DOCSIS-Bridging Configuration

This chapter describes the default configuration of the Cisco uBR924 cable access router. With this configuration, the Cisco uBR924 router functions in its "plug and play" DOCSIS-bridging mode, performing as a DOCSIS-compliant two-way cable modem. Every DOCSIS-compliant cable modem provides the following minimum set of features:

- Automatically provisions and configures itself using the DOCSIS configuration file that is downloaded from a server at the headend.
- Acts as a transparent bridge to send IP data traffic between its Ethernet and cable interfaces, providing connectivity from the customer's system to the Internet backbone.
- Provides Internet connectivity to PCs or other CPE devices connected to the Cisco uBR924 router.

Note In Cisco IOS Release 12.1, Voice over IP (VoIP) traffic is automatically supported when using the DOCSIS-bridging mode. However, in Cisco IOS Release 12.0, the default "plug and play" image does not enable the Cisco uBR924 router's voice ports. To enable the voice ports, you must use a Cisco IOS image with voice support and download an appropriate Cisco IOS configuration file. See Chapter 4, "Voice over IP Configurations," for more information.

The following sections describe the configuration for "plug and play" DOCSIS bridging:

- DHCP Server Configuration, page 2-2
- DOCSIS Configuration File, page 2-3
- Cisco IOS Software Image, page 2-6
- Cisco IOS Configuration File, page 2-7
- Configuring the Attached CPE Devices, page 2-9
- Reconfiguring DOCSIS-Compliant Bridging, page 2-9

The DHCP server configuration and DOCSIS configuration file are required for every DOCSIS-compliant cable modem. The Cisco IOS image and configuration files are optional, depending on the needs of the subscribers. The remaining configurations are optional, depending on the needs of the subscribers.

The information described in this chapter applies to every Cisco uBR924 cable access router that is used in a DOCSIS-compliant network. Additional configuration steps might be needed, however, to support additional features, such as VoIP and IPSec encryption—this additional configuration is described in the other chapters in this guide.

Caution Before attempting to reconfigure the Cisco uBR924 cable access router at a subscriber site, contact your provisioning or billing system administrator to ensure remote configuration is allowed. If remote configuration is disabled, settings you make and save at the local site will not remain in effect after the Cisco uBR924 router is powered off and on. Instead, the router's settings will return to the previous configuration.

DHCP Server Configuration

The DOCSIS specification (SP-RFI-IO5-991105 or later revision) requires that a DOCSIS-compliant cable modem connect to a DHCP server at power-on or reset to establish temporary IP connectivity with the cable network. This enables the cable modem to download the additional configuration information needed to establish a permanent connection with the headend and cable network.

The DHCP server can be a CMTS with DHCP server capabilities (such as a Cisco uBR7200 series universal broadband router), or it can be a dedicated server located at the headend. The server can be configured manually for each cable modem or it can be part of an automated provisioning system such as Cisco Network Registrar (CNR).

Note The DOCSIS specification requires that every DOCSIS cable modem obtain its IP address from an authorized DHCP server during the reset or power-on provisioning process. Any IP address specified in an IOS configuration file is overwritten by the one assigned by the DHCP server. The only way to assign a static IP address to a cable modem is to configure the DHCP server so that it assigns the desired IP address on the basis of the cable modem's MAC address. However, service providers should warn subscribers that changes in the cable network's topology—due to traffic levels, growth, or changes to the cable plant and other hardware—might still require changing the subnets and IP addresses assigned to a particular cable modem.

The DHCP server provides the information shown in Table 2-1 to each cable modem. (If the modem fails to obtain any of this information, an error messsage appears. Such messages are explained in the book, *Cisco Cable CPE Error Messages*, viewable online at www.cisco.com/univercd/cc/td/doc/product/cable/cab_modm/ubcmerrs.pdf).

