CCVP Learning

Authorized Self-Study Guide

Implementing Cisco Unified Communications Manager

Part 1 (CIPT1)

Foundation learning for CIPT1 exam 642-446

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Implementing Cisco Unified Communications Manager, Part 1 (CIPT1)

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Foreword

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I hope you will find this guide to be an essential part of your exam preparation and professional development and a valuable addition to your personal library.

Drew Rosen
Manager, Learning & Development
Learning@Cisco
December 2007

Introduction

Professional certifications have been an important part of the computing industry for many years and will continue to become more important. Many reasons exist for these certifications, but the most popularly cited reason is that of credibility. All other considerations held equal, the certified employee/consultant/job candidate is considered more valuable than one who is not.

Goals and Methods

The most important aspect of this book is to provide knowledge and skills in unified communications deploying the Cisco Unified Communications Manager (CUCM) product. Another goal of this book is to assist in the Cisco IP Telephony (CIPT) exam, which is part of the Cisco Certified Voice Professional (CCVP) certification. The methods used in this book are designed to help in both your job and the CCVP CIPT exam. This book provides many questions at the end of each chapter to reinforce the chapter content. Additional test preparation software from companies such as SelfTest Software (http://www.selftestsoftware.com) will give you even more test preparation questions to prepare you for exam success.

One key methodology used in this book is 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. This book does not try to help you pass by memorization it helps you truly learn and understand the topics. The CIPT exam is one of the foundation topics in the CCVP certification, and the knowledge contained within this book is vitally important to consider yourself a truly skilled Unified Communications (UC) engineer. The book will help you pass the CIPT 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
- Providing practice exercises on the topics and the testing process via test questions at the end of each chapter

Who Should Read This Book?

This book is designed to be both a general CUCM book and a certification preparation book. This book is intended to provide you with the knowledge required to pass the CCVP CIPT exam.

Why should you want to pass the CCVP CIPT exam? The CIPT test is one of the milestones toward getting CCVP certification. The CCVP could mean a raise, promotion, new job, challenge, success, or recognition; ultimately, however, you get to say what it means to you. Certifications demonstrate that you are serious about continuing the learning process and professional development. In technology, it is impossible to remain at the same level as the technology all around you advances. Engineers must continuously retrain themselves; otherwise, they will find themselves with outdated commodity-based skill sets.

Strategies for Exam Preparation

The strategy you use for exam preparation might differ from strategies used by others based on skills, knowledge, experience, and finding the recipe that works best for you. If you have attended the CIPT course, you might take a different approach than someone who learned Cisco Unified Communications Manager on the job. Regardless of the strategy you use or the background you have, this book is designed to help you understand the material so that you can pass the exam.

How This Book Is Organized

The book covers the following topics:

- **Chapter 1, "Cisco Unified Communications Manager Architecture,"** discusses the Architecture and all the components involved. CUCM hardware requirements, operating system, database, signaling, licensing, and database replication are discussed.
- **Chapter 2, "Deployment Models,"** covers the deployment models in which CUCM can be used. This chapter introduces the technologies required for the different UC models. The advantages and disadvantages of each deployment model are considered.
- **Chapter 3, "Installation and Upgrade,"** discusses the installation and upgrade options of CUCM.
- **Chapter 4, "Administration,"** covers the various CUCM administration user interfaces.
- **Chapter 5, "Initial Configuration Settings,"** examines the network configuration, Network Time Protocol (NTP), and DHCP configuration options of CUCM. The chapter also covers frequently adjusted CUCM enterprise and service parameters.

- **Chapter 6, "Managing User Accounts,"** examines user account configuration in CUCM administration, the Bulk Administration tool (BAT), and the Lightweight Directory Access Protocol (LDAP).
- **Chapter 7, "Endpoints,"** covers the various Cisco Unified IP Phones and the features that they support. Third-party Session Initiation Protocol (SIP) endpoint support is covered, in addition to the Cisco IP Phone boot cycle and registration process.
- **Chapter 8, "Cisco Catalyst Switches,"** covers the power and voice VLAN requirements of the Cisco IP Phone. The Catalyst switch configurations are examined for both Native IOS and CatOS switches. The Cisco and IEEE power specifications are also covered.
- **Chapter 9, "CUCM Configuration,"** examines the configuration options and procedure for inserting an IP phone into the CUCM database. The chapter also covers the hardening of the Cisco IP Phone to mitigate security risks.
- **Chapter 10, "Configuring Voice Gateways,"** discusses the configuration of Media Gateway Control Protocol (MGCP) gateways in both CUCM administration and Cisco IOS.
- **Chapter 11, "Call Routing Components,"** covers the fundamentals of call routing and a public switched telephone network (PSTN) dial plan. Digit analysis and path selection are achieved through the use of the router pattern, route list, and route group CUCM configuration elements.
- **Chapter 12, "Digit Manipulation,"** covers the process of digit manipulation through calling and called-party transformation masks, translation patterns, prefixing digits, and digit discard instructions (DDI).
- **Chapter 13, "Calling Privileges,"** covers the process of class of service through the use of partitions and calling search spaces. The chapter also covers time-of-day routing through the use of time periods and time schedules.
- **Chapter 14, "Call Coverage,"** covers the topic of call-coverage paths through the use of a hunt pilot, hunt list, and line groups. Call-hunting flow is discussed via the various distribution algorithms supported in CUCM.
- **Chapter 15, "Media Resources,"** discusses the media resources supported in and through CUCM. The media resource topics include music on hold (MOH), conference bridges, annunciators, transcoders, and media termination points. Media resource allocation is discussed through the application of CUCM Media Resource Manager (MRM), media resource group list, and media resource groups.

- **Chapter 16, "User Features,"** covers various CUCM features, including do not disturb, call park, directed call park, call pickup, hold reversion, intercom, call back, barge, privacy, and IP phone features.
- **Chapter 17, "Presence-Enabled Speed Dials and Lists,"** covers presence theory and configuration through the use of presence groups, presence speed dials, and presence calling search spaces.
- **Chapter 18, "Voice-Mail System Integration,"** covers the process of integrating Cisco Unity voice mail with Cisco Unified Communications Manager. Topics include voice-mail profiles, voice-mail ports, message waiting indicators, voice-mail call flow, Cisco TAPI service providers (TSP), and voice-mail subscriber creation.
- **Chapter 19, "Cisco Unified Video Advantage,"** covers the Cisco Unified Video Advantage camera, software, and video-streaming fundamentals. Topics include the CUCM configuration of video-enabled IP phones, including call admission control (CAC) video requirements.
- **Appendix A, "Answers to Chapter Review Questions"**

CHAPTER 1

Cisco Unified Communications Manager Architecture

A Cisco Unified Communications deployment relies on Cisco Unified Communications Manager (CUCM) (formerly known as Cisco Unified CallManager) for its call-processing and call-routing functions. Understanding the role that CUCM plays in a converged network from a system, software, and hardware perspective is necessary for successfully installing and configuring CUCM.

This lesson introduces and describes the role, architecture, hardware and software requirements, and the licensing model of the CUCM.

Chapter Objectives

Upon completing this chapter, you will have an understanding of the CUCM architecture and be able to meet the following objectives:

- Describe the components of a Cisco Unified Communications solution and each component's functionality.
- Describe the architecture and role of CUCM.
- Describe the hardware requirements for CUCM.
- Describe the characteristics of the CUCM operating system.
- Describe the characteristics of the CUCM database and how it provides redundancy.
- Describe the licensing model of CUCM.
- Describe how to calculate, verify, and add license units to CUCM.

