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Foreword

CCNA Voice Official Exam Certification Guide is an excellent self-study resource for the Cisco IIUC (640-460) exam. Passing the IIUC exam validates the knowledge and skills required to successfully deploy Cisco VoIP technologies. Gaining certification in Cisco technology is key to the continuing educational development of today's networking professional. Through certification programs, Cisco validates the skills and expertise required to effectively manage the modern enterprise network.

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May 2008

Introduction

Welcome to the world of CCNA Voice! As technology continues to evolve, the realm of voice, which was traditionally kept completely separate from data, has now begun to merge with the data network. This brings together two different worlds of people: data technicians—historically accustomed to working with routers, switches, servers, and the like—and voice technicians, historically accustomed to working with PBX systems, digital handsets, and trunk lines. Regardless of your background, one of the primary goals of the new CCNA Voice certification is to bridge these two worlds together.

In June 2008, Cisco announced new CCNA specialties, including CCNA Security, CCNA Wireless, and CCNA Voice. These certifications, released 10 years after the initial CCNA, represent Cisco's growth into new and emerging industries. Certification candidates can now specialize in specific areas of study. Figure I.1 shows the basic organization of the certifications and exams used to achieve your CCNA Voice certification.

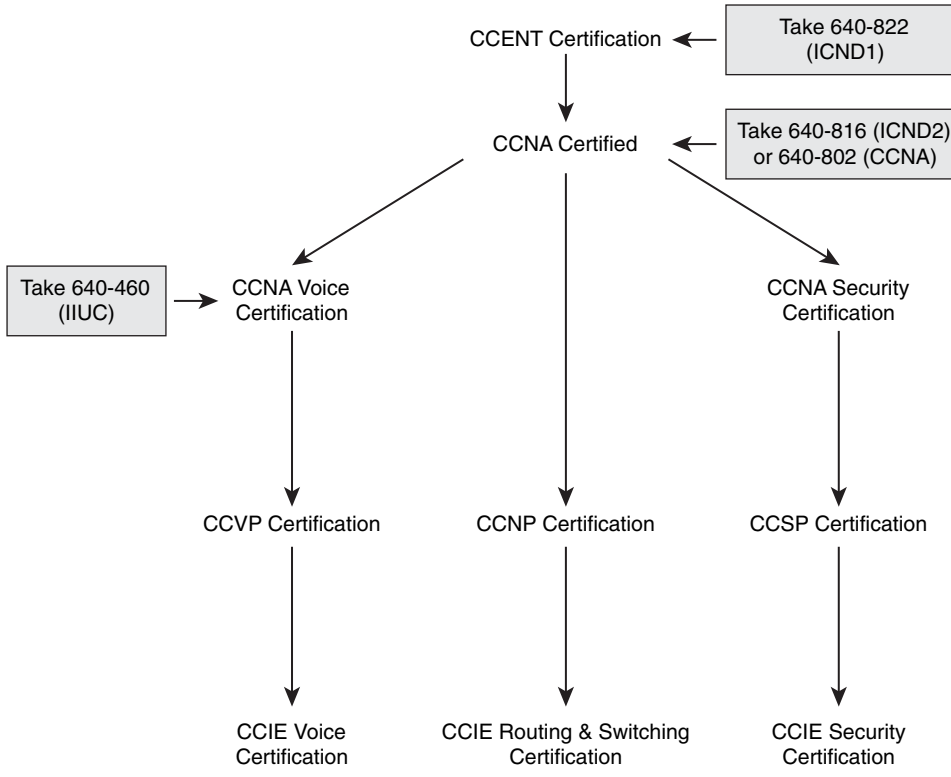

Figure I.1 *Cisco Certifications and CCNA Voice Certification Path*

As you can see from Figure I.1, a traditional CCNA certification is a prerequisite before you venture into the CCNA Voice certification. As of June 2009, the CCNA Voice certification will become a prerequisite before you are able to pursue the Cisco Certified Voice Professional (CCVP) certification.

Goals and Methods

The most important and somewhat obvious goal of this book is to help you pass the Implementing Cisco IOS Unified Communications (IIUC) exam (640-460). In fact, if the primary objective of this book were different, then the book's title would be misleading. The methods used in this book to help you pass the IIUC exam are designed to also make you much more knowledgeable about how to do your job.

This book uses several key methodologies to help you discover the exam topics that you need to review in more depth, to help you fully understand and remember those details, and to help you prove to yourself that you have retained your knowledge of those topics. So, this book does not try to help you pass by memorization, but helps you truly learn and understand the topics. The CCNA Voice exam is the foundation for many of the Cisco professional certifications, and it would be a disservice to you if this book did not help you truly learn the material. Therefore, this book will help you pass the CCNA Voice exam by using the following methods:

- Helping you discover which test topics you have not mastered
- Providing explanations and information to fill in your knowledge gaps
- Supplying exercises and scenarios that enhance your ability to recall and deduce the answers to test questions
- Providing practice exercises on the topics and the testing process via test questions on the CD-ROM.

In addition, this book uses quite a different style from typical certification-preparation books. The newer Cisco certification exams have adopted a style of testing that essentially says, "If you don't know how to do it, you won't pass this exam." This means that most of the questions on the certification exam will require you to deduce the answer through reasoning or configuration rather than just memorizing facts, figures, or syntax from a book. To accommodate this newer testing style, the authors have written this book as a "real world" explanation of Cisco VoIP topics. Most concepts are explained using real-world examples rather than showing tables full of syntax options and explanations, which are freely available on Cisco.com. As you read through this book, you will definitely get a feeling of, "This is how I can *do* this," which is exactly what you need for the newer Cisco exams.

Who Should Read This Book?

The purpose of this book is twofold. The primary purpose is to tremendously increase your chances of passing the CCNA Voice certification exam. The secondary purpose is to provide the information necessary to deploy a VoIP solution using Cisco Unified Communication Manager Express (CME) or the Smart Business Communications System (SBCS). Cisco's new exam approach provides an avenue to write the book with both a real-world and certification-study approach at the same time. As you read through this book and study the configuration examples and exam tips, you will have a true sense of understanding how you could deploy a VoIP system, while at the same time feeling equipped to pass the CCNA Voice certification exam.

Strategies for Exam Preparation

Strategies for exam preparation will vary depending on your existing skills, knowledge, and equipment available. Of course, the ideal exam preparation would consist of building a small voice lab with a Cisco Unified Communications Manager Express 2801 Integrated Services Router and Cisco Unity Express capabilities, a switch, and a few IP phones, which you could then use to work through the configurations as you read through this book. However, not everyone has access to this equipment, so the next best step you can take is to read through the chapters in this book, jotting notes down with key concepts or configurations on a separate notepad. Each chapter begins with a "Do I Know This Already?" quiz designed to give you a good idea of the chapter's content and your current understanding of it. In some cases, you might already know most of or all the information covered in a given chapter.

After you have read through the book, have a look at the current exam objectives for the CCNA Voice exam listed on Cisco.com (http://www.cisco.com/certification). If there are any areas shown in the certification exam outline that you would still like to study, find those sections in the book and review them.

When you feel confident in your skills, attempt the practice exam included on the CD with this book. As you work through the practice exam, note the areas where you lack confidence and review those concepts or configurations in the book. After you have reviewed the areas, work through the practice exam a second time and rate your skills. Keep in mind that the more you work through the practice exam, the more familiar the questions will become, so the practice exam will become a less accurate judge of your skills.

After you have worked through the practice exam a second time and feel confident with your skills, schedule the real IIUC (640-460) exam through Vue (http://www.vue.com). You should typically take the exam within a week from when you consider yourself ready to take the exam, so that the information is fresh in your mind.

Keep in mind that Cisco exams are very difficult. Even if you have a solid grasp of the information, there are many other factors that play into the testing environment (stress, time constraints, and so on). If you pass the exam on the first attempt, fantastic! If not, know that this happens commonly. The next time you attempt the exam, you will have a major advantage: you have experienced the exam first-hand. Although future exams may have different questions, the topics and general "feel" of the exam will remain the same. Take some time to study areas from the book where you felt weak on the exam. Retaking the exam the same or following day from your first attempt is a little aggressive; instead, schedule to retake it within a week, while you are still familiar with the content.

640-460 IIUC Exam Topics

Table I.1 lists the exam topics for the 640-460 IIUC exam. This table also lists the book parts in which each exam topic is covered.

