SEVENTH EDITION

BUSINESS DATA

NETWORKS AND

TELECOMMUNICATIONS
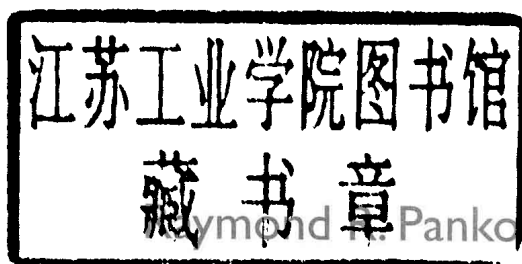
Raymond R. Panko

Business Data Networks and Telecommunications

Raymond R. Panko

University of Hawai'i at Mānoa

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PEARSON
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To Doug Engelbart, who foresaw all this in the 1960s.

Preface for Teachers

THREE QUESTIONS

Teachers who are considering this book typically have three questions:.

1. Why select this book? In this preface, we will look at three reasons:

    Job-relevant information

    Great teacher support

    Pedagogy

2. How can I teach with it?

3. What's new since the last edition?

This preface walks through these questions, in order.

WHY SELECT THIS BOOK?

Job-Relevant Information

In designing this and previous editions, the author talked extensively with working networking professionals and managers. He also got extensive market data on the technologies that corporations actually use. Many textbooks seem to be surprisingly market blind, spending time on technologies that never were adopted by the market and on technologies that have not been sold since the previous century. As a result, they are not covering important new developments. For example, Ethernet, which is now the only wired LAN technology in almost every firm, is no longer a simple technology. Students need to know about priority, VLANs, the Rapid Spanning Tree Protocol for reliability, 802.1X, 802.1AE, 802.1af, 802.1at, and other advanced aspects of Ethernet.

Up-to-Date Content

Wireless Of course, the content needs to be up-to-date. The material on wireless transmission—already strong in the last edition—has been strengthened throughout the book. Wireless material now starts earlier (in Chapter 3 on physical propagation), is the focus of Chapter 5 on wireless LANs chapters, and is taken into WANs in Chapter 6 (which discusses WiMAX and wireless access in general).

Security Network managers now find themselves spending much of their time on security. The last edition was very strong on security. Now, security has been strengthened throughout the book, including in Chapters 4 (Ethernet LANs), Chapter 5 (Wireless LANs), Chapter 9 (the anchor chapter on security), and Chapter 11 (applications).

Voice Alternatives   Telephone bills in corporations are high, and technology is changing the way we use voice. Chapter 6 provides more in-depth discussions of VoIP and cellular telephony, as well as triple play bundles for voice, data, and television and the changes this will bring.

Market-Driven Content

Even more importantly, the book's content is strongly market-driven. Too many textbooks try to cover every technology that ever existed, even when its use today is almost nonexistent. As noted earlier, this leaves far too little time for today's critical technologies and emerging technologies. Students become historians, not market-ready graduates. In fact, some books seem to ignore market data. One recent textbook even called Frame Relay a new technology, despite the fact that Frame Relay revenues were almost equal to those of private line revenues in the WAN market in the late 1990s and that Frame Relay is now a legacy technology in decline. In contrast, here are some examples of the book's market-driven content:

- ➤ Wireless LANs. As just noted, the book responds to corporate calls for greater wireless knowledge.
- ➤ Security. As you would expect from the author, security is even more pervasive throughout the text.
- ➤ TCP/IP. Above the physical and data link layers used in LANs and WANs, TCP/IP is consolidating its hold on upper-layer technologies. In the seventh edition, TCP/IP is even more pervasive than in previous editions. Chapter 1 introduces several core concepts, Chapter 2 introduces the basic elements of TCP/IP, and Chapter 8 goes into detail on advanced aspects of TCP/IP standards, including how routers make routing decisions. Chapter 10 discusses key topics in TCP/IP management. Module A covers a number of even more advanced aspects of TCP/IP.

