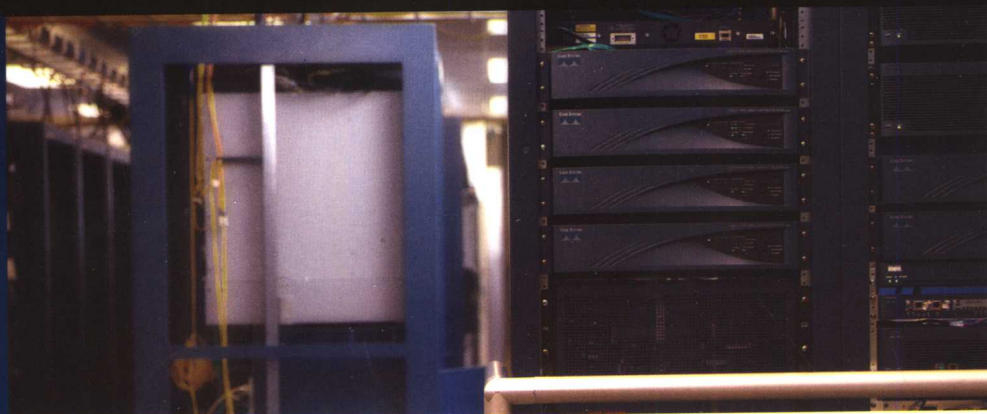




Cisco 职业认证培训系列  
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# CCIE 路由与交换 认证考试指南(第二版)(英文版)

## CCIE Routing and Switching

Official Exam Certification Guide

Second Edition

Assessment, review, and practice for the CCIE  
Routing and Switching written exam 350-001

内附光盘



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## CCIE 路由与交换认证考试指南 (第二版) (英文版)

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# 内 容 提 要

本书讲述了 Cisco 认证考试 CCIE 路由与交换 (R&S) 笔试所涉及的全部内容, 此外, 还介绍了 CCIE 服务提供商书面考试中与网络相关的内容。全书内容包括网络概念、设备操作、桥接与局域网 (LAN) 交换技术、广域网 (WAN)、IP 及 IP 路由选择协议、网络安全性以及多服务网络等。本书在介绍基本内容的同时, 还提供了多种评估工具, 以检查自己对某些内容的掌握情况。这些评估工具包括小测试、问题与答案、实践模拟练习以及 CD-ROM 中提供的 200 多道练习题。随书光盘中包含本书英文版的电子文档 (以 PDF 格式提供) 和 500 余道 CCIE 路由与交换考试模拟试题。本书适合准备参加 CCIE 认证考试的读者, 也可供相关网络技术人员参考。

## About the Author

**Wendell Odom**, CCIE No. 1624, is a senior instructor with Skyline Advanced Technology Services (<http://www.skyline-ats.com>), where he teaches the QOS, CCIE, and SAN courses. Wendell has worked in the networking arena for 20 years, with jobs in pre- and post-sales technical consulting, teaching, and course development. He has authored several Cisco Press books, including the best-selling *CCNA INTRO* and *ICND Exam Certification Guides*, the *Cisco QoS Exam Certification Guide*, and the introductory text *Computer Networking First-Step*.

## About the Contributing Authors

**Jim Geier**, author of Chapters 22 and 23, is the founder of Wireless-Nets, Ltd., ([www.wireless-nets.com](http://www.wireless-nets.com)) and the company's principal consultant. His 25 years of experience includes the analysis, design, development, installation, and support of numerous wired and wireless network systems for cities, enterprises, airports, retail stores, manufacturing facilities, warehouses, and hospitals throughout the world. Under Wireless-Nets, Ltd., Jim founded the Independent Wireless Networking Academy ([www.wirelessnetworkingacademy.com](http://www.wirelessnetworkingacademy.com)) to prepare people for working in the wireless networking industry. He has instructed hundreds of people on designing and deploying wireless LAN solutions.

Jim is the author of several books, including *Wireless LANs: Implementing Interoperable Networks*, Second Edition (SAMS), *Certified Wireless Analysis Professional—Official Study Guide* (McGraw-Hill), *Wireless Networks First-Step* (Cisco Press), *Wireless Networking Handbook* (Macmillan), and *Network Reengineering* (McGraw-Hill). Jim is the author of hundreds of articles for industry magazines and online publications, such as *Network Computing*, *Network World*, *Wi-FiPlanet.com*, and *Mobilepipeline.com*. He has been writing about computer networking topics, with emphasis on wireless systems, for the past 12 years. He is currently the editor-in-chief and regular contributor of *mobilizedsoftware.com*, an online publication providing education to enterprises involved with implementing mobile wireless systems.