Table I.1 *640-460 IIUC Exam Topics*

Chapter Where Topic Is Covered	Exam Topic
Describe the components of the Cisco Unified Communications Architecture	
Chapter 2	Describe the function of the infrastructure in a UC environment
Chapter 2	Describe the function of endpoints in a UC environment
Chapter 2	Describe the function of the call processing agent in a UC environment
Chapter 2	Describe the function of messaging in a UC environment
Chapter 2	Describe the function of auto attendants and IVRs in a UC environment
Chapter 2	Describe the function of contact center in a UC environment
Chapter 2	Describe the applications available in the UC environment, including Mobility, Presence, and Telepresence
Chapter 2	Describe how the Unified Communications components work together to create the Cisco Unified Communications Architecture
Describe PSTN components and technologies	
Chapter 1	Describe the services provided by the PSTN
Chapter 1	Describe time division and statistical multiplexing
Chapter 1	Describe supervisory, informational, and address signaling
Chapter 1	Describe numbering plans
Chapter 1	Describe analog circuits
Chapter 1	Describe digital voice circuits
Chapter 1	Describe PBX, trunk lines, key-systems, and tie lines
Describe VoIP components and technologies	
Chapter 7	Describe the process of voice packetization
Chapter 7	Describe RTP and RTCP
Chapter 7	Describe the function of and differences between codecs
Chapter 7	Describe H.323, MGCP, SIP, and SCCP signaling protocols

continues

Table I.1 *640-460 IIUC Exam Topics continued*

Chapter Where Topic Is Covered	Exam Topic
Describe and configure gateways, voice ports, and dial peers to connect to the PSTN and service provider networks	
Chapter 8	Describe the function and application of a dial plan
Chapter 8	Describe the function and application of voice Gateways
Chapter 8	Describe the function and application of voice ports in a Gateway
Chapter 8	Describe the function and operation of call-legs
Chapter 8	Describe and configure voice dial peers
Chapter 8	Describe the differences between PSTN and Internet Telephony Service Provider circuits
Describe and configure a Cisco network to support VoIP	
Chapter 3	Describe the purpose of VLANs in a VoIP environment
Chapter 3	Describe the environmental considerations to support VoIP
Chapter 3	Configure switched infrastructure to support voice and data VLANs
Chapter 3	Describe the purpose and operation of PoE
Chapter 8	Identify the factors that impact voice quality
Chapter 8	Describe how QoS addresses voice quality issues
Chapter 8	Identify where QoS is deployed in the UC infrastructure
Implement UC500 using Cisco Configuration Assistant	
Chapter 11	Describe the function and operation of Cisco Configuration Assistant
Chapter 12	Configure UC500 device parameters
Chapter 12	Configure UC500 network parameters
Chapter 12	Configure UC500 dial plan and voicemail parameters
Chapter 12	Configure UC500 SIP trunk parameters
Chapter 12	Configure UC500 voice system features
Chapter 12	Configure UC500 user parameters

Table I.1 *640-460 IIUC Exam Topics*

Chapter Where Topic Is Covered	Exam Topic
Implement Cisco Unified Communications Manager Express to support endpoints using CLI	
Chapter 4	Describe the appropriate software components needed to support endpoints
Chapter 3	Describe the requirements and correct settings for DHCP, NTP, and TFTP
Chapter 3	Configure DHCP, NTP, and TFTP
Chapter 4	Describe the differences between key system and PBX mode
Chapter 5	Describe the differences between the different types of ephones and ephone-dns
Chapter 5	Configure Cisco Unified Communications Manager Express endpoints
Chapter 6	Configure call-transfer per design specifications
Chapter 6	Configure voice productivity features, including hunt groups, call park, call pickup, paging groups, and paging/intercom
Chapter 6	Configure Music on Hold
Implement voicemail features using Cisco Unity Express	
Chapter 9	Describe the Cisco Unity Express hardware platforms
Chapter 9	Configure the foundational elements required for Cisco Unified Communications Manager Express to support Cisco Unity Express
Chapter 9	Describe the features available in Cisco Unity Express
Chapter 10	Configure AutoAttendant services using Cisco Unity Express
Chapter 10	Configure basic voicemail features using Cisco Unity Express

How This Book Is Organized

Although this book could be read cover-to-cover, it is designed to be flexible and allow you to easily move between chapters and sections of chapters to cover just the material that you need more work with. If you do intend to read all the chapters, the order in the book is an excellent sequence to use.

The core chapters, Chapters 1 through 12, cover the following topics:

- **Chapter 1, "Perspectives on Voice Before Convergence":** This chapter discusses what would be known as the traditional telephony world. It begins where the telephone system originally started: analog connectivity. It then moves into the realm of digital connections and considerations and concludes with the primary pieces that you need to know from the public switched telephone network (PSTN).
- **Chapter 2, "Perspectives on Voice After Convergence":** This chapter focuses primarily on the components of a Cisco VoIP network. By breaking down the voice infrastructure into four distinct areas, each component can be categorized and described. These components include endpoints, call processing agents, applications, and network infrastructure devices.
- **Chapter 3, "Connecting IP Phones to the LAN Infrastructure":** This chapter discusses the preparation and base configuration of the LAN infrastructure to support VoIP devices. This preparation includes support for Power over Ethernet (PoE), voice VLANs, a properly configured DHCP scope for VoIP devices, and the Network Time Protocol (NTP).
- **Chapter 4, "Installing Cisco Unified Communications Manager Express":** This chapter covers everything you need to know to get Cisco Unified Communication Manager Express (CME) ready to support IP phones. It initially walks through the Cisco Unified CME overview and licensing information, then unpacks the installation and base configuration process.
- **Chapter 5, "Basic Cisco Unified CME IP Phone Configuration":** This chapter focuses on the process to create and assign directory numbers to Cisco IP phones. In addition, the chapter walks through the configuration of IP phone auto-registration, which makes your initial network setup much easier, and the configuration of additional phone parameters such as phone locale and system messages.
- **Chapter 6, "Configuring Cisco Unified CME Voice Productivity Features":** This chapter examines feature after feature supported by the CME router. By the time you're done with this chapter, you'll understand how to configure features such as intercom, paging, call park and pickup, and many others.
- **Chapter 7, "Gateway and Trunk Concepts":** Now that the internal VoIP network is operational through the CME configuration, this chapter examines connections to the outside world through the PSTN or over an IP network. Concepts covered in this chapter include the process of converting voice to packetized format, codec considerations, and trunking methods.

- **Chapter 8, "Configuring and Verifying Gateways and Trunks":** This chapter takes the concepts from Chapter 7 and puts them into configuration action. Topics from this chapter include the configuration of physical voice ports, dial-peer and digit manipulation configuration, and quality of service (QoS).
- **Chapter 9, "Cisco Unity Express Concepts":** This chapter introduces the Cisco Unity Express (CUE), describing the differences between hardware platforms, the software components, and licensing options. The features, functions, and management of the voicemail and auto-attendant applications provided by CUE are explored.
- **Chapter 10, "Cisco Unity Express Configuration":** This chapter discusses the configuration of the Cisco Unity Express platform. It begins with the Cisco Unity Express installation process and walks through configuring Cisco Unity Express global options, mailbox settings, and auto-attendant scripts. The chapter concludes with Cisco Unity Express troubleshooting methods.
- **Chapter 11, "Introducing the Smart Business Communications System":** This chapter introduces the concept of Unified Communications (UC) and explains how the Smart Business Communications System (SBCS) is positioned to deliver UC to the small-medium business (SMB) market. Individual components of the SBCS suite and the most common ways they are deployed are discussed to lay a foundation for implementing the UC500 Series for Small Business.
- **Chapter 12, "Configuring and Maintaining the UC500 Series for Voice":** This chapter discusses the process of provisioning the UC500 Series for Small Business. The chapter begins with a discussion of the UC500's function in the SBCS family, moves into a discussion about the Cisco Configuration Assistant (CCA), and then concludes with step-by-step instructions for deploying and maintaining telephony and voice-mail services on the UC500.

In addition to the 12 main chapters, this book includes tools to help you verify that you are prepared to take the exam. Chapter 13, "Final Preparation," includes guidelines that you can follow in the final days before the exam. Also, the CD-ROM includes quiz questions and memory tables that you can work through to verify your knowledge of the subject matter.

Cisco Unified Communications Manager Express Overview: This section gives an overview of the Cisco Unified Communications Manager Express (CME) system, the Cisco hardware it can run on, and features it supports.

Licensing and Models for Cisco Unified CME: As you design your IP telephony network, you can choose a key system, PBX, or hybrid model. This section discusses these models and the licenses required by Cisco to operate a Cisco Unified CME environment.

Installing Unified CME on a Cisco Router: Many routers ship with Cisco Unified CME software preinstalled; on others, it must be installed manually. This section discusses the installation and upgrade process for Cisco Unified CME.

Configuring the Cisco Unified CME Router as a TFTP Server: The Cisco Unified CME router is responsible for serving the correct files to the IP phones during the boot process. This section discusses the configuration of the CME router as a TFTP server.

Configuring the Cisco Unified CME System-Level Functions: In this section, you will see four steps you must take to prepare the Cisco Unified CME router to handle Cisco IP phones.

CHAPTER 4

Installing Cisco Unified Communications Manager Express

At this point, you now understand the difference between TDM and IP-based voice systems. You have seen the foundation network requirements for Power over Ethernet (PoE), Dynamic Host Configuration Protocol (DHCP), virtual LANs (VLANs), and Network Translation Protocol (NTP) and understand the configuration required to build the infrastructure. Now it is time to turn the attention to the Cisco Unified Communications Manager Express (CME) installation process.

"Do I Know This Already?" Quiz

The "Do I Know This Already?" quiz allows you to assess whether you should read this entire chapter or simply jump to the "Exam Preparation Tasks" section for review. If you are in doubt, read the entire chapter. Table 4.1 outlines the major headings in this chapter and the corresponding "Do I Know This Already?" quiz questions. You can find the answers in Appendix A, "Answers to the 'Do I Know This Already?' Quizzes."

Table 4.1 *"Do I Know This Already?" Foundation Topics Section-to-Question Mapping*

Foundation Topics Section	Questions Covered in This Section
Cisco Unified Communications Manager Express Overview	1
Licensing and Models for Cisco Unified CME	2–3
Installing Unified CME on a Cisco Router	4
Configuring the Cisco Unified CME Router as a TFTP Server	5–7
Configuring the Cisco Unified CME System-Level Functions	8–10

1. How many Cisco IP phones can a Cisco 2801 CME Router support?
   - **a.** 8
   - **b.** 24
   - **c.** 50
   - **d.** 144
2. Which of the following are required licenses to operate a Cisco Unified CME router? (Choose three.)
   - **a.** IOS license
   - **b.** User license
   - **c.** Phone license
   - **d.** Phone user license
   - **e.** Feature license
3. Which design model would you use if you wanted the number of lines on each IP phone to match the number of phone lines coming in from the PSTN?
   - **a.** Shared line model
   - **b.** Limited model
   - **c.** Keyswitch model
   - **d.** Hybrid model
   - **e.** PBX model

4. What command can you use to extract a bundle of CME files into the flash of the router?

   a. **copy**
   b. **extract**
   c. **xtract**
   d. **archive**

5. Which files does the Cisco IP phone download from the TFTP server during the boot process? (Choose two.)

   a. Firmware
   b. Music on Hold
   c. XML templates
   d. Configuration files

6. What is the primary function of the **alias** syntax in the **tftp-server** command?

   a. To make files in subdirectories accessible without entering the full path
   b. To rename files
   c. To hide the original filename to increase network security
   d. To allow multiple files to be accessed through one filename

7. Once phone firmware files are downloaded and copied to the flash memory of a router, how are they made accessible to the IP phones?

   a. The CME telephony service automatically recognizes these files and makes them available via TFTP.
   b. The firmware files must be manually made available by using the **tftp-server** command.
   c. The firmware files are made available through TFTP when entered in the telephony service using the **load** command.
   d. The firmware files are copied to an external TFTP server by the router and downloaded directly to the IP phones.

