Product Overview

This chapter describes the Cisco uBR924 cable access router and its interaction with the Cable Modem Termination System (CMTS)—the cable system headend equipment that provides Internet (TCP/IP) connectivity for subscribers over the cable broadband infrastructure. The chapter provides physical and functional overviews of the Cisco uBR924 cable access router and its supported operating modes.

Cisco uBR924 Cable Access Router Description

This section provides an overview of the Cisco uBR924 cable access router, its hardware, and its basic operation:

- Introduction
- Initial Power-On and Provisioning
- Data Operations
- Voice Operations

Introduction

The Cisco uBR924 cable access router functions at its most basic level as a cable modem—a modulator/demodulator that provides high-speed network access on the cable television system to residential and small office/home office (SOHO) subscribers. The router is based on the Data-Over-Cable Service Interface Specifications (DOCSIS), a standard developed with service providers to ensure that any DOCSIS-certified cable modem can interoperate with any bidirectional, DOCSIS-qualified CMTS.

Note Information about DOCSIS requirements and current specifications are available at the CableLabs web site at http://www.cablelabs.com.

In addition to providing DOCSIS connectivity, the Cisco uBR924 router can optionally provide advanced data and routing features, as well as telephone and fax services. The Cisco uBR924 router uses the cable system's existing physical plant to provide Internet and other wide area network (WAN) connectivity over the service provider's Hybrid/Fiber Coax (HFC) cable system.

The router can connect one or more computers to the Internet over the HFC cable system. Depending on the other services purchased from the service provider, subscribers can also send voice and fax traffic over the cable system, or they can use the cable system to link multiple sites into a secure private company network (Intranet). Subscribers can use the Cisco uBR924 router to create high-speed, permanent access to the Internet, without the need for telco-based services such as leased lines.

Routing and Bridging

When acting as a DOCSIS-compliant cable modem, the Cisco uBR924 router provides DOCSIS bridging for one or more PCs and other customer premises equipment (CPE). The router ships from the factory with a Cisco IOS software image stored in nonvolatile Flash memory that supports DOCSIS-compliant bridging data operations.

Based on the feature licenses your company purchased, other Cisco IOS images can be downloaded from Cisco Connection Online (CCO). These images provide additional functionality such as advanced routing capabilities, advanced security, and Voice over IP (VoIP) support.

For most residential applications that involve basic Internet access or VoIP services, the Cisco uBR924 router is configured as a bridge. For residential and SOHO applications that involve special feature sets such as the firewall features, or that include connection to an existing network at the site, the Cisco uBR924 is configured as a router.

Note Cisco uBR924 cable access routers use Cisco IOS Release 12.0(4)XI or higher images. All Cisco IOS releases that support the Cisco uBR924 router include at least one image that supports basic DOCSIS connectivity that provides high-speed Internet data access. Most Cisco IOS releases that support the Cisco uBR924 router also include additional images that support VoIP connectivity, as well as advanced feature sets such as data encryption, firewall protection, and additional router features.

The following paragraphs summarize the router's operation in both bridging and routing modes:

- Bridging—When installed and configured as a bridge, the Ethernet hub ports at the rear of the Cisco uBR924 router can be connected directly to PCs at the subscriber site in one of the following configurations:

  - When using Cisco IOS Release 12.0(4)XI or higher interim builds in bridging mode, a maximum of three PCs can be directly connected to the hub ports—the fourth hub port is unused.

  - When using Cisco IOS Release 12.0(5)T or higher images in bridging mode, four PCs can be directly connected to the hub ports.

  - When using Cisco IOS Release 12.0(5)T or higher images in bridging mode, up to 254 PCs can be connected if one of the four Ethernet hub ports is connected to a standard 10BaseT Ethernet hub, which then connects to additional computers (or hubs) at the site.

Regardless of the configuration, Cisco IOS software treats all four Ethernet hub ports as one Ethernet interface. See Figure 1-1 for a typical configuration.

Figure 1-1 Cisco uBR924 in a Bridging Configuration
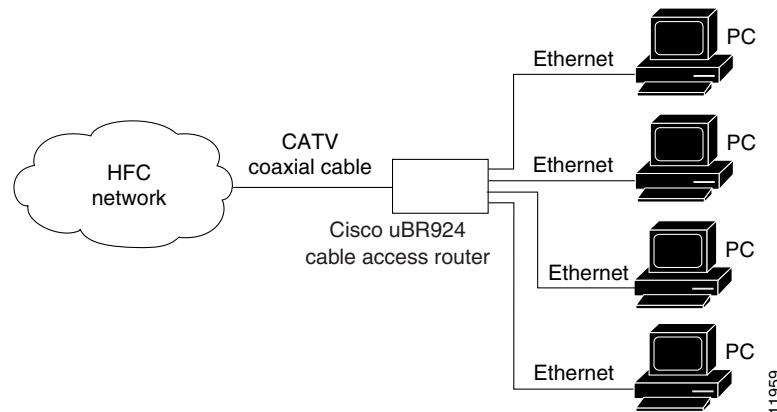
- Routing—When installed and configured as a router, the Cisco uBR924 can be connected directly to four PCs via the Ethernet hub ports at the rear of the router. One of the four Ethernet hub ports can also be connected to a standard 10BaseT Ethernet hub which then connects additional computers or Ethernet devices at the site to a local area network (LAN). (See Figure 1-2.)

