible at www.cisco.com.

For information on edge QAM device installation and software configuration, refer to the vendor's edge QAM device documentation.

Out of Scope

The Cisco Cable Wideband Solution-related information in this document pertains to the components listed in "In Scope" section above. Not included in the scope of the Cisco Cable Wideband Solution are the hardware and software components that make up the remainder of the cable data network.

For the Cisco Cable Wideband Solution, Release 1.0, cable network management tools and operations support system (OSS) facilities for wideband cable are outside the scope of the solution.

Solution Key Features

The Cisco Cable Wideband Solution, Release 1.0, provides the following key features:

- Pre-DOCSIS 3.0 version of wideband cable that uses packet bonding
- Channel-bonded wideband downstream channels
- Traditional DOCSIS 2.0 upstream channels
- Solution can be deployed in parallel with DOCSIS 1.X/2.0 technology.
- Existing Cisco uBR10012 router (CMTS) can be upgraded to wideband CMTS with add-on components.
- Modular CMTS architecture makes use of external edge QAM devices.
- Cisco uBR10012 router (CMTS) supports up to two Wideband SPAs in a Wideband SIP jacket card.
- Each Cisco Wideband SPA can support up to 24 downstream RF channels.
- Each Cisco Wideband SPA can support up 12 logical wideband channels (bonding groups).
- Cisco Wideband CMTS and line cards have built-in redundancy and resiliency features.
- Scientific Atlanta and third-party edge QAM devices are tested for interoperability.
- Linksys WCM300-NA, WCM300-EURO (for EuroDOCSIS), and WCM300-JP (for J-DOCSIS) wideband cable modems support the receiving of up to eight RF channels, which can be bonded into wideband channels. One traditional DOCSIS downstream channel is used for MAC management and signalling messages.
- Linksys WCM300-NA, WCM300-EURO, and WCM300-JP wideband cable modems support one primary bonded (wideband) channel for unicast and multicast traffic and up to two secondary bonded channels for multicast traffic.
- Scientific Atlanta DPC2505 and EPC2505 wideband cable modems support one bonded downstream channel consisting of two RF channels, and support one traditional DOCSIS downstream channel for MAC management and signalling messages.

Solution Components

Cisco Cable Wideband Solution, Release 1.0, consists of Cisco, Linksys, and Scientific Atlanta components that are tested, documented, and fully supported by Cisco, Linksys, or Scientific Atlanta. Also, third-party equipment, although not fully supported by Cisco, has been selected and tested for interoperability with the solution components.

Cisco, Linksys, and Scientific Atlanta Equipment

For the Cisco Cable Wideband Solution, Release 1.0, the following Cisco, Linksys, and Scientific Atlanta equipment have been tested in the context of the solution.

- Cisco uBR10012 universal broadband router with PRE2 processor modules and these components:
  - Cisco SPA Interface Processor (SIP) for the 1-Gbps Wideband SPA—referred to in this document as the Cisco Wideband SIP or Wideband SIP
  - Cisco 1-Gbps Wideband Shared Port Adapter (SPA)—referred to in this document as the Cisco Wideband SPA or Wideband SPA
  - Cisco uBR10-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards
- Edge QAM device
  - Scientific Atlanta Continuum DVP XDQA24 EQAM device
- Wideband cable modem
  - Linksys WCM300-NA, WCM300-EURO, and WCM300-JP wideband cable modems
  - Scientific Atlanta DPC2505 and EPC2505 wideband cable modems

Third-Party Equipment

For the Cisco Cable Wideband Solution, Release 1.0, Table 1-1 lists the third-party component, vendor, and the basic functionality each component provides.

Table 1-1 Component Partners and Basic Functionality

Component and Vendor	Basic Functionality
Harmonic NSG 9116 www.harmonicinc.com	Edge QAM device
Harmonic NSG 9000 www.harmonicinc.com	Edge QAM device
Vecima Networks VistaLynx VL1000 www.vecimanetworks.com	Edge QAM device

Cisco Cable Wideband Components

This chapter describes the components of the Cisco Cable Wideband Solution, Release 1.0, and contains the following topics:

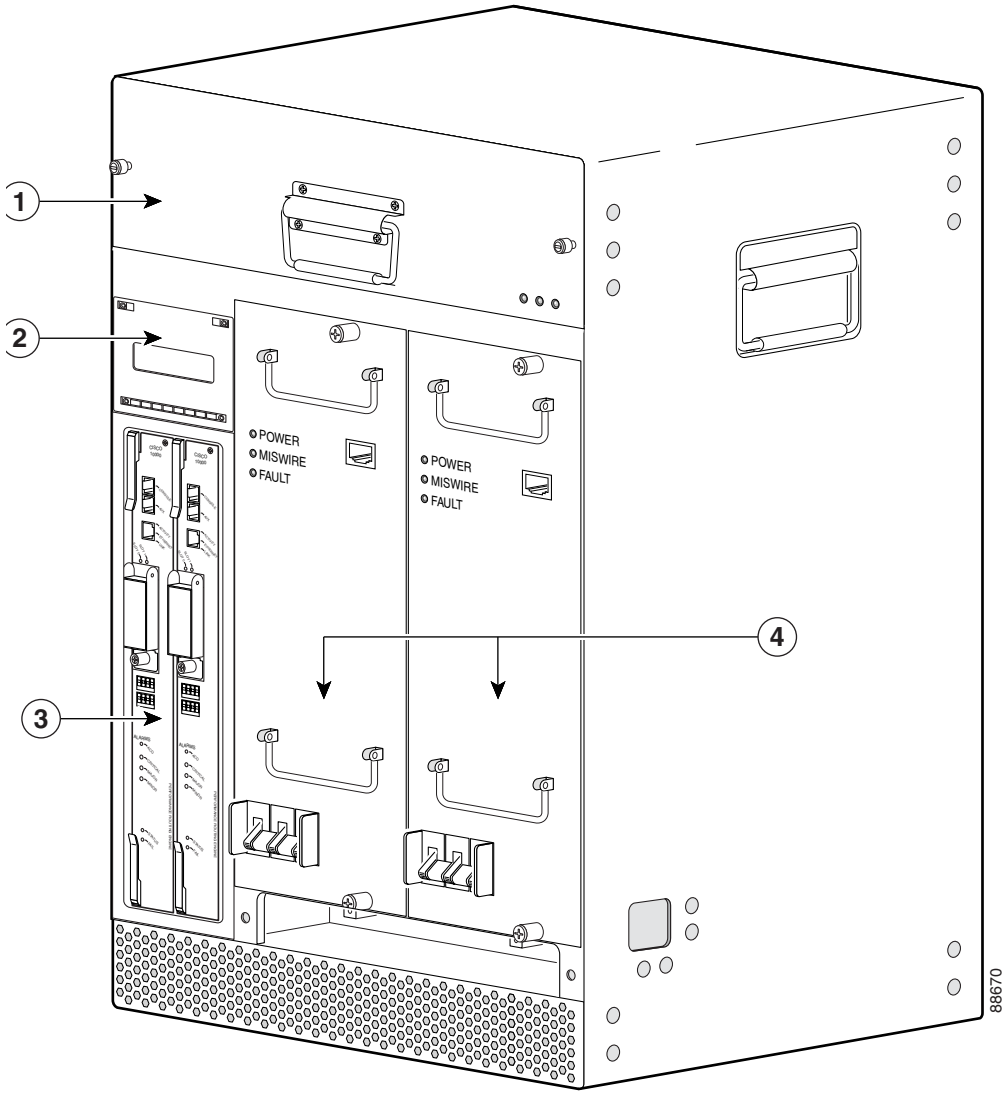
Cisco Cable Wideband Add-on Components

The Cisco uBR10012 router can be used as a DOCSIS 1.x/2.0 CMTS and, in this mode, does not need any wideband components. Wideband cable components can be added to the Cisco uBR10012 base system so that it can be used as a wideband CMTS. As demand for wideband cable grows, this ability to increase capacity by adding wideband components to an existing uBR10012 base system is less expensive than adding additional chassis. This Cisco Cable Wideband Solution add-on strategy reduces both capital expenditure and operational expenses.

Base CMTS Components

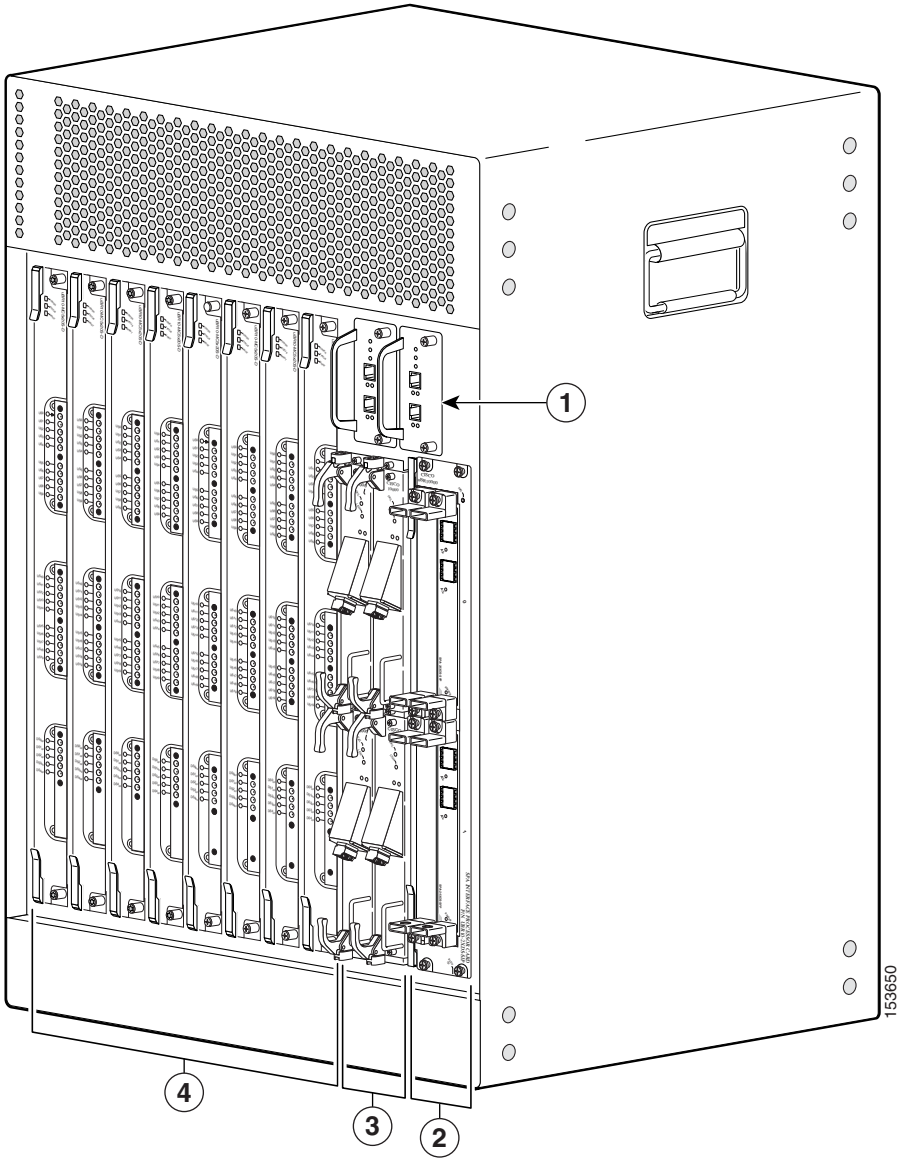
For the Cisco Cable Wideband Solution, Release 1.0, the Cisco uBR10012 router (Figure 2-1 and Figure 2-2) is the wideband cable modem termination system (WCMTS). The CMTS may be located at the cable headend or at a distribution hub. The Cisco Cable Wideband Solution uses the modular CMTS (M-CMTS) architecture with one or more external edge QAM (EQAM) devices.

Figure 2-1 Wideband CMTS: Cisco uBR10012 Router—Front View without Front Cover



1	Fan assembly module	**3**	Two Performance Routing Engine 2 (PRE2) processor modules
2	LCD module	**4**	Two DC Power Entry Modules (DC PEMs)

Figure 2-2 Wideband CMTS: Cisco uBR10012 Router —Rear View



1	Two Timing, Communication, and Control Plus (TCC+) cards	**3**	Four Half-Height Gigabit Ethernet line cards
2	One Wideband SIP with two Wideband SPAs	**4**	Eight uBR10-MC5X20S/U/H or uBR10-MC5X20U-D cable interface line cards

Figure 2-2 shows a fully loaded uBR10012 chassis. The minimum number of components needed for base CMTS or wideband CMTS operation is less than shown in Figure 2-2. For information on minimum and recommended hardware requirements, see the "Base CMTS Component Requirements" section on page 2-4 and the "Wideband CMTS Components" section on page 2-8.

Base CMTS Component Requirements

For the Cisco uBR10012 base system, Table 2-1 lists the minimum and recommended hardware configurations for major components. The base system can be used as a DOCSIS 1.x/2.0 CMTS and can be upgraded to a wideband CMTS. In the Recommended column, the number of components ensures that the Cisco uBR10012 router has component redundancy where it is available.

Cisco IOS Release 12.3(21)BC or later is required for wideband cable functionality.

Table 2-1 Cisco uBR10012 Base System: Minimum and Recommended Hardware

Component	Minimum	Recommended
Performance Routing Engine 2 (PRE2) Part number: ESR-PRE2/R	1	2
Timing, Communication, and Control Plus card (TCC+) Part number: UBR10-TCC+-T1	1	2
DC Power Entry Modules (DC PEMs) Part number: UBR10-PWR-DC (Primary) UBR10-PWR-DC\R (Redundant) OR AC Power Entry Modules (AC PEMs) Part number: UBR10-PWR-AC (Primary) UBR10-PWR-AC\R (Redundant)	1	2
Fan assembly module Part number: UBR-10-FAN-ASSY	1	1
LCD module Part number: UBR10-DSPL	1	1
Cable Interface Line Cards and Network Uplink Line Cards		
uBR10-MC5X20S/U/H or uBR10-MC5X20U-D cable interface line card Part number: uBR10-MC5X20S uBR10-MC5X20U uBR10-MC5X20H uBR10-MC5X20U-D	1	At least 2*
Half-Height Gigabit Ethernet (HHGE) network uplink line card Part number: ESR-HH-1GE	1	At least 2*
Slot splitter card (One is required for each two HHGE line cards.)	1	Varies*

* The number of line cards and slot splitter cards required will vary depending on the set of services and number of subscribers being supported.

The Cisco Gigabit Ethernet network uplink line card (part number UBR10-1GE) is also supported as a base CMTS component. It is a full-height line card that, for use with a Wideband SIP and SPA, should be installed in slot 3/0 or 4/0 of the uBR10012 router. However, the (full-height) Cisco Gigabit Ethernet line card is not recommended as a uBR10012 base system component for Wideband Cable because only two full-height Gigabit Ethernet line cards can be installed in the chassis. The uBR10012 chassis will support four Half-Height Gigabit Ethernet (HHGE) line cards in slots 3/0 and 4/0.

Cable Interface Line Cards and Network Uplink Line Cards

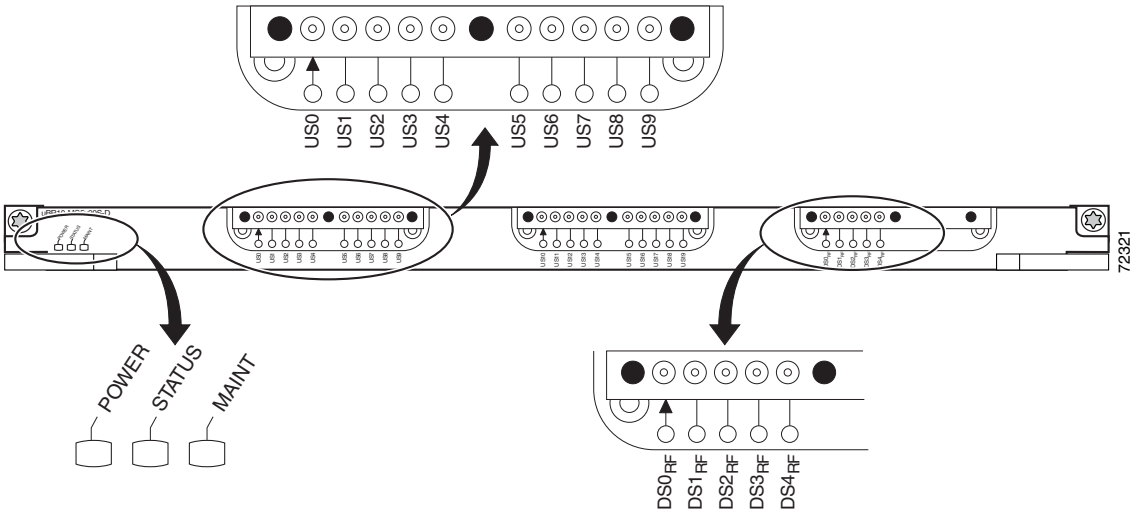
The cable interface line cards and network uplink line cards used on the Cisco uBR10012 base system are described in the following sections:

- Cisco uBR-MC5X20S/U/H and uBR10-MC5X20U-D Cable Interface Line Cards, page 2-5
- Cisco Half-Height Gigabit Ethernet Line Card, page 2-7

Cisco uBR-MC5X20S/U/H and uBR10-MC5X20U-D Cable Interface Line Cards

The Cisco uBR10-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards transmit and receive RF signals between the subscriber and the headend over hybrid fiber/coax (HFC) network. Figure 2-3 shows the faceplate for these line cards.