Table 2-1 DHCP Server Parameters

Parameter	Description
IP address for the cable modem's cable interface	This IP address typically is assigned dynamically but the service provider can also statically assign IP addresses on the basis of each modem's MAC address. **Note** When the router is in DOCSIS-bridging mode, it automatically assigns this IP address to both the cable and Ethernet interfaces. When the router is in routing mode, it assigns this IP address only to the cable interface; the IP address for the Ethernet interface must be configured separately.
IP subnet mask for the cable modem's cable interface	This subnet mask typically is used for all cable modems using the same downstream, but this depends on the setup of the CMTS network as well as subscribers' needs.
IP address for the TFTP server	This TFTP server provides the DOCSIS configuration file to the cable modem and is typically a dedicated server located at the headend.

Table 2-1 DHCP Server Parameters (continued)

Parameter	Description
IP address for the DHCP relay agent	A DHCP relay agent is required if the DHCP server is located on a different network than the IP address assigned to the cable modem's cable interface. The DHCP relay agent is also used if the DHCP server is providing IP addresses to the CPE devices connected to the cable modem and the CPE devices are on a different subnet than the cable modem.
Complete filename for the DOCSIS configuration file	This is the filename for the DOCSIS configuration file that the cable modem should download from the TFTP server.
IP address for one or more time of day (ToD) servers	The cable modem uses the ToD server to get the current date and time so that it can accurately timestamp its SNMP messages and error log entries.
One or more IP addresses for the routers that will forward IP traffic from the cable modem	Typically, the CMTS acts as the default gateway for the cable modem. **Note** Typically, the DHCP server sets the default gateway for DOCSIS cable modems. When this is done on Cisco routers, the default gateway does not appear in the Cisco IOS configuration file, to indicate that the gateway is being set dynamically by the DHCP server and should not be saved after a reset of the router. To display the default gateway, use the **show ip default-gateway** command.
One or more IP addresses for System Log (SYSLOG) servers	The cable modem can send its error log messages to the SYSLOG servers, which are optional and typically located at the headend.

After making a successful DHCP request, the cable modem contacts the ToD server to get the current date and time. It also begins the TFTP download of the DOCSIS configuration file, which is described in the next section, "DOCSIS Configuration File" section on page 2-3.

Note At this point in the registration process, the DHCP server provides an IP address only for the cable modem, not for the CPE devices it is connecting to the network. The same DHCP server can provide the IP addresses for the CPE devices after the cable modem goes online, or the cable modem itself can be configured as a DHCP server (see "Routing with DHCP Server" section on page 3-4).

DOCSIS Configuration File

The DOCSIS specification requires that a DOCSIS-compliant cable modem download a DOCSIS configuration file during its power-on or reset sequence. This file must be in the format described in the SP-RFI-IO5-991105 specification (or later revision) and must contain the information shown in Table 2-2.

Note The parameters shown in Table 2-2 are organized according to the categories used in the Cisco DOCSIS Cable Modem Configuration tool, which is available on CCO at http://www.cisco.com/support/toolkit/CableModem. (You must have an account on CCO to access this tool.)