CUCM Overview

Cisco Unified Communications (UC) is an IP-based communications system integrating voice, video, data, and mobility products and applications. It enables more effective, secure communications and can transform the way in which we communicate. UC represents a communications paradigm shift like that of the invention of the telegraph. UC removes the geographic barriers of effective communications through the use of voice, video, and data integration. Business can be conducted with a fluidity that progresses and evolves with you. Information has been at our fingertips for a long time, but UC enables the sharing of this information to create knowledge and value.

Cisco UC is part of an integrated solution that includes network infrastructure, security, mobility, network management products, lifecycle services, flexible deployment and outsourced management options, end-user and partner financing packages, and third-party communication applications.

Cisco UC can drastically change the bottom line of business by creating more effective communications without losing the personal nature of a face-to-face conversation. More effective communication leads to reduced time to market and nimble transformation of business processes through collaboration.

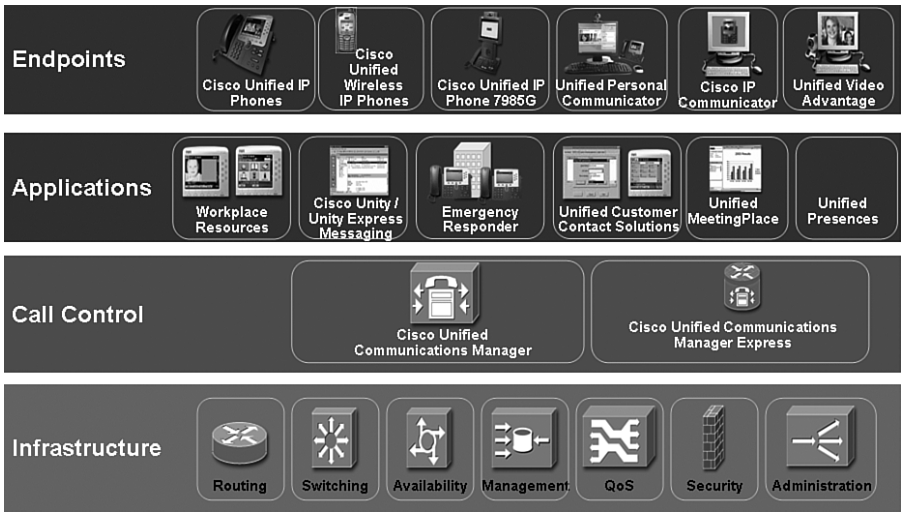
Cisco UC Solution Components

The Cisco UC strategy encompasses voice, video, and data traffic within a single network infrastructure. Cisco UC equipment is capable of managing all three traffic types and interfacing with all standards-based network protocols.

Cisco IP Communications represents a new way of delivering UC functionality to enterprise customers. Instead of delivering a collection of disjointed products with individual release dates, testing methodology, and documentation, Cisco UC is a coordinated release of an *integrated* set of products that are tested, documented, and supported *as a system*.

Figure 1-1 illustrates the four standard layers of the Cisco UC voice infrastructure model and the components that make up the layers.

Figure 1-1 *Cisco Unified Communications Solution Components*



The components of the standard layers are as follows:

- **Infrastructure layer**: The infrastructure consists of routers, switches, and voice gateways. The infrastructure layer carries data, voice, and video between all network devices and applications. This layer also provides high availability, management, quality of service (QoS), and network security.

- **Call control layer**: The call control layer provides for call processing, device control, and administration of the dial plan and features.

  Call control can be provided by a CUCM, CUCM Express, or CUCM Business Edition (CMBE). This book focuses on the CUCM product, which is almost identical to the Cisco Unified CMBE. Call processing is physically independent from the infrastructure layer. For example, a CUCM, Cisco Unified CMBE, or CUCM Express in San Jose can process call control for a device physically located in Chicago.

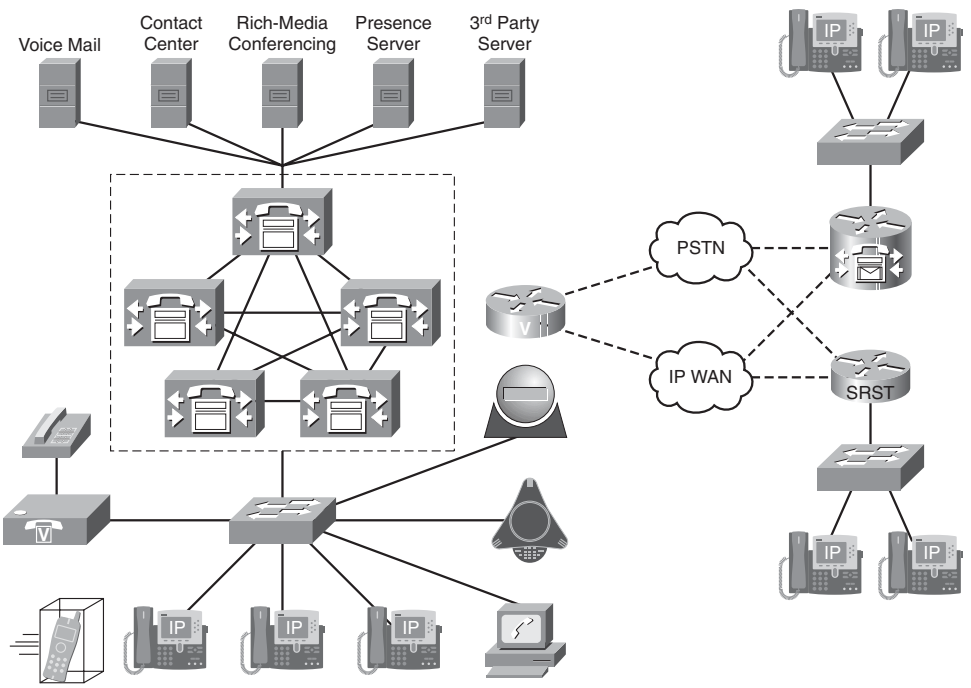
- **Applications layer**: Applications are independent from call-control functions and the physical voice-processing infrastructure. Applications, including those listed here, are integrated through IP, which allows the applications to reside anywhere within the network:
  - Voice mail, integrated messaging, and unified messaging applications are provided through Cisco Unity, Cisco Unity Express, or Cisco Unity Connections products.
  - Contact centers of various sizes can be built with Cisco Unified Contact Center and Cisco Unified Contact Center Express.
  - Cisco Unified MeetingPlace and MeetingPlace Express are medium- to large-scale conferencing servers that support video integration. The MeetingPlace product integrates lecture-style conferences with scalable collaboration and control tools. Cisco Unified MeetingPlace Express is positioned to the small to medium-sized enterprises. MeetingPlace Express is the successor of the Cisco Conference Connection server.
  - Cisco Emergency Responder (ER) enhances the existing emergency functionality offered by CUCM. Cisco ER provides physical location updates for mobile devices to guarantee that emergency calls to the public safety answering point (PSAP) are properly routed to the PSAP in charge of emergency calls for that site. Cisco ER identifies the caller location and maps all calls from that physical location to an emergency line identification number (ELIN) through the use of standard automatic number identification (ANI)/caller identification (CLID). The ELIN is registered with the PSAP as an Emergency Response Location (ERL). Deploying this capability helps ensure more effective compliance with legal or regulatory obligations, thereby reducing the life and liability risks related to emergency calls.
  - The Cisco Unified Presence server collects information about the availability and communications capabilities of a user and provides this information to watchers of the user as a status indication. The status information includes the user's communications device availability. For example, the user might be available via phone, video, web collaboration, or video-conferencing.
  - Standard protocol interfaces, including Telephony Application Programming Interface (TAPI), Java Telephony Application Programming Interface (JTAPI), Simple Object Access Protocol (SOAP), Q.SIG, H.323, Media Gateway Control Protocol (MGCP), and Session Initiation Protocol (SIP) are available to support third-party applications.