Jim has been an active member of the IEEE 802.11 Working Group, developing international standards for wireless LANs. He has also been an active member within the Wi-Fi Alliance, responsible for certifying interoperability of 802.11 ("Wi-Fi") wireless LANs. He served as Chairman of the IEEE Computer Society, Dayton Section, and Chairman of the IEEE International Conference on Wireless LAN Implementation. Jim is an advisory board member of several leading wireless LAN companies and an advisor for the Certified Wireless Network Professional (CWNP) independent certification program for people deploying wireless LANs.

Jim's education includes a bachelor's and master's degree in electrical engineering and a master's degree in business administration.

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**Naren Mehta**, CCIE No. 9797 (Routing and Switching, Security), author of Chapters 19 and 20, is a senior partner and director of training for an internationally known training and consulting company that specializes in providing customized, one-to-one training, for CCIE lab students and consulting for Cisco networks. Naren has been in the training and consulting field for the past 15 years and teaching Cisco certification courses ranging from CCNA to CCIE (written and lab) for the past 7 years. His experience includes the analysis, design, installation, training, and support for various Cisco networks for financial, manufacturing, utility, and healthcare industries. His specialty is explaining complex concepts in such a way that it becomes easier for anybody to understand them. Naren has been a source of inspiration, motivation, and encouragement for many of his students who wanted to pursue their CCIE lab certification and helped them pass their CCIE Routing and Switching and Security lab certification exams. He has an MBA in marketing and finance, an MS in industrial engineering, and a BS in mechanical engineering.

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## **Dedication**

For Lavinnie Viola McCoy Odom, aka Granny, Aunt Bill, and cousin “it.” Thanks for the hugs, prayers, late-night fried egg sandwiches, and sheets warmed by the heater in the dead of winter. 1914–2004.

# 前 言

在所有网络认证中，Cisco 认证互联网专家（CCIE）可能是最具挑战性和权威性的。它迄今已获得众多奖项，并树立了在计算机全行业中“最难取得的认证”的声望。拥有 CCIE 证书即可打开事业之门、获得高额酬劳、为事业的历程增光添彩。

Cisco 目前提供多种 CCIE 认证，并已停办数种认证。下表为本书出版时尚在提供的 CCIE 认证的详情；如欲了解最新信息，请登录网站 <http://www.cisco.com/go/ccie> 查询。认证排列以公布时间先后为序。

- CCIE 路由与交换；
- CCIE 安全；
- CCIE 服务提供商（以前称为“通信与服务”）；
- CCIE 语音；
- CCIE 存储网络。

每一项 CCIE 认证都要求考生通过笔试和为期一天的实验室实践考试。笔试旨在考查考生对于理论、协议和熟练配置知识的掌握情况。实验室考试则验证考生配置实验室真实设备及排除实验室真实设备故障的能力。

## 参加 CCIE 路由与交换笔试的理由

首先也是最明显的一个理由，就是 CCIE 路由与交换的笔试是迈向获得 CCIE 路由与交换认证的第一步。另外，考生只有在先通过了相应的笔试后，才能安排 CCIE 实验室考试。简言之，要想通过 CCIE 路由与交换认证在事业上获益，就要从通过笔试开始。

获得 CCIE 认证的益处是多方面的，这里仅略举几例：

- 更优厚的报酬；
- 前途更加光明的事业发展 / 新工作；
- Cisco 渠道合作伙伴对 CCIE 雇员的最低人数要求，使你对于渠道合作伙伴更具价值；
- 与 Cisco 技术支持中心（TAC）通话过程中，可以更为有效地解决问题；
- 权威性；
- 作为咨询师和客户工程师可提高可信性，包括可以使用 Cisco 的 CCIE 徽标。

参加 CCIE 路由与交换笔试的另外一个重要理由就是可以重新认证个人的 Cisco 工程师级别、资深工程师级别以及专家级别的认证。换言之，通过任何一种 CCIE 的笔试都是对你 CCNA、CCNP、CCIP、CCSP、CCDP 等的重新认证。（重新认证的要求常有变动，请登录到 Cisco 官方网站对要求进行核对）