Figure 1-2 Cisco uBR924 in a Routing Configuration
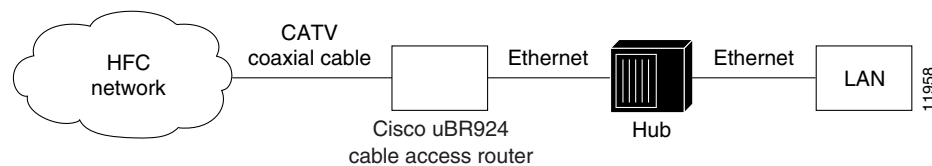
In routing mode, no maximum limitation exists. The Cisco uBR924 is configured to use the IP address of the headend router as the router's default IP gateway.

Note For better network performance, Cisco recommends a maximum limit of 16 CPE devices in either bridging or routing mode. The service provider can also set a different limit by changing the MAX CPE parameter in the DOCSIS configuration file—the default MAX CPE value is one CPE device. The MAX CPE parameter applies in both routing and bridging modes.

Upgrading the Software Image

When Cisco IOS images are updated to new releases, the service provider can download them as needed to Cisco uBR924 routers installed in the field (based on the software licenses purchased). See the release notes for the router (listed in "Related Documentation" in the Preface) for a complete list of features and Cisco IOS images that are currently supported.

Service providers can use the router's Media Access Controller (MAC) address to uniquely identify each particular router in the field. The CMTS uses this value to download the proper DOCSIS configuration file to the router before it begins operation.

The DOCSIS configuration file can also contain the name of the software image that the router should be running. If necessary, the CMTS can also download the proper software image to the router and force it to reboot using the new image.

The download of the DOCSIS configuration file usually takes only a few seconds and is done every time the Cisco uBR924 router reboots. The download of the software image can take several minutes to complete, during which time network connectivity is not available. However, the software image must be downloaded only once, until the subscriber needs to be updated with a new or updated image.

The next section, "Initial Power-On and Provisioning," explains this process. See the *Cisco uBR924 Cable Access Router Software Configuration Guide* for a description on how to download a software image and configuration file to a Cisco uBR924 router installed in the field.

Initial Power-On and Provisioning

The router ships from the Cisco factory ready to work in a DOCSIS-compliant bridging data-only mode. However, before the router can transmit traffic, the CMTS at the headend must properly provision the router as follows:

- The appropriate service must be purchased from the cable system. If certain features, such as VoIP support or IPSec data encryption, are desired, a license for the appropriate Cisco IOS software image must also be purchased.

- When the router is first brought online, the CMTS at the headend downloads a DOCSIS configuration file to the router. This file—which is a binary file that must be in the format required by the DOCSIS specification—configures the router for the appropriate level of services and sets other parameters as needed.

- At this point the router is completely configured for basic DOCSIS operations, but if additional features beyond those in the default Cisco IOS software image are desired, the DOCSIS configuration file can also specify that the router should download another Cisco IOS image from the CMTS.

- To customize the router's configuration further, the DOCSIS configuration file can also specify a Cisco IOS configuration file that the CMTS should download to the router. This second configuration file is an ASCII text file that contains the Cisco IOS commands needed to configure the router.

Note The CMTS Cisco uBR924 router downloads the DOCSIS configuration file each time it is powered on, but it downloads the Cisco IOS image (if needed) and Cisco IOS configuration file (if needed) only once when the router is initially brought online. However, a new configuration file or image can be downloaded whenever necessary, such as when the cable service offers new services or subscribers upgrade their services.

To ensure that subscribers obtain the exact services they have ordered, the Cisco uBR924 router arrives from the Cisco factory with a unique identifier (UID) that consists of a serial number and MAC address. These factory-assigned values are on a label at the bottom of the router; for convenience, these values are also in a barcode label that can be easily scanned for easy entry into the service provider's provisioning and billing system.

Using the MAC address of the router as the key, the CMTS downloads the DOCSIS configuration file and Cisco IOS image that will provide the services that this particular subscriber has purchased. Service technicians at the headend typically create a number of standard configuration files to match the range of services offered by the provider; these configuration files can be created manually or with tools provided by Cisco Systems for this purpose.

The following sections describe the initial power-on and provisioning sequence in more detail, as well as the requirements that must be met by both the router and the CMTS before provisioning can succeed.