8. Which three commands must be entered to allow the CME router to begin accepting IP phone registrations?

   a. **max-ephones**
   b. **max-dn**
   c. **no shutdown**
   d. **ip source-address**
   e. **telephony-service enable**
   f. **no telephony-service disable**

9. How does the Cisco Unified CME router create configuration files for the Cisco IP phones? (Choose two.)

   a. Configuration files are automatically created as configuration information is entered.

   b. Configuration files must be downloaded from Cisco and copied to the flash of the router.

   c. Configuration files can be generated by entering the **create cnf-file** syntax.

   d. Configuration files are generated by the IP phones and uploaded to the router's flash during the boot process.

10. The Cisco Unified CME router generates a generic configuration file for IP phones that do not have any configuration information. What is the name of this file?

   a. Config.default

   b. Default.xml

   c. Default.cnf

   d. XMLDefault.cnf.xml

   e. Holiday prompt

   f. Emergency prompt

Foundation Topics

Cisco Unified Communications Manager Express Overview

When Cisco first entered the IP telephony space, it did so with its flagship CallManager product line. CallManager was a dedicated server or servers that was a custom fit for medium to large businesses deploying thousands of phones at a single site or multiple locations. Although CallManager (now known as Cisco Unified Communications Manager) provided a cost-effective solution for these larger businesses, the startup price was far beyond the range that was affordable by small businesses.

As the CallManager product line developed, Cisco released a product known as Survivable Remote Site Telephony (SRST), which allowed a router to act as a failover device for Cisco IP phones if their CallManager server was unreachable. SRST was so fantastic, Cisco eventually turned it into a standalone solution (rather than just a failover solution) that could support a small office environment. The product was initially named IOS Telephony Service (ITS), which then became CallManager Express, which then became the Unified Communications Manager Express (CME) product used today.

Depending on the platform used, Cisco Unified CME can scale to support an environment of up to 240 IP phones. Table 4.2 gives the Cisco Unified CME IOS platforms available and the current maximum number of IP phones supported.

Table 4.2 *Current Cisco Unified Communications Manager Express Platform Limitations*

Platform	Maximum Number of Phones
Cisco 1861 Integrated Services Router	8
Cisco IAD2430 Integrated Access Device	24
Cisco 2801 Integrated Services Router	24
Cisco 3250 Ruggedize Services Router	10
Cisco 3270 Ruggedize Services Router	50
Cisco 2811 Integrated Services Router	35
Cisco 2821 Integrated Services Router	50
Cisco 2851 Integrated Services Router	100
Cisco 3725 Multiservice Access Router	144
Cisco 3745 Multiservice Access Router	192
Cisco 3825 Integrated Services Router	175
Cisco 3845 Integrated Services Router	250

The Cisco Unified CME system supports features you would come to expect from a time-division multiplexing (TDM) PBX or key system. These features can be divided into four categories: system, phone, trunk, and voice mail features. The major features in each category are included in the following list (current as of CME Version 4.3):

- System Features
  - Account codes and Call Detail Record (CDR) field entry
  - Callback busy subscriber and camp-on
  - Per-phone call coverage rules
  - Call hold and retrieve
  - Call park: personal and directed
  - Call transfer and park recall
  - Call park assign to extension
  - Call pickup directed
  - Call pickup local group
  - Call pickup explicit group
  - Call transfer: consultative and blind
  - Call waiting
  - Computer telephony integration (CTI) with Microsoft CRM and Outlook using Cisco IOS Software Telephony Services Provider (TSP)
  - E911 with two emergency location numbers per zone, unlimited zones per site
  - Eight-party impromptu conferencing
  - Directory services using XML
  - Hunt groups: sequential, circular, parallel (blast), and longest idle
  - Hunt-group dynamic login and logout
  - Hunt-groups statistics: daily and hourly
  - Intercom
  - Meet-me conferencing (32 party)
  - Music on Hold (MOH): internal or external source
  - Night service bell or call forwarding
  - Overlay extensions for enhanced call coverage
  - Called-name display for overlay extensions
  - Paging: internal through IP phones or to external system

- Per-call caller ID blocking
- Secondary dial tone
- Standards-based network call transfer and call forwarding using H.450
- Additional system speed-dial option through XML service
- Time-of-day and day-of-week call blocking
- Customizable called-name display
- Support of SRST fallback service phone auto-registration
- Basic automatic call distributor (B-ACD) (three queues) with auto-attendant and call statistics
- Display of number of calls in queue on IP phone
- Agent login and logout of B-ACD hunt group
- Integration with Cisco Unified Contact Center Express 5.0 for advanced call center features with support for up to 50 agents, agent supervisors, call recording, silent monitoring, and reporting features
- Secure Real-Time Protocol (SRTP), providing media encryption for calls on the IP network
- Secure voice IP phone certificate authentication and provisioning plus secure device signaling using Transport Layer Security (TLS)

- Phone Features
  - Maximum 250 phones per system
  - Up to 34 line appearances per phone
  - Attendant console functions using Cisco Unified IP Phone Expansion Module 7914
  - Fast transfer: blind or consult
  - Busy lamp
  - Silent ringing options
  - Automatic line selection for outbound calls
  - Call forward on busy, no answer, and all (internal or external)
  - Call-forward-all restriction control
  - Do not disturb (DND)
  - Feature ring with DND set
  - IP phone display of DND state
  - Dial-plan pattern load on SIP phones

- Diversion of calls directly to voice mail
- Customization of softkeys
- Enable and disable call-waiting notification per line
- Call waiting with overlay directory number
- Call-waiting ring
- Dual or 8 call line appearances per button
- After-hours toll-bar override
- Auto-answer with headset
- European date formats
- Hook flash passthrough across analog PSTN trunks
- Idle URL: periodically push messages or graphics on IP phones
- Last-number redial
- Live record to Cisco Unity Express mailbox
- Local name directory lookup
- On-hook dialing
- Station speed dial with configuration changes from IP phone
- System speed dial for 10,000 numbers
- Silent and feature ring options
- SIP-based line-side subscribe, providing basic presence of phone status
- Transfer to voice mail softkey
- Call barge with privacy on shared lines
- Access features using softkeys or feature access codes
- Remote teleworker IP phone support
- Dynamic hunt-group join or leave
- Support for analog phones using Cisco ATA 186 Analog Telephone Adapter or Cisco VG224 Analog Phone Gateway in SCCP mode
- Support for fax machines on Foreign Exchange Station (FXS) ports or ATA using H.323, SCCP, or SIP
- XML application services on Cisco Unified IP display phones
- Station-to-station video with voice using Cisco Unified Video Advantage or Cisco Unified IP Phone 7985G endpoints
- Extension mobility within the single site
- Wideband audio (G.722) and iLBC codec

- Trunk Features
  - Analog Foreign Exchange Office (FXO) loop and ground start
  - Ear and mouth (E&M)
  - Basic Rate Interface (BRI) and Primary Rate Interface (PRI) support (NI2, 4ESS, 5ESS, EuroISDN, DMS100, and DMS250) and several other switch types currently supported in Cisco IOS Software
  - Caller ID name and number
  - Automatic number identification (ANI)
  - Digital trunk support (T1/E1)
  - Direct inward dialing (DID)
  - Direct outward dialing
  - E1 R2 support
  - Dedicated trunk mapping to phone button
  - H.323 trunks with H.450 support
  - H450.12 automatic detection of H.450 support for remote H.323 endpoints
  - H.323-to-H.323 hairpin call routing for non-H.450-compliant H.323 endpoints
  - SIP trunks and RFC 2833 support
  - Transcoding with G.711, G.729a, and iLBC
  - ISDN Q.SIG supplementary services of basic calls, including call forwarding busy, no answer, all; calling name and line identification (CLIP and CNIP); connected line and name identification (COLP and CONP); message waiting indicator (MWI) and message center support; MWI passthrough QSIG-to-TDM voice mail
- Voice Mail Features
  - Integrated voice mail and auto-attendant solution with Cisco Unity Express
  - Integration with Cisco Unity Voice Mail and Cisco Unity Unified Messaging, or third-party voice mail integration (H.323, SIP, or dual-tone multifrequency [DTMF])

This and other upcoming chapters will discuss many of these features in depth.

Figure 4.1 displays the network diagram built in the previous chapter.

The Cisco Unified CME router in the upper right of Figure 4.1 provides connectivity to the PSTN (allowing for incoming and outgoing PSTN calls) and to the Internet. Cisco designed CME with capabilities to be an all-in-one device. With this one router, you could operate both your data and voice networks.

