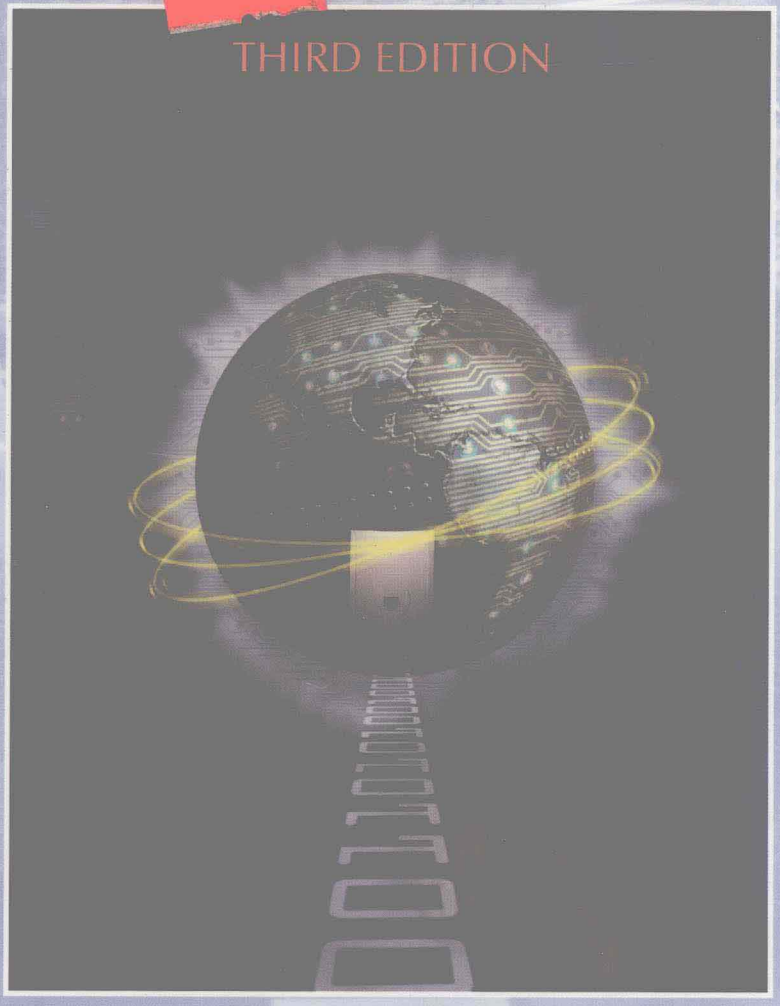
BUSINESS DATA COMMUNICATIONS AND NETWORKING

THIRD EDITION



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Business Data Communications and Networking

THIRD EDITION

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This book is dedicated to David Kalani Panko
for the inspiration of your curiosity and your
ability to solve almost any problem.

Preface

The third edition of *Business Data Communications and Networking*, like its two predecessors, is based on extensive discussions with network administrators, reflects published data about what technologies are really used in organizations, and incorporates the comments of many teachers. The goal is to focus on what students really need to know for today's and tomorrow's networking jobs, including such things as LAN switching, security, and quality of service (QoS). The current edition is an 85 percent rewrite, although it generally follows the same flow as the second edition.

A Uniquely Flexible Textbook

Every teacher has different ideas about what to cover in a networking course. This book is designed to let teachers teach the course their way.

Covering the Basics in the 12 Core Chapters Most teachers will wish to cover much or all of the 12 core chapters, which cover key networking concepts. Even within these chapters, more advanced material is placed in boxes for easy exclusion.

Free Time to Cover Your Special Topics Teaching only the core chapters will leave one to three weeks free in a one-semester course. This leaves time for hands-on exercises or for the covering of additional topics.

Tools to Help You Cover Your Special Topics To minimize the work that teachers have to do to prepare for this "extra time," there are eight advanced modules that cover more specialized topics. There is additional supplementary material at the book's website. For hands-on exercises, the book's website has Internet exercises that provide some options. The idea is to help teachers cover selected material without the need for them to create packets of special material.

End-of-Chapter Questions to Tie Things Together End-of-chapter questions help students focus on what material to study. For instance, when I cover Chapter 7, which covers hub-based and switch-based Ethernet networking, I also include some material on older 10Base2 and 10Base5 technologies, which are

covered in Module C. For homework, in addition to assigning questions from Chapter 7, I also assign relevant questions from Module C.