Initial Power-On Sequence

When connected and first powered on, the Cisco uBR924 cable access router performs the following DOCSIS-mandated procedure for automatic installation and configuration:

1. The router boots the Read Only Memory (ROM) from the ROMMON partition of its Flash memory.

2. The router performs a self-test, initializes processor hardware, and boots the main operating system software—the Cisco IOS release image stored in Flash memory.

3. The router acquires a temporary downstream channel by matching the clock sync signal that is regularly sent out by the CMTS in the downstream frequency range.

4. The router then waits for an Upstream Channel Descriptor (UCD) message from the CMTS and configures itself for the upstream frequency specified in that message.

5. The router waits for the next upstream bandwidth allocation map message (MAP). These messages are regularly sent from the CMTS to find the next available shared request timeslot. The router then uses this timeslot to send a ranging request message to the CMTS, communicating the router's user ID (UID, which includes its unique MAC address), using a temporary service identifier (SID) of 0 (zero) to indicate it has not yet been allocated an upstream channel.

6. In reply to the router's ranging request, the CMTS sends a ranging response containing a temporary SID to be used for the initial router configuration and bandwidth allocation. As needed, the router adjusts its transmit power levels using the power increment value given by the CMTS in its ranging response message.

Note   At this point, the router has established connectivity with the CMTS but is not yet online. The next steps allocate permanent upstream and downstream frequencies, as well the configuration required for IP network connectivity.

7. After the next MAP message broadcast, the router uses a shared request timeslot to invoke the Dynamic Host Configuration Protocol (DHCP) to establish IP connectivity with the TCP/IP network at the headend.

8. The DHCP server—typically a dedicated server at the headend, but it could also be a CMTS such as a Cisco uBR7200 series universal broadband router—sends a response containing the router's IP address, as well as the IP addresses for the default gateway and time of day (ToD) server. It also sends the IP address for the authorized Trivial File Transfer Protocol (TFTP) server from which the router should download its DOCSIS configuration file. Depending on the particular network configuration, other information could be provided, such as the IP addresses for a syslog server or security server.

9. The router configures itself for the specified IP address and gets the current date and time from the specified ToD server.

10. Using the TFTP protocol, the router downloads the specified DOCSIS configuration file and configures itself for the appropriate parameters. The DOCSIS configuration file defines the router's operating mode such as the provisioned downstream and upstream service assignments, assigned frequencies, data rates, modulation schemes, Class of Service (CoS), type of services to support, and other parameters. Cisco provides tools to help automate the creation of configuration files.

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Caution The DOCSIS configuration file must be in the exact format given by the DOCSIS specification. An incorrect DOCSIS configuration file can cause the Cisco uBR924 router to constantly cycle offline. Such errors include: wrong downstream frequency; wrong UCD; wrong downstream Channel ID; invalid CoS; incorrect BPI privacy configurations or shared secret strings.

11. The router sends another registration request to the CMTS containing the CoS parameters given in the DOCSIS configuration file.

12. The CMTS verifies that the router is using the appropriate CoS profile and converts the temporary SID into a data SID with a service class index that points to the applicable CoS profile.

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Note Depending on the software image being run and the capabilities of the CMTS, the DOCSIS configuration file can also specify multiple CoS profiles. Each CoS profile is assigned its own SID, either dynamically or statically, depending on the capabilities of the CMTS and software image being used.

13. The router completes its secondary ranging and is then online, passing data between the cable network and the PCs and other customer premises equipment connected to the router.

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Note At this point the router is online and operational in the basic DOCSIS bridging mode ("plug and play" mode). The next step is done only if the DOCSIS configuration file specifies that the router must also download a Cisco IOS configuration file and new Cisco IOS image.

14. If the DOCSIS configuration file specifies that the router must download a secondary Cisco IOS image and a Cisco IOS configuration file, the router uses TFTP to download the image and configuration files into its local memory. It then installs the new Cisco IOS image and runs the configuration file.

Alternatively, a system administrator can manually configure the Cisco uBR924 router by giving commands at the router's CLI interface.

15. If Baseline Privacy Interface (BPI) encryption is configured and enabled on both the router and CMTS, the router and CMTS negotiate the appropriate encryption/decryption parameters. After encryption is enabled, all information sent within Ethernet packets is encrypted to prevent interception or modification by an unauthorized party.

Figure 1-3 illustrates the traffic flow during this process.

