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Internet 路由结构

(第二版)(英文版)

Internet Routing Architectures

Second Edition

The definitive BGP resource

[美] Sam Halabi
Danny McPherson

著

人民邮电出版社
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内容提要

本书对当代 Internet 的结构、服务提供商和编址技术进行了介绍。讲述了链路状态和距离向量路由选择协议的特性以及为什么需要域间路由选择协议和它们是如何工作的，并深入探讨了 BGP 的实用的、面向设计的应用。书中包括很多 BGP 属性的编码实例和许多路由选择策略。本书通过在概念上和实例上提供实用的编址、选路和连通的技术，旨在培养读者对路由选择的理解，以便能以一种客观而又有根据的方法计划并完成主要的网络设计。学习本书，可以帮助你成为数据路由选择操作方面的专家。

本书适合于网络技术专业人员和网络爱好者阅读。

About the Authors



Sam Halabi is one of the industry's foremost experts in the Internet Service Provider line of business. Mr. Halabi was recently Vice President of Marketing at an IP networking startup and has spent many years at Cisco Systems where he led the IP Carrier Marketing effort. Mr. Halabi is an expert in complex routing protocols and has specialized in the design of large-scale IP networks.

An active member in the industry, Halabi serves as a board member of the Optical Internet-working Forum and a member of the MPLS Forum.

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Dedications

Danny McPherson: To my wife, Heather, and my two daughters, Kortney and Ashli. You are my infrastructure.

Acknowledgments

This book would not have been possible without the help of many people whose comments and suggestions significantly improved the end result. First, we would like to thank Abha Ahuja, Shane Amante, Johnson Liu, Alvaro Retana, and Alexander Rudenev for their exceptional technical review of this manuscript. We would also like to explicitly acknowledge Henk Smit, Bruce Cole, Enke Chen, Srihari Ramachandra, Rex Fernando, Satinder Singh, and Ravi Chandra, as well as the entire Cisco “BGP Coders” group, and everyone else who provided any amount of input for the second edition. Also, we would like to acknowledge the overwhelming support and patience of Danny McPherson’s present employer, Amber Networks, and previous employer, Qwest Communications, both of which had a significant impact on the value of the content. Finally, we would like to thank Christopher Cleveland, Tracy Hughes, Marc Fowler, Gayle Johnson, and the rest of the Cisco Press folks for keeping us on track and getting the book published.

Introduction

The Internet, an upstart academic experiment in the late 1960s, struggles with identity and success today. From the ARPANET to the NSFnet to ANYBODYSNET, the Internet is no longer owned by a single entity; it is owned by anybody who can afford to buy space on it. Tens of millions of users are seeking connectivity, and tens of thousands of companies are feeling left out if they do not tap into the Internet. This has put network designers and administrators under a lot of pressure to keep up with networking and connectivity needs. Understanding networking, and especially routing, has become a necessity.

Some people are surprised when networks fail and melt down, but others are surprised when they don't. This seems to be the case because there is so little useful information out there. Much of the information on routing that has been available to designers and administrators up until now is doubly frustrating: The information makes you think you know how to build your network—until you try, and find out that you don't. The first edition of this book addressed real routing issues, using real scenarios, in a comprehensive and accessible way.

In addition to providing a thorough update to the original material, this edition introduces recent enhancements to the BGP protocol, discusses changes surrounding registration and allocation of Internet numbers, and provides additional information on research and educational networks.

Objectives

The purpose of this book is to make you an expert on integrating your network into the global Internet. By presenting practical addressing, routing, and connectivity issues both conceptually and in the context of practical scenarios, this book aims to foster your understanding of routing so that you can plan and implement major network designs in an objective and informed way. Whether you are a customer or a provider (or both) of Internet connectivity, this book anticipates and addresses the routing challenges facing your network.

Audience

This book is intended for any organization that might need to tap into the Internet. Whether you are becoming a service provider or are connecting to one, you will find all you need to integrate your network. The perspectives of network administrators, integrators, and architects are considered throughout this book. Even though this book addresses different levels of expertise, it progresses logically from the simplest to the most challenging concepts and problems, and its common denominator is straightforward, practical scenarios to which anyone can relate. No major background in routing or TCP/IP is required. Any basic or background knowledge needed to understand routing is developed as needed in text discussions, rather than assumed as part of the reader's repertoire.

Organization

The book is organized into four parts:

- **Part I: The Contemporary Internet**—Chapters 1 through 3 cover essential introductory aspects of the contemporary Internet with respect to its structure, service providers, and addressing. Even if you are already familiar with the general structure of the Internet, you are encouraged to read the portions of Chapter 1 concerning Network Access Points, the Routing Arbiter Project, and Network Information Services. The pressures that precipitated these components of the Internet have continuing practical implications for routing design problems faced by administrators. Chapter 2 provides valuable criteria by which to evaluate Internet service providers. If you represent such a provider, or are already a customer of one, some of the information might be familiar to you already. Chapter 3 discusses classless interdomain rout-

ing (CIDR), VLSM (variable-length subnet masks), IPv6, and other aspects of Internet addressing.

