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, page 4-1
- Wideband Cable Modem Behavior, page 4-6
- Supported MIBs, page 4-10
- Known Restrictions, page 4-10

Wideband CMTS Configuration

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

- Configuring Base CMTS Components, page 4-1
- Configuring Wideband CMTS Components, page 4-2

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*

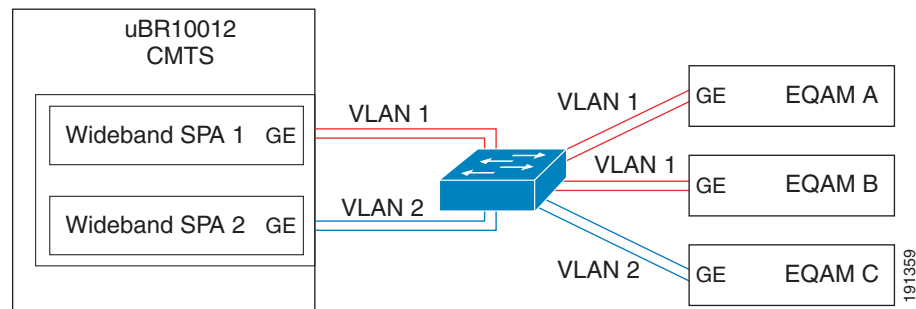| Wideband SPA RF Channel	EQAM Device			QAM Output		
	GE Input IP Address	GE Input MAC Address	QAM Output	Frequency	UDP Port Number
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19					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

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.