Job-Ready Detail

In the past, job interviewers often asked students to name the OSI layers and stopped at that. Today, however, even job interviewers for non-networking jobs grill job applicants on the details of networking. The days of feel-good "network appreciation" textbooks with far too little detail for job applicants should be over.

For example, in the Ethernet Chapter (Chapter 4), the book goes well beyond basic topology and switch operation to look at VLANs, link aggregation, the Rapid Spanning Tree Protocol, overprovisioning versus priority, and switch purchasing considerations. Detail has been beefed-up in other areas as well. The TCP/IP Chapter (Chapter 8) takes a detailed look at how routers operate, while many other books cover this critical topic superficially or even incorrectly.

Great Teacher Support

Teaching networking is very difficult, so textbooks must provide strong teacher support.

Ask the Author

I'm Ray@panko.com. If you have questions about the text, the material, or networking in general, please do not hesitate to contact me. Also, if you have suggestions for the next edition, please let me know. This book is on a two-year cycle, and it is always changing.

Detailed PowerPoint Lectures

The book has full PowerPoint lectures created and updated by the author—not just "a few selected slides." The PowerPoint lectures include builds for more complex figures and new information since the book went to press. Teachers can get annotated versions of the PowerPoint presentations to help them prepare and present lectures.

The PowerPoint slides are keyed directly to figures in the book. Almost all the important points in the book are covered in figures—including "study figures" that summarize the key points in the more complex sections.

Website

The book's website, http://www.prenhall.com/panko, created and updated by the author, is rich in teacher resources. This is where teachers can download answer keys, test item file questions, and the latest versions of the PowerPoint lectures (which are updated once or twice a year).

Flexibility: Have It Your Way

This book is not designed to be covered in its entirety, including all advanced modules. Rather, it is designed to give teachers options without their having to look for other material.

An 11-Chapter Core: A Complete Networking Course The book has 11 core chapters that can each be covered in about one week. In a three-credit, one-semester course, this leaves one to two weeks for other material. However, many teachers prefer to limit their courses to the 11 core chapters, which form a complete networking course. This allows them to go through the material at a more deliberate pace. Also, staying with the 11 core chapters may be a good strategy for teachers working with the book for the first time or teaching a networking course for the first time.

Boxed Material within Chapters Within chapters, some technical details are placed in boxes. Many teachers skip all boxed material. Others use them selectively.

"Letter" Chapters The book has two types of material beyond the 11 core chapters: "letter" chapters, such as Chapter 1a, and advanced modules. These chapters and modules should be used judiciously. Even covering two or three letter chapters or one advanced module may be pushing it.

Several core chapters are followed by "letter" chapters. For example, Chapter 1a has a design exercise and hands-on exercises. Chapter 3a deals with cutting and connectorizing UTP wiring. Although neither 802.5 Token-Ring Networks nor FDDI networks are used in corporations today, Chapter 4a gives an overview of ring topologies and token-passing. Chapter 8a introduces WinDUMP and TCPDUMP for packet capture, and Chapter 10a has hands-on exercises for network management utilities.

Advanced Modules There are three advanced modules. For teachers who really want to focus on TCP/IP, Module A has very detailed information about TCP/IP. Module C is designed for courses that focus on telecommunications. Chapter 6 looks at

telecommunications from the viewpoint of corporate information systems (IS) staffs. Module C focuses on telecommunications from the carrier's point of view. Module B covers modulation in greater detail for teachers who feel that more information on telephone modems is needed.

Chapter Questions Are Tied to Answer Keys and Test Item File Questions

The chapters have test-your-understanding questions, roughly once per page, so that students can do a brain check on what they have just read. In addition, end-of-chapter thought questions, design questions, and troubleshooting questions help students attain higher-level mastery of the material. Answer keys for all questions are available to teachers.

Multiple-choice test item file questions are keyed to specific chapter questions. This allows teachers who wish to be selective to choose specific questions which students should master, then develop tests that reflect those selected questions.

Mailing List

A low-volume mailing list used a few times per year updates adopters on new developments—most commonly, new material at the website. The mailing list is also used to solicit adopter feedback on the text.