Figure 2-3 Cisco uBR10-MC5X20S/U/H or uBR10-MC5X20U-D Cable Interface Line Card Faceplate



The Cisco uBR-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards can be used for a standard DOCSIS 1.X/2.0 service or for a Cisco Cable Wideband service or for a combination of the two. These cable interface line cards support upstream and downstream traffic over DOCSIS-based cable modem networks.

For a DOCSIS 1.X/2.0 and for Cisco Cable Wideband Solution, Release 1.0, operation, upstream data from the subscriber comes through the upstream ports (US0-US19) on the line cards. The line card processes and configures the data and sends it across the backplane to the WAN/backhaul card and out to the Internet.

For a DOCSIS 1.X/2.0 system, downstream data to the subscriber, comes from the Internet through the WAN/backhaul card, and across the backplane to the cable interface line card. The cable interface card processes and configures the data and sends it out through the appropriate downstream port (DS0 - DS4) to be combined with the rest of the downstream signals in the headend.

For Cisco Cable Wideband Solution, Release 1.0 bonded channel operation, the cable interface line cards are used for upstream return traffic and signalling, for downstream MAC management and signaling traffic, and for DOCSIS 3.0 Downstream Channel Bonding operations. With wideband, the use of the cable interface line card's downstream channel is different than for a DOCSIS 1.X/2.0 system. The wideband channel's downstream data traffic uses the Cisco Wideband SPA and an external edge QAM device. See Chapter 3, "Cisco Cable Wideband Architecture" for more information on Cisco Cable Wideband systems.

Cisco uBR10-MC5X20S

The Cisco uBR10-MC5X20S cable interface line card supports downstream and upstream traffic over Data-over-Cable Service Interface Specification (DOCSIS)-based cable modem networks. The card supports downstream channels in the 70 to 860 MHz range, and upstream channels in the 5 to 42 MHz range. Each downstream port includes an onboard integrated upconverter. The Cisco uBR10-MC5X20S cable interface line card supports Annex B radio frequency (RF) data rates, channel widths, and modulation schemes and has DOCSIS MAC management and spectrum management capabilities. DOCSIS 2.0, Asynchronous Time Division Multiple Access (A-TDMA) rates are also supported.

Cisco uBR10-MC5X20U and H

The Cisco uBR10-MC5X20U/H cable interface line card supports both DOCSIS and EuroDOCSIS cable modem networks. The card supports downstream channels in the 70 to 860 MHz range, and upstream channels in the 5 to 65 MHz range. Each downstream port includes an onboard integrated upconverter. The Cisco uBR10-MC5X20U/H cable interface line card supports Annex B and Annex A radio frequency (RF) data rates, channel widths, and modulation schemes and has DOCSIS MAC management and spectrum management capabilities. DOCSIS 2.0, A-TDMA rates are also supported.

Compared to the Cisco uBR10-MC5X20U, the uBR10-MC5X20H increases the line card CPU speed, memory, and flash, allowing support of Voice over IP (VoIP) at much higher call loads and a higher percentage of modems running advanced DOCSIS features that typically consume line card CPU resources.

Cisco uBR10-MC5X20U-D

The Cisco uBR10-MC5X20U-D cable interface line card supports both DOCSIS and EuroDOCSIS cable modem networks. The Cisco uBR10-MC5X20U-D cable interface line card supports Annex A and Annex B radio frequency (RF) data rates, channel widths, and modulation schemes and has DOCSIS MAC management and spectrum management capabilities.

Table 2-2 shows the supported DOCSIS modulation schemes.

Table 2-2 Supported DOCSIS and EuroDOCSIS Modulation Schemes

Cable Interface Line Card	Downstream Modulation	Upstream Modulation
Cisco uBR10-MC5X20S	64-QAM[1], 256-QAM	QPSK[2], 8-, 16-, 32-, 64-QAM
Cisco uBR10-MC5X20U	64-QAM, 256-QAM	QPSK, 8-, 16-, 32-, 64-QAM
Cisco uBR10-MC5X20H	64-QAM, 256-QAM	QPSK, 8-, 16-, 32-, 64-QAM
Cisco uBR10-MC5X20U-D	64-QAM, 256-QAM	QPSK, 8-, 16-, 32-, 64-QAM

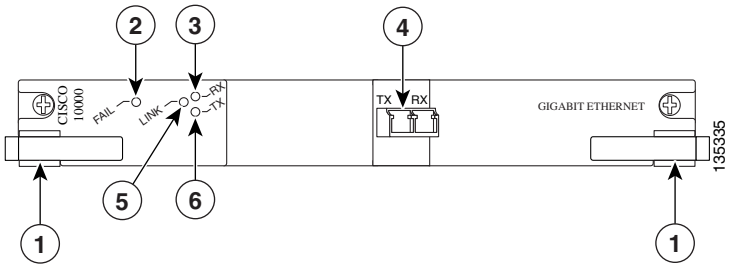
1. QAM = Quadrature Amplitude Modulation
2. QPSK = Quadrature Phase Shift Keying

The Cisco uBR-MC5X20S/U/H and uBR10-MC5X20U-D line cards use space-saving dense connectors. Each line card supports online insertion and removal (OIR) and can be added or removed without powering off the chassis. For more information on these cable interface line cards, refer to the document *Cisco uBR10-MC5X20S/U/H Cable Interface Line Card* (hardware installation).

Cisco Half-Height Gigabit Ethernet Line Card

The Cisco half-height Gigabit Ethernet (HHGE) line card is a single-port Gigabit Ethernet (GE) line card that provides a trunk uplink to devices such as backbone routers, as well as connections to content servers and IP telephony gateways. The GE line card provides the Cisco uBR10012 router with an IEEE 802.3z compliant Ethernet interface that can run up to 1 Gbps in full duplex mode. Figure 2-4 shows the faceplate for the HHGE line card.

Figure 2-4 Half-Height Gigabit Ethernet Line Card Faceplate

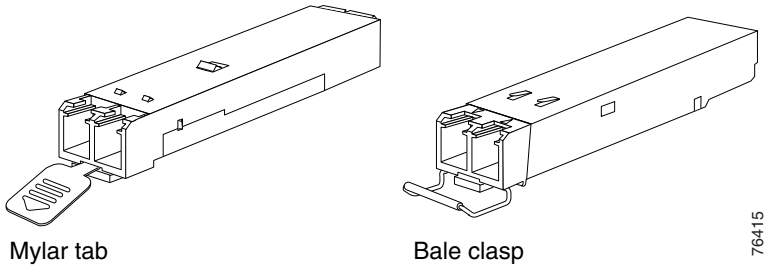


1	Ejector Levers	**4**	SFP Gigabit Ethernet Interface Converter
2	FAIL LED (yellow)	**5**	Link Status (green)
3	Receive Packet (green)	**6**	Transmit Packet (green)

The Cisco uBR10012 router supports up to four HHGE line cards to allow connectivity to multiple destinations, and to provide network layer redundancy. The HHGE line card requires a slot splitter card that should be installed in either slot 4/0 or slot 3/0 on the uBR10012 router. Each slot splitter can hold two HHGE line cards. Therefore, the uBR10012 base system with two slot splitters supports up to four HHGE lines cards.

The HHGE line card uses a small form-factor pluggable (SFP) gigabit interface converter (GBIC) module that supports a variety of Gigabit Ethernet interface types (SX LX/LH, and ZX), which you can change or upgrade at any time.

Figure 2-5 SFP Module for HHGE Line Cards



The following SFP modules are supported by the HHGE line card:

- 1000BASE-SX SFP—The SFP-GE-S, 1000BASE-SX SFP operates on ordinary multimode fiber optic link spans of up to 550 meters in length.
- 1000BASE-LX/LH SFP—The SFP-GE-L, 1000BASE-LX/LH SFP operates on ordinary single-mode fiber optic link spans of up to 10,000 meters in length.
- 1000BASE-ZX SFP—The GLC-ZX-SM, 1000BASE-ZX SFP operates on ordinary single-mode fiber optic link spans of up to 70 kilometers (km) in length. Link spans of up to 100 km are possible using premium single-mode fiber or dispersion-shifted single-mode fiber. The precise link span length depends on multiple factors such as fiber quality, number of splices, and connectors.

The HHGE line card supports online insertion and removal (OIR) and can be added or removed without powering off the chassis. For more information on the HHGE line card, refer to the *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide.*

Wideband CMTS Components

A Cisco uBR10012 base system can be upgraded to a wideband CMTS by adding these components:

- Wideband SIP and Wideband SPA, page 2-8
- External Edge QAM Device, page 2-11

For information on the wideband CMTS functionality, see the "Modular CMTS" section on page 3-4.

Wideband SIP and Wideband SPA

The Wideband SIP and Wideband SPA needed for wideband cable can be added to the base Cisco uBR10012 system when they are required. For the Wideband SIP and Wideband SPA, Table 2-3 lists the minimum and recommended hardware configurations.

Table 2-3 Cisco uBR10012 Wideband Components: Minimum and Recommended Hardware

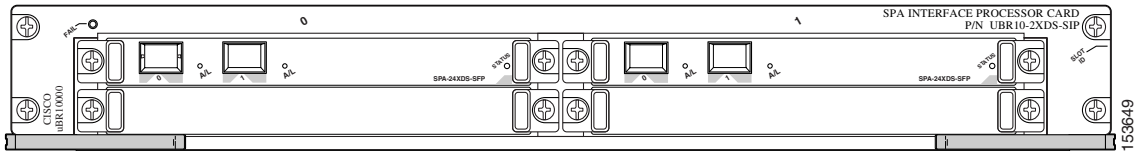
Component	Minimum	Recommended
Wideband SIP (SPA Interface Processor) Part Number: UBR10-2XDS-SIP	1	1
Wideband SPA (Shared Port Adapter) Part Number: SPA-24XDS-SFP	1	Varies*

* The number of Wideband SPAs required will vary depending on the set of services and number of subscribers being supported.

Cisco Wideband SIP

A SPA interface processor (SIP) is a carrier card that inserts into a router slot like a line card. The Wideband SIP provides no network connectivity on its own. The Wideband SIP occupies two full height slots on the uBR10012 router. Each Wideband SIP supports two Wideband SPAs. Figure 2-6 shows the Wideband SIP with two Wideband SPAs installed.

Figure 2-6 Wideband SIP Faceplate



When the uBR1012 router is used as a wideband CMTS, slots 1/0 and 2/0 are used for the Wideband SIPs. Slots 3/0 and 4/0 are reserved for half-height Gigabit Ethernet line cards.

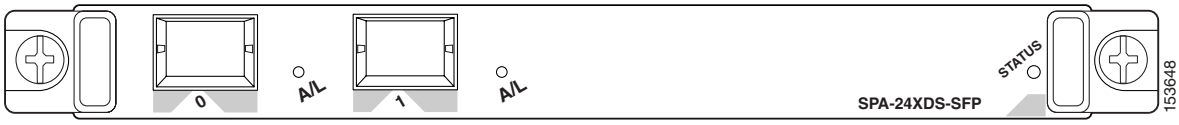
Online insertion and removal (OIR) is supported for both the Wideband SIP and the individual Wideband SPAs.

For more information on the Wideband SIP, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Hardware Installation Guide* and the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Cisco Wideband SPA

The Wideband SPA (Figure 2-7) is a single-wide, half-height shared port adapter (SPA) that provides Wideband Protocol for a DOCSIS Network formatting to the downstream data packets. The Wideband SPA is used for downstream data traffic only. It has one active and one redundant Gigabit Ethernet port that are used to send traffic to the external edge QAM device.

Figure 2-7 Wideband SPA Faceplate



The Cisco uBR10012 router can support up to two Wideband SPAs. Each Wideband SPA can support up to 12 logical wideband channels (bonding groups). Depending on how it is configured, each Wideband SPA allows up to 24 RF channels. Each logical wideband channel consists of multiple RF channels. The Cisco IOS CLI includes a set of commands to configure the Wideband SPA on the Cisco uBR10012 router.

The two Gigabit Ethernet ports on the Wideband SPA use small form-factor (SFP) modules (see Figure 2-8).

An SFP module is an input/output (I/O) device that plugs into the Gigabit Ethernet SFP ports on the Wideband SPA, linking the port with an edge QAM device through a fiber-optic network.

Figure 2-8 SFP Module (Fiber-Optic LC Connector)

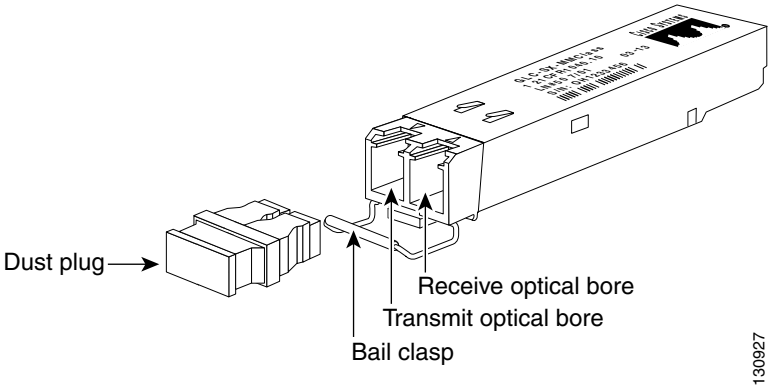


Table 2-4 lists the SFP modules that the Wideband SPA supports.

Table 2-4 SFP Modules for the Cisco Wideband SPA

SFP Module Product Number	SFP Module	Description
GLC-SX-MM	Short wavelength (1000BASE-SX)	Cisco 1000BASE-SX SFP transceiver module for multimode fiber (MMF), 850-nm wavelength
GLC-LH-SM	Long wavelength/long haul (1000BASE-LX/LH)	Cisco 1000BASE-LX/LH SFP transceiver module for single-mode fiber (SMF), 1300-nm wavelength
GLC-ZX-SM	Extended distance (1000BASE-ZX)	Cisco 1000BASE-ZX SFP transceiver module for SMF, 1550-nm wavelength

For more information on the Wideband SPA, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Hardware Installation Guide* and the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

External Edge QAM Device

The Cisco wideband CMTS uses one or more external edge QAM (EQAM) devices. The EQAM device is a network element in a separate chassis from the CMTS. The EQAM device has two or more Gigabit Ethernet input interfaces that connect to a Wideband SPA. For output, the EQAM device has multiple QAM modulators and RF upconverters that connect to a hybrid fiber coaxial (HFC) network. The edge QAM device accepts MPEG over IP on its Gigabit Ethernet interfaces and routes the services to its QAM RF outputs.

The following edge QAM devices have been tested for interoperability with other Cisco Cable Wideband Solution, Release 1.0, components:

- Scientific Atlanta Continuum DVP XDQA24, page 2-12
- Harmonic NSG 9116, page 2-12
- Harmonic NSG 9000, page 2-12
- Vecima Networks VistaLynx VL1000, page 2-13

Table 2-5 lists the number of output QAM channels supported by each edge QAM device.

Table 2-5 EQAM Devices: Number of Output QAM Channels Supported

EQAM Device	Number of Output QAM Channels Supported
Scientific Atlanta Continuum DVP XDQA24	scalable up to 24 QAM channels
Harmonic NSG 9116	16 QAM channels
Harmonic NSG 9000	scalable up to 72 QAM channels
Vecima Networks VistaLynx VL1000	scalable up to 24 QAM channels

Number of EQAM Devices Required

Each logical RF channel defined on the Wideband SPA must have one corresponding output QAM channel on an EQAM device. The number of EQAM devices required is determined by two factors:

- The number of logical RF channels in use on the Wideband SPAs in the CMTS. Each Wideband SPA supports up to 24 logical RF channels depending on how it is configured.
  - For annex A and 256 QAM, each Wideband SPA supports 18 RF channels.
  - For all other cases, each Wideband SPA supports 24 RF channels.
- The number of output QAM channels on the EQAM device. See Table 2-5.

As an example, if a Cisco uBR10012 router (CMTS) contains two Wideband SPAs and each Wideband SPA is configured for 18 RF channels, the total number of RF channels that are in use is 36. Therefore, 36 output QAM channels are required on the EQAM devices. This requirement for output QAM channels could be met by deploying, for example, two DVP XDQA24 EQAMs (with 48 total QAMs) or three NSG 9116 EQAMs (with 48 total QAMs).

If more than two EQAM devices are required for two Wideband SPAs, a Gigabit Ethernet switch is needed to connect the SPAs to the EQAM devices.

Scientific Atlanta Continuum DVP XDQA24

The Scientific Atlanta Continuum DVP eXtra Dense QAM Array 24 (XDQA24) is one of the edge QAM devices that has been tested for interoperability with other solution components. The Continuum DVP XDQA24 has two redundant Gigabit Ethernet input interfaces that use small form-factor pluggable (SFP) modules for fiber-optic and copper links. It has 24 output QAM channels (12 outputs, each with two adjacent QAM channels). The Continuum DVP XDQA24 software is customized to accommodate the requirements of the Cisco Cable Wideband Solution.