## CCIE 路由与交换笔试 350-001

截止到本书出版前，CCIE 路由与交换的笔试为 2 小时的考试由 Pearson VUE (<http://www.VUE.com/cisco>) 或 Thomson Prometric (<http://www.2test.com>) 下属的考试代理机构办理。笔试通常包括 100 道多项选择题，目前尚无相关模拟的题目。笔试之后通常都会有实验室考试，因此 Cisco 不会有意向 CCIE 的笔试中增加有关模拟器的题目。

如同对于多数其他考试一样，大家也一定想要了解本考试的内容。Cisco 在其 CCIE 路由与交换笔试大纲中对考试涉及的范围提供了概括性的指导，大纲的最新版可以到网站 <http://www.cisco.com/go/ccie> 获取。

Cisco 对于笔试和实验室考试大纲时有调整，但对于 CCIE 却绝少变更其考试代码。（Cisco 曾在对工程师、资深工程师级别的认证考试内容做出重大调整时变更过其考试代码。）鉴于考试内容会时有变化，本书中收录了附录 B “CCIE 考试更新情况”。该附录涵盖了 CCIE 路由与交换笔试中新添加的全部内容。Cisco 如变更本考试大纲，笔者即会在网站 <http://www.ciscopress.com/title/1587201410> 处添加内容，收入新的考试内容，以便购买本书早期版本的读者也能够了解到考试内容的变化。本书再版时，Cisco Press 会把新的内容收入到附录 B 中。

截止到本书出版时，CCIE 路由与交换笔试大纲包含如下内容。

### I. 网络理论概论

- A. OSI 模型
- B. 路由的基本概念
- C. 标准
- D. 协议结构
- E. 命令

### II. 桥接与局域网（LAN）交换

- A. 透明性
- B. 局域网（LAN）交换
- C. MLS
- D. 数据链路层
- E. 以太网
- F. Catalyst IOS 配置命令

### III. IP

- A. 寻址
- B. 服务
- C. 应用
- D. 传输



E. IPv6

F. 网络管理

#### IV. IP 路由

A. OSPF

B. BGP

C. EIGRP

D. 路由过滤和策略路由

E. DDR

F. RIPv2

G. “show”和“debug”命令的应用

#### V. 服务质量 (QoS)

A. 流量分类

B. 拥塞管理

C. 拥塞预防

#### VI. 广域网 (WAN)

A. 帧中继

B. 物理层

C. 专用线路协议

#### VII. IP 多点传送

A. IGMP/CGMP

B. 寻址

C. 广播发送树

D. PIM-SM 结构

E. 聚合点

F. RPF

#### VIII. 安全

A. 访问列表

B. 局域网 (LAN) 安全

C. 设备安全 / 访问

D. 欺骗

#### IX. 企业级无线移动性

A. 标准

B. 硬件

C. 结构化无线感知网络 (SWAN)

D. 射频 (RF) 故障排除

E. 基于无线局域网 (WLAN) 的语音

## F. 产品

大纲说明了考生主要学习哪些内容，哪些内容可以略过。不过，大纲不会对每个内容的范围和深度做详细说明。例如，大纲里列出了 BGP，却没有给出详尽说明。尽管缺乏有关考试内容深度、广度的详情可能让人感到无所适从，但从积极的方面看，实验室考试却要涵盖更多细节性的东西，所以，准备笔试学得细一些没有坏处，因为多学习的内容可能正是实验室考试要考查的内容。

了解 Cisco 没有把哪些内容列入大纲，特别是那些 Cisco 从早期的大纲中去掉的内容，也是不无裨益的。例如，Cisco 曾于 2005 年的夏季宣布从笔试大纲中删除 ISDN/DDR、IS-IS、ATM 和 SONET 等内容，所以现在就完全有理由略过这些内容了。另外，MPLS 有被重新添加到考试中的可能。请登录 <http://www.cisco.com/go/ccie> 了解有关 MPLS 或其他增删的大纲内容。