Table 2-2 DOCSIS Configuration File Parameters

Parameter[1]	Description
Radio Frequency Parameters	
Downstream Frequency	Specifies the center frequency (in multiples of 62500 Hz) for the downstream channel to be used by the router. (This parameter does not need to be specified in the configuration file because the router will scan the downstream for available frequencies, but typically it is specified to ensure that the router conforms to the provider's channel plan.)
Upstream Channel ID	Specifies channel ID for the upstream channel to be used by the router. (This parameter does not need to be specified in the configuration file because it can be set dynamically by the CMTS during provisioning.)
Network Access Configuration	Determines whether CPE devices attached to the cable modem are allowed access to the cable network. The default is to allow access for CPE devices (which is required for normal operations).
Class of Service	
Class of Service ID	Specifies the ID for this class of service (1–16).
Maximum Downstream Rate	Specifies the maximum downstream data rate (in bits/sec) allowed for traffic associated with this class of service. (This is a limit, not a guarantee of service.)
Maximum Upstream Rate	Specifies the maximum upstream data rate (in bits/sec) allowed for traffic associated with this class of service. (This is a limit, not a guarantee of service.)
Upstream Channel Priority	Specifies the priority for upstream traffic (0–7, where 7 is highest priority).
Minimum Upstream Rate	Specifies the minimum upstream data rate (in bits/sec) that is guaranteed for traffic associated with this class of service.
Maximum Upstream Channel Burst	Specifies the maximum size of burst traffic to be allowed on this upstream channel. The size is specified in bytes, 0–65535, where 0 is no limit. If this field is set to a non-zero value, it should be set to at least 1800 so that it is greater than the maximum Ethernet frame size of 1518 plus the associated packet overhead).
Class of Service Privacy Enable	Specifies whether BPI encryption should be enabled on traffic associated with this class of service (1 enables BPI encryption, 0 disables BPI encryption).
Vendor Specific Options	
Vendor ID	The three-byte Organization Unique Identifier for the vendor, which is also usually the first three bytes of the cable modem's MAC address. This value is usually expressed as a hexadecimal number. This field should be "**00000C**" for Cisco Systems routers.
Vendor-Specific Options	Contains any arbitrary values that are defined by the manufacturer of the cable modem. The Cisco uBR924 cable access router uses this field to identify the Cisco IOS configuration file that should be downloaded (if any). Arbitrary Cisco IOS commands can also be specified in this field.
SNMP Management	
SNMP Write-Access Control and SNMP MIB Objects	Allows the service provider to set arbitrary SNMP attributes on the cable modem. For the Cisco uBR924 router, these two fields are typically used to enable SNMP management of the router because SNMP management is disabled by default. **Note** If using the Cisco DOCSIS Cable Modem Configurator tool, you can enable SNMP management by filling in the IP address for the SNMP manager. The Configurator tool then prepares the proper MIB objects to enable SNMP access.

Table 2-2 DOCSIS Configuration File Parameters (continued)

Parameter[1]	Description
Baseline Privacy Interface Configuration	
Authorize Wait Timeout	Specifies the retransmission interval, in seconds, of Authorization Request messages from the Authorize Wait state. Valid values are 2–30 seconds.
Reauthorize Wait Timeout	Specifies the retransmission interval, in seconds, of Reauthorization Request messages from the Authorize Wait state. Valid values are 2–30 seconds.
Authorization Grace Timeout	Specifies the grace period for re-authorization, in seconds. Valid values are 1–1800 seconds.
Operational Wait Timeout	Specifies the retransmission interval, in seconds, of Key Requests from the Operational Wait state. Valid values are 1–10 seconds.
Rekey Wait Timeout	Specifies the retransmission interval, in seconds, of Key Requests from the Rekey Wait state. Valid values are 1–10 seconds.
TEK Grace Time	Specifies the grace period for re-keying, in seconds. Valid values are 1–1800 seconds.
Authorize Reject Wait Timeout	Specifies how long, in seconds, a cable modem waits in the Authorize Reject Wait state after receiving an Authorization Reject. Valid values are 60–1800 seconds.
Customer Premises Equipment	
Maximum Number of CPEs	Determines the maximum number of CPE devices that can use the cable modem to connect to the cable network. The default value is 1. In bridging mode, the Cisco uBR924 router supports a maximum number of either 3 or 254 CPE devices, depending on the Cisco IOS software release being used.
CPE Ethernet MAC Address	Configures the cable modem with the MAC addresses for one or more CPE devices that are allowed to connect to the cable network. Entering values in this field is optional because the cable modem can learn the MAC addresses of CPE devices dynamically, up to the maximum allowable number. However, DOCSIS cable modems give priority to the CPE devices whose MAC addresses are in the configuration file.
Software Upgrade	
TFTP Software Server IP Address	Specifies the IP address for the TFTP server that will provide software images. This server does not necessarily have to be the same TFTP server that provided the DOCSIS configuration file.
Software Image Filename	Specifies the fully qualified path name for the software image that the cable modem should be running. If necessary, the cable modem uses TFTP to download this image from the software server.