Pedagogy

Learning networking is difficult. Many students find that networking is the most conceptually difficult course in IS programs. Networking books need to have very strong pedagogy.

Clear Writing

All editions of this book have received accolades for clear writing—especially for its ability to teach difficult and complex topics. Every Chapter is classroom-tested.

Hands-On Opportunities

Students want opportunities to do things hands-on. With this book, they have those opportunities. The following sections are examples of hands-on training in this text:

➤ Chapters 1a and 10a, in their end-of-chapter reviews, present hands-on questions to reinforce concepts.

➤ Chapter 3a demonstrates how to cut and connectorize UTP. Teaching this material requires an investment of about $200, but undergraduate students love it.

➤ Chapter 8a shows students how to do packet capture and analysis.

➤ Other chapters have students go to the Internet to do specific tasks.

Chapter Questions

Frequent Test-Your-Understanding Questions   The book gives the student many opportunities to check his or her knowledge. Approximately once per page, there are Test-Your-Understanding questions to help the student see whether he or she has understood the material just read.

Meaty End–of-Chapter Questions End-of-chapter questions help the student integrate the material in the chapter. Thought questions challenge the student to think more deeply about the material. Troubleshooting and design questions help students develop important skills that are critical in networking. Some chapters also have hands-on questions for students to do at home.

Coordinated Test Item File for Multiple Choice Questions As noted earlier, test item file questions are keyed to specific Test-Your-Understanding and End-of-Chapter questions.

Up through the Layers/Familiar to the Unfamiliar

Like most books, the seventh edition takes an up-though-the-layers approach. However, this approach is significantly modified because most books that take this approach teach one layer at a time, in isolation. Only at the end of the book does the student see the whole picture. During the process, they have gained only a cursory framework within which to integrate chapter knowledge.

➤ This book is different. The book begins, in Chapters 1 through 3, with a strong framework to help students understand networking broadly so that when new knowledge appears, they understand its place. The difficult concept of layered network architectures is introduced early and is reinforced throughout the book.

➤ Chapters 4 through 7 deal with switched LANs, telecommunications, and switched WAN technologies. Every switched LAN and switched WAN technology is a mixture of Layer 1 (physical) and Layer 2 (data link) technologies. For this reason, this book covers Layer 1 and 2 technologies within the context of specific LAN and WAN technologies rather than individually (although Chapter 3 introduces specific physical layer information).

➤ Chapter 8 discusses internetworking, especially TCP/IP internetworking at Layer 3 (internet) and Layer 4 (transport). Once the student understands switched LAN and switched WAN technologies, they can appreciate the need to interconnect them.

➤ Chapters 9 and 10 cover material that cuts throughout the layers—security and network management. These topics are introduced early, but a full discussion has to wait until students have a solid understanding of layer technologies. These are anchor chapters that cement what was covered earlier and add detailed information.

➤ The last chapter, Chapter 11, deals with the application layer (in OSI, application layers). It might seem better to cover this information immediately after Chapter 8, but many schools cover applications in a separate course, and ending the course with applications is fun.

Synopsis Sections in Every Chapter

Each chapter ends in a synopsis section that summarizes key points. In classroom testing of the edition's chapters, these synopsis sections were very popular with students.

TEACHING WITH THIS BOOK

As noted earlier, this book has 11 core chapters. These form a complete course.

Junior and Senior Courses Information Systems

With courses for juniors and seniors, as noted earlier, covering the 11 core chapters (including "a" chapters that are case studies) will probably leave you with one or two semester weeks "free." As noted earlier, this leaves time for hands-on activities (discussed earlier), additional TCP/IP material (or other material in the advanced modules), a term project, or whatever you wish to cover. However, the book should not be covered in its entirety in a single term.

Community College Courses

For freshman and sophomore courses in community colleges, it is good practice to stay with the 11 core chapters, going over chapter questions in class. If you want to do hands-on material, it is advisable to cut some material from the core chapters.