Figure 2-9 Scientific Atlanta Continuum DVP XDQA24 Edge QAM Device

The Continuum DVP XDQA24 chassis is a single rack unit high. The Continuum DVP XDQA24 uses uses hot-swappable, auto-configurable QAM cards containing two QAM channels on a single RF converter. The Continuum DVP XDQA24 has fully redundant AC or DC power supplies. More detailed information and part numbers for the Continuum DVP XDQA24 are available at:

http://www.scientificatlanta.com/customers/source/7005301.pdf

Harmonic NSG 9116

The Harmonic Narrowcast Services Gateway (NSG) 9116 is one of the edge QAM devices that has been tested for interoperability with other solution components. The NSG 9116 has two redundant Gigabit Ethernet input interfaces that use small form factor (SFP) modules for fiber-optic and copper links. It has 16 output QAM channels (eight dual QAM output channels). The NSG 9116 software is customized to accommodate the requirements of the Cisco Cable Wideband Solution.

Figure 2-10 Harmonic NSG 9116 Edge QAM Device

The NSG 9116 chassis is a single rack unit high. The NSG 9116 comes with either an AC power supply or –48 VDC power supply. More detailed information on the NSG 9116 is available at:

http://www.harmonicinc.com/stageone/files/harmonic/collateral/NSG%5Fv03%2D09%5FRS%2Epdf

Harmonic NSG 9000

The Harmonic Narrowcast Services Gateway (NSG) 9000 is one of the edge QAM devices that has been tested for interoperability with other solution components. The NSG 9000 has three independent Gigabit Ethernet input interfaces that use small form factor (SFP) modules for fiber-optic and copper links. The NSG 9000 is DOCSIS 3.0-compliant.

The NSG 9000 provides scalable support up to 72 QAM RF outputs. The chassis is fitted with a passive backplane, while all the processing and modulation functions are performed on retrievable modules. The chassis has nine QAM RF module slots. Each hot-swappable QAM module has two RF ports, and each port is capable of supporting up to 4 adjacent QAM channels (3 channels in Annex A).

Figure 2-11 Harmonic NSG 9000 Edge QAM Device

The NSG 9000 is housed in a 2-RU chassis. The system can host two load-sharing AC or DC power supplies, which can be redundant to each other. More detailed information on the NSG 9000 is available at:

http://www.harmonicinc.com/stageone/files/harmonic/collateral/NSG9000%5Fv07%2D02%5FRS%2Epdf

Vecima Networks VistaLynx VL1000

Vecima Networks VistaLynx VL1000 is one of the edge QAM devices that has been tested for interoperability with other solution components. The VistaLynx VL1000 has two redundant Gigabit Ethernet input interfaces that use small form factor (SFP) modules for fiber-optic and copper links.

The VistaLynx VL1000 QAM channels can be increased in increments of four to a maximum of 24 QAM channels. The chassis accepts a minimum of two QAM cards and a maximum of six, for a total of 24 QAM channels. Each hot-swappable QAM card contains two RF ports capable of generating two QAM channels per port.

Figure 2-12 Vecima Networks VistaLynx VL1000 Edge QAM Device

The VistaLynx VL1000 chassis is a single rack unit high. The system has two redundant AC power supplies. More detailed information on the VistaLynx VL1000 is available at:

http://www.vecimanetworks.com/vistalynx.html

Gigabit Ethernet Switch (Optional)

A Gigabit Ethernet (GE) switch can optionally be used to link the Wideband SPAs to edge QAM devices. The Gigabit Ethernet switch concentrates traffic from multiple GE links from the SPAs to a smaller number of GE links prior to fiber transport to the edge QAM devices.

A Gigabit Ethernet switch is required to connect Wideband SPAs to the EQAM devices in the following situations:

- If more than two EQAM devices are required for two Wideband SPAs
- If video-on-demand (VOD) traffic and the RF channels for wideband channels are mixed on the same EQAM device

Wideband Cable Modems

The Cisco Cable Wideband Solution, Release 1.0, supports the following wideband cable modem:

Linksys WCM300 Wideband Cable Modem

When used with the Cisco uBR10012 CMTS, the Linksys WCM300-NA (for DOCSIS), WCM300-EURO (for EuroDOCSIS), and WCM300-JP (for J-DOCSIS) wideband cable modems (Figure 2-13) support the acquisition of up to three wideband (bonded) channels: one primary bonded channel and two secondary bonded channels.

Note Cisco IOS 12.3(21a)BC3 or a later 12.3BC3 release is required for support of the Linksys WCM300-NA, WCM300-EURO, and WCM300-JP modems in wideband mode. In wideband mode, the MAC state of the modem is w-online, and the Cisco uBR10012 uses the Cisco DOCSIS 3.0 Downstream Channel Bonding feature.

For each wideband channel, the Linksys WCM300 wideband cable modem supports the reception of one or more bonded RF channels. The Linksys WCM300 software supports the receiving of a 50 MHz capture window of up to eight downstream channels at 6 MHz per channel or six downstream channels at 8 MHz per channel. The total of the RF channels in the primary and secondary bonded channels must comply with the 50 MHz capture-window limitation.

For wideband, the Linksys WCM300 also supports reception of one *primary downstream channel* (traditional DOCSIS channel from the uBR10-MC5X20 line card) for MAC management and signaling messages, and uses the associated traditional DOCSIS upstream channel for return data traffic and signaling. The upstream channel works as it does in DOCSIS 2.0 cable modems.

Figure 2-13 Linksys WCM300 Wideband Cable Modem

The Linksys WCM300 is DOCSIS 2.0 compatible and can be used in this mode (for example, if the modem is connected to a non-wideband Cisco CMTS or to a non-Cisco CMTS). The modem is also backward compatible with existing DOCSIS 1.X networks.

The Linksys WCM300-JP supports J-DOCSIS channel operation: 6 MHz Annex B extension support with a downstream frequency range of 88 to 860 MHz and an upstream frequency range of 5 to 65 MHz.

Separate Linksys WCM300 software images are used for DOCSIS and EuroDOCSIS channel widths. Downstreams in the wideband channel and associated traditional DOCSIS downstreams support 64-QAM and 256-QAM modulation.

The Linksys WCM300 wideband cable modem has two ports: an F-type 75 ohm connector provides a cable network attachment, and an RJ-45 port provides a 10/100/1000 Mbps Ethernet connection to the home or business. More information on the Linksys WCM300 wideband cable modem is available at:

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

Scientific Atlanta DPC2505 and EPC2505 Wideband Cable Modems

When used with the Cisco uBR10012 CMTS, the Scientific Atlanta DPC2505 (for DOCSIS) and EPC2505 (for EuroDOCSIS) wideband cable modems support the receiving of one wideband channel. For the Cisco Cable Wideband Solution, Release 1.0, the wideband channel consists of two bonded downstream RF channels at 6 MHz per channel or at 8 MHz per channel.

In addition to the two bonded downstream RF channels, the Scientific Atlanta DPC2505/EPC2505 modem supports reception of one *primary downstream channel* (traditional DOCSIS channel from the uBR10-MC5X20 line card) for MAC management and signaling messages, and uses the associated traditional DOCSIS upstream channel for return data traffic and signaling. The upstream channel works as it does in DOCSIS 2.0 cable modems.

- Unicast data can be received on any downstream channel.
- DOCSIS 2.0 multicast data can be received only on the primary downstream channel.

The Scientific Atlanta DPC2505 is DOCSIS 2.0 compatible and can be used in this mode (for example, if the modem is connected to a non-wideband Cisco CMTS or to a non-Cisco CMTS). The modem is also backward compatible with existing DOCSIS 1.X networks.

Figure 2-14 Scientific Atlanta DPC2505 Cable Modem

The DPC2505/EPC2505 wideband cable modem has an F-type 75 ohm connector for a cable network attachment and has two data ports: a Gigabit Ethernet port with Auto negotiate and Auto-MDIX, and a USB 2.0 port.

The DPC2505/EPC2505 also features front-panel LEDs to provide visual feedback of real-time data transmission and operational status. The DPC2505 features WebWizard, a browser-based user interface. WebWizard is a powerful tool that facilitates installation and troubleshooting. WebWizard eliminates the need to load set-up software on the customer premises equipment (CPE).

The Scientific Atlanta DPC2505 is DOCSIS 2.0 certified, and the EPC2505 is Euro-DOCSIS 2.0 certified. More detailed information and part numbers for the DPC2505 and EPC2505 wideband cable modems are available at:

http://www.scientificatlanta.com/customers/source/7008362.pdf

Wideband CMTS Redundancy and Resiliency

The uBR10012 wideband CMTS and related hardware and software provide redundancy and resiliency to the Cisco Cable Wideband Solution. Reliable, fault-tolerant components and resilient network technologies automatically identify and overcome failures. The following sections describe the wideband CMTS redundancy and resiliency features:

- PRE2 Redundancy and Resiliency, page 2-19
- uBR10-MC5X20 Line Card Redundancy, page 2-19
- Wideband SPA Redundancy and Resiliency, page 2-20
- Edge QAM Redundancy, page 2-21

Table 2-6 summarizes redundancy and resiliency support for the Cisco uBR10012 base system's recommended hardware configuration (see Table 2-1). If component failure occurs, the components listed in Table 2-6 can be replaced without interrupting system operations when redundant components are correctly installed and configured.

Table 2-6 Cisco uBR 10012 Base System Redundancy and Resiliency

Modular CMTS Component	Redundancy and Resiliency Summary
PRE2 route processors	Two PRE2 modules. The Route Processor Redundancy Plus feature and DOCSIS Stateful Switchover provide the PRE2 modules with fast route processor failover without DOCSIS line card reboot.
Redundant power supplies	Two DC or AC power entry modules (PEMs). If one PEM fails, the other PEM immediately begins providing the required power to the system.
Redundant Timing, Communication, and Control Plus (TCC+) cards	The two TCC+ cards monitor each other's priority information so that if the active card fails, the active card role is transferred to the redundant backup card without loss of data.
Fan assembly module	The fan assembly has four internal fans. If a single fan fails and the fan assembly is still able to cool the chassis, the router will continue to function until the fan assembly module can be replaced.
Redundant Half-Height Gigabit Ethernet (HHGE) line cards	Multiple HHGE line cards to support connectivity to multiple destinations and to provide network layer redundancy.
uBR10-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards	N+1 Redundancy provides automatic switchover and recovery for cable modems connected as DOCSIS 1.X/2.0 modems in the event that there is a cable interface line card failure.

Refer to the *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* for complete information on the uBR10012 router's hardware redundancy.

PRE2 Redundancy and Resiliency

The Route Processor Redundancy Plus (RPR+) feature and DOCSIS Stateful Switchover (DSSO) in the Cisco IOS software provide the Cisco uBR10012 router's PRE2 route processors with fast route processor failover without DOCSIS line card reboot.

Route Processor Redundancy Plus

The RPR+ feature enables the Cisco uBR10012 router to use two PRE2 route processors in a redundant configuration: an active and standby PRE2 module. If the active PRE2 module fails, or is removed from the system, the standby PRE2 detects the failure and initiates a switchover. During a switchover, the standby PRE2 assumes control of the router, connects with the network interfaces, and activates the local network management interface and system console.

Using the RPR+ feature, the standby PRE2 module is fully initialized and configured. This allows RPR+ to dramatically shorten the switchover time if the active PRE2 fails, or if a manual switchover is performed. Because both the startup configuration and running configuration are continually synchronized from the active to the standby PRE2 route processor, line cards are not reset during a switchover. The interfaces remain up during this transfer, so neighboring routers do not detect a link flap (that is, the link does not go down and back up).

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

During RPR+ switchover, wideband cable modems on the CMTS will stay online. The MAC state for the wideband cable modem will remain online for a modem registered as a DOCSIS 2.0 modem, or w-online for a modem registered as a wideband cable modem.

DOCSIS Stateful Switchover

DOCSIS Stateful Switchover increases service uptime by instantaneously switching over between dual route processors should one processor fail. Switchover takes place without resetting or reloading line cards or affecting related subsystems or processes. The advantage of DOCSIS Stateful Switchover (with RPR+) is that a switchover between the primary and standby RP will not require the cable interfaces to be reset, nor do the modems reregister or go offline. Furthermore, the cable modems retain their service IDs (SIDs) through the switchover.

For more information on PRE2 and RPR+ and DOCSIS Stateful Switchover, see the document *Route Processor Redundancy Plus on the Cisco uBR10012 Universal Broadband Router.*

uBR10-MC5X20 Line Card Redundancy

The Cisco uBR10012 router supports N+1 Redundancy on the cable interface line cards including the uBR10-MC5X20S/U/H and uBR10-MC5X20U-D line cards, which are used in the Cisco Cable Wideband Solution.

N+1 Redundancy can help limit Customer Premises Equipment (CPE) downtime by enabling robust automatic switchover and recovery in the event that there is a localized system failure. N+1 Redundancy adds synchronization between Hot Standby Connection-to-Connection Protocol (HCCP) Working interface configurations and those inherited upon switchover to HCCP Protect interfaces. This makes the configuration of both easier and switchover times faster.

A single Cisco uBR10012 CMTS can support up to eight uBR10-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards, each featuring five downstream and 20 upstream cable interfaces for a total of up to 40 downstream and 160 upstream interfaces in the chassis. The eight-card 7+1 Redundancy scheme for the Cisco uBR10012 router supports redundancy for the cable interface line cards installed in a fully populated Cisco uBR10012 chassis. Other redundancy schemes are designed to support partial cable interface line card populations in a Cisco uBR10012 chassis.

N+1 Redundancy is made possible with the addition of a Cisco RF Switch to your cable headend network. A single Cisco RF Switch can be connected to the Cisco uBR10012 CMTS, allowing deployment of an N+1 Redundancy scheme where one protecting cable interface line card supports from one to seven Working cable interface line cards in the same chassis.

Note Both 7+1 and N+1 Redundancy switchover are supported *only for cable modems connected as DOCSIS 1.X/2.0 modems*. During 7+1 and N+1 Redundancy switchover, cable modems that are connected in wideband mode using the failed cable interface line card will lose connectivity. Manual intervention (for example, use of the **clear cable modem wideband reset** command) may be required to bring wideband cable modems w-online again.

For more information on N+1 redundancy for uBR1012 line cards, see the *Cisco Cable Modem Termination System Feature Guide*.

Wideband SPA Redundancy and Resiliency

The Wideband SPA provides redundancy and resiliency through a number of mechanisms. The Wideband SIP and Wideband SPAs support online insertion and removal (OIR) and are hot swappable.

Wideband SPA Redundant Gigabit Ethernet Ports

The Wideband SPA has one active and one redundant Gigabit Ethernet port that is used to send traffic to the external edge QAM device. If the link state of both Gigabit Ethernet ports (port 0 and 1) is up, the port that is discovered first as up becomes the active port (forwarding traffic). The other port, when its link state changes to up, becomes the redundant port. The Port Status LEDs for port 0 and 1 on the Wideband SPA will be green.

Each Gigabit Ethernet port can discover a link failure between itself and the device to which it is directly connected. If both Gigabit Ethernet links from the Wideband SPA to the edge QAM device are up, automatic failover to a redundant link behaves as follows:

- If both Gigabit Ethernet ports are directly connected to edge QAM device, automatic failover to the redundant link occurs.
- If both Gigabit Ethernet ports are connected to, for example, a switch between the Wideband SPA and the edge QAM device, automatic failover to the redundant link to the switch occurs.
- In the case where there is a switch between the Wideband SPA and the edge QAM device, the SPA cannot detect a link failure between the switch and the edge QAM device. No automatic failover to a redundant Gigabit Ethernet port and link occurs.

The **show controllers modular-cable** command shows the current state of the Wideband SPA's Gigabit Ethernet ports. With the Cisco IOS CLI, the Wideband SPA's Gigabit Ethernet ports are not specified on the command line as individual Gigabit Ethernet interfaces because the ports work in tandem as a redundant pair.

Wideband Channel Resiliency

If a wideband channel fails, the wideband cable modem goes offline and re-registers:

- If another wideband channel is available for the service, the wideband cable modem tries that channel and comes online.
- If no other wideband channel is available, the wideband cable modem comes online in traditional DOCSIS 2.0 mode.

Edge QAM Redundancy

Depending on the edge QAM device that is used, the edge QAM device can have varying degrees of redundancy. For information on a specific edge QAM device, see the vendor's documentation for that device.