Table 2-2 DOCSIS Configuration File Parameters (continued)

Parameter[1]	Description
Miscellaneous	
Concatenation Support	Specifies whether the cable modem supports DOCSIS 1.1 concatenation of upstream packet requests.
Use RFC2104 HMAC-MD5	Specifies the algorithm used to compute the CMTS Message Integrity Check (MIC). If yes, the HMAC-MD5 algorithm specified in RFC 2104 is used; otherwise, the algorithm specified by RFC 1321 is used. (The algorithm used must match the one used on the CMTS.) **Note** Because the RFC 1321 algorithm can be reversed, Cisco strongly recommends the use of only the more secure HMAC-MD5 algorithm.
CMTS Authentication	Specifies an authentication string to be used between the provisioning server (which creates the configuration files) and the CMTS. It allows the CMTS to authenticate the CM provisioning with a central authentication service, such as a RADIUS server. This field is typically used only for one-way cable modems that use telco-return.

1. The DOCSIS configuration file also contains fields for one-way cable modems that use telco-return, but these fields do not apply to the Cisco uBR924 router, which is a two-way cable modem.

Cisco IOS Software Image

The DOCSIS configuration file contains the filename for the software image that the Cisco uBR924 router must be running. If this filename does not match the software image that is currently installed on the router, the router must use the TFTP protocol to download the new image from the server specified in the DOCSIS configuration file.

After the new software image has been downloaded, the Cisco uBR924 router resets itself and repeats the entire power-on and provisioning process. This includes downloading the DOCSIS configuration file again. However, because the software image is stored in non-volatile Flash memory, the router does not have to download it again—the software download occurs only when the service provider specifies a new software image filename in the DOCSIS configuration file.

If the Cisco uBR924 router cannot download the new image, it retries the download, up to a maximum of 16 attempts. If the router still cannot download the image, it falls back to its previous software image and attempts to go online with that image.

The service provider can also force the Cisco uBR924 router to download new software by putting a new image filename in the DOCSIS configuration file and resetting the router. This should be done only after warning the customer that the modem will be offline for a period of several minutes.

Note Because it can take several minutes for this download to be accomplished and for the Cisco uBR924 router to repeat its power-on sequence, the desired software image can also be installed on the router at the warehouse. In this case, the DOCSIS configuration files for each router should also be updated with the proper filename.

Cisco IOS Configuration File

The DOCSIS configuration file uses the type 43 Vendor-Specific Options field to specify that the Cisco uBR924 router should download a Cisco IOS configuration file. The router's console port is automatically disabled as part of this process to prevent users at the remote site from reconfiguring the router.

Note Downloading a Cisco IOS configuration file is not usually required for plug-and-play bridging. Instead, it is normally used to configure the advanced feature sets that are described in the other chapters of this guide.

Using the Vendor-Specific Information Field

Table 2-3 shows the values that would be entered in the Vendor-Specific Information Field (VSIF) to download a Cisco IOS configuration file and automatically disable the console port.

Table 2-3 Downloading a Cisco IOS Configuration File (with console port disabled)

Field	Value
Subtype	128
Length	(number of characters in the filename)
Filename	Complete filename, including path, for the Cisco IOS configuration file on the TFTP servers specified in the DOCSIS configuration file. **Note** The Cisco IOS configuration file can contain only global configuration mode commands, not Privileged EXEC commands.

Table 2-4 shows the values that would be entered in the Vendor-Specific Information Field (VSIF) to specify a CLI command that should be executed after the Cisco uBR924 cable access router processes the DOCSIS configuration file and comes online.

Table 2-4 Specifying CLI Commands

Field	Value
Subtype	131
Length	(number of characters in the command)
CLI Command	The ASCII characters of one CLI command, as you would type it at the CLI prompt. To specify multiple commands, use this option once for each command. **Note** You can specify only global configuration mode commands, not Privileged EXEC commands, in this field.

Tip The VSIF option to include CLI commands in the DOCSIS configuration file should be used to specify a very limited number of commands for specialized applications. To perform a more substantial configuration of the router, use VSIF option 128 to download a Cisco IOS configuration file. Also see Appendix A, "Using Cisco IOS Software."