Also, end-of-chapter (and end-of-module) questions are divided into core review questions, detailed review questions, and thought questions. For faster coverage, teachers can assign core review questions and only selected detailed review questions or thought questions.

Instructor Resources

This book supports instructors intensively, again with a goal of minimizing the work that instructors have to do.

PowerPoint Presentations

Full Lecture Presentations For each chapter and module, there is a detailed PowerPoint presentation. This is a full lecture, not just "a few selected figures." Each presentation is created by the author and is closely tied to the material in the chapter itself.

Change Them to Fit Your Needs Instructors are invited to change the presentations to fit their needs. For instance, they can drop slides, add their own, or copy slides from advanced modules into core modules. (Advanced modules use the same presentation formats as the core chapters they support.) The only restrictions are that only adopters may use the presentations, that teachers must not remove the copyright notice, and that teachers may not reuse the clip art.

Gold Stars for Emphasis Gold stars in the PowerPoint presentations indicate material that is especially important or especially difficult. In either case, gold stars tell students that the material merits special care in study.

Transparencies, Too If instructors prefer transparencies or like to use transparencies selectively, there are transparency masters in Microsoft® Word for Windows format for every figure and table in the book, plus a few extra transparencies for material not presented in figures and tables.

The Companion Website: Updates

The book comes with a companion website, **http://www.prenhall.com/panko.** The third edition website will be directly controlled by the author and will be updated monthly.

Rather than putting material that ages quickly in the printed textbook, the companion website allows the author to disseminate rapidly changing and new information.

Case Studies Most importantly, the companion website has several case studies for all chapters (and for some modules). These are short cases with discussion questions to help students focus on the cases. Many cases are links to online trade journal articles on specific innovations in specific companies.

New Information Networking is changing at the speed of light, and new information is appearing constantly. The website will present new information selectively. This new information will range from new developments in the field to new data and forecasts about the use of key technologies and standards.

Supplementary Information In some cases, material will be offered that, while not entirely new, is a useful supplement that some teachers will wish to use in their classes. For instance, Chapter 1's supplementary reading page has a short tutorial on Base 2 arithmetic.

The Companion Website: Student Support

The website will also be a place for students to go to for interactive support.

Internet Exercises All chapters and some modules will have Internet exercises to provide hands-on learning. For instance, do students know how to learn their PC's IP address? Do they know how many routers there are between themselves and their favorite websites? Do they know how fast their Internet connection really is? In the Internet exercises, they'll be able to find out.

End-of-Chapter/Module Question Downloads Each chapter and module ends with a series of review questions that test students in their understanding of the material. Students can download the end-of-chapter and end-of-module questions. They can type in their answers and then give their work to the teacher on paper or electronically.

PowerPoint Presentation Downloads For teachers who use PowerPoint presentations, students can download them from the website. In addition, adopters of the book are free to copy the presentations to their local sites for easier access. Even if the teacher does not use the presentations in class, many students will wish to download them as study guides.

Other Support for Instructors

Instructor's CD-ROM Disk with Test Bank and Answer Keys An instructor's CD-ROM disk contains support materials you may use without the work of downloading material:

- PowerPoint presentations
- Transparency masters
- Computerized test bank and answer key
- Answers to end-of-chapter/module questions.

Contact the Author Do you have a question or comment? Please contact the author at Ray@Panko.com.

Instructor's Mailing List for News Also, if you adopt the book, send Ray an e-mail, and he will put you on a mailing list for adopters. You will get notices of updates to material.

Coverage and Pedagogy

Topical Coverage

As noted earlier, the goal in writing this book was to cover the technology and standards that corporations actually use and will use, so that students will have the knowledge they really need.

TCP/IP and OSI TCP/IP and OSI often are taught as competitors. In reality, however, they have become partners. On the Internet and within corporations today, the dominant "architecture" is really a hybrid of TCP/IP and OSI. Computers increasingly use TCP/IP at higher layers (internet, transport, and application) while using OSI at the data link and physical layers. This book takes this hybrid TCP/IP–OSI architecture as its basic architectural model. It does introduce full OSI layering, and it introduces IPX/SPX–OSI communication in Chapter 7 and SNA–OSI communication in Chapter 11. No matter what standards are used at upper layers, OSI standards are always used at the physical and data link layers.