Figure 1-3   Cisco uBR924 Cable Access Router Provisioning Overview
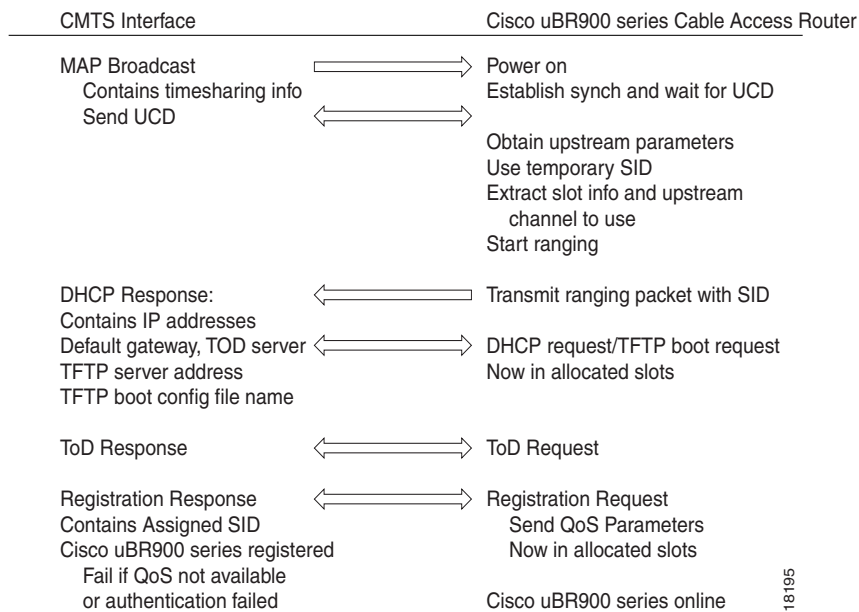
> **Note**   For more detail on the provisioning process, see the DOCSIS 1.0 Radio Frequency Interface (RFI) specification (SP-RFII01-990731 or later revision).

After the Cisco uBR924 router goes online, it sends traffic between the attached CPE devices and the network (Internet, Intranet, VoIP). The service provider typically uses DHCP to assign IP addresses to the CPE devices. The number of IP addresses each subscriber can obtain depends on the services purchased from the provider.

Provisioning Prerequisites

The following requirements must be met before a router can be provisioned:

- All required CMTS routing and network interface equipment must be installed, configured, and operational. This includes all headend routers, servers (DHCP, TFTP, and TOD), network management systems, and/or other configuration or billing systems required for your network.

- Based on the quality and capacity of your cable plant, your system administrator or network planner must have defined your network's IP address allocation plan; spectrum management plan outlining the recommended operating parameters to optimize performance; channel plan identifying the channels available to assign to specific Cisco uBR924 routers; and dial plan to match the supported VoIP protocol.

- A CMTS customer service representative must have recorded all needed subscriber information, initiated a work order, and arranged an installation date with the subscriber. For subscriber sites that support multiple telephones or fax devices on a telephone line, all wiring associated with the telephone line extension must be in place. Inside wiring must be in compliance with the country of operation to prevent degradation of service.

- The CMTS system administrator or appropriate personnel must have specified the policy parameters for the Cisco uBR924 router and all computers and other CPE devices to be supported at the subscriber site. See Cisco's Network Registrar (CNR) product documentation for more information.

- The CMTS system administrator or appropriate personnel must have defined and pushed DHCP and DOCSIS configuration files to the appropriate servers so that each router, when initialized, can transmit a DHCP request, receive its IP address, obtain its TFTP and TOD server addresses, and download its DOCSIS configuration file. Cisco IOS images and Cisco IOS configuration files must also be prepared for subscribers who are purchasing services that require new software images and advanced configurations.

Note The CMTS uses the router's unique MAC address for the cable interface to ensure that the router downloads only the file(s) appropriate for the levels of service that have been purchased.

- If DHCP is also being used to provision the IP addresses used by the CPE devices at the subscriber's site, the DHCP server must be able to respond to those requests as well.

- The CMTS system administrator must ensure appropriate databases are updated to activate and support the new subscriber account in the provisioning, billing, and/or network management systems in place for your network after each router is registered with the CMTS.

- The following files should be prepared and available on the TFTP server:

  - DOCSIS configuration file—This is required for every installation. The DOCSIS configuration file specifies the DOCSIS-mandated parameters, such as upstream and downstream frequencies, as well as optional features, such as whether to download a new software image or a Cisco IOS configuration file.

  - Cisco IOS image—If upgrading to a Cisco IOS image different from the factory default, that image must be specified in the router's DOCSIS configuration file and available on a TFTP server, which is accessible either through the serial or the cable interface.

  - Cisco IOS configuration file—Unless the network administrator at the subscriber's site is manually configuring the Cisco uBR924 router through its command-line interface, a Cisco IOS configuration file must be prepared that specifies the routing parameters required to route data between the cable and serial interfaces. This file can specify any other optional features that are desired. It must be made available on a TFTP server, which is accessible either through the serial or the cable interface.

Data Operations

This section provides an overview of how data is transmitted to and from the Cisco uBR924 router across the cable system's HFC network. Figure 1-4 illustrates a typical broadband data cable system, showing the network path between the Cisco uBR924 router and the CMTS headend equipment (Cisco uBR7200 series universal broadband router or other DOCSIS-compliant CMTS).