Graduate Courses

Graduate courses tend to look a lot like junior and senior level courses, but with greater depth. More focus can be placed on end-of-chapter questions and novel hands-on exercises, such as OPNET simulations. It is also typical to have a term project.

CHANGES SINCE THE SIXTH EDITION

The seventh edition generally follows the same basic flow as the sixth. The following table lists some major and minor changes:

Seventh Edition	Remarks on the Seventh Edition, Relative to the Sixth Edition (6e)
Key Changes	Chapter 1 now jumps right into applications, quality of service, and network management, including operational management. This reflects the fact that networking is increasingly a managerial concern.
	Chapter 10 is much richer in network management and has been completely reorganized and heavily rewritten.
	The subject of wireless has been enhanced throughout the book. Propagation is moved up to Chapter 3, Chapter 5 on WLANs has been strengthened, and WiMAX is enhanced in Chapter 6.
	Security is strengthened in Chapter 4 on Ethernet, Chapter 5 on wireless LANs, and Chapter 9 (especially on management and stateful inspection firewalls).
	The short, but important, VoIP discussion in Chapter 6 has been strengthened.
Specific General Changes	The term "host" is used for all computers
	In the sixth edition, there was an important and pervasive distinction between single networks, which used switches, and internets, which used routers to connect single networks. In the seventh

	edition, these concepts have been changed to switched networks and routed networks (which are also called internets).
	In the sixth edition, the speed of WANs was set at 128 kbps to a few megabits per second. Due to speed increases, the range in the seventh edition has been raised to 256 kbps to about 50 Mbps. This is still far lower than LAN speeds.
	The terms "mobiles" and "mobile phones" usually replace the term "cellular phones."
	Perspective questions at the end of each chapter have students decide what was the most surprising thing to them in the chapter and what was the most difficult material for them in the chapter.
Chapter 1. An Introduction to Networking	This chapter has been almost completely rewritten to focus more heavily on applications and management.
	The chapter begins with a large section on applications, which are the things that users care about (including traditional Internet applications, IM, streaming audio and video, VoIP, file service, Web 2.0, P2P, and business-specific applications such as transaction processing).
	Rather than being delayed to Chapter 2, standards and the important distinction between proprietary and open standards (TCP/IP, OSI, etc.) are introduced in Chapter 1.
	The chapter has a strong quality of service section dealing with speed, cost, availability, error rates, latency and jitter.
	For cost, the system life cycle and the total cost of ownership (TCO) are introduced.
	The chapter ends with management, including operational management after the network is functioning. This section uses the OAM&P (operations, administration, management, and provisioning) framework.
	Security is shortened and focused on four key protections: authentication, cryptographic protections, firewalls, and host hardening. Authentication is developed throughout the book, including in Chapters 4, 5, and 9.
	The chapter discusses message switching versus packet switching and introduces the concepts of switched networks (single networks, in the sixth edition) and routed networks or internets (internets, in the sixth edition)
	The chapter emphasizes that LANs and WANs can be either switched or routed. Chapter 4 specifically ends with discussion of a routed LAN.
	The chapter introduces the Internet and key routed network concepts.
Chapter 1a. Introductory Design and Hands-On Exercises	This material was presented mostly in Chapter 1 in the sixth edition.
	There is a design exercise based on XTR, but simplified.
	Hands-On exercises that are largely from Chapter 1 in the previous edition.
Chapter 2. Layered Standards Architectures	This chapter is largely the same as in the sixth edition, although some material has been moved around or emphasized in the seventh edition.