# 《CCIE 路由与交换认证考试指南（第二版）》说明

## 本书结构

本书包含的 9 个主要部分与 CCIE 路由与交换笔试大纲中的 9 部分一一对应。每一部分都由一章或多章组成，涵盖了大纲各部分所涉及的主要内容。

本书各部分的顺序安排也大体上与大纲相吻合，只有一处例外：大纲中的第 1 部分安排在本书第 9 部分中。这样做主要有两个原因：一是大纲中这一部分的内容更易于与其他内容结合讲解，所以本部分的详细内容分散收入了本书的其他部分；二是大纲第一部分中有些内容相对简单，是 CCNA 考试的内容，为求完整，仍然收入了这些内容并放在了书的最后。

本书每一部分都由一章或多章组成。有些部分只有一章，如第 7 部分；而第 3 部分则有 7 章之多，占据了大量的篇幅。

除了本书 9 大部分中的章节外，读者还会看到在第 10 部分中汇集了数个实用的附录。特别是附录 B，如前所述，会在 <http://www.ciscopress.com/title/1587201410> 上更新，适时向读者提供最新的资料。附录 C 讲述 MPLS，因为在本书出版时，已有考虑要将 MPLS 纳入 CCIE 路由与交换考试大纲中。请查询 <http://www.cisco.com> 和本书在 <http://www.ciscopress.com/title/1587201410> 处的网页获取最新信息，以确认是否需要阅读 MPLS 附录。第 10 部分还在附录 D 中收录了十进制到二进制的换算参考表。

以下是各部分内容的简介。

### ■ 第 1 部分：桥接与局域网交换（1~3 章）

这一部分集中讲解局域网层的两个特征，分为以太网（1 章）、虚拟局域网与中继（2 章）和生成树协议（3 章）。

### ■ 第 2 部分：TCP/IP（4~6 章）

如果与大纲保持一致，这一部分的标题应该是“IP”，但把它标为“TCP/IP”可能更为

恰当，因为它囊括了 TCP/IP 协议栈的全部细节。这一部分包括 IP 寻址（4 章），DHCP、ARP 和 ICMP 等 IP 服务（5 章）以及 TCP、UDP 和应用层协议等的协议细节（6 章）。

### ■ 第 3 部分：IP 路由（7~13 章）

这一部分涵盖了笔试中一些比较重要的内容，在本书中自然成了篇幅最大的一部分。它包括层的 3 个转发概念（7 章），随后是 3 章路由协议，RIP、EIGRP、OSPF 各占一章（8~10 章），接下来第 11 章讲述 IGP 间的路由再分布。最后，用两章（12、13 章）的篇幅探讨了 BGP 的细节。

### ■ 第 4 部分：服务质量（14~16 章）

这一部分介绍了一些流行的服务质量管理工具（如一些基于 MQC 的工具）和几款老式的工具（特别是 FRTS）。各章内容包括分类与标记（14 章）、排队与拥塞预防（15 章）以及修整、校验和链路效率（16 章）。

### ■ 第 5 部分：广域网（17~18 章）

广域网的内容在 2005 年的夏天有所缩减，删除了 ATM、SONET、ISDN 和 DDR 等内容。目前存在把 MPLS 加回到 CCIE 路由与交换笔试大纲里的可能（最新动态见 <http://www.cisco.com> 或本书的网页 <http://www.ciscopress.com/title/1587201410>），那样广域网方面就可能会增加一个新的内容。本书广域网部分包括两个主要内容：点对点协议与概念（17 章）和帧中继（18 章）。

### ■ 第 6 部分：IP 多点传送（19~20 章）

本书中有两部分的内容通常被 CCNP 考试所忽略，这部分是其中之一。所以假定读者在开始学习这部分之前对于多点传送没有任何了解。第 19 章中讲述局域网中的多点传送，包括 IMGP 和主机如何加入多点传送组。第 20 章讲述多点传送广域网的问题。

### ■ 第 7 部分：安全（21 章）

如果 CCIE 要把安全和语音都作为考查项目，Cisco 就会面临一个难题：是不是要把这些内容放进 CCIE 路由与交换考试，如果是，那么放进多少细节为宜？这一部分在一章中收入了适合 CCIE 路由与交换考试的多方面有关安全的内容。这一章集中讨论的是交换机和路由器的安全问题。（注意，语音的协议以前包含在 CCIE 路由与交换考试中，目前大纲和本书均不包含语音部分。）