Figure 1-4   Cisco Broadband Data Cable System
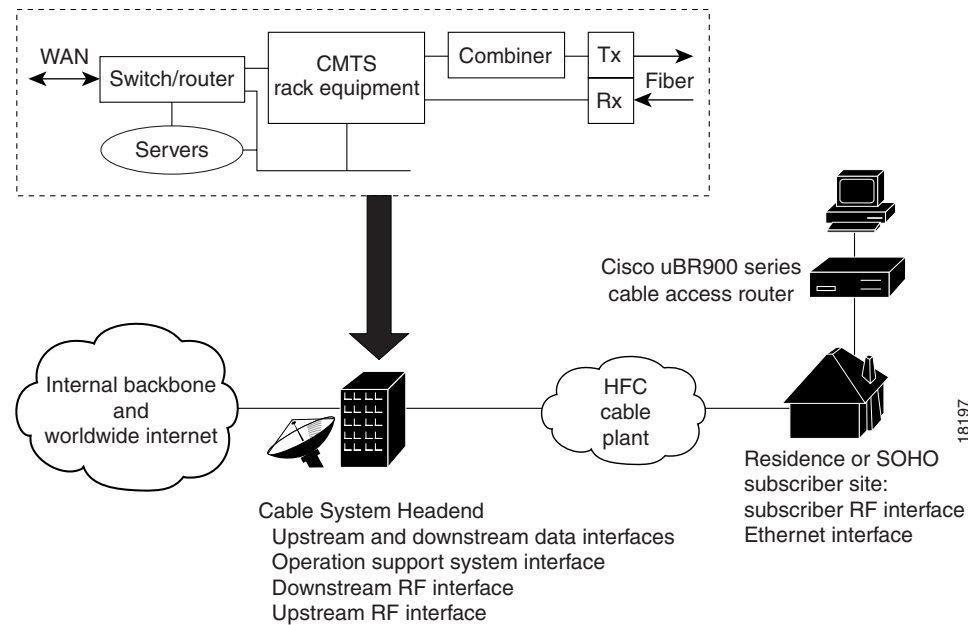
The Cisco uBR924 router provides the connection between the PC and the cable system, modulating the data transmitted to and from the PC so that it can be carried over the coaxial cable installed by the service provider. To avoid interfering with the cable video signals that are also transmitted over this same coaxial cable, the DOCSIS specification allows only certain frequencies to be used for data transmissions. Separate frequencies are used for the data sent from the CMTS to the cable modem (the downstream direction) and for the data sent from the cable modem to the CMTS (the upstream direction).

The CMTS divides the cable plant into downstream channels and upstream segments or clusters of nodes. Each Cisco uBR924 router on the network is configured to receive data on a particular downstream channel. A downstream channel contains one or more upstream segments; partitioning the upstream plant into smaller segments significantly reduces the number of potential ingress sources and failure points.

Downstream Transmissions

Because 90% of the data transmitted on the Internet is, on average, sent from the network to the user, the cable system allocates the majority of bandwidth for downstream data (data sent from the CMTS to the router). Downstream transmissions use a 6 MHz data channel in the 88 to 860 MHz range, providing an approximate maximum bandwidth of 27 or 26 Mbps. This bandwidth is shared among all subscribers who have been assigned to this particular downstream channel.

The CMTS receives the downstream data from its Internet or other WAN connections. It addresses the data to the appropriate Cisco uBR924 router and modulates it for transmission on the cable network. When the data arrives at the subscriber's site, the router modulates it for transmission over the Ethernet connection to the appropriate CPE device.

Upstream Transmissions

The data transmitted in the upstream direction (from the user to the network) is typically much less than that on the downstream direction, so a smaller bandwidth is allocated to it. The upstream transmissions share a 200 kHz-wide to 3.2 MHz-wide channel in the 5 to 42 MHz range, providing a bandwidth of up to 10 Mbps.

Depending on the quality of the physical plant and the CMTS used at the headend, users on a single downstream can be allocated across several upstreams to ensure a responsive network. Service providers can allocate different upstream bandwidths depending on the services purchased by a subscriber. For example, a subscriber purchasing basic home service might be allocated a 128 kbps upstream, while businesses purchasing premium services might be allocated a 384 kbps upstream.

The Cisco uBR924 router receives the upstream data from the CPE devices to which it is connected. It modulates this data for transmission on the coaxial cable system to the CMTS. The CMTS then routes the data to the appropriate destination (local server, Internet, and so forth) through its WAN interfaces.

All DOCSIS cable modems use a request/grant mechanism to obtain bandwidth on the upstream. The CMTS grants the bandwidth according to the requestor's level of service, ensuring that the cable modem is not exceeding the maximum bandwidth for upstream transmissions that has been specified by the subscriber's service agreement.