In the first three chapters, students become very familiar with TCP/IP standards. In Chapter 3, for instance, they learn to think like a router by comparing the destination address of incoming packets with entries in a router forwarding table. They learn OSI physical and data link layer standards throughout the book, in appropriate places.

LAN Switching LANs, including large site networks, are now "switch rich." We now introduce Ethernet switches and hubs equally in Chapters 6 and 7, and Chapter 8 discusses large switch-based site networks. The focus is Ethernet switching, but ATM switching is also covered. Chapter 8 covers switch selection, switch learning, VLANs, Layer 3 switches, Layer 4 switches, and other crucial LAN switching topics.

Quality of Service (QoS) As networks get larger and more complex, quality of service (QoS) is an increasing concern. Chapter 1 introduces QoS in terns of latency and reliability. Chapter 8 looks at QoS for latency in depth, covering overprovisioning, priority, full QoS guarantees, and traffic shaping.

Wide Area Networking In wide area networking, leased lines and public switched data networks are used about equally, so both are covered. However, in public switched data networking, Frame Relay is used much more than ATM. Consequently, Chapter 9 concentrates more heavily on Frame Relay, including its flexible virtual circuit numbering scheme and how to purchase Frame Relay service.

Security Security has grown in importance and also, unfortunately, complexity. Chapter 10 treats security in depth, including authentication, public key infrastructures, and automatic integrated security systems (using SSL as an example). Module F, among other things, discusses IPsec, Kerberos, and PPTP.

Wireless Networking and Non-PC User Devices Wireless networking has long been a promising way to support mobile devices. However, wireless networking at the LAN and metropolitan area levels is just now reaching the maturity it will need for explosive growth. In addition, desktop and notebook PCs will be joined by a large number of other different-size devices for user access. Chapters 5, 7, and 12 discuss wireless networking and Internet access. Chapter 4 spends considerable time on radio propagation, and Module B goes into even more detail.

Microsoft Windows Networking Setup Given the dominance of Microsoft Windows, Chapter 2 presents netwqork steup for Internet access, and Chapter 6 discusses network setup for client PCs.

Telephony Telephony is introduced throughout the book, including telephony's hierarchy of switches and circuit switching in Chapter 1, carriers in Chapter 9, IP telephony in Chapter 11, and cellular principles in Chapter 12. Many adopters choose to cover the telephony module, Module D.

Web-Enabled Database Access and Mainframes Contrary to popular belief, mainframes are not dying. Chapter 11 discusses web–host integration and offers a box covering mainframe communication and SNA.

Pedagogy As much as possible has been done to make the student's learning easier and more effective. The previous sections already discussed the use of end-of-chapter questions to guide student learning and the use of gold stars to mark important or difficult material in the PowerPoint presentations. The book has several other innovations.

Vignettes All chapters open with vignettes to pique student interest. Most vignettes raise issues that the student must address in an end-of-chapter thought question, using material learned in the chapter.

Begin with the Familiar and Concrete Many textbooks begin with wide area networks, which few students have experienced personally. *Business Data Communications and Networking,* in contrast, begins with two very familiar situations: Internet access (Chapters 2–5) and small PC networks (Chapters 6 and 7). Within these familiar and comfortable environments, students learn concepts in ways to which they can relate. Later, when more unfamiliar types of networking are encountered, students have the knowledge they need to approach them.

Layering Is Treated Early and Often Layering is the most difficult material in the course. Many textbooks introduce one layer at a time, only giving the whole picture very late in the book. *Business Data Communications and Networking* introduces networking at the beginning of the book and repeats it in several contexts, such as Internet access and PC networking. This repetition is needed to learn this difficult material.

Illustrations The book's extensive illustrations are tightly integrated into the text. Many have numbered items corresponding to items discussed in the text.

Case Studies and Internet Exercises As noted earlier, there case studies with discussion questions at the book's companion website. There are also Internet exercises for hands-on work.

Changes From the Second Edition

More but Smaller Chapters and the Same General Flow

The third edition looks somewhat different from the second edition. This edition has 12 core chapters, while the second edition only had eight. This has resulted largely from breaking Chapters 2 through 6 into smaller units for easier digestibility.

The mapping between the second and third editions is very direct at the first six chapters of the second edition, which map rather directly into chapters of the third.