Sample Configuration for DOCSIS-Compliant Bridging

The following shows a typical Cisco IOS configuration for a Cisco uBR924 router that is operating in "plug and play" DOCSIS-compliant bridging mode.

```
version 12.1
service config
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname ubr924
!
clock timezone - 4
ip subnet-zero
no ip routing
!
voice-port 0
!
voice-port 1
!
interface Ethernet0
no ip directed-broadcast
 no ip route-cache
 bridge-group 59
 bridge-group 59 spanning-disabled
!
interface cable-modem0
 ip address dhcp
 no ip directed-broadcast
 no ip route-cache
 bridge-group 59
 bridge-group 59 spanning-disabled
!
ip classless
no ip http server
no service finger
!
!
line con 0
 transport input none
line vty 0 4
!
end
```

This configuration shows the following requirements for DOCSIS-compliant bridging:

- IP routing is disabled.
- No IP address is assigned to the cable interface; instead, the **ip address dhcp** command indicates that a DHCP server assigns an IP address to the cable interface. The Ethernet interface uses the same IP address because the router is acting as a bridge between the two interfaces, making them part of the same IP network—when the router is in DOCSIS-bridging mode, the IP addresses are automatically assigned during the provisioning process.

Configuring the Attached CPE Devices

In its "plug-and-play" bridging mode, the Cisco uBR924 router does not need any additional configuration to support the computers or other CPE devices that will access the Internet through the router's connection to the cable network. However, the PCs and CPE devices must be configured to support DHCP allocation of IP addresses.

Each computer and CPE device performs this configuration differently. For Windows 95, for example, you would open up the Network control panel, select the computer's TCP/IP Ethernet adapter, and set the IP address configuration to "Obtain an IP address automatically."

Reconfiguring DOCSIS-Compliant Bridging

To reconfigure the Cisco uBR924 router to support DOCSIS-compliant bridging after it has been configured for routing, log in to the Cisco uBR924 router, enter global configuration mode, and enter the following commands:

	Command	Purpose
Step 1	uBR924(config)#**no ip routing**	Disable IP routing on the Cisco uBR924 router.
Step 2	uBR924(config)#**int e 0**	Enter interface configuration mode for the Ethernet interface.
Step 3	uBR924(config-if)# **no ip address**	Remove the IP address from the Ethernet interface.
Step 4	uBR924(config-if)# **no ip route-cache**	Remove the high-speed switching caches for IP routing.
Step 5	uBR924(config-if)# **bridge-group** *bridge-group*	Assign the Ethernet interface to a bridge spanning group (choose an arbitrary integer from 1–63).
Step 6	uBR924(config-if)# **bridge-group** *bridge-group* **spanning-disabled**	Disable the spanning tree on the Ethernet interface.
Step 7	uBR924(config-if)# **exit**	Exit the interface configuration mode for the Ethernet interface.
Step 8	uBR924(config)# **int c 0**	Enter interface configuration mode for the cable interface.
Step 9	uBR924(config-if)# **no ip address**	Remove the IP address from the cable interface.
Step 10	uBR924(config-if)# **no keep alive**	Disable keepalive messages on the cable interface.
Step 11	uBR924(config-if)# **no ip route-cache**	Remove the high-speed switching caches for IP routing.
Step 12	uBR924(config-if)# **cable modem compliant bridge**	Enable DOCSIS-compliant bridging.
Step 13	uBR924(config-if)# **bridge-group** *bridge-group*	Assign the cable interface to the same bridge spanning group used for the Ethernet interface.
Step 14	uBR924(config-if)# **bridge-group** *bridge-group* **spanning-disabled**	Disable the spanning tree on the cable interface.
Step 15	uBR924(config-if)# **Ctrl-Z**	Return to privileged EXEC mode.
Step 16	uBR924# **copy running-config startup-config**	Save the configuration to nonvolatile RAM.
Step 17	uBR924# **show startup-config**	Display the configuration file that was just created.