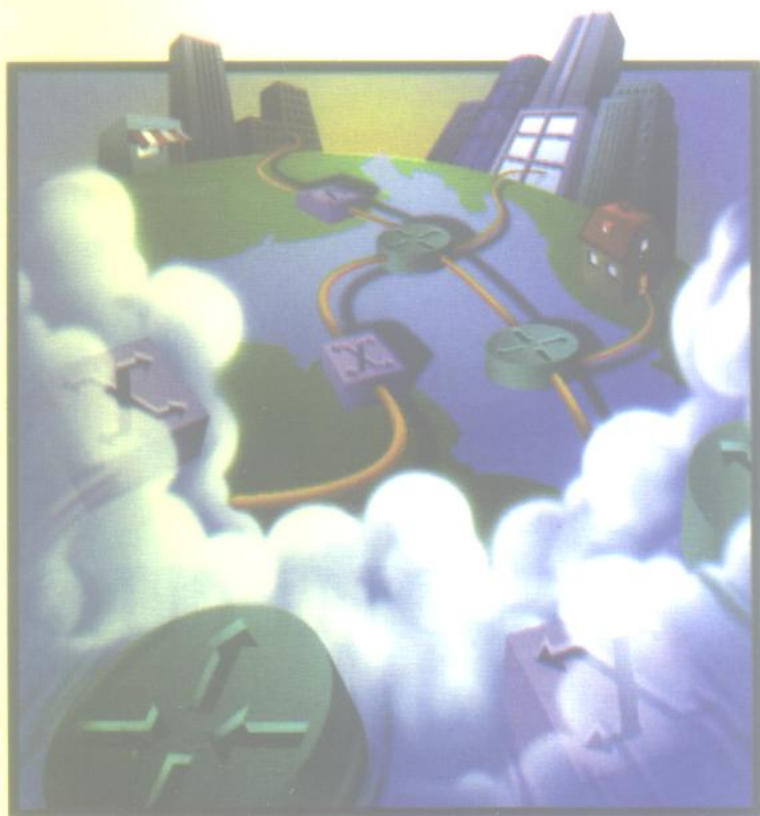


CISCO系列丛书（影印版）



Mark A.  
Sportack

A comprehensive introduction to routing  
concepts and protocols in IP networks

# IP ROUTING FUNDAMENTALS

## IP路由技术原理

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Mark A. Sportack



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## 出版前言

21 世纪将会是一个信息高速公路四通八达的时代,信息产业发展的水平亦将是评估一个国家综合国力的重要依据。世界各国将会在信息技术的研究开发和信息产业的发展方面展开激烈的竞争。这既是一种挑战也是一种机遇。有鉴于此,我国已经开始全面快速地发展网络技术和因特网。

Cisco Systems 公司是世界领先的全球 Internet, Intranet 以及电信网络设备及解决方案的供应商,1996 年名列世界十大电信公司之一。Cisco Systems 的联网操作系统(IOS)是支持网络服务和网络应用的坚实基础。该公司与麦克米伦计算机出版公司合作创立了 Cisco Press,出版了一系列关于最新的网络技术的权威著作。这些著作不仅兼顾建网与网际互联的基础理论和实际应用,为网络专业人员和用户提供必要的技术支持,还有一部分是为 Cisco CCIE 考试和 CCNA,CCNP,CCDA 及 CCDP 职业考试认证准备的自学和培训教材。Cisco 公司早于 1994 年就进入中国,已为国内信息产业界所熟悉。我们引进其中部分著作组成“CISCO 系列丛书(影印版)”影印出版,以祈对我国信息产业的发展稍尽绵薄之力,并衷心希望这套丛书对从事建网,网际互联的专业人员;有志于我国信息产业发展的读者,以及参加 Cisco 培训和准备 Cisco 考试认证的人员有所裨益。

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## **Dedications**

To my precious wife, Karen; I never realized how wonderful life could be until I met you.

To my children, Adam and Jennifer; you two are my pride and my joy.

## **Acknowledgments**

I would like to express my thanks to Ronald Hagen. Thanks, Ron, for that life-changing lunchtime chat all those years ago. You were right: The future of networking was IP. It still is. Thanks for the advice and guidance.

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# Introduction

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Routing is simultaneously the most complicated function of a network and the most important. Most knowledgeable people agree that networking and routing technologies have been around about 25 years. The concept of routing actually dates back to the late 1950s, when computing was still an arcane science in its infancy. Precious few organizations had a single computer, much less multiple computers that needed to be linked together. Internetworking, the interconnection of multiple computers, was still more of a futuristic vision than a reality. This vision predicted a day when computers would be widely implemented and interconnected via a ubiquitous global internetwork: the Internet.