Where to Find Information on Solution Hardware Components

Table 2-7 provides a list of the hardware installation documents that are most relevant to the Cisco Cable Wideband Solution's components. The complete list of uBR10012 hardware installation and upgrade guides are available at:

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

The *Release Notes for Cisco uBR10012 Universal Broadband Router for Cisco IOS Release 12.3(21) BC* are available at:

http://www.cisco.com/univercd/cc/td/doc/product/cable/ubr10k/ub10krns/index.htm

Table 2-7 Cisco Hardware Components: Where to Find More Information

Solution Component	Where to Find More Information
uBR10012 chassis Performance Routing Engine 2 (PRE2) Timing, Communication, and Control Plus card (TCC+) DC Power Entry Modules (DC PEMs) AC Power Entry Modules (AC PEMs) Fan assembly module LCD module	*Regulatory Compliance and Safety Information for the Cisco uBR10012 Universal Broadband Router* *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* (full installation guide) *Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* (quick start guide)
uBR10-MC5X20S/U/H and uBR10-MC5X20U-D cable interface line cards	*Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* (full installation guide) *Cisco uBR10-MC5X20S/U/H Cable Interface Line Cards - Hardware Installation Guide* *Cabling the Cisco uBR10-MC5X20S/U/H Cable Interface Line Card with Universal Cable Holder—UCH1* *Cabling the Cisco uBR10-MC5X20S/U/H Cable Interface Line Card with Universal Cable Holder—UCH2*
Half-Height Gigabit Ethernet (HHGE) network uplink line card	*Cisco uBR10012 Universal Broadband Router Hardware Installation Guide* (full installation guide) *Cisco uBR10012 Universal Broadband Router Gigabit Ethernet Half-Height Line Card Installation*
Wideband SPA Interface Processor (SIP) Wideband Shared Port Adapter (SPA)	*Cisco uBR10012 Universal Broadband Router SIP and SPA Hardware Installation Guide* *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*
Harmonic NSG 9116 and NSG 9000 edge QAM devices	Refer to the vendor documentation.
Scientific Atlanta Continuum DVP XDQA24 edge QAM device	Refer to the vendor documentation.
Vecima Networks VistaLynx VL1000 edge QAM device	Refer to the vendor documentation.
Linksys WCM300-NA, WCM300-EURO, and WCM300-JP wideband cable modems	*Release Notes for Linksys WCM300 Cable Modem Software* Cisco Cable Wideband Solution Design and Implementation Guide, Release 1.0 (this document) *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*
Scientific Atlanta DPC2505 and EPC2505 wideband cable modems	Refer to the vendor documentation.

Cisco Cable Wideband Architecture

This chapter explains the architecture used for the Cisco Cable Wideband Solution, Release 1.0. It explains the following topics:

The DOCSIS 3.0 Downstream Channel Bonding feature is backward compatible with DOCSIS 1.X/2.0 services and networks.

Wideband Channel Bonding

The DOCSIS 3.0 Downstream Channel Bonding feature uses a selected subset of the DOCSIS 3.0 downstream channel bonding protocol.

With channel bonding, bandwidth is increased by combining or bonding multiple RF channels to create a wideband channel. The DOCSIS 3.0 Downstream Channel Bonding feature affects the CMTS and the cable modem as well as the provisioning and network management systems.

The core of the DOCSIS 3.0 Downstream Channel Bonding feature is the sending of DOCSIS packets for a given service flow across multiple RF channels. The transmit framer in the Cisco Wideband SPA "stripes" the DOCSIS packets for a given flow and transmits them across the multiple RF channels of the wideband channel. When the packets are received at the wideband cable modem, the modem's receiver framer uses a sequence number embedded in each DOCSIS packet to reassemble the packets into the original flow.

A *wideband channel* is a unique combination of downstream RF channels. The wideband CMTS manages up to 24 wideband channels (12 wideband channels per Wideband SPA). A wideband cable modem joins a wideband channel. Many wideband cable modems can share the same wideband channel.

In this document, the terms *wideband channel*, *bonded channel*, *bonding group* have the same meaning: a logical grouping of one or more physical radio frequency (RF) channels over which MPEG-TS packets are carried.

The DOCSIS 3.0 Downstream Channel Bonding feature is overlaid on top of and is transparent to a DOCSIS 2.0 system. In the Cisco Cable Wideband Solution, Release 1.0, these channels are used for wideband operations:

- For the wideband downstream channel, the Wideband SPA uses its Gigabit Ethernet port to send data traffic to the EQAM device. This EQAM device uses one or more QAM output channels, depending on how the wideband channel is configured, to send striped packets to the wideband cable modem. In Release 1.0, channel bonding is used for downstream wideband channels only.
  - With the Linksys WCM300-NA modem, a downstream wideband channel can combine up to eight RF channels for a total bandwidth of up to approximately 292 Mbps (at 6 MHz and 256 QAM).
  - With the Scientific Atlanta DPC2505 modem, a downstream wideband channel can combine up to two RF channels for a total bandwidth of up to approximately 74 Mbps (at 6 MHz and 256 QAM).
- A traditional DOCSIS 2.0 downstream channel is associated with the wideband channel and carries MAC management and signaling messages. The traditional DOCSIS 2.0 downstream channel does not carry any bonded traffic. The traditional DOCSIS downstream channel used in this way is called the *primary downstream channel*.
- A traditional DOCSIS 2.0 upstream channel associated with the primary downstream channel carries return traffic and signaling.

The wideband channel, a primary downstream channel, and an associated upstream channel are configured for each fiber node that provides the wideband channel.

Figure 3-1 shows a wideband channel consisting of four bonded RF channels on the EQAM device. These RF channels are asynchronous and carry only bonded traffic. As shown in Figure 3-1, a traditional DOCSIS 2.0 downstream channel associated with the wideband channel carries MAC layer signaling for the wideband channel. The upstream channel associated with the wideband channel is a traditional DOCSIS 2.0 upstream.

Figure 3-1 Channel Bonding to Create a Wideband Channel

The Cisco Wideband SPA on the uBR10012 router provides the logical RF channels for the DOCSIS 3.0 Downstream Channel Bonding feature. The service provider uses a customized set of Cisco IOS commands to configure the Wideband SPA for each wideband channel and its associated DOCSIS 2.0 downstream and upstream channels.

Software Configuration for Fiber Nodes

In a cable network, a fiber node is a point of interface between a fiber trunk and the coaxial distribution. A cable modem is physically connected to only one fiber node. Fiber node software configuration mirrors the physical topology of the cable network. When configuring fiber nodes with Cisco IOS CLI commands, a fiber node is a software mechanism to define the following:

- The set of downstream RF channels that will flow into the fiber node
- At least one primary downstream channel (traditional DOCSIS downstream channel) for the fiber node
- The set of upstream channel ports on the cable interface line card that are connected to the fiber node and available as upstream channels

The DOCSIS 3.0 Downstream Channel Bonding feature requires that a fiber node be associated with at least one primary downstream channel (traditional DOCSIS downstream channel). A fiber node can be associated with more than one primary downstream channel though only one primary downstream channel is used at any given point in time. On the uBR10-MC5X20 cable interface card, each primary downstream channel has an upstream port that is statically associated with the downstream port.

For information on configuring fiber nodes, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Virtual Interface Bundling for Primary Downstream Channels and Wideband Channels

The Cisco IOS virtual interface bundling feature is used for the wideband channel and the primary downstream channels. Both the wideband channel and primary downstream channel must be members of the same virtual bundle. Virtual interface bundling prevents loss of connectivity on physical interfaces should there be a failure or problematic insertion and removal (OIR) of one line card in the bundle.

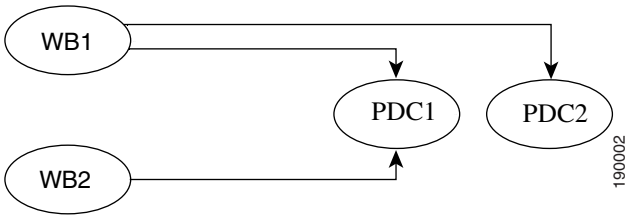
The DOCSIS 3.0 Downstream Channel Bonding feature allows the following scenarios for wideband channel to primary downstream channel association on a fiber node:

1. WCMs on one wideband channel use the same primary downstream channel.
2. WCMs on one wideband channel use different primary downstream channels.
3. WCMs on different wideband channels use the same primary downstream channel.
4. Combinations of scenarios 2 and 3.

Figure 3-2 provides an example of wideband channel to primary downstream channel association on a fiber node.

- Wideband channel WB1 is associated with primary downstream channels PDC1 and PDC2.
- Wideband channel WB2 is associated with only primary downstream channel PDC1.

Figure 3-2 Wideband Channels and Primary Downstream Channels on a Fiber Node



A WCM on the fiber node can come online on WB1/PDC1, on WB1/PDC2, or on WB2/PDC1. On the CMTS, WB1, WB2, PDC1, and PDC2 all are members of the same virtual interface bundle.

For information on configuring virtual bundle interfaces, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

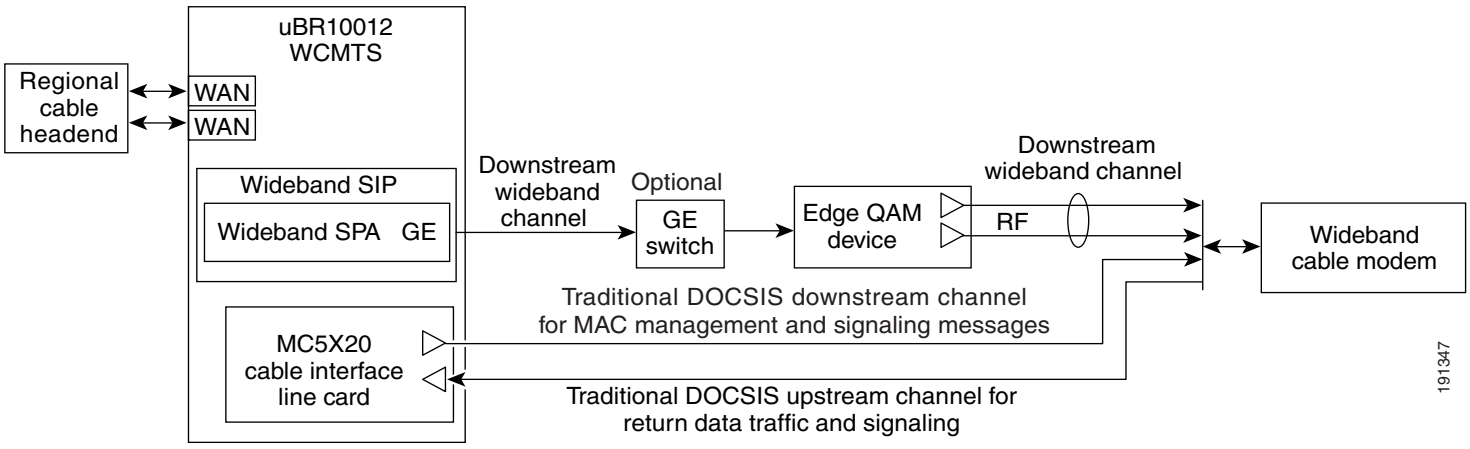
Modular CMTS

The Cisco Cable Wideband Solution, Release 1.0, uses of a variant of the modular CMTS (M-CMTS) architecture. With a modular CMTS architecture, the downstream PHY (physical layer) of the CMTS is located in a separate network element: the edge QAM device. CableLabs defines the M-CMTS architecture, which is one of the DOCSIS specifications. The M-CMTS architecture and wideband (DOCSIS 3.0) channel bonding are closely related technology pieces.

The CableLabs specification for the M-CMTS architecture defines changes to the edge QAM device that require it to be both DOCSIS-aware and synchronized to the DOCSIS subsystem. The Cisco Cable Wideband Solution, Release 1.0, implementation of the M-CMTS architecture does not place these requirements on the edge QAM device.

For a single wideband channel, Figure 3-3 shows the M-CMTS architecture as it is used in the Cisco Cable Wideband Solution, Release 1.0. In this example, two downstream RF channels are bonded together into one wideband channel. The Gigabit Ethernet (GE) switch is optional.

Figure 3-3 Cisco Cable Wideband M-CMTS Architecture



In the M-CMTS architecture used for the Cisco Cable Wideband Solution, Release 1.0, traditional CMTS functionality is divided into two network elements as follows:

- *M-CMTS Core*—Contains the traditional functionality of a CMTS except for the downstream PHY. The M-CMTS Core provides CMTS functionality, such as DOCSIS MAC (media access control) and upstream QPSK and QAM demodulation. DOCSIS MAC includes upstream and downstream packet transmission services and MAC management message exchanges with cable modems. In the Cisco Cable Wideband Solution, the Cisco uBR10012 router is the M-CMTS Core device.
- *Edge QAM (EQAM) Device*—Connects to the M-CMTS Core and contains PHY-related hardware, such as QAM modulators. For input, the EQAM device communicates with the M-CMTS through redundant Gigabit Ethernet interfaces. For output, the EQAM device has multiple QAM modulators and RF upconverters that connect to a hybrid fiber coaxial (HFC) network. In the Cisco Cable Wideband Solution, four EQAM devices are tested for interoperability with solution components:
  - Scientific Atlanta Continuum DVP eXtra Dense QAM Array 24 (XDQA24)
  - Harmonic Narrowcast Services Gateway (NSG) 9116
  - Harmonic Narrowcast Services Gateway (NSG) 9000
  - Vecima Networks VistaLynx VL1000

Benefits of M-CMTS Architecture

Some of the benefits of a modular CMTS architecture are described in these sections:

- Cost Effective Architecture, page 3-5
- Multiservice Architecture, page 3-6

Cost Effective Architecture

The Cisco Cable Wideband Solution, Release 1.0, can use the MSO's existing network. Deployed uBR10012 routers that are used as a DOCSIS 1.x/2.0 CMTS's can be upgraded to a modular CMTS's that support wideband cable by adding on hardware (the Cisco Wideband SIP and SPA) and upgrading software. Some existing external QAM array devices used for video on demand (VOD), with a software upgrade, may be able to be employed as the edge QAM device. For edge QAM devices that have been tested for interoperability, see the "External Edge QAM Device" section on page 2-11.

MSOs can repurpose their existing network infrastructure, including existing fiber nodes, for wideband cable. The benefits of the M-CMTS architecture include:

- Takes advantage of the lower cost, lower power requirements, and higher density of edge QAM devices.
- Uses less-expensive external QAM arrays for downstream wideband channels. This is more cost effective than locating the downstream QAMs in the CMTS chassis.
- Saves operating costs by avoiding rewiring and moving customers to new systems.

With traditional CMTS architecture, adding downstream RF channels for a wideband channel would mean also adding multiple upstreams. With the M-CMTS architecture, multiple downstream RF channels can be aggregated into a wideband channel without adding any additional upstreams. This independent scaling of downstream channels makes wideband channels economically feasible.

Multiservice Architecture

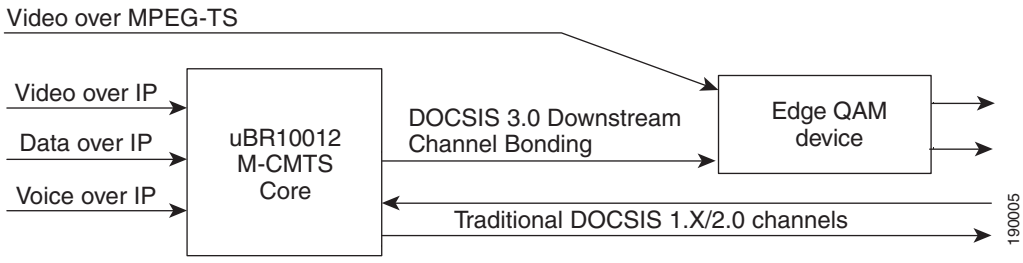
With M-CMTS architecture, the use of external edge QAM devices allows MSOs to use the same network resources for a video on demand (VOD) network and a Cisco wideband cable network. With updated firmware, some edge QAM devices can be used for VOD and for wideband channels though individual output QAM channels in the device cannot be shared.

The wideband channel uses the edge QAM device for downstream data traffic, and uses the M-CMTS's uBR10-MC5X20 cable interface line card for upstream traffic and for downstream MAC management and signaling messages.

In the Cisco Cable Wideband Solution, Release 1.0, traditional DOCSIS 1.X/2.0 services are supported by the CMTS; uBR10-MC5X20 cable interface line cards (not edge QAM devices) are used for these services.

A multiservice architecture (see Figure 3-4) with converged IP triple play (voice, data, and video services) on wideband channels is the ultimate goal for DOCSIS 3.0 services.

Figure 3-4 M-CMTS Multiservice Architecture



Note In the Cisco Cable Wideband Solution, Release 1.0, the uBR1012 router currently supports a data-only service on wideband channels. A Cisco Cable Wideband Solution, Release 1.0, system does not currently support video or voice on wideband channels.

M-CMTS Interactions with Wideband Cable Modems

The following sections provide information on interactions between the M-CMTS and wideband cable modems:

MAC Domains

A DOCSIS MAC Domain is a logical subcomponent of a CMTS and is responsible for implementing all DOCSIS functions on a set of downstream channels and upstream channels. All MAC Domain operations are performed by the Core CMTS's uBR10-MC5X20 cable interface line cards. A CMTS MAC Domain contains at least one downstream channel and at least one upstream channel. Each downstream channel or upstream channel is contained by a single MAC Domain.

A MAC domain is responsible for all MAC Management Messages to the set of cable modems that are registered on that MAC Domain. A cable modem is registered to only a single MAC Domain.

A MAC Domain provides Layer 2 data forwarding services between the CMTS and the set of cable modems registered to that MAC Domain.

