

Cisco DOCSIS 3.0 Downstream Solution Components

This chapter describes the components of the Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, and contains the following topics:

- [Base CMTS Components, page 2-1](#)
- [Wideband CMTS Components, page 2-8](#)
- [Wideband Cable Modems, page 2-13](#)
- [Wideband CMTS Redundancy and Resiliency, page 2-15](#)
- [Where to Find Information on Solution Hardware Components, page 2-18](#)

Cisco DOCSIS 3.0 Downstream Solution 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 Cisco uBR10012 base system is less expensive than adding additional chassis. This Cisco DOCSIS 3.0 Downstream Solution add-on strategy reduces both capital expenditure and operational expenses.

Base CMTS Components

For the Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, 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 DOCSIS 3.0 Downstream Solution uses the modular CMTS (M-CMTS) architecture with an external DTI server and 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 DOCSIS Timing and Control Cards (DTCC)	3	Four Half-Height Gigabit Ethernet line cards
2	One Wideband SIP with two Wideband SPAs	4	Eight Cisco uBR10-MC5X20S/U/H or Cisco uBR10-MC5X20U-D cable interface line cards

Figure 2-2 shows a fully loaded Cisco 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
DOCSIS Timing and Control Card (DTCC) Part number: UBR10-DTCC=	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		
Cisco uBR10-MC5X20S/U/H or Cisco uBR10-MC5X20U-D cable interface line card Part number: uBR10-MC5X20S uBR10-MC5X20U uBR10-MC5X20H uBR10-MC5X20U-D	1	At least 2 ¹
Half-Height Gigabit Ethernet (HHGE) network uplink line card Part number: ESR-HH-1GE	1	At least 2 ¹
Slot splitter card (One is required for each two HHGE line cards.)	1	Varies ¹

1. 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 Cisco uBR10012 router. The Cisco Gigabit Ethernet line card is not recommended as a Cisco uBR10012 base system component for wideband cable because only two full-height Gigabit Ethernet line cards can be installed in the chassis. The Cisco uBR10012 chassis supports 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 Cisco 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 Cisco uBR10-MC5X20U-D Cable Interface Line Cards

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

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



The Cisco uBR-MC5X20S/U/H and Cisco uBR10-MC5X20U-D cable interface line cards can be used for a standard DOCSIS 1.x/2.0 or for a Cisco DOCSIS 3.0 Downstream Solution 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 or for the Cisco DOCSIS 3.0 Downstream Solution, 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 or DOCSIS 3.0 downstream solution, 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 line 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.

The wideband channel's downstream data traffic uses the Cisco Wideband SPA and an external edge QAM device. See [Chapter 3, “Cisco DOCSIS 3.0 Downstream Solution 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 line 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 line 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 Cisco 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 Cisco 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 HHGE 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 LED (green)
3	Receive Packet LED (green)	6	Transmit Packet LED (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 3/0 or slot 4/0 on the Cisco uBR10012 router. Each slot splitter can hold two HHGE line cards. Therefore, the Cisco uBR10012 base system with two slot splitters supports up to four HHGE line 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 operates on ordinary multimode fiber optic link spans of up to 1,805 feet/550 meters in length.
- 1000BASE-LX/LH SFP—The SFP-GE-L, operates on ordinary single-mode fiber optic link spans of up to 32,808 feet/10,000 meters in length.
- 1000BASE-ZX SFP—The GLC-ZX-SM, 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.
- 1000BASE-T SFP—The SFP-GE-T provides full-duplex Gigabit Ethernet connectivity to high-end workstations and between wiring closets over an existing copper network infrastructure. The SFP-GE-T maximum cabling distance is 328 feet (100 m).

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](#)
- [DOCSIS Timing Interface Server, page 2-12](#)
- [External Edge QAM Device, page 2-11](#)

For information on the wideband CMTS functionality, see the “[Modular CMTS](#)” section on [page 3-2](#).

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 ¹

1. 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 Cisco 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 Cisco uBR10012 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 DOCSIS 3.0 downstream support 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 32 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.

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 (ports 0 and 1) is up, the port that is discovered first as up becomes the active port (forwarding traffic), and the other port 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 the 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 Gigabit Ethernet ports. With the Cisco IOS CLI, the Wideband SPA 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.

The two Gigabit Ethernet ports on the Wideband SPA use small form-factor pluggable (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
SFP-GE-T	1000BASE-T-SFP pluggable transceiver	Cisco 1000BASE-T SFP, pluggable transceiver module, 100-m on Category 5 (Cat5), Category 5e (Cat 5e) and Category 6 (Cat 6) cable.
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 Harmonic NSG 9000 edge QAM device, which has up to 72 QAM channels, has been tested for interoperability with other Cisco DOCSIS 3.0 Downstream Solution, Release 2.0 components.

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 at full rate and up to 24 RF channels at less than full rate.
 - For all other cases, each Wideband SPA supports 24 RF channels.
- The number of output QAM channels on the EQAM device.