The challenge in building and using a global internetwork is developing the means to find, access, and communicate with remote hosts. Ostensibly, a global internetwork would offer redundancy. In other words, there could be many different physical paths through a network between any given pair of hosts. Mechanisms would be needed that could discover remote networks and hosts and explore the different possible paths (or routes) through the network to those networks and hosts.

Finally, some way to apply either logic or mathematics would be needed. Logically, if there are many different routes to a specific destination, they can't all be equal. Some routes would likely offer either shorter overall paths or better performance than others. Thus, it would be logical to compare all the possible routes and then select the best route or routes. In time,

these mechanisms would become known as *routers*. The process of discovering, calculating, and comparing routes to remote networks and hosts is routing.

This book will help you explore the mechanics of routers and routed and routing protocols, and build internetworks using routing technologies. Although this book was designed primarily for the novice, it contains detailed technical examinations of many of today's leading routing protocols. These examinations are sufficiently detailed to be valuable to technical professionals at all levels of expertise. Consequently, you will find this book an indispensable technical reference long after you have mastered the basic theory and mechanics of routing and routing protocols.

Part I of this book provides an overview of internetworking, including the implications of using routers in both LANs and WANs. This overview is provided using the Internet Protocol (IP), which is the predominant routed protocol in use today. IP has grown substantially since its inception approximately two decades ago. Its once simple addressing architecture has become quite complicated during its life. An entire chapter is devoted to examining IP's addressing. This includes the original class-based address architecture, subnet numbers, and classless interdomain routing (CIDR) addresses. This chapter also provides a glimpse at how IP's addresses will change with the IPv6, the next generation of IP. IP addresses are used extensively throughout the book to present you with specific examples of the various routing concepts that are introduced.

Part II of the book delves into a slightly deeper level of detail. Instead of looking at internetworking from a high level, Part II looks at the inner workings of a router. This includes a side-by-side comparison of the two versions of IP, IPv4 (the current version) and IPv6 (the next generation); the various transmission technologies that a router can use for communications; and the mechanics of routing protocols.

There are different types of routing protocols. Generally speaking, they fall into two categories: those that calculate routes based on some measurement of distance, and those that calculate routes based on some measurement of the state of the links that comprise a route. The first type is known as a distance-vector routing protocol and the second type is a link-state routing protocol. An appreciation of the basic functional differences between these two types of routing protocols will prepare you for Part III of this book.

Part III presents a detailed examination of today's leading routing protocols. You will see exactly how RIP, RIP-2, OSPF, IGRP, and EIGRP operate in an internetwork. Understanding



the mechanics of a routing protocol will help you design better networks and more effectively troubleshoot and fine-tune an existing network.

The detailed examination of routers and routing in the first three sections of the book provides the context for the last section. The last section of this book emphasizes the implementation of routing technologies and provides insight into the future of routing.

The first chapter of Part IV focuses on building internetworks. An internetwork must accommodate different types of needs. These needs vary considerably from network to network but encompass some specific attributes. These attributes include scalability, geographic distance between the locations in the network, traffic volumes, performance delays, and monetary costs of operating and maintaining the network. The implications of each of these are explored, along with sample network topologies and guidelines for selecting transmission technologies.

One of the more challenging aspects of building an internetwork is coping with multiple protocols. Precious few networks have the luxury of using a single routed and/or routing protocol. There are many reasons for this, including merger and acquisitions, extranets, and even migrations to new technologies. Regardless of the reason, the challenge lies in overcoming the dissimilarities of the routed and/or routing protocols. Chapter 14 examines the options for internetworking with dissimilar protocols (both routed and routing). This chapter includes a look at the implications of a migration to IPv6 from IPv4 and some strategies for successfully conducting such a migration.

The book concludes with an assessment of the future of routing. This is necessary, as technological advances have created substantial confusion, and even doubts, about routers and routing! For example, Microsoft's Windows NT operating system can enable a client or server-grade computer to function as a router. What does this mean for the future of stand-alone routers?

Additional confusion about the future of routers has been caused by the technological developments that blur the previous distinctions between LANs and WANs. Switching, in particular, is rapidly being implemented for both network types, and it can forward Layer 3 packets as easily as Layer 2 frames. Thus, one of the biggest issues facing IT planners is: What is the future role of routing? Are routers still needed? These questions are probed and answered in the concluding chapter.

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