In the downstream direction, the MAC Domain classifies downstream packets into downstream service flows based on Layer 2, 3, and 4 information in the packets. The MAC Domain then schedules the packets from each downstream service flow onto the set of downstream channels of the MAC domain.

The CMTS assigns a downstream service flow to either a single downstream RF channel or to a Downstream Bonding Group for a wideband channel. A downstream sequence of bonded packets is identified at the CMTS and wideband cable modem by a Bonding Group ID (BG ID). Packets destined to different wideband cable modems can share the same Bonding Group ID. The CMTS assigns a downstream service flow to either a single downstream RF channel or to a downstream Bonding Group for a wideband channel.

For the Scientific Atlanta DPC2505 or EPC2505 wideband cable modem, each of the modem's unicast service flows is sent as a bonded group and is tied to the modem's bonded downstream channel. A downstream sequence of unicast bonded packets is identified at the CMTS and the cable modem by a unique Downstream Service Identifier (DSID). Multicast traffic on bonded downstream channels is not supported. Multicast service flows that the modem sees on the bonded downstream channel are discarded.

In the upstream direction, the behavior and handling of traffic by the CMTS is identical to the DOCSIS 2.0 behavior and handling.

Addressing

All addressing is done with Ethernet and IP addresses. The wideband cable modem uses the same IP address space as a standard cable modem so it is able to use the same DHCP procedure to procure an IP address.

The DOCSIS 3.0 Downstream Channel Bonding feature does not limit the number of wideband cable modems that can exist on a downstream channel. The limit is set either by the availability of bandwidth, or by the 8175 service identifiers (SIDs) limit in DOCSIS 2.0.

Because wideband channels and a traditional DOCSIS channel can be within the same subnet, a wideband cable modem can be moved between services without the need to change the IP address space of the home network.

Since the IP address space is homogeneous, it is not necessary to have a NAT function in the wideband cable modem. The rules for distribution of IP address for a home network with a wideband cable modem are the same as for a DOCSIS 2.0 cable modem.

Security

A wideband channel uses Baseline Privacy Plus (BPI+) for its link level encryption. As with DOCSIS 2.0, BPI+ provides cable modem users with data privacy across the cable network by encrypting traffic flows between the wideband cable modem and the wideband CMTS. BPI+ also provides MSOs with protection against theft of service.

The wideband cable modem uses the same BPI+ keys on its wideband channels as it does on its traditional DOCSIS channel. The wideband cable modem uses the BPI+ keys negotiated on the primary service flow of the traditional DOCSIS downstream channel for the service flows on the wideband channel.

Quality of Service

For quality of service (QoS) on a wideband downstream channel, a wideband cable modem can be assigned multiple service flows. Only Best Effort (BE) service flows are currently supported. The CMTS sends data traffic on a non-guaranteed best-effort basis.

For the traditional DOCSIS upstream channel associated with a wideband channel, QoS capabilities supported are identical to those in DOCSIS 2.0.

Gigabit Ethernet Switch Functionality

The Gigabit Ethernet (GE) switch is an optional device that receives downstream packets from the Cisco Wideband SPA and passes the packets to the edge QAM device. The Gigabit Ethernet switch is used for these purposes:

- To concentrate traffic from multiple Gigabit Ethernet links to a smaller number of Gigabit Ethernet links prior to fiber transport to the edge QAM devices
- To provide 1+1 or N+1 redundancy for downstream Gigabit Ethernet links
- To multiplex wideband DOCSIS traffic and video traffic onto the same edge QAM devices

If more than two EQAM devices are required for two Wideband SPAs, a Gigabit Ethernet switch is needed to connect the SPAs to the EQAM devices.

If video-on-demand (VOD) traffic and the RF channels for wideband channels are mixed on the same EQAM device, a Gigabit Ethernet switch is required.

When an RF channel for a wideband channel is configured using Cisco IOS commands on the uBR10012 router, the **rf-channel** command's **mac-address** argument specifies the MAC address for the next-hop interface on the switch if it is a Layer-2 GE switch. The **rf-channel** command's **ip-address** argument specifies the IP address of the Gigabit Ethernet interface on the edge QAM device. The MAC address on the switch and the IP address on the EQAM device are used to route downstream traffic for the RF channel to the correct destinations.

Edge QAM Device Functionality

The edge QAM (EQAM) device receives wideband as MPEG-TS over IP on its Gigabit Ethernet interfaces. The edge QAM device extracts the MPEG-TS packets from the MPEG-TS over IP stream and routes them to the proper QAM RF outputs to the HFC plant for transmission to the wideband cable modem.

The edge QAM devices are not involved in the active management of bandwidth or QOS for wideband channels. The edge QAM devices are not aware of the IP addressing used by the wideband cable modems.

A single QAM's total bandwidth can be divided up and statically allocated to more than one wideband channel. When a wideband channel is configured on the CMTS, the wideband channel uses multiple specified logical RF channels on the Wideband SPA. Each RF channel is associated with a QAM output on the edge QAM device.The bandwidth of an RF channel can be divided between one or more wideband channels as long as the total allocated bandwidth for an RF channel (and QAM) does not exceed 100 percent. For more information on configuring RF channels, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

The QAM channels on the edge QAM device do not need to be adjacent. If certain QAM channels have already been assigned to non-DOCSIS uses, the DOCSIS 3.0 Downstream Channel Bonding feature uses the channels that are available. The system does impose certain constraints. For example, if the QAMs are frequency stacked, certain QAMs will have to be adjacent.

Wideband Cable Modem Functionality

The wideband cable modem is a standalone device capable of interoperation with an industry standard DOCSIS 2.0 compatible CMTS, but it supports wideband operation when used with a wideband CMTS. At any one time, the wideband cable modem operates in one of two ways:

- As a traditional DOCSIS 2.0 cable modem, it receives all downstream traffic as non-bonded traffic on its traditional downstream.
- As a wideband cable modem, it receives all downstream traffic as bonded traffic—a wideband channel consisting of one or more RF downstreams.

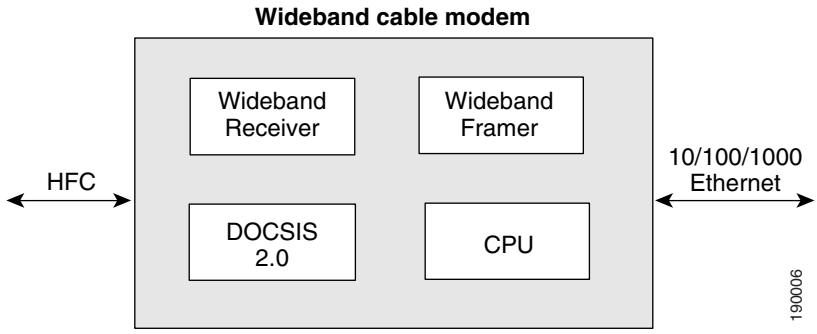
This discussion focuses on the modem's role as a wideband cable modem. The explanations in this section are generic and apply to all wideband cable modems supported by the Cisco Cable Wideband Solution, Release 1.0.

Wideband cable modem functionality may vary depending on the wideband cable modem. For implementation information on specific wideband cable modems, see the "Wideband Cable Modem Behavior" section on page 4-6.

Wideband Cable Modem Design and Operation

The wideband cable modem is backward compatible with DOCSIS 2.0 and contains a complete DOCSIS 2.0 core. If a wideband channel is not available, the wideband cable modem can operate strictly as a DOCSIS 2.0 cable modem. Figure 3-5 shows a simplified block view of the wideband cable modem.

Figure 3-5 Wideband Cable Modem Block View



The wideband cable modem has a wideband receiver that receives the multiple RF channels of a bonded channel. It also has a wideband framer that decodes the signal from the wideband receiver and extracts the packets for the 10/100/1000 Mbps Ethernet home network.

The wideband cable modem identifies itself as being wideband-capable during the configuration process. This allows the DOCSIS TFTP provisioning server to enable or disable wideband mode, and to choose the appropriate configuration parameters.

A wideband channel uses the same DOCSIS frame format as a traditional DOCSIS channel uses. The channel just has more bandwidth. A new extended header for wideband has been added to the DOCSIS protocol. The extended header defines the logical wideband channel and a sequence number that the wideband cable modem uses for re-sequencing the wideband packets.

The CISCO-CABLE-WIDEBAND-MODEM-MIB for the wideband cable modem is supported and is an extension to the existing cable modem MIB.

Implementing and Configuring the Solution

This chapter provides implementation and configuration information for the Cisco Cable Wideband Solution, Release 1.0, and contains the following topics:

Wideband CMTS Configuration

This section provides overview information on the wideband CMTS configuration tasks:

This section also lists documents where you can find the detailed information needed to configure the Cisco IOS software for the uBR10012 router components, including the components needed for the Cisco Cable Wideband Solution, Release 1.0.

Configuring Base CMTS Components

The base CMTS is the Cisco uBR10012 router with the components needed for DOCSIS 1.x/2.0 operation. Wideband cable components can be added to the Cisco uBR10012 base system so that it can be used as a wideband CMTS. For wideband cable operation, the configuration tasks for the base CMTS components are similar to the configuration tasks used for DOCSIS 1.x/2.0 operation. The base CMTS can be used as a DOCSIS 1.x/2.0 CMTS.

For wideband cable operation, one additional configuration task is required on the uBR10-MC5X20 cable interface line cards that will be used for primary downstream channels on fiber nodes. For each fiber node, a traditional DOCSIS downstream channel is used to carry MAC management and signaling messages, and the associated traditional DOCSIS upstream channel is used for return data traffic and signaling. The traditional DOCSIS downstream channel used in this way is referred to as the *primary downstream channel*.

All wideband channels used on a fiber node and all associated primary downstream channels on Cisco uBR10-MC5X20 cable interface line cards must be configured to belong to the same virtual bundle interface. For detailed information on this configuration task, see the "Configuring Wideband Channels and Primary Downstream Channels as Virtual Bundle Members" section in the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Table 4-1 provides a list of the software configuration documents that are likely to be useful for configuring the Cisco Cable Wideband Solution, Release 1.0, base CMTS components.

Table 4-1 Base CMTS Components Configuration: Where to Find Information

Solution Component	Where to Find Information
Cisco uBR10012 router (general and feature-specific configuration)	*Release Notes for Cisco uBR10012 Universal Broadband Router for Cisco IOS Release 12.3 BC (which includes information on Cisco IOS Release 12.3(21)BC)* *Cisco uBR10012 Universal Broadband Router Software Configuration Guide* *Cisco Cable Modem Termination System Feature Guide*
Performance Routing Engine 2 (PRE2)	*Route Processor Redundancy Plus for the Cisco uBR10012 Universal Broadband Router*
Cisco uBR-MC5X20 line cards	Chapter 3, "Configuring Cable Interface Features for the Cisco uBR10012 Router," in the *Cisco uBR10012 Universal Broadband Router Software Configuration Guide* "Cable Interface Bundling and Virtual Interface Bundling for the Cisco CMTS" in the *Cisco Cable Modem Termination System Feature Guide* "N+1 Redundancy for the Cisco Cable Modem Termination System" in the *Cisco Cable Modem Termination System Feature Guide*
Half-Height Gigabit Ethernet (HHGE) network uplink line cards	Configuring the Half-Height Gigabit Ethernet Line Card for the Cisco uBR10012 Universal Broadband Router

The technical documentation set for the Cisco uBR10012 router includes many documents not shown in Table 4-1 that are useful for configuring this CMTS. The Cisco uBR10012 documentation set can be accessed from this web site area:

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

Configuring Wideband CMTS Components

The wideband CMTS components are added to the base CMTS components to make the CMTS wideband capable. This section provides overview information on configuring the wideband CMTS components:

- Configuring the Wideband SIP and Wideband SPA, page 4-3
- Configuring the Edge QAM Device Configuration, page 4-3
- Configuring the Gigabit Ethernet Switch, page 4-5

Configuring the Wideband SIP and Wideband SPA

The wideband CMTS components that require configuration include the Cisco Wideband SIP and Cisco Wideband SPA. Cisco IOS commands are issued on the uBR10012 router to configure the Wideband SIP and SPA. An outline of the configuration tasks needed for the Wideband SIP and SPA is as follows:

- Preprovisioning of the Wideband SIP and Wideband SPA
- Setting General Configuration Values for the Wideband SPA
- Configuring RF Channels
- Configuring Fiber Nodes
- Configuring Wideband Channels and Primary Downstream Channels as Virtual Bundle Members
- Setting Optional Configuration Values

For information on the preceding tasks and for reference information on the Cisco IOS commands used for Wideband SIP and SPA configuration, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Configuring the Edge QAM Device Configuration

Edge QAM (EQAM) device configuration is device-specific and implementation-specific.

- For the Scientific Atlanta Continuum DVP XDQA24 device, the *Continuum DVP eXtra Dense QAM Array 24 Configuration Guide* contains configuration information. See the appendix "Cisco Wideband Applications" in that document for information on configuring this EQAM device for wideband.
- For information on configuring other EQAM devices, refer to the device's documentation.

Regardless of the edge QAM device or implementation, these items are used for Wideband SPA configuration and must be configured on each EQAM device:

- For the edge QAM device:
  - IP address of the EQAM device's Gigabit Ethernet interface (input port)
  - MAC address of the EQAM device's Gigabit Ethernet interface (input port)
- For each of the EQAM device's QAM outputs that will be used for a Wideband SPA RF channel:
  - Center frequency of the QAM output
  - UDP number of the QAM output

The IP address, MAC address, frequency, and UDP port configured on the edge QAM device are specified when configuring RF channels on the CMTS. Be certain to verify that the RF-channel values set with **rf-channel** (issued on the CMTS) match the values configured on the edge QAM device.

Note If a Layer-2 Gigabit Ethernet switch is used to connect the Wideband SPA to the EQAM device, the MAC address specified in the **rf-channel** command is the MAC address of the switch's Gigabit Ethernet interface.

An RF channel and EQAM configuration worksheet such as the one shown in Table 4-2 may be useful for coordinating Wideband SPA RF channel and EQAM device configuration. A Wideband SPA supports either 18 or 24 RF channels depending on how the SPA is configured. For more information, see the description of the **rf-channel** command in the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Table 4-2 RF Channel and EQAM Configuration Worksheet

	EQAM Device		QAM Output		
Wideband SPA RF Channel	**GE Input IP Address**	**GE Input MAC Address**	**QAM Output**	**Frequency**	**UDP Port Number**
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

Configuring the Gigabit Ethernet Switch

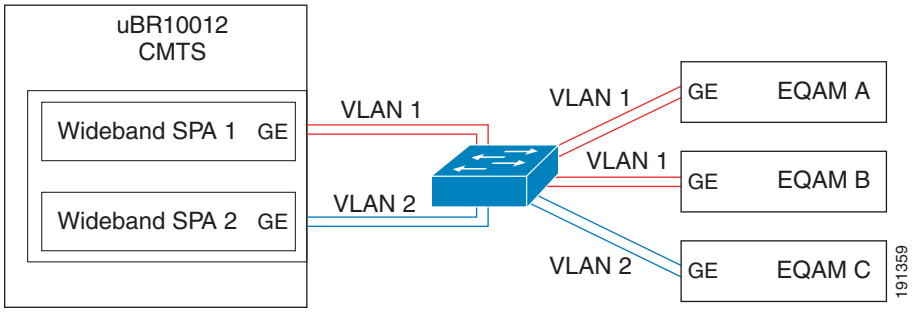
A Gigabit Ethernet (GE) switch linking the Cisco Wideband SPAs and the edge QAM (EQAM) devices is optional except when more than two EQAM devices are required for two Wideband SPAs, or when video-on-demand (VOD) traffic and the RF channels for wideband channels are mixed on the same EQAM device. The configuration of the Gigabit Ethernet switch is device-specific and implementation-specific, but it is recommended that virtual LANs (VLANs) be used to create separate broadcast domains for the traffic of each Wideband SPA.

Figure 4-1 shows an example of VLAN usage. Wideband SPA 1 uses the QAM outputs on EQAM A and EQAM B. Wideband SPA 2 uses the QAM outputs on EQAM C and EQAM D.

- VLAN 1 carries traffic for Wideband SPA 1.
- VLAN 2 carries traffic for Wideband SPA 2.

Both the Wideband SPAs and EQAM devices have redundant Gigabit Ethernet links that are members of the appropriate VLANs.

Figure 4-1 VLANs for Wideband Traffic



Wideband Cable Modem Behavior

This section provides information on the wideband cable modems and their interactions with the CMTS. The following topics are discussed:

Linksys WCM300-NA, WCM300-EURO, and WCM300-JP Modems

With the Linksys WCM300-NA, WCM300-EURO, and WCM300-JP wideband cable modems, Cisco's DOCSIS 3.0 Downstream Channel Bonding feature supports downstream data service to the cable modem on multiple bonded downstream channels. The Linksys WCM300 wideband cable modem supports the receiving of up to three wideband downstream channels:

- One primary bonded channel
- Up to two secondary bonded channels

The *primary bonded channel* is the wideband channel on which the wideband cable modem receives all of its unicast traffic and some multicast traffic. The cable modem may identify the primary bonded channel and any secondary bonded channels to the CMTS at cable modem registration time. The DOCSIS configuration file may define the primary bonded channel for the CMTS to assign to the cable modem.