- **Endpoints layer**: The endpoints layer brings applications to the user, whether the end device is a Cisco IP Phone, a PC using a software-based phone, or a communications client or video terminal. Cisco UC provides multiprotocol support for Skinny Client Control Protocol (SCCP), H.323, MGCP, and SIP.

Cisco UC Network

The Cisco UC system delivers fully integrated communications, converging voice, video, and data over a single network infrastructure using standards-based protocols. The Cisco UC system delivers unparalleled performance and capabilities to address current and emerging communications needs in the enterprise environment, as illustrated by the network topology in Figure 1-2.

Figure 1-2 *Cisco UC Network*



The Cisco UC product suite is designed to optimize functionality, reduce configuration and maintenance requirements, and provide interoperability with a variety of other applications. It provides this capability while maintaining high availability, QoS, and security.

The Cisco UC system integrates the following major communications technologies:

- **IP telephony**: IP telephony refers to technology that transmits voice communications over a network using IP standards. Cisco UC includes a wide array of hardware and software products such as call-processing agents, IP phones, voice-messaging systems, video devices, conferencing, and many other applications.
- **Customer contact center**: Cisco Unified Contact Center products are a combination of strategy and architecture to revolutionize call center environments. Cisco Unified Contact Center promotes efficient and effective customer communications across large networks by enabling organizations to draw from a broader range of resources to service customers. These resources include access to a large pool of agents and multiple channels of communication and customer self-help tools.
- **Video telephony**: The Cisco Unified Video Advantage products enable real-time video communications and collaboration using the same IP network and call-processing agent as Cisco UC. Cisco Unified Video Advantage does not require special end-user training. Video calling with Cisco Unified Video Advantage is as easy as dialing a phone number.
- **Rich-media conferencing**: Cisco Unified MeetingPlace creates a virtual meeting environment with an integrated set of IP-based tools for voice, video, and web conferencing.
- **Third-party applications**: Cisco works with leading-edge companies to provide the broadest selection of innovative third-party IP communications applications and products focused on critical business needs such as messaging, customer care, and workforce optimization.

CUCM Functions

CUCM extends enterprise telephony features and functions to packet telephony network devices. These packet telephony network devices include Cisco IP Phones, media-processing devices, VoIP gateways, and multimedia applications. Additional data, voice, and video services, such as converged messaging, multimedia conferencing, collaborative contact centers, and interactive multimedia response systems, interact with the IP telephony solution through the CUCM application programming interface (API).

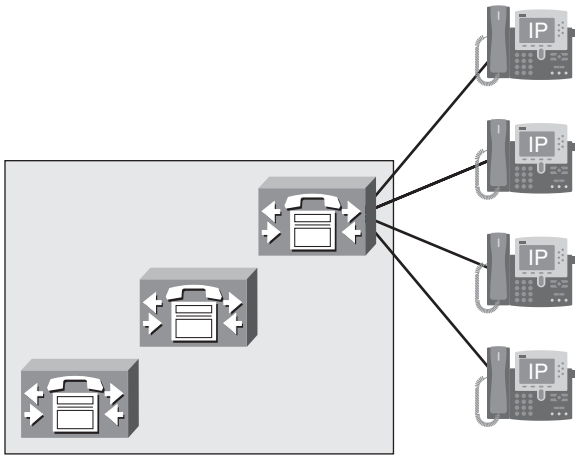
CUCM provides these functions:

- **Call processing**: Call processing refers to the complete process of originating, routing, and terminating calls, including any billing and statistical collection processes.

- **Signaling and device control**: CUCM sets up all the signaling connections between call endpoints and directs devices such as phones, gateways, and conference bridges to establish and tear down streaming connections. Signaling is also referred to as call control and call setup/call teardown.
- **Dial plan administration**: The dial plan is a set of configurable lists that CUCM uses to perform call routing. CUCM is responsible for digit analysis of all calls. CUCM enables users to create scalable dial plans.
- **Phone feature administration**: CUCM extends services such as hold, transfer, forward, conference, speed dial, redial, call park, and many other features to IP phones and gateways.
- **Directory services**: CUCM uses its own database to store user information. User authentication is performed locally or against an external directory. Directory synchronization allows for centralized user management. Directory synchronization allows CUCM to leverage users already configured in a corporate-wide directory. Microsoft Active Directory (2000 and 2003), Netscape 4.*x*, iPlanet 5.1, and Sun ONE 5.2 directory integrations are supported. The local CUCM database is a Lightweight Directory Access Protocol (LDAP)-compliant database (LDAPv3) component in the IBM Informix Database Server (IDS).
- **Programming interface to external applications**: CUCM provides a programming interface to external applications such as Cisco IP SoftPhone, Cisco IP Communicator, Cisco Unified IP Interactive Voice Response (IP IVR), Cisco Personal Assistant, Cisco Unified Personal Communicator, and CUCM Attendant Console.
- **Backup and restore tools**: CUCM provides a Disaster Recovery System (DRS) to back up and restore the CUCM configuration database. The DRS system also backs up call details records (CDR), call management records (CMR), and the CDR Analysis and Reporting (CAR) database.

Figure 1-3 shows IP phones that logically register with one of the CUCMs in the cluster. Multiple CUCM servers share one database, and the phone maintains an active connection to both the primary and backup CUCM server. The figure shows the phone's logical TCP/IP connections to the primary server.

Figure 1-3 *CUCM Functions*



CUCM Signaling and Media Paths

CUCM uses SIP or SCCP to communicate with Cisco IP Phones for call setup and teardown and for supplementary service tasks.

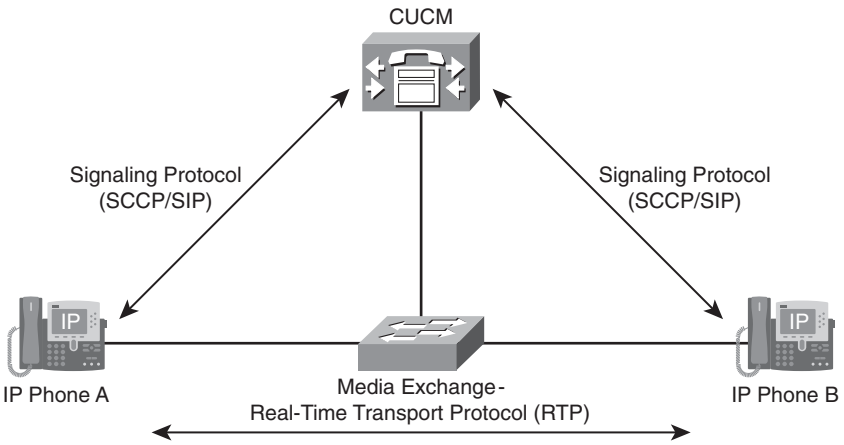
After a call has been set up, media exchange occurs directly between the Cisco IP Phones across the IP network, using the Real-Time Transport Protocol (RTP) to carry the audio. CUCM is not involved in a call after the call has been set up. If the CUCM server were unplugged during the duration of the call, users would not notice unless they attempted to use a feature on the phone. CUCM is involved only in call setup, teardown, and features. If the CUCM server that set up the call were down during a conversation, end users would see a message indicating "CM Down, Features Disabled" on the LCD screen of the IP phone.