- **Part II: Routing Protocol Basics**—Chapters 4 and 5 cover the basics: properties of link-state and distance vector routing protocols and why interdomain routing protocols are needed and how they work. These topics are covered both generally and in the specific context of BGP (Border Gateway Protocol)—the de facto standard interdomain routing protocol used in the Internet today. BGP’s particular capabilities and attributes are thoroughly introduced.
- **Part III: Effective Internet Routing Designs**—Chapters 6 through 10 delve into the practical, design-oriented applications of BGP. The BGP attributes introduced in Part II are shown in action, in a variety of representative network scenarios. BGP’s attributes are put to work in implementing design goals such as redundancy, symmetry, and load balancing. The challenges of making intradomain and interdomain routing work in harmony, managing growing or already-large systems, and maintaining stability are addressed.
- **Part IV: Internet Routing Device Configuration**—Chapters 11 and 12 contain numerous code examples of BGP’s attributes and of various routing policies. The code examples will make the most sense to you after you have read the earlier chapters, because many of them address multiple concepts and design goals. So that you can juxtapose textual discussions from earlier chapters with the code examples in Chapters 11 and 12, pointers called “Configuration Examples” appear in the earlier chapters. When you see one, you might want to fast-forward to the referenced page to see a configuration example of the attribute or policy being discussed.

Finally, several appendixes provide additional references for further reading, an up-to-date Cisco IOS™ BGP command reference, and information regarding IOS™ modifications intended to provide a more intuitive BGP command-line interface.

Approach

It is very hard to write about technical information in an accessible manner. Information that is stripped of too much technical detail loses its meaning, but complete and precise technical detail can overwhelm readers and obscure concepts. This book introduces technical detail gradually and in the context of practical scenarios whenever possible. The most heavily technical information—configuration examples in the Cisco IOS language—is withheld until the final two chapters of this book so that it is thoroughly grounded in the concepts and sample topologies that precede it.

Although your ultimate goal is to design and implement routing strategies, it is critical to grasp concepts and principles before applying them to your particular network. This book balances conceptual and practical perspectives by following a logical, gradual progression from general to specific, and from concepts to implementation. Even in chapters and sections that necessarily take a largely descriptive approach, hands-on interests are addressed through pointers to configuration examples, frequently asked questions, and scenario-based explanations.

The scenario-based approach is an especially important component of this book: it utilizes representative network topologies as a basis for illustrating almost every protocol attribute and routing policy discussed. Even though you might not see your exact network situation illustrated, the scenario is specific enough to facilitate learning by example, and general enough that you can extrapolate how the concepts illustrated apply to your situation.

Features and Text Conventions

This book works hard not to withhold protocol details and design-oriented information, while at the same time recognizing that building general and conceptual understanding necessarily comes first. Two features are included to help emphasize what is practical and design-oriented as underlying concepts are developed:

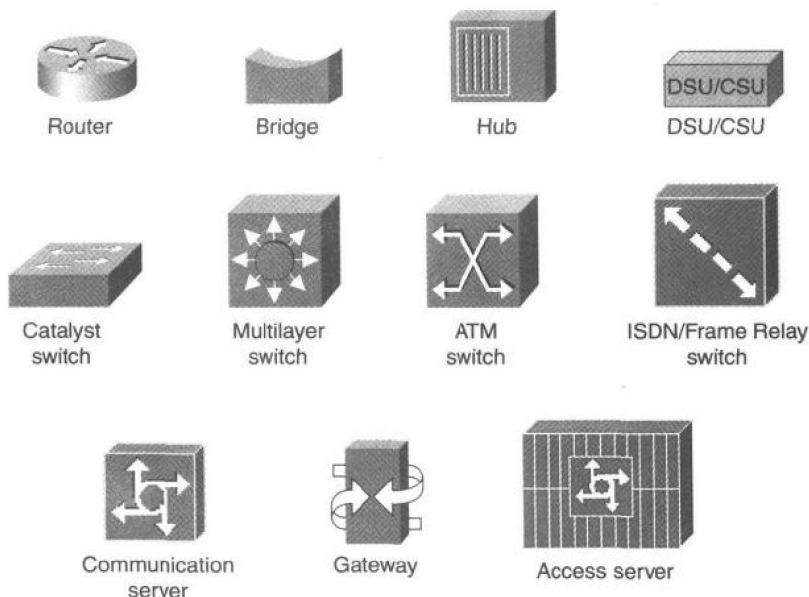
- **Pointers to configuration examples**—Located close to pertinent text discussions, these references point forward to places in Chapters 11 and 12 where related configuration examples can be found.
- **Frequently Asked Questions**—Located at the end of every chapter, these questions anticipate practical and design-oriented questions you might have, for your particular network, after having read the chapter.

Command Syntax Conventions

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

- 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 n optional elements.
- **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* indicates arguments for which you supply actual values.

Icons Used in This Book



Throughout the book, you will see the following icons used for peripherals and other devices.



PC



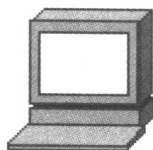
PC with
software



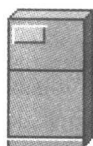
Sun
workstation



Macintosh



Terminal



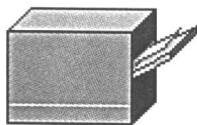
File
server



Web
server



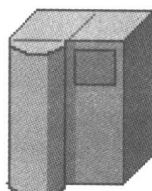
Cisco Works
workstation



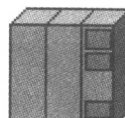
Printer



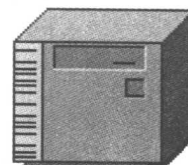
Laptop



IBM
mainframe



Front end
processor



Cluster
controller

Throughout the book, you will see the following icons used for networks and network connections.



Line: Ethernet



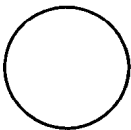
Line: serial



Line: switched serial



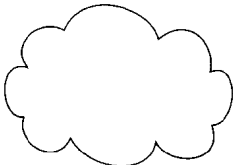
Frame Relay virtual circuit



Token ring



FDDI



Network cloud

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