Secondary bonded channels are the wideband channels on which the wideband cable modem receives additional multicast data streams. The DOCSIS configuration file defines the secondary bonded channels for the modem to pass to the CMTS. Secondary bonded channels are intended to receive multicast traffic such as broadcast video that is not available on the primary bonded channel.

When the wideband cable modem registers with one primary and one or more secondary wideband channels, it accepts multicast packets from all associated wideband channels. The CMTS ensures that a multicast packet is not forwarded on the primary and secondary wideband channels simultaneously.

A primary bonded channel cannot also be configured as a secondary bonded channel, and vice-versa. Primary and secondary bonded channels can be configured on the CMTS with the **cable bonding-group-id** command and with the DOCSIS configuration file using TLVs (primary bonding group ID and secondary bonding group ID).

The Linksys WCM300 wideband cable modem implements a subset of the DOCSIS 3.0 protocol for channel bonding. Channel bonding is accomplished by the use of a per-packet sequence number to enable the wideband cable modem to deliver, in order, the packets from multiple RF channels that are destined to the CPE device. The WCM300 modem supports up to 16 independent resequencing engines for the receiving of bonded unicast traffic and bonded multicast traffic over its three bonded channels.

DOCSIS Configuration File for Wideband on Linksys WCM300 Modems

The Linksys WCM300 wideband cable modem obtains a DOCSIS configuration file as it does in DOCSIS 2.0. For wideband operation, the file may contain three wideband-related Type/Length/Value (TLV) encodings.

- Primary bonding group ID
- Bonded channel enable
- Secondary bonding group ID

Note The preceding TLVs can optionally be specified in the DOCSIS configuration file. These TLVs are *not required* for the Linksys WCM300 modem to operate in wideband mode (w-online).

All three TLVs are encoded as vendor-specific options (type 43) to facilitate interoperability and reduce future compatibility issues.

Primary Bonding Group ID

The primary bonding group ID option is encoded as subtype 14:

- Type.Subtype: 43.14
- Length: 2
- Value: primary bonding group ID

The primary bonding group ID option allows the provisioning system to force the wideband cable modem to use a particular primary bonded downstream channel. The modem can use a single primary bonded channel for unicast and multicast traffic. When the primary bonding group ID value is present, the CMTS assigns the wideband cable modem to the wideband-channel interface identified by the configured bonding group ID. If the CMTS is unable to assign the wideband cable modem to the wideband-channel interface specified by the configured bonding group ID, the CMTS causes the wideband cable modem to fail registration.

Only a single occurrence of the primary bonding channel ID option may be specified in the DOCSIS configuration file. The total of the RF channels in the primary and secondary bonded channels must comply with the 50 MHz capture-window limitation of the Linksys WCM300 modem.

Note If a wideband channel is specified as a primary bonded channel in the DOCSIS configuration file, the channel *must be identically specified* as a primary bonded channel in the CMTS active, running configuration file. The **cable bonding-group-id** command specifies whether a bonding group is a primary or secondary bonding group. For information on this command, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Bonded Channel Enable

The bonded channel enable option is encoded as subtype 15:

- Type.Subtype: 43.15
- Length: 1
- Value: 0 equals Disable, and 1 equals Enable

The bonded channel enable option allows the provisioning system to require that a wideband cable modem operate in traditional DOCSIS 2.0 mode. When the bonded channel enable option has a value of 0 (disable), the CMTS ensures that a wideband-channel interface is not assigned to the wideband cable modem at registration time.

Only a single occurrence of the bonded channel enable option may be specified in the DOCSIS configuration file.

Secondary Bonding Group ID

The secondary bonding group ID option is encoded as sub-type 16.

- Type.Subtype: 43.16
- Length: 2
- Value: secondary bonding group ID

The secondary bonding group ID option allows the provisioning system to specify secondary bonded downstream channels for the wideband cable modem to use. The modem can use one or two secondary bonded channels for multicast traffic. If the configured secondary bonding group ID is not valid, the CMTS causes the wideband cable modem to fail registration

Up to two secondary bonding group IDs can be specified in the DOCSIS configuration file. The total of the RF channels in the primary and secondary bonded channels must comply with the 50 MHz capture-window limitation of the Linksys WCM300 modem.

Note If a wideband channel is specified as a secondary bonded channel in the DOCSIS configuration file, the channel *must be identically specified* as a secondary bonded channel in the CMTS active, running configuration file. The **cable bonding-group-id** command specifies whether a bonding group is a primary or secondary bonding group. For information on this command, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Scientific Atlanta DPC2505 and EPC2505 Modems

The Scientific Atlanta DPC2505 and EPC2505 wideband cable modem makes use of Broadcom Corporation's BCM93381 cable modem chip. The BCM93381 chip provides three tuners, allowing the three downstream receivers to be independently tuned to any frequency. The M-CMTS and the DPC2505 wideband cable modem use these three channels as follows:

- It uses one of these downstream RF channels as its *primary downstream channel* for MAC management and signalling messages.
- It uses the other two downstream RF channels as *non-primary downstream channels*. These two RF channels can be bonded together to form one wideband channel.

The DPC2505/EPC2505 wideband cable modem uses a selected subset of the DOCSIS 3.0 protocol for channel bonding. Channel bonding is the transmission of a stream of packets across multiple RF channels with the use of sequence numbers to ensure the modem receiver delivers packets in the proper order to the CPE. The DPC2505/EPC2505 wideband cable modem filters packets on a Destination Address and Security Association Identifier (SAID). The DPC2505/EPC2505 modem supports up to 16 independent re-sequencing contexts.

The DPC2505/EPC2505 wideband cable modem does not support multicast traffic on the wideband channel. Multicast service flows that the modem sees on the bonded downstream channel are discarded.

The configuration file used for the Scientific Atlanta DPC2505/EPC2505 wideband cable modem is identical to a DOCSIS 2.0 configuration file. DOCSIS 2.0 configuration file tools like the Cisco Broadband Configurator can be used to create configuration files for this modem.

Automatic Adjustments During Scientific Atlanta DPC2505 and EPC 2505 Registration

During modem registration, upon reception of the REG-RSP from the CMTS, the Scientific Atlanta DPC2505/EPC2505 modem first checks for presence and correctness of the various encodings.

- If any encodings are incorrectly formatted or exceed the modem's capabilities, the wideband cable modem may detect this and immediately send a REG-ACK message with a confirmation code indicating failure. The confirmation code will be reject-bad-rcc(208) if the RCC encoding is bad, or reject-other(1) if some other problem is found.
- If encodings appear to be valid, the wideband cable modem attempts to tune its non-primary receivers to the non-primary downstream channels specified in the RCC. The RCC may specify zero, one, or two non-primary downstream channels. If the cable modem fails to tune to the designated non-primary downstream channels, it will send a REG-ACK with confirmation code reject-bad-rcc(208).

In the case of wideband channels overlapping on some sets of QAMs, if the DPC2505 modem rejects the registration with confirmation code of reject-bad-rcc(208), something is wrong— either an incorrect plant topology configuration or a bad tuner in the cable modem. The CMTS records this occurrence. When the same cable modem tries to register again, the CMTS chooses different wideband channels preferably residing on a different sets of QAMs.

The process continues until the wideband cable modem successfully registers on a wideband channel or all choices of wideband channels are exhausted. If all choices are exhausted, the CMTS put the Scientific Atlanta DPC2505 modem in DOCSIS 2.0 mode on its next attempt to register.

A timeout value of 24 hours is defined for the CMTS to clear the bad QAM status recorded for each CM. Therefore, the wideband cable modem is allowed to retry the bad set of QAMs in the future.

CMTS Interactions with Wideband Cable Modems

This section provides information CMTS interactions with wideband cable modems:

- Registration for Wideband Cable Modems, page 4-9
- Load Balancing for Wideband Cable Modems, page 4-10

In these sections, all statements are generic and apply to the following modems:

- Linksys WCM300-NA
- Linksys WCM300-EURO
- Linksys WCM300-JP
- Scientific Atlanta DPC2505
- Scientific Atlanta EPC2505

Registration for Wideband Cable Modems

After the wideband cable modem completes the initialization process on the primary downstream channel, the CMTS uses the REG-RSP message to enable multiple downstream RF channel operation (wideband channel operation) and to assign channels to the cable modem.

Consistent with DOCSIS 3.0, the assignment of multiple channels takes place at two layers. The lower layer is that of physical receiver configuration, or the Receive Channel Set, of the cable modem. The CMTS uses a specific subset of DOCSIS 3.0 Receive Channel Configuration (RCC) encodings to tell the wideband cable modem what center frequencies to use for its primary downstream channel receiver and its non-primary downstream channel receivers.

With the wideband cable modem as per DOCSIS 3.0, bonding and sequencing of traffic can take place across all channels of a cable modem's Receive Channel Set, or across any subset of these channels. A second, higher layer of channel assignment deals with bonding and resequencing. This higher layer is handled by assignment of a Downstream Service Identifier (DSID) for each independent sequence number space. In the REG-RSP message, the CMTS uses a subset of DOCSIS 3.0 DSID encodings to tell the cable modem the DSID values to recognize and the channels and resequencing timeouts that are associated with each DSID.

Load Balancing for Wideband Cable Modems

If multiple wideband channels are available on the same fiber node, and the wideband cable modem comes online with one of the wideband channels, the CMTS has the choice of assigning it to a different wideband channel. In this case, a simple random load balancing algorithm distributes the cable modems on the fiber node across the multiple wideband channels.

If the CMTS has a choice between a wideband channel consisting of one RF channel and another channel consisting of two RF channels, the CMTS uses a weighted random load-balancing algorithm to determine the wideband channel that the wideband cable modem will use. The wideband channel with two RF channels is weighted so that it has two-thirds of a chance of being chosen while the wideband channel with one RF channel has one-third of a chance.

Supported MIBs

The following MIBs are supported in Cisco IOS Release 12.3(21)BC and later for the Cisco uBR10012 router and the Cisco Wideband SIP and Wideband SPA:

- ENTITY-MIB
- CISCO-CABLE-WIDEBAND-MIB
- IF-MIB
- CISCO-VENDORTYPE-OID-MIB

For more information about MIB support on a Cisco uBR10012 router, refer to the *Cisco CMTS Universal Broadband Router MIB Specifications Guide.*

For information about MIBs associated with edge QAM devices or wideband cable modems, refer to the vendor documentation.

Known Restrictions

The following restrictions apply to the Cisco Wideband SPA for Cisco IOS Release 12.3(21)BC:

- Wideband services are data-only.
- Only best effort flows are configurable on wideband channels.
- No dynamic services are configurable on wideband channels.

- Traffic from different Wideband SPAs cannot be mixed on the same QAM port.
- Scientific Atlanta DPC2505 and EPC2505 wideband cable modems support multicast traffic on the primary downstream channel only. These modems do not support multicast traffic on wideband downstream channels.

Monitoring and Troubleshooting Wideband Components

This chapter provides an introduction to monitoring and troubleshooting the wideband components of the Cisco Cable Wideband Solution, Release 1.0. The chapter includes the following topics:

Monitoring Wideband Components

The Cisco IOS command-line interface includes commands that can be issued on the CMTS for the following:

For detailed information on the syntax, usage, and additional examples for each command, see the documents shown in Table 5-1.

Note Many of the commands used to configure the Cisco uBR10012 router and the Cisco Wideband SIP and SPA *are not* currently part of the command set that can be searched with the Cisco Command Lookup Tool (available on Cisco.com). Use the documents listed in Table 5-1 to find information on these commands.

Table 5-1 Wideband Command Reference Documentation

Document	Command Described
Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide	Commands for the Wideband SIP and Wideband SPA, including commands for RF and wideband channels

Table 5-1 Wideband Command Reference Documentation

Document	Command Described
Cisco Broadband Cable Command Reference Guide	Commands for cable modems and wideband-cable interfaces (wideband channels)
Cisco IOS Release 12.3 Commands Master Commands List	Commands for IOS Release 12.3 that are not cable-specific

Monitoring Wideband SIPs

The following command is useful for monitoring a Cisco Wideband SIP: show diag.

In addition, the **show controllers jacket** command displays Wideband SIP register values. The **show controllers jacket** is intended for use by Cisco Systems technical support personnel.

show diag

To verify that the Wideband SIP is powered on, use the **show diag** command. If **show diag** displays any output, the Wideband SIP is powered on. The **show diag** command provides a variety of information on the Wideband SIP. For example, the hardware type of the Wideband SIP is 2jacket-1 card.

```
Router# show diag 1/0

Slot/Subslot 1/0:
        2jacket-1 card, 0 ports
        Card is full slot size
        Card is analyzed
        Card detected 16:46:44 ago
        Card uptime 0 days, 16 hours, 46 minutes, 36 seconds
        Card idle time 0 days, 14 hours, 22 minutes, 34 seconds
        Voltage status: 3.3V Nominal 2.5V Nominal 1.5V Nominal 12V Nominal
EEPROM contents, slot 1/0:
        Hardware Revision         : 1.0
        Top Assy. Part Number     : 800-22843-04
        Board Revision            : 01
        Deviation Number          : 0-0
        Fab Version               : 04
        PCB Serial Number         : CSJ09030613
        RMA Test History          : 00
        RMA Number                : 0-0-0-0
        RMA History               : 00
        CLEI Code                 :
...
```

If **show diag** displays no output, the Wideband SIP is not powered on.

```
Router# show diag 1/0     // Displays no output
Router#
```

Monitoring Wideband SPAs

The following commands are useful for monitoring a Cisco Wideband SPA:

- show hw-module bay oir
- show diag
- show controllers modular-cable

show hw-module bay oir

To verify that the Wideband SPA is powered on, use the **show hw-module bay oir** command. If the Operational Status is "ok", the Wideband SPA is powered on and operational.

```
Router#show hw-module bay 1/0/0 oir

Module        Model                Operational Status
------------ -------------------- ------------------------
bay 1/0/0     SPA-24XDS-SFP        ok
```

If **show hw-module bay oir** displays "admin down" in the Operational Status field, the Wideband SPA has been administratively disabled.

```
Router#show hw-module bay 1/0/0 oir

Module        Model                Operational Status
------------ -------------------- ------------------------
bay 1/0/0     SPA-24XDS-SFP        admin down
```

show diag

To display hardware and diagnostic information for a Wideband SPA, use the **show diag** command.

```
Router# show diag 1/0/0

Slot/Subslot/Port 1/0/0:
        24rfchannel-spa-1 card, 1 port + 1 redundant port
        Card is half slot size
        Card is analyzed
        Card detected 16:47:55 ago
        Card uptime: Not Supported
        Card idle time: Not Supported
        Voltage status: 3.3V (+3.291) NOMINAL  2.5V (+2.495) NOMINAL
                        1.2V (+1.201) NOMINAL  1.8V (+1.811) FIXED
EEPROM contents, slot 1/0/0:
        Hardware Revision        : 1.0
        Boot Timeout             : 500
        PCB Serial Number        : CSJ09379726
        Part Number              : 73-9597-03
        Part Number Revision     : 05
        Fab Version              : 03
        RMA Test History         : 00
        RMA Number               : 0-0-0-0
        RMA History              : 00
        Deviation Number         : 0
        Product (FRU) Number     : SPA-24XDS-SFP
        Version Identifier (VID) : V01
        Top Assy. Part Number    : 68-2562-03
        Board Revision           : 05
```

```
CLEI Code                :
MAC Address              : 0019.06a5.d9b2
MAC Address block size   : 1
Manufacturing Test Data  : 00 00 00 00 00 00 00 00
Field Diagnostics Data   : 00 00 00 00 00 00 00 00
Calibration Data         : Minimum: 0 dBmV, Maximum: 0 dBmV
      Calibration values :
Platform features        : 00 00 00 00 00 00 00 00
                           00 00 00 00 00 00 00 00
                           00 00 00 00 00 00 00 00
                           00 00 00 00 00 00 00
```

show controllers modular-cable

With Cisco IOS commands, the Wideband SPA and its Gigabit Ethernet ports are not considered standard user-configurable interfaces and do not appear in the output of the **show interfaces** command. The Wideband SPA is a controller and the **show controller modular-cable** command displays information about the SPA, its Gigabit Ethernet ports, installed SFPs, wideband channels, and so on.