Example: Basic IP Telephony Call

Figure 1-4 illustrates a user at phone A placing a call to phone B.

At the beginning of a call, a user at IP phone A picks up the handset, and a message is sent to CUCM letting CUCM know that the device has gone off-hook. CUCM responds to this stimulus by replying with a message that tells the device to play the dial tone file that is stored in the flash memory of the phone. The user at phone A hears the dial tone and begins dialing the phone number of phone B. SCCP phones send their digits to CUCM as they are pressed (digit by digit), whereas SIP phones send their dialed digits in one message (enbloc signaling) by default. SIP phones have options that allow them to behave similarly to SCCP phones (Keypad Markup Language [KPML] and dial rules). CUCM performs digit analysis against the dialed digits. If a match is found, CUCM routes the call per its configuration. If CUCM does not find a match, a reorder tone is sent to the calling party.

Figure 1-4 *CUCM Signaling and Media Paths*



CUCM signals the calling party to initiate ringback, so the user at phone A will hear the ringback tone. CUCM also signals the call to the destination phone, which plays the ringdown tone. Additional information is provided to the phones to indicate the calling and called party name and number. (Phone A will show the destination device name and number, and phone B will show the calling party name and number.)

When the user at phone B accepts the call, CUCM sends a message to the devices letting them know the IPv4 socket (IPv4 address and port number) information in which they should communicate for the duration of the call. The RTP media path opens directly between the two phones.

The Cisco IP Phones require no further communication with CUCM until either phone invokes a feature, such as call transfer, call conferencing, or call termination.

CUCM Hardware, Software, and Clustering

CUCM Release 6.0 is a complete hardware and software solution that works as a network appliance. A network appliance is a closed system that supports only Cisco-authorized applications and utilities. Goals of the appliance model are to simplify the installation and upgrade of the system and to hide the underlying operating system. An appliance-based model makes it possible for an administrator to install, implement, and manage a CUCM server without requiring knowledge of or having access to the underlying operating system.

The CUCM appliance has these features:

- Complete hardware and software solution.

  CUCM servers are preinstalled with all software that is required to operate, maintain, secure, and manage a server or cluster of servers (including Cisco Security Agent).

  CUCM is also provided as a software-only product, which may be installed on supported Cisco Media Convergence Servers (MCS) or Cisco-approved third-party server platforms.

- Appliance operating system provides ease of installation and upgrade, while also providing security and reliability.

- You can upgrade CUCM servers while they continue to process calls.

- System administration is performed via graphical user interface (GUI), command-line interface (CLI), and through documented APIs for third-party access.

- Outputs a variety of management parameters via a published interface to provide information to approved management applications, such as NetIQ Vivinet Manager, HP OpenView, and Integrated Research PROGNOSIS.

- Appliance operates with or without keyboard, mouse, and monitor (also known as headed or headless). Third-party access is allowed via documented APIs only.

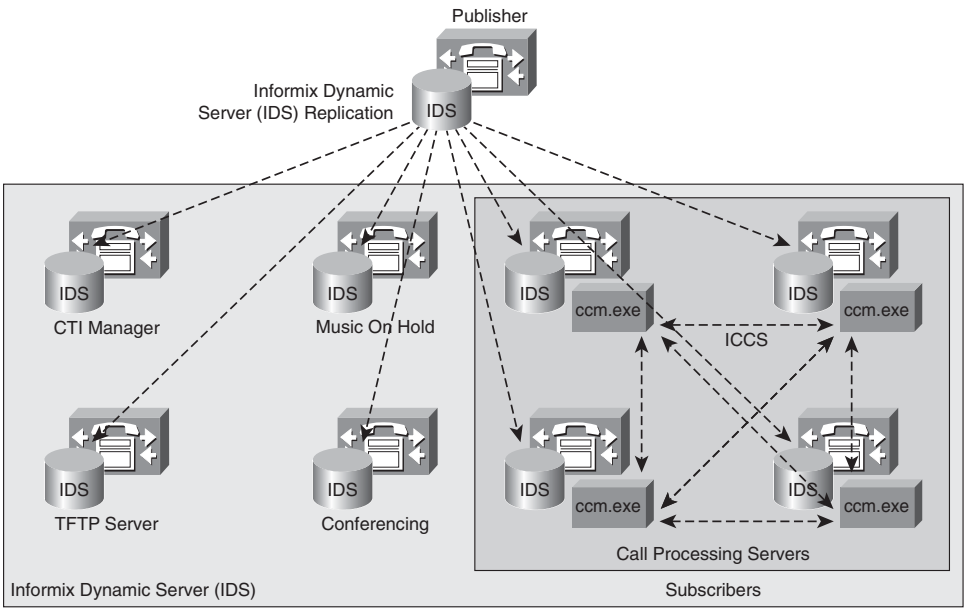
- CUCM supports clustering of servers for the purpose of redundancy and load sharing. Database redundancy is provided by sharing a common database across multiple servers. Call-processing redundancy is achieved through the Call Manager Group setting, in which multiple servers are assigned to a device for the purposes of providing fault tolerance.

A CUCM cluster can have up to 20 servers in it. Only one publisher server is allowed in the cluster. The publisher houses the read/write copy of the database. Up to eight subscriber servers can be in the cluster, with the restriction that only four of the subscriber servers can perform active call processing. If more than four subscriber servers are used in a cluster, the additional servers are dedicated standby servers in case the active subscriber server is not available. The other 11 servers in the cluster can be responsible for various services, including TFTP and media resources (conferencing, music on hold, transcoding).

CUCM Cluster

Clustering allows the network to scale to several thousands of endpoints, provides redundancy in case of network or server failure, and provides a central point of administration. Figure 1-5 displays a Publisher database synchronizing database components to all the other servers in the cluster. The servers running the CCM.exe process are performing call processing, and the other servers are taking on special roles described in later chapters of this book. CUCM clustering creates scalability by segregating processes to other machines, which increases performance.

Figure 1-5 *CUCM Cluster*



Device settings are stored in the IBM IDS database. The database is the repository for service parameters, features, device configurations, and dial plan configurations.

The database replicates nearly all configuration information in a hub-and-spoke topology (one publisher, many subscribers). CUCM nodes also use a second communication method to replicate runtime data using a mesh topology. (Every node updates every other node.) A mesh topology of information sharing provides dynamic registration and active call information that changes much more frequently than database changes. Real-time mesh replication is used to communicate newly registered phones, gateways, and digital signal processor (DSP) resources, guaranteeing optimum call routing.

Cisco 7800 Series Media Convergence Servers

Although it is possible for CUCM to run on most computers, Cisco supports CUCM running only on Cisco-approved hardware that they will support. The minimum hardware requirements for CUCM Release 6.0 are as follows:

- 2-GHz processor
- 2 GB RAM
- 72-GB hard disk

Minimum requirements for CUCM 6 are the same as for Cisco Unified CallManager Version 5, but only specific MCS models are approved.