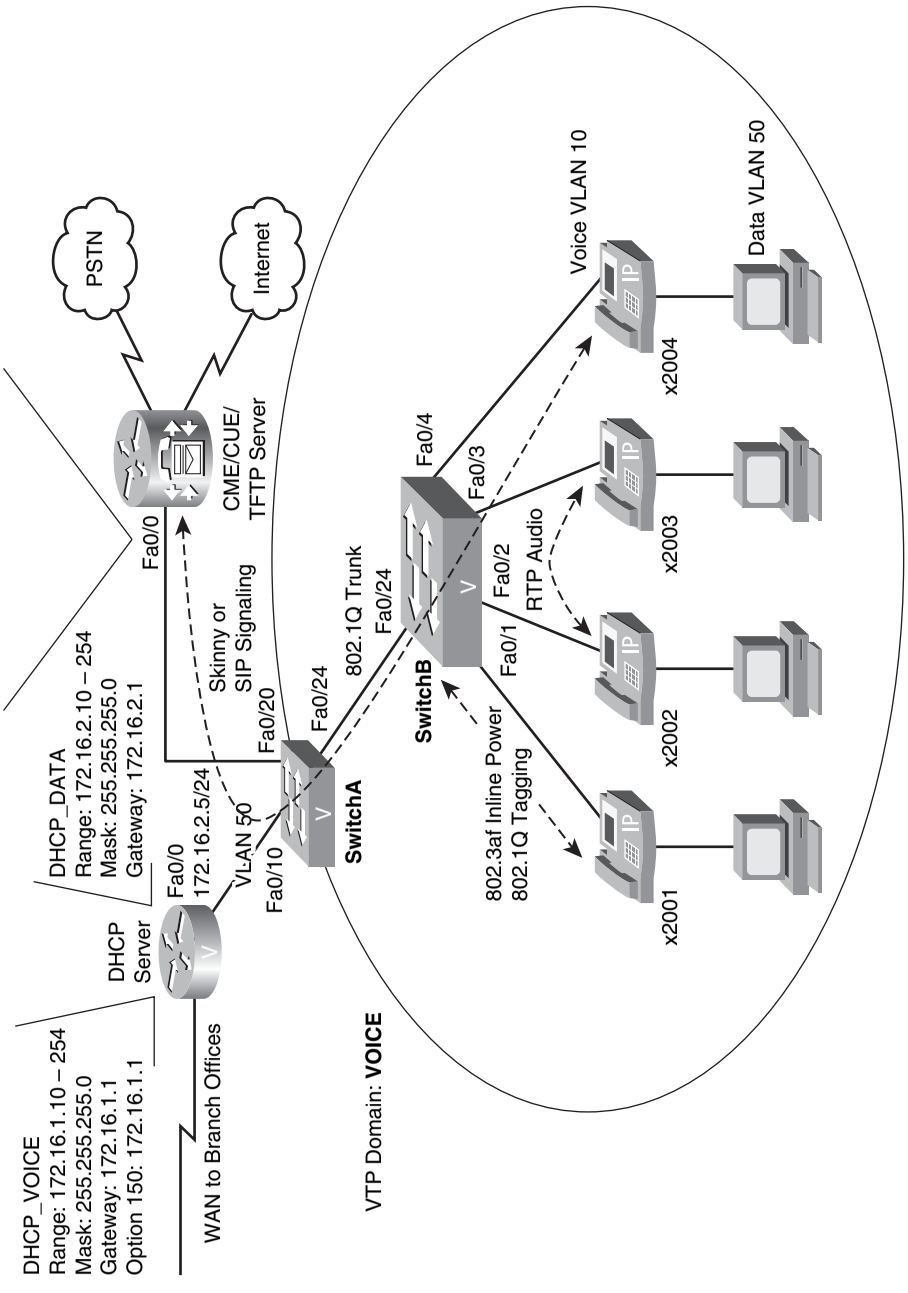

Figure 4.1 *VoIP Network Diagram*

The network diagram pictured in Figure 4.1 shows a separate router connecting to the corporate branch offices. From a design standpoint, this functionality could be integrated into the Cisco Unified CME router as well. CME is able to integrate into other VoIP or TDM network environments. Figure 4.2 illustrates potential integration scenarios.

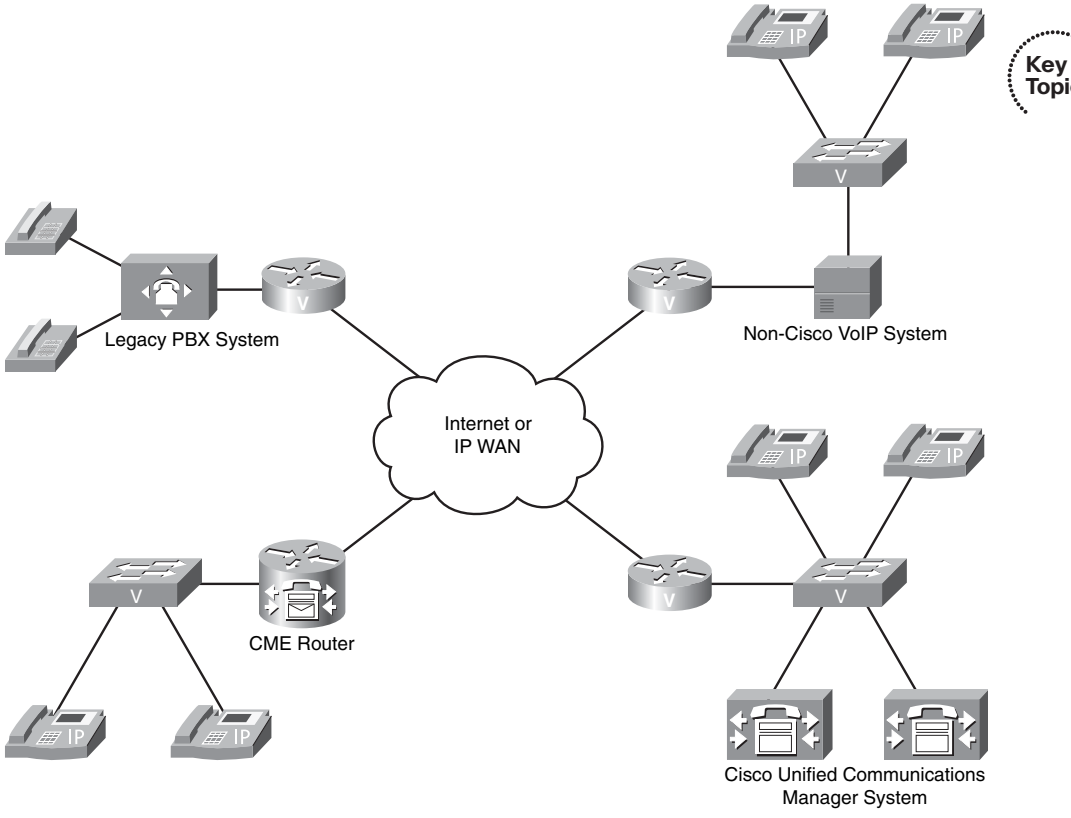

Figure 4.2 *CME Integration Scenarios*

A network using the design shown in Figure 4.2 would be able to place calls between any of the network systems shown using the IP WAN as a transport. The PSTN would still exist at each of these locations but would be used as a backup connection should a WAN failure at any or all of the locations occur.

Note Chapter 7, "Gateway and Trunk Concepts," and Chapter 8, "Configuring and Verifying Gateways and Trunks," discuss the specifics of integrating the Cisco Unified CME system with other VoIP and TDM systems.

Licensing and Models for Cisco Unified CME

Alas, all is not free in the world of IP telephony. To legally operate a Cisco Unified CME system, you must purchase three types of licenses:

- **IOS license:** The CME router must be licensed to run a version of Cisco IOS that is capable of supporting the CME software.
- **Feature license:** The feature license (also known as seat license) grants the CME router the ability to support a specific number of IP phones. These licenses are sold in incremental blocks
- **Phone user licenses:** You must purchase one phone user license for each Cisco IP phone supported by the CME system.

Often, vendors bundle the licenses with the Cisco Unified CME products being sold. For example, when you purchase a Cisco IP phone, it will come with a phone user license, allowing it to connect to a Cisco Unified CME or Cisco Unified Communications Manager system. The vendor may also bundle the CME router with the IOS license and a 24-seat feature license. Table 4.3 shows the current feature licenses available for the CME system.

Table 4.3 *Cisco Unified Communications Manager Express Feature Licenses*

Number of Phones	License
24	FL-CCME-SMALL
36	FL-CCME-36
48	FL-CCME-MEDIUM
96	FL-CCME-96
144	FL-CCME-144
168	FL-CCME-168
250	FL-CCME-250

You can add feature licenses incrementally to your system. For example, you might start with a network of 80 IP phones and purchase an FL-CCME-96 license, allowing the network to grow up to 96 IP phones. Once you grow beyond that, you could add on a FL-CCME-SMALL license incrementally to add an additional 24 phones per license purchase.

Once all your licensing is in place, you can begin to plan the model you would like to use for Cisco Unified CME. CME supports three different models of configuration:

- PBX
- Keyswitch
- Hybrid

Choosing a model does not "lock you in" to one configuration or another; rather, the model represents more of a design that you can use for your company. This section describes each of the three models.

PBX Model

Using a PBX model of configuration gives most of the IP phones in your system a unique extension number, as shown in Figure 4.3.