<div align="right">(continued)</div>

	Material has been added on embedding and final frames, a topic that students typically find difficult. (See Figure 2-18.)
	The text emphasizes that TCP and UDP are the only protocols at the transport layer.
	Hybrid TCP/IP-OSI architecture (Figure 2-6) has been changed to begin with broad functions, then the five specific layers (Figure 2-20).
	The Ethernet frame (Figure 2-11) has been changed in the new edition. See notes on Chapter 4, to follow, which discuss the changes.
	Figure 2-13 "Why make only TCP/IP reliable?" was added to help students with this difficult, but critical, concept.
Chapter 3. Physical Layer Propagation	The section on digital signaling and baud rates has been rewritten, and the study figure has been extended. Most teachers ignore this box.
	The section on optical fiber has been almost completely rewritten. LAN fiber now comes before WAN fiber, which makes sense because only carriers use WAN fiber. Figure 3-24 visually contrasts the two types of fiber.
	In the seventh edition, the material on wireless propagation has been moved from Chapter 5 to Chapter 3, to bring all propagation information together (and to leave room for more wireless LAN discussion in Chapter 5).
	The section on decibels has been heavily rewritten.
	Small form factor connectors are introduced for fiber.
	The section on UTP quality standards has been rewritten to take recent developments into account. Figure 3-19 succinctly compares the fiber types.
Chapter 3a. Hands On: Cutting and Connectorizing UTP	No changes since the 6th edition.
Chapter 4. Ethernet which LANs	The seventh edition deletes the discussion of "fast Ethernet," is now slow, and "10/100 Ethernet," which is no longer relevant.
	The section on Ethernet standards has been changed to reflect the fact that the 802.3 Working Group has decided to produce both 40 Gbps and 100 Gbps versions as its next step.
	The section on Ethernet frame structure has been rewritten. The LLP subheader and PAD are not shown as part of the data field. This greatly simplifies the material the students need to understand about frame data fields holding packets.
	The section on introducing redundant links in Ethernet hierarchical networks has been rewritten to focus on RSTP (802.1w), not STP (802.1D), which is now obsolete.
	The section on VLANs has been streamlined, and security is given as an equal reason for using VLANs (a recent development in most firms).
	Overprovisioning is no longer an automatic win over priority, so statements saying that it is have been dropped.
	The Ethernet security section was strengthened, including the addition of artwork.

	The section on CSMA/CD has been rewritten somewhat, to help students learn the sequence of steps.
	The seventh edition drops switching matrix throughput, which is no longer a concern in networking.
	The power over Ethernet (POE) section has been completely rewritten, and the emerging POE Plus standard was added.
	There are now more design questions permitting easier student transitions in understanding from trivial LANs to complex LANs.
Chapter 4a. Token-Ring Networks and Early Ethernet Technologies	This chapter has been heavily rewritten to make early Ethernet equally important to token-ring networks. Again, this is material that most teachers will not want to cover.
Chapter 5. Wireless LANs (WLANs)	The chapter now starts with a discussion of 802.11 instead of the topic of new wireless technologies, which has been moved to the end of the chapter.
	Wireless propagation moved to Chapter 3.
	The material on 802.11 was heavily reorganized. Discussions of licensed and unlicensed radio bands appear earlier, and 802.11 standards are initially presented in the context of the two main unlicensed radio bands.
	The new edition lumps 802.11, 802.11a, and 802.11b in a section on early 802.1 standards and reduces their discussion to make room for today's dominant technologies. This edition is stronger than the sixth edition on 802.11g and even stronger on 802.11n and MIMO.
	Figure 5-18, the 802.11 WLAN standards table, now includes 802.11n.
	The new edition adds mesh networking and smart antennas to the 802.11 discussion because these are appearing in the marketplace.
	The crucial security section has been rewritten. WEP has been reduced in the discussion because it is no longer an issue, and a discussion on whether 802.11i can replace WPA has been added. VPNs and VLANs now are addressed in a separate section, and an Evil twin figure has been added.
	Software-defined radio is mentioned.
Chapter 6. Telecommunications	The seventh edition adds T1 TDM to the virtual circuits discussion. In cellular, more non-call features of mobile phones are needed.
	A stronger compare–and–contrast discussion has been added for WLAN with access points and cellular telephony in terms of hand-offs and roaming, and a figure has been added.
	The VoIP section has been heavily rewritten
	The last section, on residential Internet access, has been rewritten to be "rebuilding the last mile" for better integration with the chapter. Telephone service and cable TV histories have been added, and the section on telephone modems has been reduced.
	There is now a distinct section on wireless access, including 3G and satellite service, and a strengthened WiMAX section.
	There is a section on triple-play services including voice, data, and TV.
	Fiber to the home is expanded because this offering is now appearing.