Note   End-to-end throughput varies based on the design and loading of network components, the mix of traffic, the processing speed and interface of the host server(s), the processing speed and local Ethernet performance of the subscriber's computer, as well as other parameters. Because the network can be configured to support multiple levels of service with different performance requirements, the subscriber's service level agreement also affects throughput. DOCSIS also specifies fundamental performance limitations to ensure that the majority of subscribers experience good performance, rather than permitting a few users to consume the entire capacity.

Voice Operations

When using a voice-enabled Cisco IOS image, the Cisco uBR924 cable access router supports Voice over IP (VoIP), which transmits voice and fax calls over a TCP/IP network such as the Internet. Depending on the services purchased from the cable service provider, subscribers can place and receive calls without using the local exchange carrier.

The router supports two simultaneous voice and fax calls from each subscriber site, but multiple telephones and fax devices can be connected to each of the router's two VoIP telephone lines (provided the 5 REN limit for each telephone line is not exceeded). Telephones at each subscriber site must support touch-tone dialing; rotary dialing is not supported, nor are special telephone features such as call waiting, forwarding, and conferencing.

Subscribers can connect standard telephones and fax machines to the Cisco uBR924 router; IP telephones are not required. Depending on the voice network set up by the service provider, subscribers can place calls to numbers that are in the existing telco network; the called party does not have to be using VoIP telephone service.

Note   Fax devices—standard Group III and computer-based Group III machines up to 14,400 baud—are supported in Cisco IOS Release 12.0(5)T and higher voice-enabled images. In general, fax/modem cards are not supported over VoIP links.

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Caution   In certain countries, the provisioning of voice telephony over the Internet or use of these products may be prohibited and/or subject to laws, regulations or licenses, including requirements applicable to the use of the products under telecommunications and other laws and regulations; customer must comply with all such applicable laws in the country where the customer intends to use the product.

Features

The Cisco uBR924 cable access router is a compact, easy-to-install device that contains:

- A single F-connector interface to the cable system.

- Four RJ-45 (10BaseT Ethernet) hub ports to connect up to four computers directly to the Ethernet hub ports at the rear of the unit (depending on the Cisco IOS release). Alternatively, one of the four ports can connect to an Ethernet hub which then can connect additional computers or devices at the site. (The actual number of supported CPE devices depends on the Cisco IOS release; see the "Routing and Bridging" section on page 1-2 for details.)

- Two RJ-11 Foreign Exchange Station (FXS) ports to connect telephones and fax devices to the cable system and IP backbone; the router ships from the Cisco factory with the voice ports disabled.

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Note   To enable the voice ports, use a Cisco IOS Release 12.0(4)XI or higher image that supports VoIP and configure the router according to your business practices and network configuration. To support fax, use a Cisco IOS Release 12.0(5)T or higher image that supports VoIP and configure the router as appropriate. Also configure the CMTS and related servers. See the *Cisco uBR924 Cable Access Router Software Configuration Guide* for examples of configuration files.

- One RJ-11 port to connect to a standard, analog telephone line (optional) to provide a backup Plain Old Telephone Service (POTS) connection to the Public Switched Telephone Network (PSTN) should the Cisco uBR924 cable access router lose power.

- One RJ-45 console port (optional) to connect to a laptop PC or console terminal when locally configuring the router; the router ships from the Cisco factory with the console port enabled.

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Note   By default, downloading a Cisco IOS configuration file disables the console port and erases all previously saved configurations. This default behavior is recommended as it prohibits configuration access at the remote site.

Figure 1-5 depicts the front of the Cisco uBR924 cable access router. Figure 1-6 shows the rear of the unit.

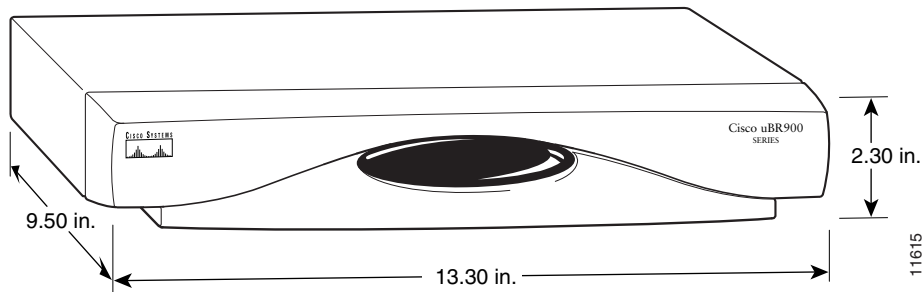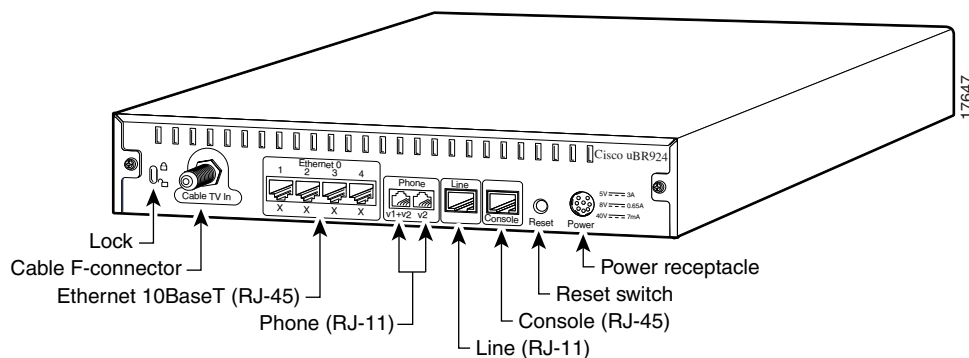*Figure 1-5   Cisco uBR924 Cable Access Router Front View*