The 7800 series servers are available in the –H or –I variants. –H stands for Hewlett-Packard, and –I stands for IBM server platforms. The 7825 server is a 19-inch or 23-inch rack-mountable server that provides a single SATA hard drive and one power supply. The 7835 server improves reliability and performance by including hot-swappable SCSI hard drives, hardware RAID 1 disc duplexing, and redundant power supplies. The 7845 improves reliability and performance by providing a second CPU and a backup fan assembly.

You can find the most detailed, current Cisco hardware specifications at http://www.cisco.com/en/US/products/hw/voiceapp/ps378/prod_brochure0900aecd8062a4f9.html.

CUCM must be installed on a server that meets Cisco configuration standards. Cisco actively collaborates with two server hardware manufacturers to meet this requirement: Hewlett-Packard (HP) and IBM. You can find additional information at the following sites:

- **Cisco-approved IBM server solutions**: http://www.cisco.com/en/US/products/hw/voiceapp/ps378/prod_brochure0900aecd80091615.html
- **Cisco-approved HP server solutions**: http://www.cisco.com/en/US/products/hw/voiceapp/ps378/prod_brochure09186a0080107d79.html

Cisco UC Operating System

The CUCM operating system is based on Red Hat Linux. Operating system and application updates are provided by Cisco through patches that are digitally signed by Cisco. Unsupported software and applications (not digitally signed by Cisco) cannot be uploaded or installed into the system.

Root access to the file system is not permitted. The operating system has been hardened by disabling all unnecessary accounts and services. There is also no access to native operating

system debug interfaces. Traces, alarms, and performance counters can be enabled and monitored through the CUCM GUI. Some files and directories are accessible through the Cisco CLI and GUI for maintenance purposes.

Remote-access support allows Cisco Technical Assistance Center (TAC) engineers to remotely access the CUCM server for a restricted time interval. Remote-access support can be enabled in CUCM serviceability tools.

The IBM IDS is the database for the Cisco UC applications. The IDS database installation and configuration is scripted into the CUCM installation DVDs. No UNIX or IBM IDS database knowledge is required to configure and operate CUCM.

Cisco Secure Agent is included with the appliance to provide protection against known and unknown attacks. Cisco Secure Agent is a host-based intrusion prevention system (HIPS).

A DHCP server is integrated into CUCM to provide IP telephony devices with their IP addressing requirements.

The Cisco UC operating system is also used for these Cisco UC applications:

- Cisco Emergency Responder 2.0
- Unity Connection 2.0
- Cisco Unified Presence 6.0

Cisco UC Database

The data in the CUCM database is divided into two types, as described in the sections that follow.

Static Configuration Data

Static configuration data is created as part of the configuration of the CUCM cluster. Read/write access to this data is provided for the publisher only. Subscribers provide only read-only access to this data. If the publisher becomes unavailable, the subscriber data can be used to process calls, but it cannot be modified. Database replication is unidirectional, from the publisher to the subscribers. Only CDRs and CMRs are replicated from the subscriber servers to the publisher. All other configuration information is downloaded from the publisher.

User-Facing Features

You have learned that the publisher is the only server with a read-write copy of the database, and all configuration changes should be made on the publisher. These changes are then

replicated downstream to the subscribers. This model represents a single point of failure from the perspective of moves, adds, and changes (MAC). The problem is further exacerbated because the publisher was the only server in the cluster responsible for call-forwarding changes, extension mobility logins, and message-waiting indicators before CUCM 6.0.

CUCM 6.0 treats a portion of the database as dynamic configuration data. Read/write access to dynamic configuration data is provided on all servers, allowing certain information to be modified if the publisher server is unavailable. The dynamic information that can be changed during a publisher outage is known as user-facing features (UFF). UFF data is replicated from the subscriber servers where the change was initiated to all other subscriber servers in the CUCM cluster.

Examples of UFFs include the following:

- Call Forward All (CFA)
- Message Waiting Indication (MWI)
- Privacy, Enable/Disable
- Do Not Disturb, Enable/Disable (DND)
- Extension Mobility Login (EM)
- Hunt Group Login Status
- Monitor (future use)
- Device Mobility
- CTI CAPF Status (Computer Telephony Integration, Certificate Authority Proxy Function)

The services listed in Table 1-1 rely on the availability of the publisher server regardless of the version of CUCM used.

Table 1-1 *Publisher Server Required Services*

Component	Function
CCMAdmin	Provisions everything
CCMUser	Provisions user settings
BAT	Provisions everything initiated by the Bulk Administration tool
TAPS	Provisions everything initiated by the Tool for Auto-Registered Phone Support

Table 1-1 *Publisher Server Required Services (Continued)*

AXL	Provisions everything initiated by the AVVID XML Layer service
AXIS-SOAP	Enables and disables services through SOAP
CCM	Inserts phones (auto-registration only)
LDAP Sync	Updates end-user information
License Audit	Updates license tables

Database Access Control

Database access is secured using the embedded Red Hat, iptables dynamic firewall and a database security password.

The procedure to allow new subscribers to access the database on the publisher is as follows:

Step 1 Add the subscriber to the publisher database using CUCM Administration.

Step 2 During installation of the subscriber, enter the same database security password that was entered during installation of the publisher.

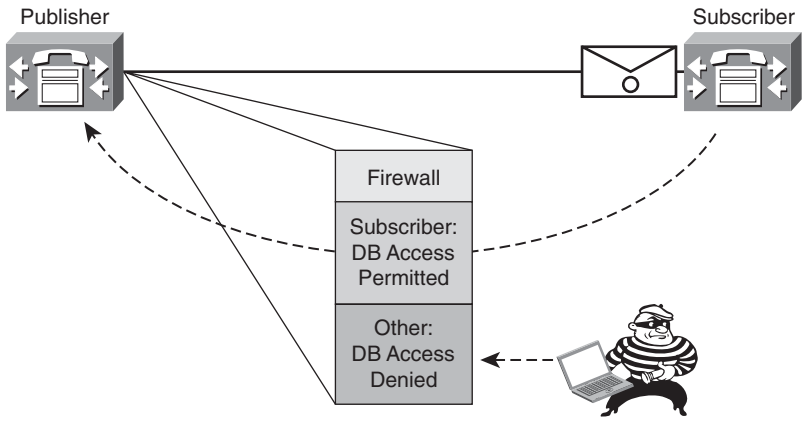
After this configuration, the following process occurs to replicate the database from the publisher to the newly added subscriber:

1. The subscriber attempts to establish a connection to the publisher database using the database management channel.
2. The publisher verifies the subscriber's authenticity and adds the subscriber's IP address to its dynamic firewall (iptables).
3. The subscriber is allowed to access the publisher database.
4. The database content is replicated from the publisher to the subscriber.

Figure 1-6 illustrates the iptables firewall allowing subscriber access to the publisher database.

You can find CUCM 6.0 TCP and UDP port usage information at http://www.cisco.com/en/US/docs/voice_ip_comm/cucm/port/6_0/60plrev1.pdf.

Figure 1-6 *Database Access Control*



CUCM Licensing

Licensing is implemented in CUCM beginning with Release 5.0. Administration of license management is done through CUCM GUI administration, allowing accurate tracking of active device registrations compared to the license units that have been purchased. License enforcement occurs at the time of phone provisioning and CUCM service activation.