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. The Harmonic NSG 9000 edge QAM device has 72 QAM RF outputs and therefore the deployment of a single Harmonic NSG 9000 edge QAM device will meet the requirement of two Wideband SPAs.

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.

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 Harmonic NSG 9000 has three independent Gigabit Ethernet input interfaces that use small form-factor pluggable (SFP) modules for fiber-optic and copper links. The Harmonic NSG 9000 edge QAM device is DOCSIS 3.0-compliant.

The Harmonic NSG 9000 edge QAM device provides scalable support for 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 four adjacent QAM channels (three channels in Annex A).

Figure 2-9 shows the Harmonic NSG 9000 Edge QAM device.

Figure 2-9 Harmonic NSG 9000 Edge QAM Device

The Harmonic NSG 9000 edge QAM device is housed in a 2-rack unit 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 Harmonic NSG 9000 edge QAM device is available at:

http://www.harmonicinc.com/view_product.cfm?id=327

Gigabit Ethernet Switch (Optional)

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

DOCSIS Timing Interface Server

The DOCSIS Timing Interface (DTI) server provides DOCSIS clock generation and can act as a standalone module or lock to a GPS server or a network clock. It provides power and clock-card redundancy and ensures that the modular CMTS core, edge QAM and upstream are synchronized to nanosecond levels to support the existing DOCSIS requirements for frequency and time stamps that existed in the traditional CMTS. Additionally, the modular CMTS core is synchronized to the edge QAM to schedule, correct and insert MPEG time stamps for video. Refer to www.symmetricom.com for additional information on Symmetricom DTI server.

The following configurations are required for a reliable and scalable DTI-server solution:

- The M-CMTS devices should have two DTI ports, where one port serves as a backup during cable restructuring or a cable failure.
- The DTI servers, power supplies and clock cards must have internal redundancy. This ensures that the DTI clients are not forced to switch or do not fail if only one port is used.
- The DTI server must support multiple configurations, such as, optional power supply, clock card, GPS and network time protocol (NTP) redundancies.

Symmetricom TimeCreator 1000

The Symmetricom TimeCreator 1000 DTI server delivers a precise time and frequency synchronization between the modular CMTS and the edge QAM devices. The Symmetricom TimeCreator 1000 is a DOCSIS-compliant Timing Interface Server with optional GPS traceability, redundant clock cards, redundant power supplies and an NTP server option.

Figure 2-10 shows the Symmetricom TimeCreator 1000 DTI Server.

Figure 2-10 Symmetricom TimeCreator 1000 DTI Server



The Symmetricom TimeCreator 1000 integrated DOCSIS Timing Interface Server capabilities ensure that the M-CMTS core, EQAM and upstream are synchronized to nanosecond levels to support the existing DOCSIS requirements for frequency and time stamps that existed in traditional CMTS. With the Symmetricom TimeCreator 1000 in an M-CMTS architecture, a cable modem receives its synchronization from the EQAM so that it is synchronized to other cable modems to properly transmit to the upstream burst receiver. Additionally, the M-CMTS core is synchronized to the EQAM to schedule, correct and insert MPEG time stamps for video.

More detailed information for the Symmetricom TimeCreator 1000 is available at <http://ngn.symmetricom.com/products/cable/timecreator1000.asp>.

Wideband Cable Modems

The Cisco DOCSIS 3.0 Downstream Channel, Release 2.0, supports the following wideband cable modems:

- [Linksys WCM300 Wideband Cable Modem, page 2-13](#)
- [Scientific Atlanta DPC2505 and EPC2505 Wideband Cable Modems, page 2-14](#)

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 2-11) support the acquisition of up to three wideband (bonded) channels: one primary bonded channel and two secondary bonded channels.



Note

Cisco IOS Release 12.3(21a)BC3 or a later 12.3BC 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 solution.

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 wideband cable modem uses one or more bonded RF channels. For wideband, the Linksys WCM300 uses a primary downstream channel from the SPA to carry MAC management and signaling messages.

Figure 2-11 shows the Linksys WCM300 Wideband cable modem.

Figure 2-11 Linksys WCM300 Wideband Cable Modem

The Linksys WCM300 is DOCSIS 2.0-compatible and can be used in the DOCSIS 2.0 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 support 64-QAM and 256-QAM.

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/ps8426/tsd_products_support_series_home.html

Scientific Atlanta DPC2505 and EPC2505 Wideband Cable Modems

When used with the Cisco uBR10012 CMTS, the Scientific Atlanta DPC2505 and EPC2505 (for EuroDOCSIS) wideband cable modems support the receiving of one wideband channel, which consists of up to three bonded downstream RF channels from the SPA at 6 MHz per channel or at 8 MHz per channel. One of the RF channels from the Wideband SPA serves as the primary downstream channel.

The Scientific Atlanta DPC2505 is DOCSIS 3.0-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 2-12 shows the Scientific Atlanta DPC2505 cable modem.