### ■ 第 8 部分：企业级无线移动性（22~23 章）

Cisco 于 2004 年夏天将无线局域网的内容加入大纲中。这一部分在讲解无线信号的射频属性的同时，着重于讲解无线局域网的概念和协议。本部分内容分为两章：第 22 章讲述 802.11 无线局域网的基本原理；第 23 章讲述部署解决方案。

### ■ 第 9 部分：OSI 和 Cisco 设备基础（24 章）

本书最后一部分包含了大纲第 1 部分中的几项内容，主要是把对本书其他部分都不适合的几部分简短的内容整合在一章中。

### ■ 第 10 部分：附录

#### — 附录 A “Do I know this already?” 答案

本附录列出了每一章开始部分所提的问题及答案。

#### — 附录 B CCIE 路由与交换考试更新情况 1.0 版

本书首次印刷时，附录 B 中只有不多的文字，引用了本书的网页 <http://www.ciscopress.com/title/1587201410>。随着大纲的变化，会在网站上张贴新的资料。本书如有再版，也会把近期新增加的资料加入附录 B 中。

#### — 附录 C MPLS

本附录中讲述了很多 MPLS 的基础知识，主要偏重于 CE 路由器和 PE 路由器之间的问题。这些内容之所以列入附录，是因为截至本书付印时为止，Cisco 尚未最后决定是否要把 MPLS 内容加回到 CCIE 路由与交换考试中。详情请查询 <http://www.ciscopress.com/title/1587201410>，确定是否应该学习这一部分的内容。

#### — 附录 D 十进制到二进制换算表

本附录列出十进制数 0~255 及其二进制对应值。

#### — （仅在 CD 上）附录 E IP 寻址实践

（本附录以可打印格式存于 CD 上的 PDF 文件中。）本附录列举了 IP 子网划分和查询汇总路由（Summary routes）的几个实际问题。答案的解释用到了本书中说到的简便方法。

#### — （仅在 CD 上）附录 F “CCIE 学习重点表格”

（本附录以可打印格式存于 CD 上的 PDF 文件中。）本附录中列出了本书核心章节中最为重要的表格。表格中很多内容已经删除。读者可打印此 PDF 文件，然后凭记忆填补表上空白，对照书中表格，检查答案。

## 本书特色

本书核心章节具有以下特色，可以帮助读者最充分地利用时间备考。

- **“基础问答”问题** 每一章起始处都有一个问题，可以帮助读者确定要在学习该章时花费多少时间。如果读者遵照一章开篇处的指导，即可引导读者学习该章全部或特定部分的内容。
- **基础内容** 这些是每一章的核心部分，解释该章内容中的协议、概念、配置等问题。
- **基础概要** 本书的“基础概要”部分与 Cisco Press 出版的“认证考试指南”丛书中“基础概要”部分的基本特点不同。这一部分不会重复“基础内容”部分的任何具体内容，而只是归纳、列举出与该章有关的一些内容，不一定会对其进行较多、较详细的解释。
- **要点** 贯穿“基础内容”始终，都会有要点图标设置在需要复习的最重要的区域旁边。读完一章，在为考试作最后准备时，可以翻看这些篇章，找到要点图标，复习这些段落、表格、图表、列表等。
- **凭记忆填写重点表格** 各章比较重要的表格都复制在 PDF 文件中，作为附录 F 放在

CD 中。表格中多数内容已经删除。读者可以把这些大部分空白的表格打印出来，试着填写，以增强对表中内容的记忆。这种方法应该对于记忆重点内容有很好的效果。

- **基于 CD 的模拟考试** 随书 CD 收入了多项选择题和测试引擎。CD 中包含两套题库：一套包括“基础问答”全部问题，另一套题库则收入了 CD 独有的题目。作为最后准备的一部分。读者应实际做一下这些考题，这不仅有助于巩固和验证考试内容知识，还有助于让读者熟悉考试过程。
- **主要术语和术语表** 每章中提及比较重要的术语都列在章末“定义”标题下。书末的术语表集中列出各章中的全部术语。读者学习各章时，都应查阅这些主要术语，而对于定义没有把握的术语，则可以查阅术语表中的简明定义。
- **相关资源** 每章都收录一些推荐书目和相关网址，方便读者对该章中讲述的内容作进一步的学习。这些参考书和相关网址对准备 CCIE 路由与交换实验室考试大有帮助。