The following example provides sample **show controller modular-cable** output for the Wideband SPA located in slot 1, subslot 0, bay 0 of a Cisco uBR10012 router. In the output, the Gigabit Ethernet Port Selected field indicates that Port 0 is the active Gigabit Ethernet port on the Wideband SPA.

```
Router# show controller modular-cable 1/0/0 brief
SPA 0 is present
status LED: [green]
Host 12V is enabled and is okay.
Power has been enabled to the SPA.
SPA reports power enabled and okay.
SPA reports it is okay and is NOT held in reset.

Gigabit Ethernet Port Selected : Port 1
Receive Interface              : In Reset
Receive Interface              : Disabled
Transmit Interface             : Out of Reset
Transmit Interface             : Enabled
Primary Receive Clock          : Disabled
Backup Receive Clock           : Disabled
SFP [Port 0] : 1000BASE-SX Present
 Tx Enabled , LOS Detected , TxFault Not Detected
 Link Status [Port 0] : DOWN

SFP [Port 1] : 1000BASE-T Present
 Tx Enabled , LOS Not Detected , TxFault Not Detected
 Link Status [Port 1] : UP


Wideband Channel information
Channel    RF bitmap   Police Info: Bytes      Interval
0          0x3                      0            0 ms
1          0xC                      0            0 ms
2          0x30                     0            0 ms
3          0xC0                     0            0 ms
4          0x300                    0            0 ms
5          0xC00                    0            0 ms
6          0x3000                   0            0 ms
7          0xC000                   0            0 ms
8          0x30000                  0            0 ms
9          0x0                      0            0 ms
10         0x0                      0            0 ms
11         0x0                      0            0 ms
```

```
RF Channel information
Modulation corresponds to : QAM 256
Annex corresponds to : Annex B
Modulation Data :GE Interframe Gap = 12 , MPEG-TS Frames per pkt = 4
SPA IP address = 0.0.0.0           SPA MAC Addr = 0012.001A.888B
QAM       Channel Rate     Rate adjust   State
0         0                1             Enabled
1         0                1             Enabled
2         0                1             Enabled
3         0                1             Enabled
4         0                1             Enabled
5         0                1             Enabled
6         0                1             Enabled
7         0                1             Enabled
8         0                1             Enabled
9         0                1             Enabled
10        0                1             Enabled
11        0                1             Enabled
12        0                1             Enabled
13        0                1             Enabled
14        0                1             Enabled
15        0                1             Enabled
16        0                1             Enabled
17        0                1             Enabled
18        0                1             Enabled
19        0                1             Enabled
20        0                1             Enabled
21        0                1             Enabled
22        0                1             Enabled
23        0                1             Enabled

Interrupt Counts
Idx  Interrupt Register       Interrupt Bit            Total Count  Masked:
69   blz_sp_int_stat_reg_0    spi_train_vld            24           YES
84   spa_brd_int_stat_reg     sp_int_0                 24           NO
85   spa_brd_int_stat_reg     scc_int                  2            NO
86   spa_brd_int_stat_reg     phy1_int                 1            NO
87   spa_brd_int_stat_reg     phy0_int                 1            NO
92   spa_brd_int_stat_reg     temp1_int                2            NO
93   spa_brd_int_stat_reg     temp0_int                2            NO
97   bm_int_stat_reg          bm_spa_brd               26           NO
```

To display information about the SFP module in a Wideband SPA port, use the **show controllers modular-cable** with the **sfp** keyword. In the following example, the information is for the SFP module in port 1.

```
show controllers modular-cable 1/0/0 sfp port 1

SFP in port 1
SFP is present
SFP LOS is not detected
SFP TX FAULT is not detected
SFP TX is enabled

ID: SFP
        Extended ID: 4
        Connector: LC
        SONET compliance:  not specified
        Gigabit Ethernet compliance: 1000BASE-SX
        Fibre Channel link length:  not specified
        Fibre Channel transmitter technology:  not specified
        Fibre Channel transmission media:  not specified
        Fibre Channel speed:  not specified
        Encoding: 8B10B
```

```
        Bit Rate: 1300 Mbps
        50 micron-multimode fiber supported length: 550 m
        62.5 micron-multimode fiber supported length: 270 m
        Upper bit rate limit: not specified
        Lower bit rate limit: not specified
        Date code (yy/mm/dd): 05/02/23
        Vendor name: CISCO-AGILENT
        Vendor OUI: 12499
        Vendor Part Number (PN): QFBR-5766LP            Vendor Rev:
        Vendor SN (SN): AGS090855CE
        Options implemented:
                LOS Signal
                TX Fault Signal
                TX Disable Signal
        Enhanced options implemented: none
        Diagnostic monitoring implemented: none
        Idprom contents (hex):
        0x00:   03 04 07 00 00 00 01 00 00 00 00 01 0D 00 00 00
        0x10:   37 1B 00 00 43 49 53 43 4F 2D 41 47 49 4C 45 4E
        0x20:   54 20 20 20 00 00 30 D3 51 46 42 52 2D 35 37 36
        0x30:   36 4C 50 20 20 20 20 20 20 20 20 20 03 52 00 B5
        0x40:   00 1A 00 00 41 47 53 30 39 30 38 35 35 43 45 20
        0x50:   20 20 20 20 30 35 30 32 32 33 20 20 00 00 00 C4
        0x60:   00 00 06 C9 F0 FA 7C 01 B3 C8 41 6B 39 04 FC 85
        0x70:   BB 20 9E 00 00 00 00 00 00 00 00 00 B4 94 52 CC
        0x80:   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        0x90:   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
        State: Initalized
Phased Initialization
        Phase Reached: 4
        Phase Exit Code: 0
        Phase Read Offset: 0
...
```

Monitoring Wideband Channels

The following commands are useful for monitoring wideband channels:

- show interface wideband-cable
- show hw-module bay

show interface wideband-cable

To display information about a wideband-cable interface (wideband channel), use the **show interface wideband-cable** command. Wideband channels are similar to cable interfaces and information about them is also displayed with the **show ip interfaces** and **show interfaces** commands.

The following example displays **show interface wideband-cable** command output for wideband channel 0 on the Wideband SPA in slot/subslot/bay 1/0/0.

```
Router# show interface wideband-cable 1/0/0:0

Wideband-Cable1/0/0:0 is up, line protocol is up
  Hardware is Wideband CMTS Cable interface, address is 0012.001a.8896 (bia
0012.001a.8896)
  MTU 1500 bytes, BW 74730 Kbit, def 74730 Kbit DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation MCNS, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output 00:00:16, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     17470 packets output, 1810488 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Hardware Status and Line Protocol Status for a Wideband-Channel Cable Interface

When a wideband-channel cable interface is specified in **show interface wideband-cable** or another Cisco IOS command that displays hardware status and line protocol status for a cable interface, the following applies:

- The hardware status for a wideband-channel cable interface will be up if the Wideband SPA is installed in the Wideband SIP and both are powered on.
- The line protocol for a wideband-channel cable interface will be up if the wideband channel is associated with at least one RF channel and the following parameters have been set for the RF channel:
  - RF channel frequency
  - MAC address of the edge QAM device or next-hop router
  - IP address of the edge QAM device
  - UDP port number for the QAM that is used for the RF channel

If the line protocol for a wideband-channel cable interface is up, all wideband-channel configuration information needed to successfully send data is present. However, additional configuration information may be needed to complete the Wideband SPA configuration process. For information on Wideband SPA configuration procedures, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide.*

show hw-module bay

To display additional information about a wideband channel, use the **show hw-module bay** command with the **wideband-channel** keyword. You also have to specify one of the following keywords indicating the particular type of information you want to show:

- **association**—Displays wideband-to-narrowband (traditional DOCSIS) channel association information. The association of a wideband channel to a traditional DOCSIS downstream channel is made when a primary downstream channel for the fiber node is configured with the **downstream cable** command.
- **config—**Displays wideband channel configuration information.
- **counters—**Displays wideband channel statistics.
- **mapping—**Displays the mapping of RF channels to wideband channels.

To display wideband-to-narrowband channel association information, use **show hw-module bay** with the **association** and **wideband-channel** keywords. If you specify a wideband channel number after **wideband-channel**, output is for that channel only. For example:

```
Router# show hw-module bay 1/0/0 association wideband-channel 0

WB                      BG   Bundle  NB          NB chan  Reserved  Avail
channel                 ID   num     channel     ID       CIR       CIR
Wideband-Cable1/0/0:0   24   123     Cable5/0/1  120      0         0
```

In the preceding example, the following information is displayed for each wideband channel:

- WB channel—Wideband-cable interface (wideband channel).
- BG ID—Bonding Group ID for the wideband channel.
- Bundle num—The number of the virtual bundle interface in which the wideband channel is a member.
- NB channel—The slot/subslot/port of the primary downstream channel (narrowband channel or traditional DOCSIS channel) for the wideband channel.
- NB channel ID—Channel ID for the primary downstream channel.
- Reserved CIR—The reserved committed information rate (CIR). Because CIR is not currently supported for wideband traffic, reserved CIR is always 0.
- Avail CIR—The part of the CIR that is currently available. Because CIR is not currently supported for wideband traffic, available CIR is always 0.

To display configuration information for a wideband channel, use **show hw-module bay** with the **config** and **wideband-channel** keywords. If you do not specify a wideband channel number after **wideband-channel**, output is for all wideband channels. For example:

```
Router# show hw-module bay 1/0/0 config wideband-channel

WB                      BG    Bundle  WB Host       Primary
channel                 ID    num     Slot/Subslot  BG
Wideband-Cable1/0/0:0   24    123     5/0           Yes
Wideband-Cable1/0/0:1   25    123     5/0           Yes
Wideband-Cable1/0/0:2   26    123     5/0           Yes
Wideband-Cable1/0/0:3   27    123     5/0           Yes
Wideband-Cable1/0/0:4   28    123     5/0           Yes
Wideband-Cable1/0/0:5   29    123     5/0           Yes
Wideband-Cable1/0/0:6   30    123     5/0           Yes
Wideband-Cable1/0/0:7   31    123     5/0           Yes
Wideband-Cable1/0/0:8   32    123     5/0           Yes
Wideband-Cable1/0/0:9   33    123     5/0           Yes
Wideband-Cable1/0/0:10  34    123     5/0           Yes
Wideband-Cable1/0/0:11  35    123     5/0           Yes
```

In the preceding example, the following information is displayed for each wideband channel.

- BG ID—Bonding Group ID.

- Bundle num—The number of the virtual bundle interface in which the wideband channel is a member.
- WB Host Slot/Subslot—The cable interface line card that has been configured for Wideband protocol operations. For information, see the **modular-host subslot** command in the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Confirguration Guide*.
- Primary BG—Yes indicates that the wideband channel is a primary bonding group (primary wideband channel).

To display wideband-channel statistics, use **show hw-module bay** with the **counters** and **wideband-channel** keywords.

```
Router#show hw-module bay 1/0/0 counters wideband-channel 0

SPA      WB channel   Tx packets              Tx octets
1/0/0    0            29069                   4032392
```

To display RF-channels that have been configured for a wideband channel, use **show hw-module bay** with the **mapping** and **wideband-channel** keywords. The BW % column is the percent of the RF channel's bandwidth that is assigned to the wideband channel with the **cable rf-channel** command.

```
Router# show hw-module bay 1/0/0 mapping wideband-channel

SPA      WB       RF         BW %
         channel  channel
1/0/0    0        0          100
                  1          100
1/0/0    1        2          100
                  3          100
1/0/0    2        4          100
                  5          100
1/0/0    3        6          100
                  7          100
1/0/0    4        8          100
                  9          100
1/0/0    5        10         100
                  11         100
1/0/0    6        12         100
                  13         100
1/0/0    7        14         100
                  15         100
1/0/0    8        16         100
                  17         100
1/0/0    9        18         100
                  19         100
1/0/0    10       20         100
                  21         100
1/0/0    11       22         100
                  23         100
```

Monitoring RF Channels

The following command is useful for monitoring RF channels on a Wideband SPA: show hw-module bay.

show hw-module bay

To display information about RF channels on a Wideband SPA, use the **show hw-module bay** command with the **rf-channel** keyword. You also have to specify one of the following keywords indicating the particular type of information you want to show:

- **config—**Displays RF channel configuration information.
- **counters—**Displays RF channel statistics.
- **mapping—**Displays the mapping of RF channels to wideband channels.

To display configuration information for an RF channel, use **show hw-module bay** with the **config** and **rf-channel** keywords. If you specify an RF channel number after **rf-channel**, output is for that channel only. For example, the following output is for RF channel 0 on the Wideband SPA located in slot/subslot/bay 1/0/0.

```
Router# show hw-module bay 1/0/0 config rf-channel 0

SPA     RF       Freq       Mod     Annex  IP Address       MAC Address     UDP
        channel                                                            port
1/0/0   0        699000000  64qam   B      192.168.200.30   0011.920e.a9ff  49152
```

In the preceding output, these fields provide information on the edge QAM device that is associated with the RF channel:

- IP Address—The IP address of the edge QAM device.
- MAC address—The MAC address of the next-hop or edge QAM device.
- UDP port—The UDP port number for the edge QAM that will be used for this RF channel.

To display MPEG packets transmitted for an RF channel, use **show hw-module bay** with the **counters** and **rf-channel** keywords.

```
Router#show hw-module bay 1/0/0 counters rf-channel 0

SPA      RF channel   MPEG packets tx
1/0/0    0            334815
```

Monitoring Wideband Cable Modems

The following commands are useful for monitoring wideband cable modem:

- show cable modem wideband
- show cable modem summary

Many other **show cable** commands display information on wideband cable modems if a wideband cable modem or a cable interface used for a wideband cable modem is specified in the command's arguments. Some examples of these commands are:

- **show cable modem vendor**
- **show cable modem cnr**

- **show cable modem errors**
- **show cable modulation profile**
- **show interface cable privacy**

show cable modem wideband

To display information for registered and unregistered wideband cable modems, use the **show cable modem wideband** command. For example:

```
Router# show cable modem wideband

MAC Address    IP Address      I/F       MAC          Prim  WB     DSID MD-DS-SG
                                         State        Sid   Ch ID
0014.bfbe.3cc0 1.11.0.1        C5/0/1/U0 w-online(pt)  3    24     24   N/A
0016.92f0.90d6 1.11.0.4        C5/0/1/U0 w-online(pt)  5    24     272  1
0014.bfbe.3cb8 1.11.0.2        C6/0/1/U0 w-online(pt)  3    36     36   N/A
0016.92f0.90d8 1.11.0.3        C6/0/1/U0 w-online(pt)  5    36     274  1
```

With the **show cable modem wideband** command, you can specify a particular wideband cable modem by IP address or MAC address. You can also specify a set of wideband cable modems that are on a particular cable interface.
Table 5-2 describes the fields that are shown in the **show cable modem wideband** display.

Table 5-2 Descriptions for the show cable modem wideband Fields

Field	Description
MAC Address	The MAC address for the CM.
IP Address	The IP address that the DHCP server has assigned to the CM.
I/F	The cable interface providing the upstream for this CM.
MAC State	The current state of the MAC layer. For information on MAC states, see the **show cable modem wideband** command in the *Cisco Broadband Cable Command Reference Guide*.
Prim SID	The primary SID assigned to this CM.
WB Ch ID	The identifier of the primary wideband channel.
DSID	The Downstream Service Identifier.
MD-DS-SG	The MAC Domain Downstream Service Group, the downstream channels of a single MAC domain that reach the cable modem.

If you specify **show cable modem wideband registered-traditional-docsis,** the command displays wideband-capable modems that are registered as DOCSIS 1.X or DOCSIS 2.0 modems.

show cable modem summary

To display summary information for cable modems including modems registered as wideband cable modems, use the **show cable modem summary** command.

```
Router# show cable modem summary
Interface                    Cable Modem                    Description
          Total   Reg   Unreg   Offline   Wideband   initRC   initD   initIO   initO
C5/0/1/U0   2       2     0       0         2          0        0       0        0
C6/0/1/U0   2       2     0       0         2          0        0       0        0
```

```
Router#
```

The following example displays summary information and totals for the set of modems on a range of cable interfaces (in this example, cable 5/1/1 to cable 5/1/2).