Figure 2-12 Scientific Atlanta DPC2505 Cable Modem

The Scientific Atlanta DPC2505 and EPC2505 wideband cable modems have an F-type 75-ohm connector for a cable network attachment and two data ports: a Gigabit Ethernet port with Autonegotiate and Auto-MDIX, and a USB 2.0 port.

The Scientific Atlanta DPC2505 and EPC2505 also feature front-panel LEDs to provide visual feedback of real-time data transmission and operational status. The Scientific Atlanta 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).

Wideband CMTS Redundancy and Resiliency

The Cisco uBR10012 wideband CMTS and related hardware and software provide redundancy and resiliency to the Cisco DOCSIS 3.0 Downstream 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 2-16](#)
- [Cisco uBR10-MC5X20 Line Card Redundancy, page 2-17](#)
- [Wideband SPA Redundancy and Resiliency, page 2-17](#)
- [Edge QAM Redundancy, page 2-18](#)

[Table 2-5](#) 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 2-5](#) can be replaced without interrupting system operations as long as redundant components are correctly installed and configured before the component failure occurs.

Table 2-5 *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 (RPR+) feature and DOCSIS Stateful Switchover (DSSO) 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 DOCSIS Timing and Control Cards (DTCC)	The two DTCCs 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.

Table 2-5 Cisco uBR 10012 Base System Redundancy and Resiliency

Modular CMTS Component	Redundancy and Resiliency Summary
Redundant Half-Height Gigabit Ethernet (HHGE) line cards	Multiple HHGE line cards to support connectivity to multiple destinations and to provide network layer redundancy.
Cisco uBR10-MC5X20S/U/H and Cisco 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 Cisco uBR10012 router 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 come 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 PRE 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 stay online. The MAC state for the wideband cable modem remains 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 (DSSO) 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 does 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*.

Cisco uBR10-MC5X20 Line Card Redundancy

The Cisco uBR10012 router supports N+1 Redundancy on the cable interface line cards including the Cisco uBR10-MC5X20S/U/H and Cisco uBR10-MC5X20U-D cable interface 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. Upon switchover, N+1 Redundancy uses Hot Standby Connection-to-Connection Protocol (HCCP) to synchronize the configurations and current status between Working interfaces and the Protect interfaces. This makes the configuration of both easier and switchover times faster.

A single Cisco uBR10012 CMTS can support up to eight Cisco uBR10-MC5X20S/U/H and Cisco 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 Protect cable interface line card supports from one to seven Working cable interface line cards in the same chassis.



Note

Both 7+1 Redundancy and N+1 Redundancy switchover are supported *only for cable modems connected as DOCSIS 1.x/2.0 and DOCSIS 3.0 modems*. During 7+1 Redundancy and N+1 Redundancy switchover, cable modems that are connected in wideband mode using the failed cable interface line card lose connectivity. Manual intervention (for example, use of the **clear cable modem wideband reset** command) may be required to bring wideband cable modems wideband-online mode again.

For more information on N+1 redundancy for Cisco uBR10012 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 is up, port 0 comes up as the active port and port 1 will be the redundant port. If the link state of port 0 is not up, port 1 comes up as the active port.

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

For Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, if a Gigabit Ethernet link from the Wideband SPA to the edge QAM device fails, automatic failover to a redundant link is not supported.

Wideband Channel Resiliency

If a wideband channel fails, the wideband cable modem goes offline and reregisters:

- 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 DOCSIS 1.x/2.0 mode.

Edge QAM Redundancy

For information on redundancy for the Harmonic NSG 9000, see the vendor documentation for that device. This section describes one mechanism for redundancy that is available with Harmonic NSG 9000.

Edge QAM Redundant Gigabit Ethernet Ports

The Harmonic NSG 9000 has redundant Gigabit Ethernet ports that are used to receive downstream traffic from the Wideband SPA. If the link state of the Wideband SPA's active Gigabit Ethernet port goes down, the redundant link from the Wideband SPA to the edge QAM device becomes the active link. On the CMTS, the **show controllers modular-cable** command shows the current state of the Wideband SPA Gigabit Ethernet ports, which connect to the EQAM device.

Where to Find Information on Solution Hardware Components

Table 2-6 provides a list of the hardware installation documents that are most relevant to the Cisco DOCSIS 3.0 Downstream Solution components. The complete list of Cisco uBR10012 hardware installation and upgrade guides is 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/en/US/docs/cable/cmts/ubr10012/release/notes/12_3bc/ubr10k_123bc_rn.html

Table 2-6 Cisco Hardware Components: Where to Find More Information

Solution Component	Where to Find More Information
Cisco uBR10012 chassis Performance Routing Engine 2 (PRE2) DOCSIS Timing and Control Card (DTCC) 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)
Cisco uBR10-MC5X20S/U/H and Cisco 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
Symmetricom TimeCreator 1000	Refer to the vendor documentation.
Harmonic NSG 9000 edge QAM device	Refer to the vendor documentation.
Scientific Atlanta DPC2505 and EPC2505 wideband cable modems	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 uBR10012 Universal Broadband Router SIP and SPA Software Configuration Guide

■ Where to Find Information on Solution Hardware Components