(continued)

	The chapter notes the lag in U.S. speeds and high costs compared with international speeds and costs. The United States has a median download speed of 1.9 Mbps, while France has 17 Mbps, and Korea has 45 Mbps. The United States is now 16th in broadband speed.
Chapter 7. Wide Area Networks (WANs)	The chapter has been restructured to discuss carrier offerings in terms of Layer 1, 2, and 3 offerings.
	The typical speed range has been raised to 256 kbps to 50 Mbps for WANs—still much slower than LANs.
	This edition moves CSU/DSU devices forward to the discussion of leased lines, which better reflects the Layer 1 nature of CSU/DSU units.
	Frame Relay is reduced to reflect its declining use.
	The ATM cell concept has been eliminated from the text because it is confusing, is not fundamental, and is not relevant to corporate networking professionals.
	The discussion of IP WAN service has been heavily rewritten because Layer 3 carrier services are growing rapidly in importance, including IP carrier networks. In fact, carriers are beginning to set deadlines for clients switching from legacy Frame Relay service to IP carrier services.
	In the discussion of VPNs, the concept of host-to-host VPNs has been dropped. Now the book discusses only remote access and site-to-site VPNs. This sharpens the discussion.
	There is now a Test Your Understanding question on the implications for mesh versus hub-and-spoke designs, and there is a more complex design question on this at the end of the chapter.
Chapter 7a. Case Study: First Bank of Paradise's Wide Area Networks	No changes since the 6th edition.
Chapter 8. TCP/IP Internetworking	The section on router forwarding has been completely rewritten to streamline the presentation. ARP moved up to this section, and decision caching has been further emphasized.
	A box has been added with instructions for students on how to handle masks that do not break nicely at 8-bit boundaries and so must be handled at the bit level.
	The FIN section has been changed to note that after one side of a transmission initiates a close with a FIN, it will still send acknowledgments.
	The treatments of TCP and IP were moved up, and the treatments of other standards moved down to produce a smoother flow and to emphasize TCP and IP.
	The discussions of MPLS and DNS have been moved to Chapter 10 in order to have a complete section in Chapter 10 on TCP/IP management.
Chapter 8a. Hands On: Packet Capture and Analysis with WinDUMP and TCPDUMP	No changes since the 6th edition.

Chapter 9. Security	The chapter begins with a recap of Chapter 1.
	The chapter does not present CSI/FBI data.
	The section on attacks on individual consumers has been heavily modified for flow and content.
	The plan-protect-respond cycle has been introduced in the section on security management, and security planning principles have been emphasized.
	The stateful inspection firewall section has been completely changed to give a clearer concept of states and how stateful inspection relates to filtering.
	The DDoS figure has been simplified, and zombie changed to bot to reflect current practice.
	The topic of public key encryption for confidentiality has been left out to avoid confusion between the use of public keys in authentication and their use in confidentiality. Public key encryption for confidentiality is very rare and is better left to texts on security.
Chapter 10. Network Management	There is a completely new organization to the chapter.
	The chapter begins with a recap of management sections from earlier chapters.
	Within a planning section for technological infrastructure decisions, the treatment of traffic shaping has been improved, and a discussion of compression has been added.
	This chapter includes a dominant section on TCP/IP management, addressing IP subnet planning, NAT, MPLS, DNS, DHCP servers, and /SNMP. The NAT discussion is new and substantial. The section discusses authoritative DNS servers and how they are used.
	The final section deals with directory servers, including Active Directory.
Chapter 10a. Network Management Utilities and Router Configuration	Hands-on questions have been moved here from Chapter 10. Router configuration material has been moved here from Chapter 10.
Chapter 11. Networked Applications	Applications were introduced substantially in Chapter 1. E-commerce security has been left out of Chapter 11 because it is no longer a distinct issue.
	There has been a total rewrite of the Web Services (SOA) section, including WSDL.
Module A. More on TCP/IP	There are no changes in this module since the 6th edition.
Module B. More on Modulation	There are no changes in this module since the 6th edition.
Module C. More on Telecommunications	There are no changes in this module since the 6th edition.