The publisher is the only licensing server. The licensing server is the logical component that keeps track of the licenses purchased and the licenses used. If the publisher fails, no new phones can register, and no configuration changes will be allowed. Existing phones will continue to operate during a publisher outage.

CUCM tracks the license compliance for devices, applications, and software as follows:

- **Device units licenses**: The maximum number of provisioned devices in the CUCM database will be tracked and enforced. Route points and CTI ports are not enforced.
- **Application licenses**: Application licenses are required for every call-processing server running the CallManager service. Application licenses are tied to the MAC address of the network interface card (NIC) of the server.
- **Software licenses**: Software licenses are tied to the major version of the software. Software licenses are required for upgrade to CUCM 6.

Licenses are created and distributed in accordance with the Cisco FlexLM process. Cisco product license registration is performed at http://www.cisco.com/go/license.

These two types of product IDs are available:

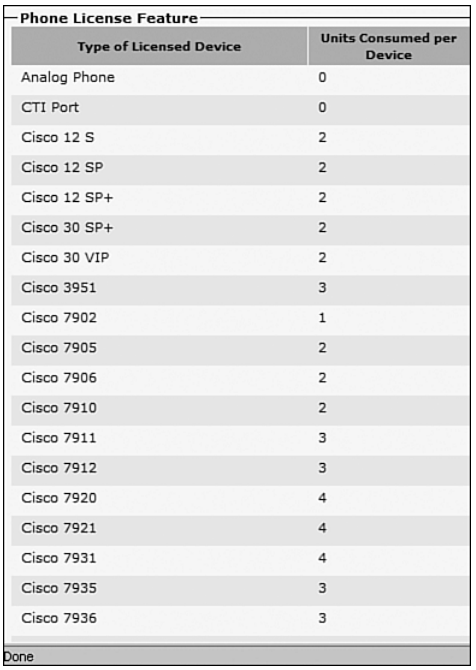
- **Cisco device license units**: Cisco device license units (DLU) are for Cisco devices only.
- **Third-party device license units**: Third-party DLUs can be converted to Cisco units, but not vice versa.

CUCM tracks the number of units required by each device, as shown in Figure 1-7. Each device type corresponds to a fixed number of units.

The number of DLUs consumed per device depends on the device type and capabilities of the phone.

The number of units required per device can be viewed from CUCM Administration. DLUs are perpetual and device independent. Figure 1-7 displays the number of DLUs consumed in CUCM 6.0 by some popular phones.

Figure 1-7 *Device License Units*



Phone License Feature

Type of Licensed Device	Units Consumed per Device
Analog Phone	0
CTI Port	0
Cisco 12 S	2
Cisco 12 SP	2
Cisco 12 SP+	2
Cisco 30 SP+	2
Cisco 30 VIP	2
Cisco 3951	3
Cisco 7902	1
Cisco 7905	2
Cisco 7906	2
Cisco 7910	2
Cisco 7911	3
Cisco 7912	3
Cisco 7920	4
Cisco 7921	4
Cisco 7931	4
Cisco 7935	3
Cisco 7936	3

Done

The main components of the license file are as follows:

- MAC address of the license server (publisher)
- Version (major release) of the CUCM software
- Number of node licenses (number of CUCM servers in cluster)
- Number of DLUs

License files are additive. (Multiple license files can be loaded.) The Cisco FlexLM process is used to obtain licenses, and integrity of license files is assured by a digital signature.

When upgrading from Cisco Unified CallManager 4.*x*, the number of DLUs required is calculated during the CUCM migration process, and an intermediate XML file containing these license counts is generated. The number of devices and servers that are in the database at the time of migration is the basis for the number of DLUs and node licenses in the interim license file. No additional phones may be added until the interim license file has been replaced by a real license file.

After upgrading to CUCM 6.0(1), use the **View File** option in the License File Upload window to view the intermediate XML file. Copy and paste the intermediate license file into the CUCM License Upgrade window on Cisco.com to obtain the actual license file. Upload the actual license file to the publisher (license server).

Existing device and node licenses from CUCM 5.*x* can be used in CUCM 6.*x*.

Example 1-1 shows an example license file.

Example 1-1 *Example License File*

```
INCREMENT PHONE_UNIT cisco 6.0 permanent uncounted \
VENDOR_STRING=<Count>1000</Count><OrigMacId>000BCD4EE59D</OrigMacId>
  <LicFileVersion>1.0</L icFileVersion> \
HOSTID=000bcd4ee59d NOTICE="<LicFileID>20050826140539162</LicFileID><LicLineID>2
  </LicLineID> \
<PAK></PAK>" SIGN="112D 17E4 A755 5EDC F616 0F2B B820 AA9C \
0313 A36F B317 F359 1E08 5E15 E524 1915 66EA BC9F A82B CBC8 \
4CAF 2930 017F D594 3E44 EBA3 04CD 01BF 38BA BF1B"
```

Significant fields are highlighted and described as follows:

- `INCREMENT PHONE_UNIT Cisco 6.0` indicates a phone unit license file for Cisco Unified CM 6.0. There is no expiration date for this license, as indicated by the keyword *permanent*.

> **NOTE** The `INCREMENT` type for CUCM node licenses is `CCM_NODE cisco 6.0 permanent uncounted`. The `INCREMENT` for software licenses is `SW_FEATURE cisco 6.0 permanent uncounted`.

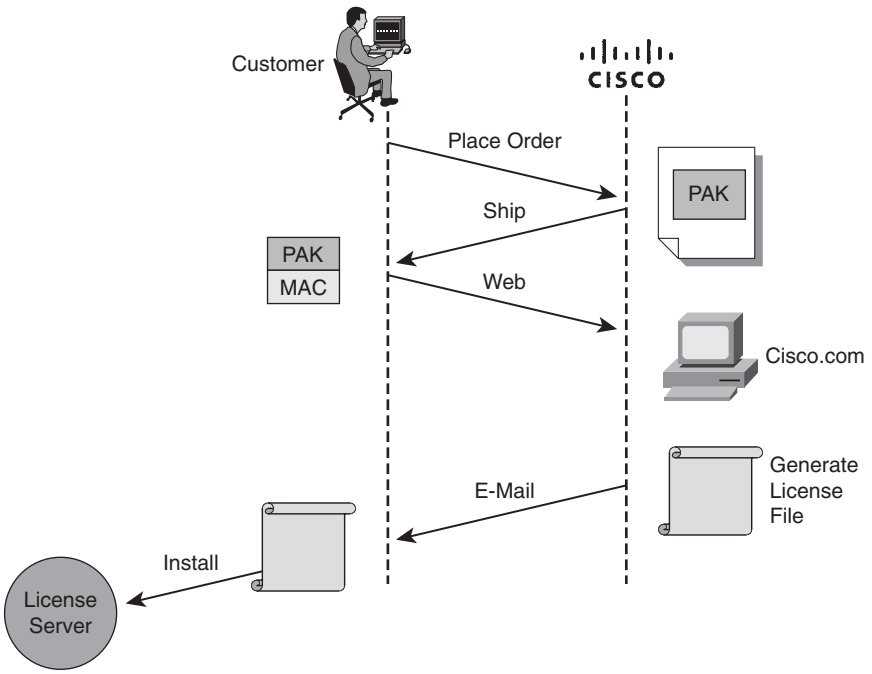
- This license file includes 1000 license units.
- The MAC address of the license server is `000BCD4EE59D`.