Figure 1-6   Cisco uBR924 Cable Access Router Rear View

The Cisco uBR924 router is designed to work with commercial security products, such as Kensington-compatible lock and cable devices, that attach to the router to prevent theft in small office applications. The router's rear panel contains generic lock and unlock symbols, identified as "Lock" in Figure 1-6.

Note   Cisco does not supply these security products.

The following sections describe the router and its features in more detail:

- LED Descriptions
- Data Ports
- Voice Ports
- Backup POTS Connection (RJ-11 Line Connector)
- Power Supply

See Appendix B, "Connector and Cable Specifications," for the pinouts and cabling information for each of these connectors. For information on using the console port, see the *Cisco uBR924 Software Configuration Guide*.

LED Descriptions

The Cisco uBR924 router contains 15 LEDs on the front panel that provide information about the router's status and network connections. Figure 1-7 illustrates the LEDs on the router's front panel. Table 1-1 lists each LED and its meaning.

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Note   LEDs that are not labeled are not in use.

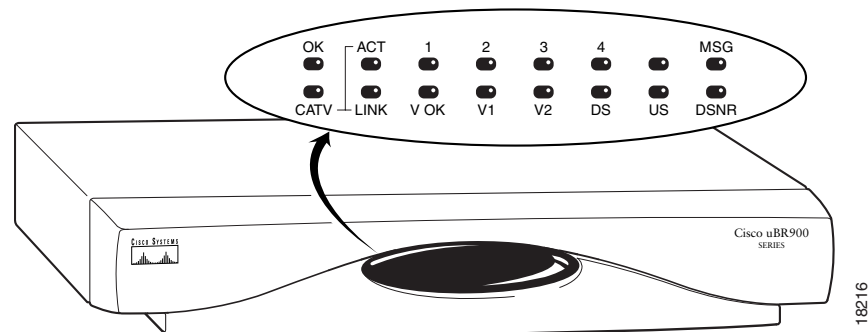*Figure 1-7   Cisco uBR924 Cable Access Router Front Panel LEDs*

Table 1-1   Cisco uBR924 Cable Access Router Front Panel LED Description

Label	Description	Color	Function
OK	System Status	Green	On = Cisco uBR924 power-on and self-test diagnostics have completed successfully, the system image has been booted, and the system is operational.
			Blink = After power-on and self-test diagnostics have completed successfully, LED blinks as the system image is booted.
			Off = No Power. If the OK LED turns off and remains off during the boot process, it indicates the router has failed its self-test diagnostics; in this situation the bottom row of LEDs contain more information about the type of failure (see Table 4-1 on page 4-3).
ACT	Cable Activity	Green	On = Cable Activity Off = No Activity
1–4	Ethernet 1–Ethernet 4	Green	On = Link Up Blink = Activity Off = Link Down
MSG	Message	Green	Reserved for service provider use (typically indicates that messages are waiting in the subscriber's voicemail, but the exact usage depends on the service provider).
V OK	Voice System Status	Green	On = VoIP system is operational Off = VoIP problem; the voice devices may have switched over to the backup POTS line
V1	Voice Port 1	Green	On = Call in progress Off = No call

Table 1-1   Cisco uBR924 Cable Access Router Front Panel LED Description (continued)

Label	Description	Color	Function
V2	Voice Port 2	Green	On = Call in progress Off = No call
LINK	Cable RF Link	Green	On = Cable connection up; RF link up Blink = Cisco uBR924 is searching for a downstream frequency Off = Cable connection down; RF link down
DS	Downstream Signal Lock Status	Green	On = Cisco uBR924 is locked to a downstream frequency (channel). Off = Cisco uBR924 has not yet locked to a downstream frequency (channel) or the router has not yet located a digital signal.
US	Upstream Signal Quality	Green	On = Cisco uBR924 has established upstream communications with the CMTS; cable access router has completed ranging state 2 (as per DOCSIS), has entered provisioning state, and is communicating within 6 dB of desired final power level (generally within 3 dB). Off = Cisco uBR924 has not completed secondary ranging; the CMTS has heard from the cable access router, however, and there is some upstream continuity.
DSNR	Downstream Signal-to-Noise Ratio	Green	On = Receiving quality, downstream signal; SNR is greater than 5 dB above the downstream lock threshold. Off = Receiving low or marginal downstream signal strength or quality. **Note** The signal is checked approximately every 25 seconds and the DSNR LED is updated to reflect the current state. If this LED remains off, it could indicate a problem with the cable at the subscriber's site.

