

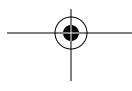
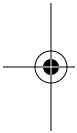
Preface

Ants, single-celled creatures such as the cellular slime mold, plants and animals in ecosystems, and (even) human beings can congregate and display miraculously complex behaviors.* Say a colony of ants in a tree needs to move to another tree, perhaps in search of food. Some ants build a bridge by joining their bodies in a chain stretching from one limb in one tree to another limb in another tree. Other ants cross over this ant structure, walking over their peers. Once all the ants have crossed over, the ants in the bridge begin to gracefully undo the structure, crossing one by one. Each ant only repeats simple actions, over and over again; the net result of thousands of ants working together is the miracle of the bridge, which allows the ant colony to migrate.

In our own human society we hope to emulate this level of cooperation. Each one of us is useful to others in some way: we write, lay bricks, act in the theater, farm, drive buses, repair helicopters, tend to the sick, make coffee... As individuals, we repeat the same acts again and again, whether it be making coffee cup after coffee cup or seeing patient after patient. The net result of all these acts is our complex, wonderful society.

So, what does all this have to do with IP routing? Each router in a network repeats simple processes over and over again, as described in the specification of the routing protocol it is executing. The net result of all the routers in a network repeating these simple processes is IP routing, or the movement of IP packets in a network.

* *The New York Times* has reported some intriguing examples of such behavior, quoting research work from the Santa Fe Institute in New Mexico ("Mindless Creatures Acting Mindfully," *The New York Times*, March 23, 1999, Science Times).



My advice to you, the student of IP routing, is this: study the simple behaviors of each ant, and make sure you understand them in detail. There is no other way to understand how IP networks behave as ordered organisms.

Audience

This text assumes that the reader has knowledge of basic networking concepts—the ISO/OSI model, bridging versus routing, IP addressing, TCP/IP, etc.

This text is not meant to replace Cisco manuals. Use this text to build concepts. IP routing commands are described as they are used to illustrate concepts; however, this text does not contain an exhaustive list of all IP routing commands. Use Cisco documentation for details on commands, to find out which IOS release supports new features, and for the (inevitable) bug lists.

Most of the time I have used addresses from the private address pool. However, sometimes I have had to dip into the registered address pool, especially when talking about BGP. If you use the examples in this book, be careful that you do not choose addresses that conflict with existing addresses in your environment.

Organization

This book is comprised of eight chapters:

Chapter 1, *Starting Simple*

This chapter introduces the basic concepts of IP routing. It will show you the simplest method of creating entries in a routing table—by defining static routes.

Chapter 2, *Routing Information Protocol (RIP)*

RIP is the earliest dynamic routing protocol. This chapter describes RIP in detail, including a discussion of the Distance Vector (DV) algorithms that are the foundation of RIP and other routing protocols. Since RIP is the simplest dynamic routing protocol, it is a great tool from which to learn. It may be a good idea to study this chapter even if you do not intend to use RIP.

Chapter 3, *Interior Gateway Routing Protocol (IGRP)*

IGRP is Cisco's proprietary routing protocol, which directly descended from RIP. IGRP contains some features that make it much more useful than RIP. This chapter focuses on these new features (study Chapter 2 to learn about the foundations of IGRP—the DV protocols).

Chapter 4, *Enhanced Interior Gateway Routing Protocol (EIGRP)*

The DV algorithms employed by RIP and IGRP have inherent limitations. EIGRP is Cisco's proprietary routing protocol, which interworks seamlessly with IGRP but attempts to overcome these limitations. EIGRP supports classless networks and Variable Length Subnet Masks (VLSM).

Chapter 5, *Routing Information Protocol Version 2 (RIP-2)*

RIP-2 is an attempt to bring RIP back into vogue. RIP-2 is really RIP with support for classless networks and VLSM. RIP-2 still has all the limitations of DV protocols, such as long convergence times.

Chapter 6, *Open Shortest Path First (OSPF)*

OSPF is an open routing protocol. It is most commonly used to build large IP networks. The standards bodies are focusing their work on OSPF, and it is constantly evolving. OSPF is not a DV protocol: OSPF is based on the Dijkstra algorithm. This chapter explains Dijkstra in detail and lays the foundation of how to build hierarchical networks using OSPF.

Chapter 7, *Border Gateway Protocol 4 (BGP-4)*

BGP is the glue that binds the thousands of networks that comprise the Internet. Routing in the Internet is quite different from routing in intranets. There are several new concepts in this chapter.

Chapter 8, *Administrative Controls*

This chapter describes the administrative tools available to all the routing protocols. These tools are used to block the advertisement of routing updates, set up preferences for one routing protocol over another, and more.

Conventions Used in This Book

Italic

Used for emphasis and the first use of technical terms, as well as for the names of networks and routers used in the examples.

Constant Width

Used for IP addresses.

Constant width italic

Used for replaceable parameter names in command syntax.

Code blocks are used throughout the text to make concepts concrete. Line numbers in the lefthand margins are used to refer to specific pieces of the code block. To avoid confusion, within each chapter the line numbers used in the code blocks start at 1 and continue consecutively through the end of the chapter. Code lines that are in bold but are not numbered are also of particular relevance to the surrounding text.

```
NewYork#sh ip ospf interface
...
Ethernet0 is up, line protocol is up
1  Internet Address 172.16.1.1/24, Area 0
2  Process ID 10, Router ID 172.16.251.1, Network Type BROADCAST, Cost: 10
...
Serial0 is up, line protocol is up
Internet Address 172.16.250.1/24, Area 0
Process ID 10, Router ID 172.16.251.1, Network Type POINT_TO_POINT, Cost: 64
```

The use of “...” in the code block indicates that some lines (which were not useful in the discussion) have been omitted.



Indicates a tip, suggestion, or general note.



Indicates a warning or caution.

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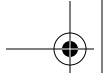
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Rachel Wheeler served as a very gracious Production Editor, coordinating the details that were essential to producing the book on time. Thanks also to Jessamyn Read, the O'Reilly Illustrator who transformed my rough sketches into the figures you'll find in this book.



As the first editor, Mike Loukides helped define the organization and content of the book. Jim Sumser took over from Mike partway through the project. Jim helped me see the work in perspective and led me through the mire of the detailed work. I want to thank Jim for the patience with which he worked with me. Everything that could prevent me from getting to the book seemed to happen: even I did not believe it would get done, but somehow Jim believed in it. I must have worked through two summers with him, for I remember him talking about two very sweet crops from his cherry tree.

Writing this book was a long, winding road that led me away from my loved ones on many an evening. I have missed Char, my wife, all those evenings when I was locked away somewhere, rewriting a chapter. I am not sure how much Char missed me, but she certainly missed having me around to look after Lucas and Theo, who are quite young and absolutely adorable to be around.

This last piece of this book is being written in the weeks after September 11, 2001. Much of this book was written around the World Trade Center: in it, under it, in its shadow, looking up at it, in a bus traveling to it, in a subway moving away from it, under the influence of coffee bought there, while waiting to meet my family in a nearby park. The Towers symbolize a time of freedom and innocence. We live in a different era now, and I have come to think of this book as belonging to that era of freedom and happiness and innocence.