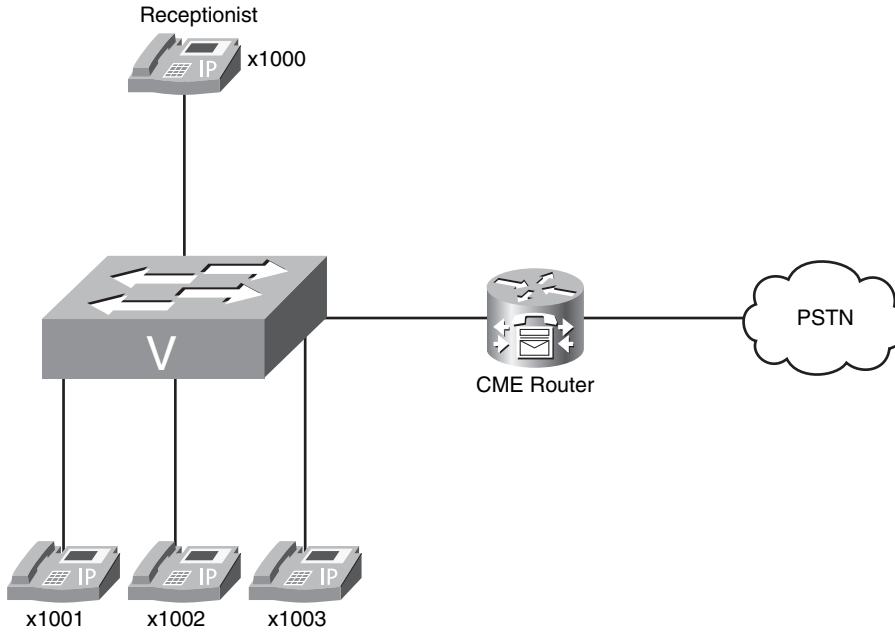

Figure 4.3 *Cisco Unified CME PBX Model*

In this model, users can dial each other using their own, unique extension numbers. To get an outside line to the PSTN, the user would first dial a 9 (or some other access code) and receive a second dial tone. A local receptionist or auto-attendant system running on the Cisco Unified CME router is responsible for distributing incoming calls from the PSTN to the users. If the company is large enough to warrant a Direct Inward Dial (DID) block of phone numbers, the CME can route incoming PSTN calls directly to the users.

Keyswitch Model

Using a keyswitch model of configuration mirrors the TDM keyswitch environment, which provided shared numbers to the phones supported by the system. Figure 4.4 illustrates a keyswitch model design.

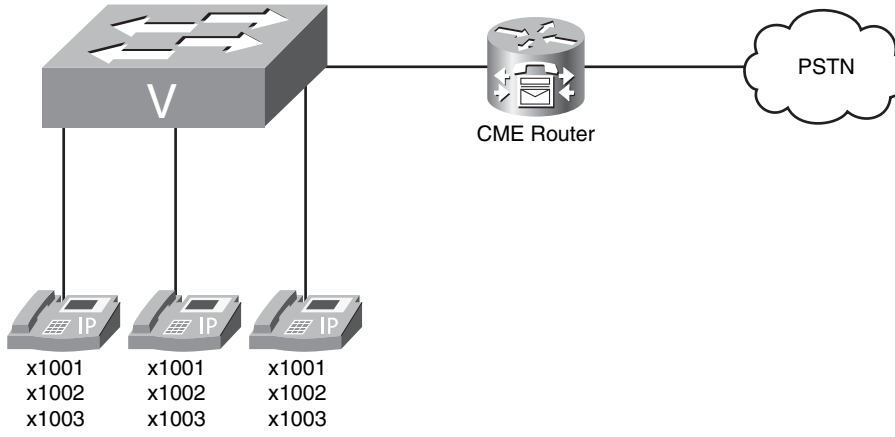

Figure 4.4 *Cisco Unified CME Keyswitch Model*

The receptionist is not included in the design in Figure 4.4 because keyswitch environments typically provide a 1:1 ratio between directory numbers on phones and PSTN circuits. For example, if an office has three incoming PSTN lines, the three lines on each phone map directly to one of these lines. When the Cisco Unified CME router receives an incoming call on the first PSTN line, it rings the first line of all the IP phones connected to the system. A receptionist may be present in the office; however, the office would be small enough that any employee could answer any line.

In a keyswitch environment, intra-office calls are rare because the office environment is small enough for a user to walk to another cubical or yell, "Hey Beth, pick up line 1!" over a cubical wall.

Hybrid Model

The hybrid model is useful for environments that want a keyswitch feel, where each line maps directly to a PSTN line, but also want to allow simple intra-office calling. In a pure keyswitch environment with three lines on each phone, an intra-office call between two employees would use up two of the lines, leaving only one line remaining for incoming or outgoing PSTN calls. In the hybrid model, each user would receive a unique extension in addition to the shared "keyswitch" lines, as shown in Figure 4.5.

Depending on your configuration, the extension unique to each user may or may not be able to reach the PSTN. If you have a limited number of PSTN lines available at the office, you may want to restrict PSTN access from the unique extension on each phone. You can also have this unique extension be the default active line when the user picks up the phone so that a user does not temporarily tie up one of the shared, PSTN lines each time the receiver is lifted.

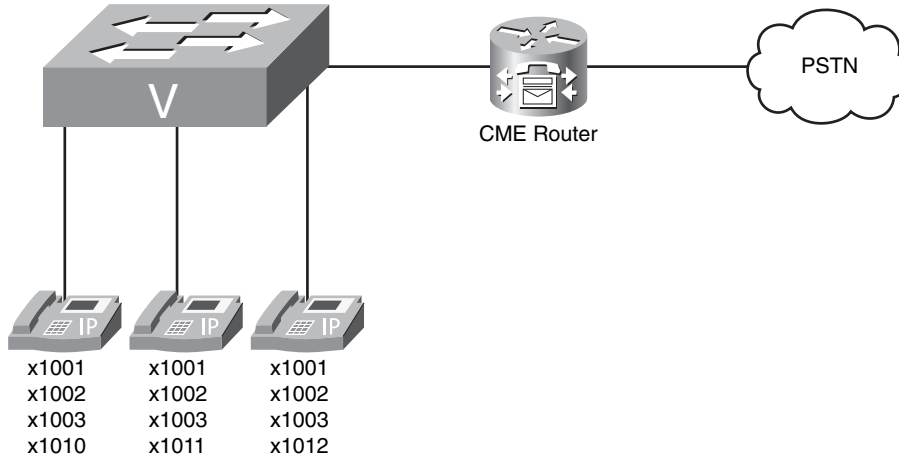

Figure 4.5 *Cisco Unified CME Hybrid Model*

Installing Unified CME on a Cisco Router

One advantage of Cisco IOS is the ease of installation and upgradability. To perform an IOS installation or upgrade, you can set up a TFTP server on your PC, download IOS from Cisco.com, and then enter a command similar to the following:

```
Router# copy tftp://172.16.2.5/c2801-adventerprisek9-mz.124-19.bin flash:
```

Assuming your TFTP server is working correctly and assigned the IP address 172.16.2.5, the single BIN IOS file would copy over. Once you reboot the router, you would be running the new IOS version.

Installing Cisco Unified CME is not quite as simple. Rather than being an all-in-one BIN file, the CME software is a series of files, which breaks down into the following categories:

- **Basic files:** The core files needed to run CME. This file set includes the firmware files that the Cisco IP phones need to operate.
- **GUI files:** The files required to power the CME web-based management utility.
- **XML template file:** The file that dictates the structure of the CME web-based management utility. Editing this file allows you to create different levels of administrators (such as a CME administrator who can only modify IP phone configurations through the web-based utility).
- **MOH files:** Audio files used for Music on Hold (MOH).
- **Script files:** Various Tool Command Language (Tcl) script files to provide more advanced functionality to CME (such as auto-attendant and automatic call distributor [ACD] functions).
- **Miscellaneous files:** Additional files that allow you to have custom ringtones or different backgrounds on select models of Cisco IP phones.

Performing a full installation of the Cisco Unified CME software adds around 150 files to the flash memory of your router. If you were to download each of these files manually and copy them one by one, it could be an all-day process just to get the CME files in place. To save you some pain, Cisco has introduced the **archive** command in the IOS syntax, which allows you to extract a group of files to flash all at once.

Note Many routers ship with the Cisco Unified CME software conveniently preinstalled. However, with the speed of change in the VoIP world, it won't be long before you find yourself upgrading the CME version or firmware files for your Cisco IP phones. You can use the following processes for clean installs or upgrades of the CME software.

To perform an installation of the CME files on your router, you must first download the appropriate files from the Cisco website. Figure 4.6 gives you an idea of what the CME file download area looks like.

Select a File to Download

Sort by: Filename Go

Filename	Release	Date	Size (Bytes)
cme-full-4.3.0.0.tar CME 4.3 Full System Files for IOS 12.4(15)XZ releases, includes MOH and GUI files, BACD prompts, Ringtones, 7970 Backgrounds, and all phone loads (except 7905)	4.3.0.0	02-MAY-2008	68423168
cme-basic-4.3.0.0.tar CME 4.3 basic system files for IOS 12.4(15)XZ releases, includes GUI files and Basic Phone Loads (7906/11, 7921, 7937, 7941/61)	4.3.0.0	02-MAY-2008	32422912
cme-gui-4.2.0.4.tar CME 4.2 GUI files for IOS 12.4(11)XW6 and later releases with updated GUI. Includes additional support for 7942/7945/7965/7975 phones and extension mobility.	4.2.0.4	25-APR-2008	815104
directxfer.aef Direct Transfer system script that allows system to transfer outside caller into users voice mail box on CUE - also used in UCC Mobility installations.	1.0	25-APR-2008	18032
Cisco-CUCME-TSP-2.1.2.exe Cisco Unified Communications Manager Express Telephony Service Provider (TSP) 2.1.2 - Compatible CME Version:4.1 using 12.4(15)T1 or later IOS. Provides support for Windows Vista.	2.1.2	13-MAR-2008	4931954
cme-gui-4.1.0.2.tar CME 4.1 GUI files 4.1.0.2 for IOS 12.4(11)XJ and 12.4(15)T releases, with additional support for 7942/7945 /7965/7975 phones	4.1.0.2	11-MAR-2008	827392
moh.zip CME MOH files recorded at different volumes	1.0	10-MAR-2008	1264530

Figure 4.6 *CME Software Download Page*

As you can see, Cisco offers many different "packs" of files, such as the basic files, GUI files, or MOH files. In addition, there is also a full CME pack of files, which includes all the files in the previous bulleted list in a single TAR archive.