Data Ports

As shown in Figure 1-6, the Cisco uBR924 cable access router contains a coaxial cable F-connector and four Ethernet 10Base T connectors. The cable F-connector must always be connected to the cable system for proper operation. The Ethernet connectors can be connected in one of the following configurations:

- If the router is configured for bridging mode, from one to four CPE devices can be connected directly to the router when using Cisco IOS 12.0(5)T or higher images. (Only three devices can be connected if using Cisco IOS 12.0(4)XI or prior images.)

- If the router is configured for bridging mode, an Ethernet hub can be connected to one of the router's Ethernet ports. The hub can then in turn be connected to up to additional CPE devices (up to three devices are supported in Cisco IOS 12.0(4)XI or prior images, and up to 254 devices are supported in Cisco IOS 12.0(5)T or higher images).

- If the router is configured for routing mode, up to four CPE devices can be directly connected to the router's Ethernet ports.

- If the router is configured for routing mode, an Ethernet hub can be connected to one of the router's Ethernet ports. The hub can then in turn be connected to any number of devices.

> **Note**   For network performance reasons Cisco recommends a maximum limit of 16 CPE devices
> in either bridging or routing mode. The service provider may also set a different limit by
> changing the MAX CPE parameter in the DOCSIS configuration file—the default MAX
> CPE value is one CPE device, which applies in both bridging and routing modes.

Voice Ports

As Figure 1-6 shows, the Cisco uBR924 router contains two FXS VoIP ports that are labelled V1+V2
and V2 at the rear of the unit. These ports can be connected directly to analog telephones or fax devices,
or to adapters that allow multiple analog telephones or fax devices to be connected to each of the two
VoIP telephone lines.

The V1+V2 port on the Cisco uBR924 is a 4-wire port, with the second telco pair wired in parallel with
V2. A two-line analog telephone can be connected, therefore, to the V1+V2 port. In this configuration,
devices plugged into the V2 port act as extensions to the line 2 telephone.

> **Caution**   Do not connect the V1+V2 and V2 ports to telephone wires that exit the building without
> appropriate agency-approved protection devices. This is a safety hazard.

Between 5 and 10 analog telephone devices can be connected to each of the 2 VoIP telephone lines,
provided each telephone line does not exceed its Ringer Equivalence Number (REN). In most areas, the
sum of the RENs of all devices on any one line should not exceed five. If too many devices are attached,
they may not ring properly.

> **Note**   Only one voice call—telephone or fax—per VoIP line is active at a time. The actual
> number of voice devices supported depends on the services purchased from the service
> provider and on the Cisco IOS image that is running on the router.

Typical length of telephone wire is 3,000 feet (or more) of 26 gauge. The wiring in the average small
business usually does not exceed this limit, so the Cisco uBR924 router can support the number of
telephones or fax devices typically found in small businesses.

Backup POTS Connection (RJ-11 Line Connector)

The Cisco uBR924 router provides an RJ-11 cutover port that connects to a standard analog telephone
wall jack. In the event of a building power failure or other Cisco uBR924 power problem, this port
connects the VoIP ports to the backup PSTN line. If the Cisco uBR924 router loses power while VoIP
calls are in progress, the subscriber can re-establish one of the two connections by dialing out over the
PSTN.

✎ **Note**   The backup POTS connection enables only one of the VoIP ports that can be connected to the Cisco uBR924 to function during a power outage. Calls in progress prior to the power outage are disconnected.

If power is re-established while a cutover call is in progress, the connection remains in place until the call is terminated. After the cutover call is terminated, the router automatically reboots.

Power Supply

The Cisco uBR924 cable access router uses an external AC-input power supply. Refer to Table A-1 in Appendix A, "Technical Specifications," for the AC-input power supply power specifications, including input voltage and operating frequency ranges.

The Cisco uBR924 cable access router does not contain a power switch. After the cable system technician installs, connects, powers on, and initializes the unit, it is intended to remain connected to the broadband network when operating normally.

The same power supply supports both domestic (U.S.) and international operation. Different power cords are required, however, depending on the country of operation.

⚠ **Warning**   **The router is designed to work with TN power systems. TN power systems have a protective earth. Read the installation instructions in Chapter 3, "Installing the Cisco uBR924 Router," before you connect the system to its power source.**

⚠ **Caution**   Use only a Cisco-provided power supply and cord. Using any other vendor's power supply and cord can cause loss of data or permanent damage. Cisco uBR924 and Cisco uBR904 power supplies and cords are identical and interchangeable, provided the power cords are applicable to the country of operation.