Preface for Students

PERSPECTIVE

Initially, information systems (IS) graduates had a single career track: programmer–analyst–database administrator–manager. Today, however, many IS graduates find themselves on the networking career track—often to their surprise. This course is an introduction to the networking track.

Even programmers now need a strong understanding of networking. In the past, programmers wrote stand-alone programs that ran on a single computer. Today, however, most programmers write networked applications that work cooperatively with other programs on other computers.

LEARNING NETWORKING

Networking Is Difficult

Networking is an exciting topic. It is also a difficult topic. In programming, the focus is on creating and running programs. In networking, the critical skills are design, product selection, and troubleshooting. These rather abstract skills require a broad and deep knowledge of many concepts. Many IS students have a difficult time adjusting to these cerebral skill requirements.

Employers Are Growing More Demanding

In the past, many teachers tried to deal with the complexity of networking by selecting what was in essence a "network appreciation" book—a feel-good book that lacked the detailed knowledge needed for actual networking jobs.

Today, however, employers demand—and get—strong job readiness from new graduates. If you want to get a job in the IS field, you will need to have a competitive level of knowledge in every IS subject that you study. Even applicants for database jobs are grilled in networking knowledge (and networking applicants are grilled in database and other areas).

How to Study the Book

There are several keys to studying this book:

- ➤ Reading chapters once will not be enough. You will need to really study the chapters.
- ➤ Slow down for the tough parts. Some sections will be fairly easy, others difficult. Too many students study the harder stuff at the same speed they use to study the easier stuff.
- ➤ When you finish studying a section, do the Test Your Understanding questions immediately. If you don't get one of the questions, go back over the text. The understanding of networking is strongly cumulative, and if you skim over one section, you

will have problems with other sections later. Multiple choice questions in the test item file are taken entirely from the Test-Your-Understanding questions and the End-of-Chapter questions.

➤ Later, in groups of a few students, go over the Test-Your-Understanding questions to see whether you got the correct answers.

➤ Study the figures. Nearly every key point in each chapter is covered in the figures. If there is something in a figure you don't understand, you need to study the corresponding section in the chapter.

➤ If several concepts are presented in a section or chapter, do not just study them individually. You need to know which one to use in a particular situation, and that requires compare/contrast knowledge. Study the figures that compare concepts, and make your own figures and lists or charts of features if the book does not provide them. Comparing different technologies in order to select the best one for corporate needs is a critical skill for all IT professionals.

➤ Study the synopsis section at the end of each chapter. The synopsis summarizes the core concepts in the chapter. Be very sure that you know them well. You might even study them before beginning the chapter, to get a broad understanding of the material.

Hands-On

One way to make networking less abstract to you is to do as many hands-on activities as possible.

➤ Be sure to do the hands-on exercises in Chapters 1a and 10a.
➤ To really understand TCP/IP, download WinDUMP and play with it. (See Chapter 8a.)

A NETWORKING CAREER

If you like the networking course and think you want a networking career, there are a number of steps you should take before graduation, even if your school does not have advanced networking courses.

➤ Most importantly, do a networking internship. Employers really want workers with job experience—often preferring it to an absurd degree over academic preparation.

➤ Learn systems administration (the management of servers). Learn the essentials of Unix and Windows Server. You can download a server version of Linux and install it on your home computer in order to play with Unix commands and network management functions.

➤ Learn about security. Security and networking are now inextricably intertwined.

➤ Consider getting one or more industry certifications. In networking, the low-level CompTIA Network+ certification should be obtainable with just a bit more study after you take your core networking course. Cisco's CCNA (Cisco Certified Network Associate) certification, which focuses on switching and routing, will require substantially more study. Microsoft server certification is also valuable. Employers like certifications, but they know that certifications are no substitutes for job experience.