Note TAR archives (files with a .tar extension) are the only files that you can extract into the router flash memory by using the **archive** command.

Cisco offers these different file packs as options for you to download and install. These CME file packs give you flexibility to install only the files you want. For example, you may only have enough flash memory on your router for the CME basic and GUI files. In this case, you can install just those components. Likewise, some may prefer to manage

the CME system solely from the command line. In this case, there is no reason to use up valuable router flash space with the CME GUI files.

To install the full CME software package onto a router, obtain the full TAR file from Cisco and place the file on your TFTP server (which should be accessible from your Cisco router). Then issue the command shown in Example 4.1.

Example 4.1 *Installing CME Files into Flash Memory*

```
CME_Voice# archive tar /xtract tftp://172.16.2.5/cme-full-4.3.0.0.tar flash:
Loading cme-full-4.3.0.0.tar from 172.16.2.5 (via FastEthernet0/0): !
bacdprompts/ (directory) 0 (bytes)
extracting bacdprompts/app-b-acd-2.1.2.2-ReadMe.txt (18836 bytes)
extracting bacdprompts/app-b-acd-2.1.2.2.tcl (24985 bytes)
extracting bacdprompts/app-b-acd-aa-2.1.2.2.tcl (35485 bytes)
extracting bacdprompts/en_bacd_allagentsbusy.au (75650 bytes)
extracting bacdprompts/en_bacd_disconnect.au (83291 bytes)
extracting bacdprompts/en_bacd_enter_dest.au (63055 bytes)!
extracting bacdprompts/en_bacd_invalidoption.au (37952 bytes)
extracting bacdprompts/en_bacd_music_on_hold.au (496521 bytes)!!
extracting bacdprompts/en_bacd_options_menu.au (123446 bytes)
extracting bacdprompts/en_bacd_welcome.au (42978 bytes)
extracting bacdprompts/en_bacd_xferto_operator.au (34794 bytes)!
extracting CME43-full-readme-v.2.0.txt (22224 bytes)
Desktops/ (directory)
Desktops/320x212x12/ (directory)
extracting Desktops/320x212x12/CampusNight.png (131470 bytes)
extracting Desktops/320x212x12/CiscoFountain.png (80565 bytes)!
extracting Desktops/320x212x12/List.xml (628 bytes)
extracting Desktops/320x212x12/MorroRock.png (109076 bytes)
extracting Desktops/320x212x12/NantucketFlowers.png (108087 bytes)
extracting Desktops/320x212x12/TN-CampusNight.png (10820 bytes)
extracting Desktops/320x212x12/TN-CiscoFountain.png (9657 bytes)
extracting Desktops/320x212x12/TN-Fountain.png (7953 bytes)
extracting Desktops/320x212x12/TN-MorroRock.png (7274 bytes)!
extracting Desktops/320x212x12/TN-NantucketFlowers.png (9933 bytes)
extracting Desktops/320x212x12/Fountain.png (138278 bytes)
gui/ (directory)
extracting gui/Delete.gif (953 bytes)
extracting gui/admin_user.html (3845 bytes)
extracting gui/admin_user.js (647358 bytes)!!!
!output omitted
```

As you can see, the cme-full-4.3.0.0.tar file is expanded into the flash of the router. The output shown in Example 4.1 is only one page out of five pages of files that would copy into the router's flash. Now imagine copying each one of those files one by one using the **copy** command. No thanks!

Note Example 4.1 demonstrates how to install the full CME package onto a router. You can follow a similar process if you only want to install individual components.

Configuring the Cisco Unified CME Router as a TFTP Server

Now that you have the Cisco Unified CME files installed into the router flash, you can configure the CME router as a TFTP server. Before diving right into the syntax, let's review *why* we are making the CME router a TFTP server. The following is the boot process of a Cisco IP phone:

1. The Cisco IP phone connects to an Ethernet switchport. If the IP phone and switch support PoE, the IP phone receives power through either Cisco Proprietary PoE or 802.3af PoE.
2. As the Cisco IP phone powers on, the Cisco switch delivers voice VLAN information to the IP phone using CDP as a delivery mechanism. The Cisco IP phone now knows what VLAN it should use.
3. The Cisco IP phone sends a DHCP request asking for an IP address on its voice VLAN. The router connecting to the voice VLAN receives this DHCP request and, through the **ip helper-address** command, forwards the request directly to the DHCP server.
4. The DHCP server responds with an IP address offer. When the Cisco IP phone accepts the offer, it receives all the DHCP options that go along with the DHCP request. DHCP options include items such as default gateway, DNS server information, domain name information, and so on. In the case of Cisco IP phones, a unique DHCP option is included known as Option 150. This option directs the IP phone to a TFTP server.
5. When the Cisco IP phone has the IP address of the TFTP server, it contacts the TFTP server and downloads its firmware and configuration files. Included in the configuration file is a list of valid call processing agents (such as Cisco Unified Communications Manager or CME agents).
6. The Cisco IP phone attempts to contact the first call processing server (the primary server) listed in its configuration file to register. If this fails, the IP phone moves to the next server in the configuration file. This process continues until the IP phone registers successfully or the list of call processing agents is exhausted.

Chapter 3 completed up through Step 4 of the boot process. The Cisco IP phone received its IP address information from the DHCP server and now has the IP address of the TFTP server (from DHCP Option 150), which is going to be the Cisco Unified CME router. But, as of yet, the CME router is not acting as a TFTP server. The CME router needs to hand out both the phone firmware (for whichever applicable Cisco IP phone models you are using) and the necessary phone configuration files. Otherwise, the Cisco IP phones will reach Step 5 of the boot process and stop.

Cisco routers will allow you to turn them into TFTP servers to serve files from the router's flash memory. Now, you do not want to serve up the *entire* flash memory of your router to the TFTP service. Otherwise, unauthorized users could download copies of your router's IOS or other sensitive files stored in flash. Instead, you must specify exactly what files are served from the flash memory.

In the "old days" of the CME software, this used to be a major challenge, because CME would dump all its software files into a flat directory in your router flash. That's right; you would enter **dir flash:** and see 100+ CME files without any subdirectories to organize them. You would then have to weed through the files and use extensive documentation to figure out which firmware files belonged to each phone (the firmware files have names such as P00308000500.bin, so it was not obvious just based on the filename). Thankfully, in the newer versions of CME software, that has all changed. The phone firmware files are all organized in subdirectories that make it clear which files belong to each. Example 4.2 shows the directory listings of the router's flash after installing the CME full TAR package.

Example 4.2 *Verifying Installed CME Files*

```
CME_Voice# dir flash:
Directory of flash:/

    1  -rw-    32999900  May 12 2008 21:28:00 -07:00  c2801-adventerprisek9-mz.124-
19.bin
    2  drw-           0  Jun 10 2008 14:57:20 -07:00  bacdprompts
   14  -rw-       22224  Jun 10 2008 14:57:30 -07:00  CME43-full-readme-v.2.0.txt
   15  drw-           0  Jun 10 2008 14:57:30 -07:00  Desktops
   28  drw-           0  Jun 10 2008 14:57:36 -07:00  gui
   46  -rw-      496521  May 12 2008 21:30:00 -07:00  music-on-hold.au
   47  drw-           0  May 12 2008 21:30:00 -07:00  phone
  128  drw-           0  May 12 2008 21:35:46 -07:00  ringtones
129996800 bytes total (28583936 bytes free)

CME_Voice# dir flash:/phone
Directory of flash:/phone/
   48  drw-           0  May 12 2008 21:30:00 -07:00  7945-7965
   57  drw-           0  May 12 2008 21:30:34 -07:00  7937
   59  drw-           0  May 12 2008 21:31:12 -07:00  7914
   61  drw-           0  May 12 2008 21:31:12 -07:00  7906-7911
   70  drw-           0  May 12 2008 21:31:46 -07:00  7920
   72  drw-           0  May 12 2008 21:31:52 -07:00  7931
   80  drw-           0  May 12 2008 21:32:24 -07:00  7942-7962
   89  drw-           0  May 12 2008 21:32:58 -07:00  7921
   97  drw-           0  May 12 2008 21:33:54 -07:00  7940-7960
  102  drw-           0  May 12 2008 21:34:02 -07:00  7970-7971
  111  drw-           0  May 12 2008 21:34:36 -07:00  7975
  119  drw-           0  May 12 2008 21:35:12 -07:00  7941-7961
```

continues

Example 4.2 *Verifying Installed CME Files continued*

```
129996800 bytes total (28583936 bytes free)

CME_Voice# dir flash:/phone/7940-7960
Directory of flash:/phone/7940-7960/
   98  -rw-      129824  May 12 2008 21:33:56 -07:00  P00308000500.bin
   99  -rw-         458  May 12 2008 21:33:56 -07:00  P00308000500.loads
  100  -rw-      705536  May 12 2008 21:34:00 -07:00  P00308000500.sb2
  101  -rw-      130228  May 12 2008 21:34:00 -07:00  P00308000500.sbn
129996800 bytes total (28583936 bytes free)
```

As you dig deeper in the router flash directory listing, you can find the actual firmware files that are used for the IP phones. Example 4.3 shows output for the Cisco 7940 and 7960 IP Phone models. Now that you know the names of the firmware files, you can make them available through TFTP.

Example 4.3 *Configuring Router-Based TFTP Services for IP Phone Firmware Files*

Key Topic

```
CME_Voice# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CME_Voice(config)# tftp-server flash:/phone/7940-7960/P00308000500.bin alias
  P00308000500.bin
CME_Voice(config)# tftp-server flash:/phone/7940-7960/P00308000500.loads alias
  P00308000500.loads
CME_Voice(config)# tftp-server flash:/phone/7940-7960/P00308000500.sb2 alias
  P00308000500.sb2
CME_Voice(config)# tftp-server flash:/phone/7940-7960/P00308000500.sbn alias
  P00308000500.sbn
```

The **alias** syntax that follows the **tftp-server** command allows the firmware file to be requested simply by asking for the aliased filename. This is necessary in the newer CME versions, which organize the firmware files into subdirectories. The Cisco IP phones do not know the full path to the firmware file; they only ask for the firmware filename.