```
Router# show cable modem summary c5/1/1 c5/1/2 total

Interface                        Cable Modem                    Description
            Total Reg   Unreg Offline Wideband initRC initD initIO initO
C5/1/1/U0   84    84    0     0       84       0      0     0      0
C5/1/1/U1   84    84    0     0       83       0      0     0      0
C5/1/1/U2   83    83    0     0       83       0      0     0      0
C5/1/1/U3   83    83    0     0       83       0      0     0      0
C5/1/2/U0   84    84    0     0       84       0      0     0      0
C5/1/2/U1   84    84    0     0       84       0      0     0      0
C5/1/2/U2   83    83    0     0       83       0      0     0      0
C5/1/2/U3   83    83    0     0       83       0      0     0      0

Total:      668   668   0     0       667      0      0     0      0

Router#
```

Troubleshooting Wideband Components

This section provides an introduction to troubleshooting the wideband components of the Cisco Cable Wideband Solution:

The following Cisco cable documents provide useful information on troubleshooting the non-wideband components of the uBR10012 router:

- *Cisco uBR10012 Universal Broadband Router Troubleshooting Guide*
- "Troubleshooting the System" chapter in the *Cisco uBR10012 Universal Broadband Router Software Configuration Guide*
- *Online Offline Diagnostics—Field Diagnostics on Cisco uBR10012 Router User's Guide*

For information on troubleshooting non-Cisco components (such as edge QAM devices) used in the Cisco Cable Wideband Solution, see the vendor documentation for the device.

Troubleshooting Wideband SIPs and Wideband SPAs

This section describes troubleshooting techniques for a Wideband SIP or Wideband SPA. It includes the following sections:

Performing Basic Troubleshooting on a Wideband SIP and Wideband SPA

To perform basic troubleshooting on a Wideband SIP and Wideband SPA, complete the following steps:

	Action	More Information or Example

Step 1	Use the **show diag** command to check that a Wideband SIP is powered on.	`Router# show diag 1/0`
		
		`Slot/Subslot 1/0:`
		`  2jacket-1 card, 0 ports`
		`  Card is full slot size`
		`  Card is analyzed`
		`  Card detected 0:3:16 ago`
		`Card uptime 0 days, 0 hours, 3 minutes, 17 seconds`
		`...`
		
		If **show diag** displays output, the Wideband SIP is powered on. If **show diag** displays no output, the Wideband SIP is not powered on.

Step 2	Check that the Wideband SIP's FAIL LED is not on.	The FAIL LED is turned on by default and turned off by software after basic board functionality has been verified. If the SIP's FAIL LED remains on, the SIP has failed to initialize or has encountered an error.

Step 3	Use the **show hw-module bay oir** command to check that a Wideband SPA is powered on.	`Router# show hw-module bay 1/0/0 oir`
		
		`Module  Model  Operational Status`
		`bay 1/0/0  SPA-24XDS-SFP  ok`
		
		• If the Operational Status is "ok", the Wideband SPA is powered on and operational.
		• If the Operational Status is "admin down", the Wideband SPA is not powered on.

Step 4	Check that the Wideband SPA's STATUS LED is lighted green.	• If the STATUS LED is green, the SPA is ready and operational. • If the STATUS LED is amber, SPA power is on and good, and the SPA is being configured. • If the STATUS LED is off, SPA power is off.
Step 5	If cables are connected to one or both of the SPA's Gigabit Ethernet port SFPs and the links for these should be up, check that the Wideband SPA's two A/L (Active Loopback) LEDs are lighted green.	• If the A/L LED is green, the port is enabled and the link is up. • If the A/L LED is amber, the port is enabled and the link is down. • If the A/L LED is off, the port is not enabled.

Verifying That a Wideband SPA's Active Gigabit Ethernet Port Is Up

The Gigabit Ethernet ports on a Wideband SPA are not considered standard user-configurable interfaces and do not appear in the output of the **show interfaces** command. The Wideband SPA is a controller with one active and one redundant Gigabit Ethernet port. The **show controller modular-cable** command displays information about the SPA, its Gigabit Ethernet active port, installed Small Form-Factor Pluggable (SFP) modules, and so on.

The following example provides sample **show controller modular-cable** output for the Wideband SPA located in slot 1, subslot 0, bay 0 of a Cisco uBR10012 router.

```
Router# show controller modular-cable 1/0/0 brief

SPA 0 is present
status LED: [green]
Host 12V is enabled and is okay.
Power has been enabled to the SPA.
SPA reports power enabled and okay.
SPA reports it is okay and is NOT held in reset.

Gigabit Ethernet Port Selected : Port 1
Receive Interface              : In Reset
Receive Interface              : Disabled
Transmit Interface             : Out of Reset
Transmit Interface             : Enabled
Primary Receive Clock          : Disabled
Backup Receive Clock           : Disabled
SFP [Port 0] : 1000BASE-SX Present
 Tx Enabled , LOS Detected , TxFault Not Detected
 Link Status [Port 0] : DOWN

SFP [Port 1] : 1000BASE-T Present
 Tx Enabled , LOS Not Detected , TxFault Not Detected
 Link Status [Port 1] : UP
...
```

In the preceding output, notice the following:

- The Gigabit Ethernet Port Selected field indicates the active Gigabit Ethernet port.
- For the active Gigabit Ethernet port, the SFP [Port 1] field indicates the type of SFP that is present.
- For the active Gigabit Ethernet port, the Link Status [Port 1] field indicates whether the link is up.

The Cisco Wideband SPA transmits data in a unidirectional manner only and does not receive data from devices connected to its active Gigabit Ethernet port.

If the link for the active Gigabit Ethernet port is not up, check the following:

- Check that the SFP module is correctly installed and matches the SFP module in the connected device.
- Check that the cables to the Wideband SPA ports are correctly connected to a powered-on device.
- Check that the cables to the Wideband SPA ports are not bent or damaged.
- Check that a hardware failure has not occurred. For information, see the "Performing Basic Troubleshooting on a Wideband SIP and Wideband SPA" section on page 5-13.

Use the **show controller modular-cable** command with the **sfp** keyword to get more detailed information on the SFP modules installed in a Wideband SPA's Gigabit Ethernet ports.

Verifying That a Wideband SPA Is Correctly Configured for SPA-to-EQAM Communications

If a Wideband SPA is unable to communicate with an edge QAM device, check that the RF channels configured with the **rf-channel** command match the values required by the edge QAM device. You can use the **show hw-module bay** command to see the values that have been configured for an RF channel. For example:

```
Router# show hw-module bay 1/0/0 config rf-channel 0 verbose

SPA                                 : Wideband-Cable 1/0/0
RF channel number                   : 0
Frequency                           : 699000000 Hz
Modulation                          : 64qam
Annex                               : B
IP address of next hop              : 192.168.200.30
MAC address of EQAM                 : 000c.3033.2cbf
UDP port number                     : 49152
EQAM headroom                       : 0
```

Check that the following values are correct and match what is configured on the edge QAM device:

- Frequency—The center frequency used for this RF channel.
- IP address of next hop—The IP address of the edge QAM device for this RF channel.
- MAC address—The MAC address of the next-hop or edge QAM device for this RF channel.
- UDP port—The UDP port number for the QAM output port for this RF channel.

If any of the above values do not match what is present on the edge QAM device, the Wideband SPA will not be able to successfully communicate with that device.

On the uBR10012 router, RF channels are configured with the **rf-channel** command. The values on the edge QAM are device-specific and are typically configured when setting up the edge QAM device.

Verifying That a Wideband SPA Is Able to Communicate with the Edge QAM Device

To verify that a Wideband SPA that has been correctly configured for wideband operations is communicating with the edge QAM device, use the **show hw-module bay** command with the **counters** and **rf-channel** keywords. In the following example, only RF channels 0 to 3 on the Wideband SPA are transmitting MPEG packets.

```
Router# show hw-module bay 1/0/0 counters rf-channel

SPA      RF channel   MPEG packets tx
1/0/0    0            3703146
1/0/0    1            3636531
1/0/0    2            3589760
1/0/0    3            3549859
1/0/0    4            0
1/0/0    5            0
1/0/0    6            0
1/0/0    7            0
1/0/0    8            0
1/0/0    9            0
1/0/0    10           0
1/0/0    11           0
1/0/0    12           0
1/0/0    13           0
1/0/0    14           0
1/0/0    15           0
1/0/0    16           0
1/0/0    17           0
```

```
1/0/0    18          0
1/0/0    19          0
1/0/0    20          0
1/0/0    21          0
1/0/0    22          0
1/0/0    23          0
```

Troubleshooting Wideband Channels

This section describes troubleshooting techniques for wideband channels. It includes the following sections:

- Verifying That a Wideband Channel is Up and Is Transmitting Packets
- Verifying That a Wideband Channel is Configured Correctly

For information on configuring wideband channels, see the *Cisco uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide*.

Verifying That a Wideband Channel is Up and Is Transmitting Packets

To verify that a wideband channel is up and transmitting packets, use the **show interface wideband-cable** command and examine the first line of output and the packets output field:

```
Router# show interface wideband-cable 1/0/0:1

Wideband-Cable1/0/0:1 is up, line protocol is up
  Hardware is Wideband CMTS Cable interface, address is 0012.001a.8897 (bia
0012.001a.8897)
  MTU 1500 bytes, BW 74730 Kbit, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation MCNS, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output 00:00:09, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  30 second input rate 0 bits/sec, 0 packets/sec
  30 second output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     24224 packets output, 1222002 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

For information on what criteria are used to determine whether a wideband channel and its associated line protocol are up, see the "show interface wideband-cable" section on page 5-6.

Verifying That a Wideband Channel is Configured Correctly

To verify whether a wideband channel is configured correctly, use the **show hw-module bay** command with the **wideband-channel** keyword and the **association**, **config**, or **mapping** keywords. The following examples show the output for **association** keyword:

```
Router# show hw-module bay 1/0/0 association wideband-channel 0

WB                      BG    Bundle  NB          NB chan  Reserved  Avail
channel                 ID    num     channel     ID       CIR       CIR
Wideband-Cable1/0/0:0   24    123     Cable5/0/1  120      0         0
```

In the preceding output, the Bundle num field indicates the virtual bundle interface to which the wideband channel belongs. For a description of each field in the preceding output, see the "show hw-module bay" section on page 5-7.

The wideband channel and the primary downstream channel (NB channel) must be members of the same virtual bundle interface. The CMTS running configuration file shows the virtual bundle (cable bundle) for the primary downstream channel (Cable5/0/1):

```
interface Cable5/0/1
 no ip address
 load-interval 30
 no cable packet-cache
 cable bundle 123
 cable downstream channel-id 120
...
```

The **downstream modular-cable rf-channel** command specifies the RF channels that are available for wideband channels on a fiber node. If a wideband channel attempts to use an RF channel that has not been made available for use on the fiber node, a misconfiguration error occurs. In this case, the **show hw-module bay** command displays the following error message:

```
Router# show hw-module bay 1/0/0 association wideband-channel

WB                      BG    Bundle  NB          NB chan  Reserved  Avail
channel                 ID    num     channel     ID       CIR       CIR
Wideband-Cable1/0/0:0   RF channel mismatch with Fiber Node 1
```

The following example shows the **show hw-module bay** output for the **config** keyword:

```
Router# show  hw-module bay 1/0/0 config wideband-channel

WB                      BG    Bundle  WB Host       Primary
channel                 ID    num     Slot/Subslot  BG
Wideband-Cable1/0/0:0   24    123     5/0           Yes
Wideband-Cable1/0/0:1   25    123     5/0           Yes
Wideband-Cable1/0/0:2   26    123     5/0           Yes
Wideband-Cable1/0/0:3   27    123     5/0           Yes
Wideband-Cable1/0/0:4   28    123     5/0           Yes
Wideband-Cable1/0/0:5   29    123     5/0           Yes
Wideband-Cable1/0/0:6   30    123     5/0           Yes
Wideband-Cable1/0/0:7   31    123     5/0           Yes
Wideband-Cable1/0/0:8   32    0       5/0           Yes
Wideband-Cable1/0/0:9   33    0       5/0           Yes
Wideband-Cable1/0/0:10  34    0       5/0           Yes
Wideband-Cable1/0/0:11  35    0       5/0           Yes
```

In the preceding output, each wideband channel that will be used should be configured as a member of a virtual bundle interface. Channels 8 through 11 are not members of a virtual bundle interface.

The following example shows the **show hw-module bay** output for the **mapping** keyword:

```
Router# show hw-module bay 1/0/0 mapping wideband-channel

SPA       WB        RF          BW %
          channel   channel
1/0/0     0         0           100
                    1           100
1/0/0     1         2           100
                    3           100
1/0/0     2         4           100
                    5           100
1/0/0     3         6           100
                    7           100
1/0/0     4         8           100
                    9           100
1/0/0     5         10          100
                    11          100
1/0/0     6         12          100
                    13          100
1/0/0     7         14          100
                    15          100
1/0/0     8         16          100
                    17          100
1/0/0     9         18          100
                    19          100
1/0/0     10        20          100
                    21          100
1/0/0     11        22          100
                    23          100
```

A channel-bonded wideband channel is associated with at least two RF channels depending on the wideband channel's configuration. The **cable rf-channel** command associates an RF channel with a wideband channel. The bandwidth percent (BW %) of each RF channel used for the wideband channel is 100 percent by default but is configurable with the **cable rf-channel** command.

Troubleshooting Wideband Cable Modems

This section describes troubleshooting techniques for wideband cable modems. It includes the following sections:

Pinging a Wideband Cable Modem

To determine whether a wideband cable modem or any DOCSIS cable CPE device is reachable from the CMTS at the DOCSIS MAC layer, use the **ping docsis** command with either a MAC address or IP address. For example:

```
Router# ping docsis 1.11.0.5

Queueing 5 MAC-layer station maintenance intervals, timeout is 25 msec:
!!!!!
Success rate is 100 percent (5/5)
```

The **ping docsis** command uses 1/64—the bandwidth of IP ping—and works with cable modems that have not yet acquired an IP address. This allows cable operators to ping cable modems that are unable to complete registration, that have internal bugs, or that are unresponsive due to a crash.

The **ping docsis** command with the **verbose** keyword includes a real-time view and plot of requested power adjustments, frequency, timing offset adjustments, and a measure of optimal headend reception power.

```
Router# ping docsis 1.11.0.5 verbose

Queueing 5 MAC-layer station maintenance intervals, timeout is 25 msec:
Reply from 0014.bfbe.3e3c: 46 ms, tadj=1, padj=0, fadj=34
Reply from 0014.bfbe.3e3c: 46 ms, tadj=0, padj=0, fadj=26
Reply from 0014.bfbe.3e3c: 50 ms, tadj=0, padj=0, fadj=29
Reply from 0014.bfbe.3e3c: 50 ms, tadj=1, padj=0, fadj=29
Reply from 0014.bfbe.3e3c: 50 ms, tadj=-1, padj=0, fadj=39

Success rate is 100 percent (5/5)
```

For more information on the **ping docsis** command, see the *Cisco Broadband Cable Command Reference Guide*.

Verifying That a Wideband-Capable Cable Modem is Registered as a Wideband Modem

To verify that a wideband-capable cable modem is registered as a wideband modem, use the **show cable modem** command. In the following example, the MAC address of the wideband cable modem is specified.

```
Router# show cable modem 0014.bfbe.3e70

MAC Address    IP Address      I/F       MAC          Prim RxPwr  Timing Num BPI
                                         State        Sid  (dBmv) Offset CPE Enb
0014.bfbe.3e70 1.11.0.3        C5/0/1/U0 w-online(pt) 1     0.00  1231    0   Y
```

If a wideband-capable cable modem is registered as a wideband modem, the MAC State field will have one of the w-online values (wideband-online), such as w-online(pt) in the preceding example. For descriptions of the complete set of MAC state values, see the **show cable modem** command in the *Cisco Broadband Cable Command Reference Guide*.

A wideband-capable modem may also register as a DOCSIS 2.0 modem (for example, if a wideband channel is not available). In this case, the MAC State field displayed by **show cable modem** will not have one of the w-online values.

To determine the set of wideband-capable cable modems that have registered as wideband modems on the CMTS, use the **show cable modem wideband** command.

```
Router# show cable modem wideband

MAC Address    IP Address      I/F       MAC            Prim  BG  DSID  MD-DS-SG
                                         State          Sid   ID
0014.bfbe.3e70 1.11.0.3        C5/0/1/U0 w-online(pt)   1     24  24    N/A
0014.bfbe.3e3c 1.11.0.4        C5/0/1/U0 w-online(pt)   2     24  24    N/A
0016.92fb.5742 1.11.0.6        C5/0/1/U0 w-online(pt)   3     24  256   1
0016.92fb.580e 1.11.0.7        C5/0/1/U0 w-online(pt)   4     24  264   1
0014.bfbe.3eaa 1.11.0.2        C6/0/1/U0 w-online(pt)   7     36  36    N/A
0016.92fb.57f8 1.11.0.5        C6/0/1/U0 w-online(pt)   8     36  298   1
0016.92fb.57f4 1.11.0.8        C6/0/1/U0 w-online(pt)   9     36  306   1
```

To determine the set of wideband-capable cable modems that have registered as DOCSIS 2.0 modems on the CMTS, use the **show cable modem wideband** command with the **registered-traditional-docsis** keyword.

Verifying Other Information for Wideband Cable Modems

To verify other information related to wideband cable modems, use the **show** commands that display information relevant to all cable modems:

- **show cable modem access-group**—Displays information about the access group for each CM.
- **show cable modem classifiers**—Displays information about the classifiers being used for each CM.
- **show cable modem cnr**—Displays carrier-to-noise ratio (CNR) information for CMs that are using cable interface line cards with hardware spectrum-management capabilities.
- **show cable modem connectivity**—Displays connectivity information for each CM.
- **show cable modem counters**—Displays traffic counters for each CM.
- **show cable modem cpe**—Displays information about the CPE devices using each CM.show cable modem errors—Displays packet error information for each CM.
- **show cable modem flap**—Displays flap-list information for each CM.
- **show cable modem mac**—Displays MAC-layer information for each CM.
- **show cable modem offline**—Lists the offline CMs.
- **show cable modem maintenance**—Displays information about the Station Maintenance errors for each CM.
- **show cable modem offline**—Lists the offline CMs.
- **show cable modem phy**—Displays the PHY layer information for each CM.
- **show cable modem qos**—Displays the quality of service (QoS) information for each CM.
- **show cable modem registered**—Lists the registered CMs.
- **show cable modem remote-query**—Displays information collected by the remote-query feature.
- **show cable modem rogue**—Displays a list of cable modems that have been marked, locked, or rejected because they failed the dynamic shared-secret authentication checks.
- **show cable modem summary**—Displays summary information about the CMs on each cable interface.
- **show cable modem unregistered**—Lists the unregistered CMs.
- **show cable modem vendor**—Displays vendor names and identifies for each CM.

For information on the preceding commands, see the *Cisco Broadband Cable Command Reference Guide.*

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