License File Request Process

Figure 1-8 displays the license file request process, which includes these steps:

1. The customer places an order for CUCM.
2. The manufacturing database scans the Product Authorization Key (PAK) and records it against the sales order.
3. The product (CD or paper claim certificate) is physically delivered to the customer.
4. The customer registers the product at http://www.cisco.com/go/license or a public web page and provides the MAC address of the publisher device that will become the license server.
5. The license fulfillment infrastructure validates the PAK, and the license key generator creates a license file.
6. The license file is delivered via e-mail to the customer. The e-mail also contains instructions on how to install the license file.
7. The customer installs the license file on the license server (publisher).

Figure 1-8 *License File Request Process*



Obtaining Additional Licenses

The process of obtaining additional DLUs and node licenses is as follows:

1. The customer places an order for the additional licenses for a license server (publisher MAC address has to be specified).
2. When the order is received, Cisco.com generates a license file with the additional count and sends it to the customer.
3. The new license file has to be uploaded to the license server and will be cumulative.

Consider this example. A CUCM server has an existing license file that contains 100 DLUs. Another 100 DLUs are purchased. The second license file that is generated will contain only 100 DLUs. When the new license file with 100 DLUs is uploaded to CUCM, the 100 DLUs from the first license file are added to the devices of the second license file, resulting in a total of 200 DLUs.

Licensing Components

The key licensing components of CUCM licensing are the license server and the license manager.

License Server

The license server service runs on the publisher in the CUCM cluster and is responsible for keeping track of the licenses purchased and consumed. The MAC address of the publisher is required to generate a license file.

License Manager

The license manager acts as a broker between CUCM applications that use licensing information and the license server. The license manager receives requests from the CUCM applications and forwards the requests to the license server. The license manager then responds back to the application after the request has been processed by the license server. The license manager acts a licensing proxy server.

An administration subsystem and alarm subsystem complete the functional diagram. Details of these two subsystems are as follows:

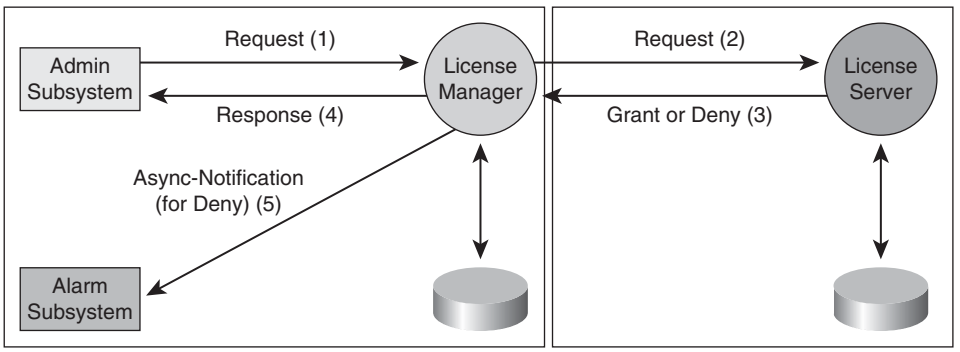
- The administration subsystem provides the following capabilities:
  - Keeps information about the license units required for each phone type. The customer can view this information using a GUI.
  - Supports a GUI tool that calculates the required number of phone unit licenses. The customer inputs phone types and the number of phones of each type that the customer wants to purchase. The output is the total number of licenses that the customer needs for the given configuration.
  - Supports a GUI tool that displays the total license capacity and the number of licenses in use and license file details. The tool can also report the number of available licenses.
- The alarm subsystem generates alarms that are routed to event logs or sent to a management station as Simple Network Management Protocol (SNMP) traps to notify the administrator of the following conditions:
  - **Overdraft**: Occurs when an overdraft condition exists. An overdraft condition occurs when more licenses are used than available but the amount of exceeding licenses is in an acceptable range. (5 percent overdraft is permitted.)
  - **License server down**: Occurs when the License Manager cannot reach the license server.
  - **Insufficient licenses**: Occurs when the license server detects the fact that there are not sufficient licenses to fulfill the request and raises an alarm to notify the administrator.

Issues with the license file occur when there is a version mismatch between the license file and the CUCM (license file version mismatch alarm), or when the number of licenses in the license file is less than the number of phones provisioned (license file insufficient licenses alarm). Another cause of this condition is an invalid MAC address (for instance, after a NIC change).

Figure 1-9 is a functional diagram stepping through the process of a license request, as described in the list that follows:

1. A request for a certain number of DLUs is made by the admin subsystem because of an event (for example, phone registration).
2. The License Manager service on a CUCM subscriber forwards the request to the publisher server running the License Server service.
3. The License Server service receives the license request event and allocates the required number of DLUs required based on the type of device. If not enough license units are available to accommodate the request, a deny message is sent back to the license manager on the subscriber server. If resources are available, the license server grants the request and sends a grant message to the license manager on the subscriber server.
4. The License Manager service on the subscriber server receives the license grant or deny message and allows the phone to register.
5. If the license request was denied, the subscriber server generates an alarm in the alarm subsystem. The deny message will be available in the CUCM syslog server by default.

Figure 1-9 *Licensing Functional Diagram*



Calculating License Units

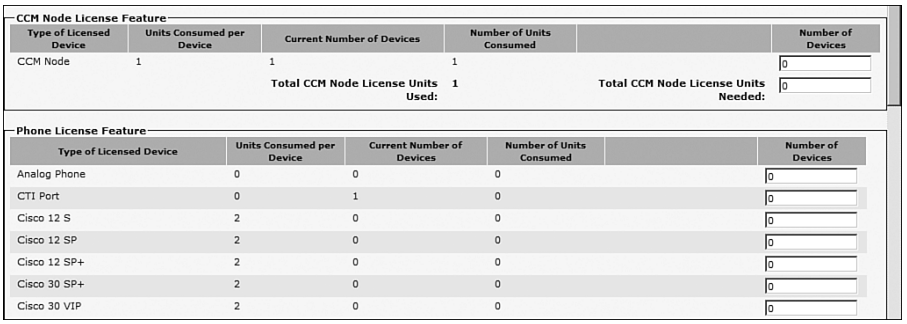
To calculate the number of phone licenses required, follow these steps:

Step 1 Choose **System > License > License Unit Calculator**. The License Unit Calculator window displays. The number of license units consumed per device and the current number of devices display as shown in Figure 1-10.

Step 2 In the Number of Devices column, enter the desired number of devices, corresponding to each node or phone.

Step 3 Click **Calculate**. The total number of CUCM node license units and DLUs required for specified configuration will display.

Figure 1-10 *License Unit Calculator*



License Unit Reporting

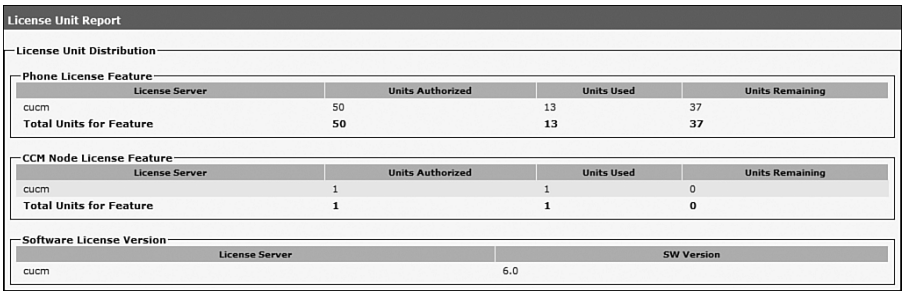
License unit reports can be run to verify the number of licenses consumed and available for future expansion. Use the following procedure to generate a license unit report:

Step 1 Choose **System > License > License Unit Report**.