Note Be sure to make all the firmware files in each subdirectory available through TFTP. The Cisco IP phones will use most, if not all, of these files during the boot process.

The firmware files for the Cisco 7940 and 7960 IP Phones are now available via TFTP from the Cisco Unified CME router. You can repeat this process as many times as necessary to make the firmware files available for the additional models of IP phones you have on your network.

Note There may be models of Cisco IP phones that are supported by Cisco Unified CME whose firmware files are not contained in the CME full TAR package. The firmware files for these IP phone models can be individually downloaded from the Cisco website and placed into the router's flash memory. This same principle also applies for IP phone firmware that has been upgraded since the CME software release you are using.

Configuring the Cisco Unified CME System-Level Functions

Now that the Cisco Unified CME router is serving up the correct firmware files, you can get into the configuration of the CME system itself. You can configure just about all of the CME settings from the telephony-service configuration mode, which you access simply by entering **telephony-service** from global configuration mode.

Four key system-level functions need to be specified in order for the CME router to begin supporting IP phones:

- Maximum phones and directory numbers
- Firmware load files
- Source IP address information
- Generated configuration files

The following sections describe each system-level function.

Maximum Phones and Directory Numbers

Before the Cisco Unified CME router can begin registering and supporting IP phones, it needs to know the number of phones and directory numbers it will be supporting. By default, both values are set to zero, so the router will not support any VoIP devices. To configure this value, you can use the syntax shown in Example 4.4.

Example 4.4 *Provisioning CME Phone and Directory Number Support*


```
CME_Voice(config)# telephony-service
CME_Voice(config-telephony)# max-ephones ?
  <1-30>  Maximum phones to support
CME_Voice(config-telephony)# max-ephones 24
CME_Voice(config-telephony)# max-dn ?
  <1-150>  Maximum directory numbers supported
  <cr>
CME_Voice(config-telephony)# max-dn 48
```

The **max-ephones** parameter configures the maximum number of IP phones the router will support, whereas the **max-dn** parameter specifies the maximum number of directory numbers.

Note These parameters directly affect how much memory the router reserves to support the CME service. Setting the value much higher than you actually need may reserve excessive resources on your router and impact other network services.

In addition, the **max-ephones** parameter should not be any higher than the number of feature licenses you have purchased for your CME system.

Firmware Load Files

In the section "Configuring the Cisco Unified CME Router as a TFTP Server," you saw how to configure the CME router to serve the phone firmware files via TFTP. You must now tell the telephony service which firmware files it should use for the various models of Cisco IP phones it will be supporting. This can be done under the telephony-service configuration mode by using the **load** command, as shown in Example 4.5.

Example 4.5 *Specifying Firmware Loads for Cisco IP Phones*

```
CME_Voice(config-telephony)# load ?
  12SP       Select the firmware load file for 12SP+ and 30VIP phones
  7902       Select the firmware load file for 7902
  7905       Select the firmware load file for 7905
  7910       Select the firmware load file for Telecaster 7910 phones
  7912       Select the firmware load file for 7912
  7914       Select the firmware load file for sidecar 7914
  7920       Select the firmware load file for 7920
  7935       Select the firmware load file for 7935 Conference Station
  7936       Select the firmware load file for 7936
  7960-7940  Select the firmware load file for Telecaster 7960 & 7940 phones
  7970       Select the firmware load file for 7970
  7971       Select the firmware load file for 7971
  ATA        Select the firmware load file for ATA
CME_Voice(config-telephony)# load 7960 ?
  WORD  firmware filename for Telecaster 7960 & 7940 [without .bin]
CME_Voice(config-telephony)# load 7960 P00308000500
Updating CNF files
CNF files updating complete
CME_Voice(config-telephony)#
```

Notice that after you enter the **load ?** command, the CME router displays all supported Cisco IP phone models. You need to enter a unique **load** command for each IP phone model you are using in your Cisco Unified CME system. Only enter the firmware filename; do not enter the .bin extension.

Note Because the newer Cisco Unified CME software creates a directory structure in the flash memory, be sure you have aliased each of the firmware files using the **tftp-server** syntax discussed earlier in this chapter. The Cisco IP phones simply ask for a firmware filename during the boot process; they do not specify subdirectory information.

To put all the pieces into place, the syntax in Example 4.6 walks through the complete TFTP server and load configuration for the Cisco 7970 and 7971 IP Phones.

Example 4.6 *Configuring CME for 7970 and 7971 Firmware Loads*

```
CME_Voice# dir flash:/phone
Directory of flash:/phone/
   48  drw-           0  May 12 2008 21:30:00 -07:00  7945-7965
   57  drw-           0  May 12 2008 21:30:34 -07:00  7937
   59  drw-           0  May 12 2008 21:31:12 -07:00  7914
   61  drw-           0  May 12 2008 21:31:12 -07:00  7906-7911
   70  drw-           0  May 12 2008 21:31:46 -07:00  7920
   72  drw-           0  May 12 2008 21:31:52 -07:00  7931
   80  drw-           0  May 12 2008 21:32:24 -07:00  7942-7962
   89  drw-           0  May 12 2008 21:32:58 -07:00  7921
   97  drw-           0  May 12 2008 21:33:54 -07:00  7940-7960
  102  drw-           0  May 12 2008 21:34:02 -07:00  7970-7971
  111  drw-           0  May 12 2008 21:34:36 -07:00  7975
  119  drw-           0  May 12 2008 21:35:12 -07:00  7941-7961
129996800 bytes total (28583936 bytes free)
CME_Voice# dir flash:/phone/7970-7971
Directory of flash:/phone/7970-7971/
  103  -rw-     2494499  May 12 2008 21:34:14 -07:00  apps70.8-3-2-27.sbn
  104  -rw-      547706  May 12 2008 21:34:16 -07:00  cnu70.8-3-2-27.sbn
  105  -rw-     2456051  May 12 2008 21:34:28 -07:00  cvm70sccp.8-3-2-27.sbn
  106  -rw-      530601  May 12 2008 21:34:32 -07:00  dsp70.8-3-2-27.sbn
  107  -rw-      538527  May 12 2008 21:34:34 -07:00  jar70sccp.8-3-2-27.sbn
  108  -rw-         638  May 12 2008 21:34:36 -07:00  SCCP70.8-3-3S.loads
  109  -rw-         642  May 12 2008 21:34:36 -07:00  term70.default.loads
  110  -rw-         642  May 12 2008 21:34:36 -07:00  term71.default.loads
129996800 bytes total (28583936 bytes free)
CME_Voice# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CME_Voice(config)# tftp-server flash:/phone/7970-7971/apps70.8-3-2-27.sbn alias
  apps70.8-3-2-27.sbn
```

continues

Example 4.6 *Configuring CME for 7970 and 7971 Firmware Loads continued*

```
CME_Voice(config)# tftp-server flash:/phone/7970-7971/cnu70.8-3-2-27.sbn alias
  cnu70.8-3-2-27.sbn
CME_Voice(config)# tftp-server flash:/phone/7970-7971/cvm70sccp.8-3-2-27.sbn alias
  cvm70sccp.8-3-2-27.sbn
CME_Voice(config)# tftp-server flash:/phone/7970-7971/dsp70.8-3-2-27.sbn alias
  dsp70.8-3-2-27.sbn
CME_Voice(config)# tftp-server flash:/phone/7970-7971/jar70sccp.8-3-2-27.sbn alias
  jar70sccp.8-3-2-27.sbn
CME_Voice(config)# tftp-server flash:/phone/7970-7971/SCCP70.8-3-3S.loads alias
  SCCP70.8-3-3S.loads
CME_Voice(config)# tftp-server flash:/phone/7970-7971/term70.default.loads alias
  term70.default.loads
CME_Voice(config)# tftp-server flash:/phone/7970-7971/term71.default.loads alias
  term71.default.loads
CME_Voice(config)# telephony-service
CME_Voice(config-telephony)# load ?
  12SP       Select the firmware load file for 12SP+ and 30VIP phones
  7902       Select the firmware load file for 7902
  7905       Select the firmware load file for 7905
  7910       Select the firmware load file for Telecaster 7910 phones
  7912       Select the firmware load file for 7912
  7914       Select the firmware load file for sidecar 7914
  7920       Select the firmware load file for 7920
  7935       Select the firmware load file for 7935 Conference Station
  7936       Select the firmware load file for 7936
  7960-7940  Select the firmware load file for Telecaster 7960 & 7940 phones
  7970       Select the firmware load file for 7970
  7971       Select the firmware load file for 7971
  ATA        Select the firmware load file for ATA
CME_Voice(config-telephony)# load 7970 SCCP70.8-3-3S.loads
Updating CNF files
CNF files update complete
CME_Voice(config-telephony)# load 7971 SCCP70.8-3-3S.loads
Updating CNF files
CNF files update complete
```

Note You might be wondering how to determine which of the firmware files should be specified in the **load** command. This information is available at Cisco.com by searching for **Cisco Unified CME Supported Firmware, Platforms, Memory, and Voice Products**. From the search results, pick the version of Cisco Unified CME you are using. The resulting page will show all the firmware files supported for each Cisco IP phone model. One of those files will have an asterisk next to it; this represents the file you should use with the **load** command.