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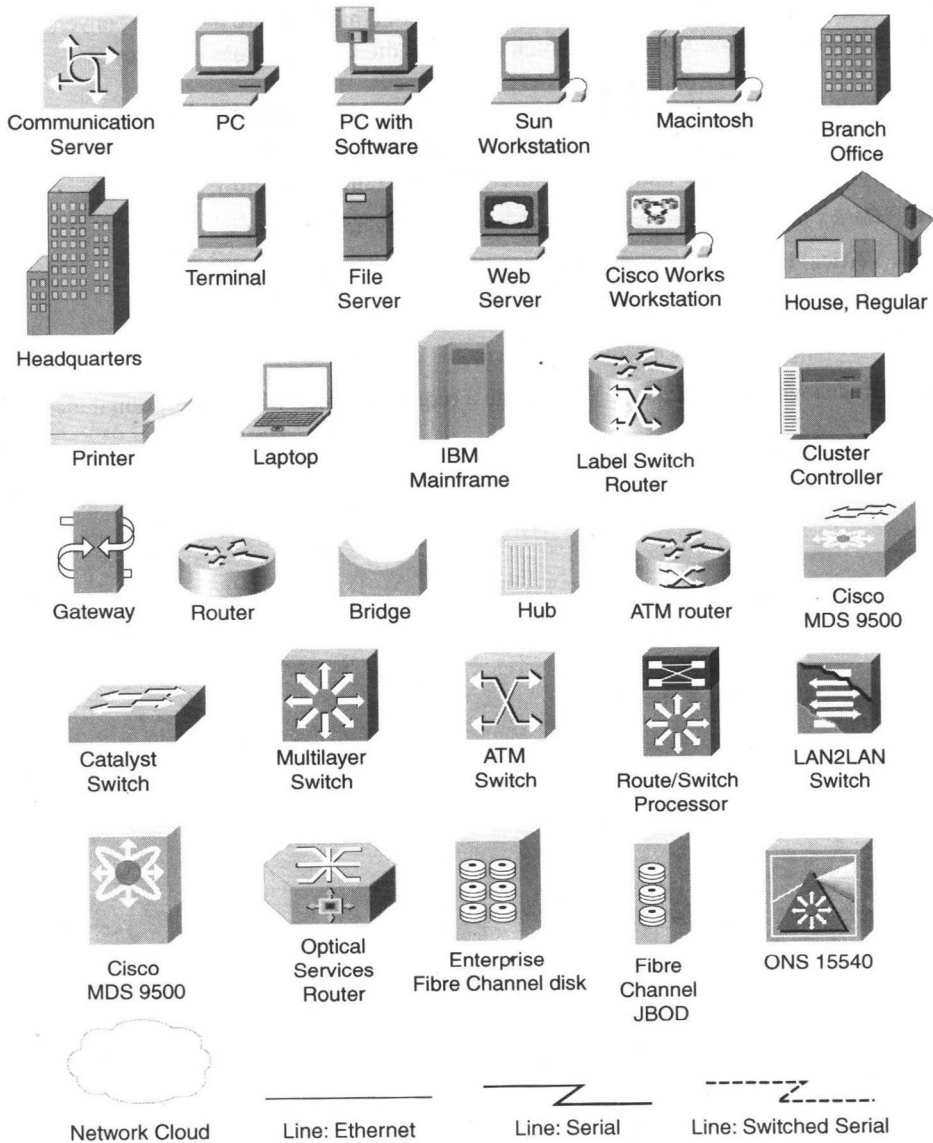
Brett Bartow, executive editor, did his usual New-York-Yankees-like job in helping steer this project to completion. In between talking about sports, Brett worked through the many changes in direction with this book, and helped guide us to the right product. He found Jim and Naren, who were vital to the process as well. And yes, so the whole world knows, he did win his fantasy baseball league in 2005—again proving he's a really smart guy.

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## Icons Used in This Book



## Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the *Cisco IOS Command Reference*, which describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a **show** command).
- *Italics* indicate arguments for which you supply actual values.
- Vertical bars | separate alternative, mutually exclusive elements.
- Square brackets, [ ], indicate optional elements.
- Braces, { }, indicate a required choice.
- Braces within brackets, [{ }], indicate a required choice within an optional element.



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