Step 2 The License Unit Report window displays as shown in Figure 1-11. This window displays the number of phone licenses and number of node licenses, in these categories:

- Units Authorized
- Units Used
- Units Remaining

Figure 1-11 *License Unit Report*



License Unit Report

License Unit Distribution

Phone License Feature

License Server	Units Authorized	Units Used	Units Remaining
cucm	50	13	37
Total Units for Feature	**50**	**13**	**37**

CCM Node License Feature

License Server	Units Authorized	Units Used	Units Remaining
cucm	1	1	0
Total Units for Feature	**1**	**1**	**0**

Software License Version

License Server	SW Version
cucm	6.0

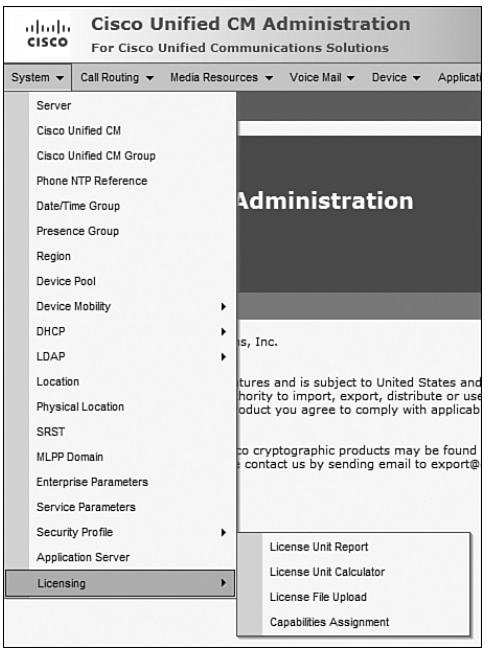
License files (CCMxxxxx.lic) are uploaded to the publisher (license server). To upload a license file to the publisher server, follow these steps:

Step 1 Ensure that the license file is downloaded to a local PC.

Step 2 From the PC and using a supported browser, log in to CUCM Administration.

Step 3 Choose **System > License > License File Upload**, as shown in Figure 1-12. The License File Upload window displays.

Figure 1-12 *License File Upload Procedure*

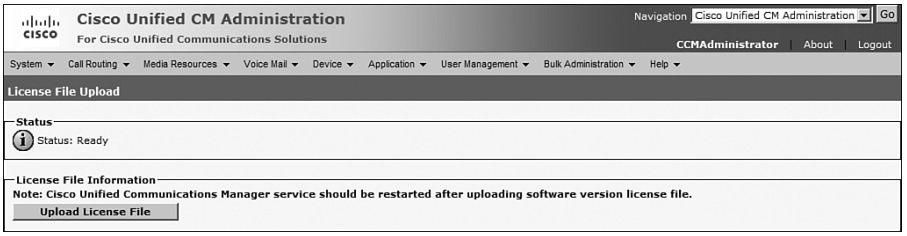


Step 4 In the window shown in Figure 1-13, click **Upload License File**.

Step 5 Click **Browse** to choose the license file from the local directory.

Step 6 Click **Upload**.

Figure 1-13 *License File Upload Procedure (continued)*



Step 7 After the upload process has completed, click the **Continue** prompt when it appears. The content of the newly uploaded license file will display.

Chapter Summary

The following list summarizes the key points that were discussed in this chapter:

- Cisco Unified Communications (UC) is a community of components designed to enable rapid, efficient communications. UC components include the following:
  - —Endpoints
  - —Application integration
  - —Call control
  - —Infrastructure
- Cisco Unified Communications Manager (CUCM) is the call-routing component of the Cisco UC ecosystem, providing call setup and teardown services to both voice and video communications. CUCM provides a centralized command and control topology to configuration management while leveraging the distributed nature of IP communications.
- CUCM is a software solution that is supported on various hardware configurations. Media Convergence Servers (MCS) are Cisco-branded hardware solutions that run on HP or IBM server platforms.

- CUCM Versions 5.0 and later use an appliance model where most administration is performed on a client pointing to the web services running on CUCM. The hardened operating system is based on the Red Hat Linux variant. There is no access to the Linux kernel, and this lack of access provides a high level of security to the Cisco UC platform. CUCM versions before 5.0 (4.*x* and earlier) used a Microsoft Windows-based operating system.
- CUCM database Versions 5.0 and later leverages the IBM Informix Dynamic Server (IDS) to store all configuration data, including the user database. Versions earlier than 5.0 use a Microsoft SQL server database for most configuration information, while user information is stored in the DC Directory server. The DC Directory and the IBM IDS are LDAP-compliant databases.
- CUCM licensing consists of the license server and the license manager. The license server component runs on the publisher server, whereas the license manager runs on every server.

Review Questions

Use the questions here to review what you learned in this chapter. The correct answers are found in Appendix A, "Answers to Chapter Review Questions."

1. Which layer of the Cisco Unified Communications components is responsible for delivering a dial tone?
   a. Endpoints
   b. Applications
   c. Call control
   d. Infrastructure

2. What is the name of the server in a CUCM cluster that maintains a read/write copy of the entire database?
   a. Member server
   b. Domain controller
   c. Subscriber
   d. Publisher

3. What protocol is responsible for transporting voice over IP?
   a. Skinny Client Control Protocol (SCCP)
   b. H.323
   c. Real-Time Transport Protocol (RTP)
   d. Real-Time Transport Control Protocol (RTCP)
   e. Media Gateway Control Protocol (MGCP)
   f. Skinny Gateway Control Protocol (SGCP)

4. How many call-processing agents can be active in a CUCM cluster?
   a. 20
   b. 4
   c. 8
   d. 9
   e. 2

5. How many call-processing agents can be in a CUCM cluster?
   a. 20
   b. 4
   c. 8
   d. 9
   e. 2

6. How many servers can be in a CUCM cluster?
   a. 20
   b. 4
   c. 8
   d. 9
   e. 2

7. Which CUCM server is the license manager component active on?
   a. Member server
   b. Domain controller
   c. Subscriber
   d. Publisher
   e. All servers

8. Which CUCM server is the license server component active on?
   a. Member server
   b. Domain controller
   c. Subscriber
   d. Publisher
   e. All servers

9. On which server in the CUCM cluster are license files loaded?
   a. Member server
   b. Domain controller
   c. Subscriber
   d. Publisher
   e. All servers

10. Which of the following features is *not* a user-facing feature (UFF)?
    a. Call Forward All (CFA)
    b. Message Waiting Indication (MWI)
    c. Attendant Console (Login/Logout)
    d. Privacy (Enable/Disable)
    e. Do Not Disturb (Enable/Disable) (DND)
    f. Extension Mobility (Login/Logout) (EM)
    g. Hunt Group Login Status

Index

Symbols

Numerics

A

B

C

D

E

F

G-H

I-J

K-L

M

N

T

U

V

W