Source IP Address Information

Before the Cisco Unified CME router can respond to the Cisco IP phones it is supporting, it must know what source IP address to use when communicating. This is specified using the command **ip source-address** from the telephony service configuration mode. Based on the network diagram shown earlier in Figure 4.1, the CME router should use the source IP address 172.16.1.1, which also acts as the default gateway for the Cisco IP phones in the network, as follows:

```
CME_Voice(config-telephony)# ip source-address 172.16.1.1
```

If the Cisco Unified CME router supports IP phones on multiple VLANs or has multiple interfaces the IP phones could use to reach the CME router, it is common to use a loopback interface as the source IP address. A loopback interface is a virtual interface on the router that is reachable as long as the router is online. The previous syntax set the CME source IP address to 172.16.1.1, which will work as long as the FastEthernet 0/0.10 interface is online. However, if that interface were to go offline, the CME router would not be able to provide service to IP phones through any other interface. Example 4.7 shows how to create a loopback interface on a Cisco router.

Example 4.7 *Configuring the CME Source IP Address*

```
CME_Voice# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CME_Voice(config)# interface loopback ?
  <0-2147483647>  Loopback interface number
CME_Voice(config)# interface loopback 0
CME_Voice(config-if)# ip address 172.16.254.254 255.255.255.255
CME_Voice(config-if)# exit
CME_Voice(config)# telephony-service
CME_Voice(config-telephony)# ip source-address 172.16.254.254
```

A few items to note about this configuration: first, notice the range of loopback interface numbers. Cisco enables you to create more than two billion loopback interfaces. Your router would most likely run out of memory if you tried this; however, this enables you to create as many loopback interfaces as you could practically use on the router.

Second, take a look at the subnet mask on the loopback interface IP address. This is known as a *host mask*. The router now knows that the loopback interface connects to only a single IP address instead of using up an entire subnet, as it would if you were to use a less-specific subnet mask. For example, if you used a Class C subnet mask (255.255.255.0 or /24) on the loopback interface, the router would now believe that the loopback interface connects to an entire Class C subnet of addresses. You would not be able to use the 172.16.254.0/24 addresses on any other interfaces of your router.

Finally, loopback interfaces come up automatically as long as the router is running. There is no need to enter the **no shutdown** command unless the loopback interface was manually shut down.

Once you create the loopback interface, you can then change the **ip source-address** command on the router to use the new loopback interface as a means of communicating with the IP phones.

Note In the VoIP network diagram shown in Figure 4.1 (and also Figure 3.1), there would be no real advantage to using a loopback interface because all the IP phones are located on VLAN 10 and can get to the router only through the single FastEthernet 0/0 interface. The loopback configuration would be advantageous when the IP phones have more than one path to reach the CME router.

Generated Configuration Files

The last area of configuration focuses on generating configuration files for the Cisco IP phones. Think back to the IP phone boot process: once the IP phone gets an IP address and TFTP server information from the DHCP server, it then attempts to contact the TFTP server to download its configuration file and firmware. Up to this point, there has been no discussion about that configuration file. So what is it?

The IP phone uses its configuration file to determine which IP address to use when contacting the CME router (specified via the **ip source-address** command in the previous section), the firmware file it should download, the IP phone's extension number (if it has one), and many other configuration items. You may have noticed the following output when looking through the previous syntax examples:

```
Updating CNF files
CNF files update complete
```

That output represents the Cisco Unified CME router updating the configuration files that are sent to the IP phones. This process occurs any time a change is made to the CME router that would affect the IP phone boot process (such as specifying new firmware files or source-address information). If you ever want to manually instruct the router to create the configuration files, use the command shown in Example 4.8 from telephony service configuration mode.

Example 4.8 *Generating IP Phone Configuration Files*


```
CME_Voice(config-telephony)# create cnf-files
CNF file creation is already On
Updating CNF files
CNF files update complete
```

At this point, the CME router does not have any configured IP phones, so it generates only generic configuration files. These generic configuration files allow IP phones to reach the CME router and download the necessary firmware files, but not much else. Once you configure the router to support IP phones, the CME router generates a unique configuration file for each phone with the information specific to the IP phone. Let's take a look at the generic configuration files generated so far, shown in Example 4.9.

Example 4.9 *Verifying Files Served by the CME TFTP Service*

```
CME_Voice# show telephony-service tftp-bindings
tftp-server system:/its/SEPDEFAULT.cnf
tftp-server system:/its/SEPDEFAULT.cnf alias SEPDefault.cnf
tftp-server system:/its/XMLDefault.cnf.xml alias XMLDefault.cnf.xml
tftp-server system:/its/ATADefault.cnf.xml
tftp-server system:/its/united_states/7960-tones.xml alias United_States/7960-
  tones.xml
tftp-server system:/its/united_states/7960-font.xml alias English_United_States/
  7960-font.xml
tftp-server system:/its/united_states/7960-dictionary.xml alias English_United_
  States/7960-dictionary.xml
tftp-server system:/its/united_states/7960-kate.xml alias English_United_States/
  7960-kate.xml
tftp-server system:/its/united_states/SCCP-dictionary.xml alias English_United_
  States/SCCP-dictionary.xml
```

The **show telephony-service tftp-bindings** command shows all the files the CME service itself is serving to the IP phones via TFTP. This is in addition to the files manually specified using the **tftp-server** command in global configuration mode. There is one file specifically that is of interest right now: XMLDefault.cnf.xml. This is the default configuration file handed out to any IP phone that does not have an existing configuration in the CME router (which is all IP phones at this point). Notice that all these files are located on the system: drive of your router. This drive represents the router's RAM. Each time the router is rebooted, these configuration files are rebuilt by the CME process using the configuration you have saved in NVRAM and placed back into the router's memory.

Using the **more** command, you can dig deeper into the contents of the XMLDefault.cnf.xml file, as shown in Example 4.10.

Example 4.10 *Inspecting the IP Phone Generic Configuration File*


```
CME_Voice# more system:/its/XMLDefault.cnf.xml
<Default>
<callManagerGroup>
<members>
<member  priority="0">
<callManager>
<ports>
```

continues

Example 4.10 *Inspecting the IP Phone Generic Configuration File continued*

```
<ethernetPhonePort>2000</ethernetPhonePort>
</ports>
<processNodeName>172.16.1.1</processNodeName>
</callManager>
</member>
</members>
</callManagerGroup>
<loadInformation6  model="IP Phone 7910"></loadInformation6>
<loadInformation124  model="Addon 7914"></loadInformation124>
<loadInformation9  model="IP Phone 7935"></loadInformation9>
<loadInformation8  model="IP Phone 7940">P00308000500</loadInformation8>
<loadInformation7  model="IP Phone 7960">P00308000500</loadInformation7>
<loadInformation20000  model="IP Phone 7905"></loadInformation20000>
<loadInformation30008  model="IP Phone 7902"></loadInformation30008>
<loadInformation30002  model="IP Phone 7920"></loadInformation30002>
<loadInformation30019  model="IP Phone 7936"></loadInformation30019>
<loadInformation30006  model="IP Phone 7970">SCCP70.8-3-3S.loads
  </loadInformation30006>
<loadInformation119  model="IP Phone 7971">SCCP70.8-3-3S.loads
  </loadInformation119>
<loadInformation30018  model="IP Phone 7961"></loadInformation30018>
<loadInformation30007  model="IP Phone 7912"></loadInformation30007>
</Default>
```

As you can see, XML files are formatted into various tags (if you have had experience with HTML, this is very similar). Each configuration item will have an open and close tag. For example, consider the following line:

```
<processNodeName>172.16.1.1</processNodeName>
```

This line tells the Cisco IP phone the IP address of the Cisco Unified CME router. The <processNodeName> tag opens the line and the </processNodeName> tag closes the line. The IP address information of the CME router is in between the tags. Looking through this default configuration file, you can see that three pieces of information are provided to the IP phone:

- The correct Ethernet port to use (which is always 2000, by default)
- The CME router IP address
- Phone firmware information

The Cisco Unified CME router has been configured with the correct firmware information only for the Cisco 7940, 7960, 7970, and 7971 IP Phone models, so the XMLDefault.cnf.xml file displays only these firmware images.

If you were to connect a Cisco IP phone to the network at this point, it would boot, retrieve the correct VLAN information, get its IP address, contact the TFTP server, and download the generic configuration and firmware files. If you were to look at one of these devices, the display screen would look like the image shown in Figure 4.7.

Figure 4.7 *Cisco IP Phone Using the CME Router Generic Configuration File*

You can see that the phone has registered, is receiving the correct date and time information, and has active softkeys on the bottom of the display window. However, there is no line information shown next to the line buttons. When the handset of the phone is lifted, no dial tone is played. You learn more about this topic in Chapter 5, "Basic CME IP Phone Configuration," where you will configure the IP phones in the CME router.

Exam Preparation Tasks

Review All the Key Topics

Review the most important topics in the chapter, noted with the key topics icon in the outer margin of the page. Table 4.4 lists and describes these key topics and identifies the page number on which each is found.

Table 4.4 *Key Topics for Chapter 4*

Key Topic Element	Description	Page Number
Table 4.2	Lists hardware platforms supporting CME	105
Figure 4.2	Shows possible CME integration scenarios	111
List	Discusses three types of CME licenses	112
Example 4.1	Configuration to install CME	117
List	Cisco IP phone boot process	118
Example 4.3	Configuration allowing CME router to act as TFTP server	120
Example 4.4	Key **max-ephones** and **max-dn** commands to enable CME services	121
Syntax	Key **ip source-address** command to enable CME services	125
Example 4.8	Command to generate IP phone configuration files	126
Example 4.10	Inside view of the XML Default.cnf.xml configuration file	127

Complete the Tables and Lists from Memory

Print a copy of Appendix C, "Memory Tables" (found on the CD), or at least the section for this chapter, and complete the tables and lists from memory. Appendix D, "Memory Tables Answer Key," also on the CD, includes completed tables and lists to check your work.

Definitions of Key Terms

Define the following key terms from this chapter, and check your answers in the glossary.

Survivable Remote Site Telephony (SRST)

IOS license

feature license

phone user license

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Numbers

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