Chapter 1 of the second edition generally matches Chapter 1 of the third edition.

Chapter 2, on layering and TCP/IP, is now Chapters 3 and 4.

Chapter 3, on physical layer technology and devices, is now Chapters 4 and 5.

Chapter 4, on PC networks, is now Chapters 6 and 7.

Chapter 5, on large network transmission, is now Chapters 8 and 9.

Chapter 6, on managing large networks, corresponds to Chapter 10 and parts of Chapter 12.

In the second edition, Chapters 7 and 8 covered applications, and there was no definitive "closing chapter." Chapters 11 and 12 now cover applications but do so more selectively. Chapter 11 focuses on crucial current applications, including web-based database applications, electronic mail, and IP telephony. Chapter 12 focuses on future applications, including wireless applications and networked object oriented programming.

Chapter 12 also covers product selection and purchasing considerations, which some teachers will wish to cover early in the course. The last chapter also provides closure to the book.

Topic Differences

TCP/IP In some sense, the TCP/IP material in early chapters in simplified for easier digestibility. For instance, fragmentation, flow control, and some other TCP details are now moved to Appendix A. However, UDP is now introduced with TCP, and there is

now a section on how routers actually decide what to do with incoming IP packets by comparing destination addresses with entries in the router's forwarding table.

Increased Emphasis Throughout the book, greater emphasis is given to several emerging topics, including the following:

Quality of Service (QoS). See Chapters 1 and 8.
LAN Switching. See Chapters 6–8, especially 8.
Security. See the all-new treatment in Chapter 10 and Module F.
Wide Area Networking. See Chapter 9.
Wireless Networking. See Chapters 7 and 12 especially.
Microsoft Windows Setup for Networking. See Chapters 2 and 7.

Integrating Telephony The telephone module was very popular in the second edition. As noted earlier, some basic telephone material is now integrated into the core chapters, including some information about carriers, the telephone switching hierarchy, circuit switching, cellular basics, and IP telephony.

Design and Pedagogy Differences

More Open Book Design Prentice Hall has nicely given the book a more "open" design so that the text will not feel cramped to students.

Vignettes As noted earlier, each chapter begins with an opening vignette that engages student interest and usually raises issues students will have to resolve by understanding the material in the chapter.

Test Your Understanding At the end of each section, there is a "Test Your Understanding" opportunity that points students to end-of-chapter questions they can answer to test their understanding of the section.

Bye, Bye, "PDU" Chapter 2 used the term *protocol data unit (PDU)* for any message between peer processes at the same layer but on different computers. This OSI-specific term proved to cause a surprising number of problems for students. In response to the comments of several adopters, the term "PDU" is not used in the third edition. Messages between peer processes are simply called *messages, frames* (data link layer), or *packets* (internet layer), or are called by their standard-specific names, such as "TCP segment."

Renumbering Cellular Generations The second edition numbered current personal communication system (PCS) systems as the third generation in cellular telephony. However, marketers have labeled PCS systems as "second generation" cellular and the merging multimedia cellular technology as the third generation. The third edition renumbers cellular generations to reflect this changing terminology.

Broad Syllabi for Different Courses

A General One-Semester Course for IS Students

Most instructors will cover the 12 core chapters in a general one-semester course for information systems (IS) students. In a one-semester course with two examinations, covering the 12 core chapters will leave about two weeks for hands-on exercises or to cover two additional modules fully or in part. Furthermore, some material from the modules can be covered along with the core chapters.

One-Quarter Course for IS Students

Covering networking in a quarter instead of a semester is daunting. It can be done by focusing on the core chapters, eliminating boxed material, and, if this is still too much material, by focusing mainly on the core review questions at the end of each chapter.

A One-Semester Course for Community Colleges

Covering networking in a community college may necessitate lightening the material, depending on student preparation. Again, the instructor may wish to focus on the core chapters, eliminate boxed material, and possibly focus on the core review questions at the end of each chapter.

An MBA Course

In an MBA course, it is common to reduce the technical content by focusing on the core chapters and core review questions. In addition, in the more technical chapters (Chapters 2, 3, 4, and 7), a great deal can be skipped for MBA students. For instance, in Chapter 7, I usually cover only CSMA/CD, wireless LANs, and a brief overview of Token-Ring Networks. Most instructors use the freed time for case studies at the book's website and for individual projects and term papers.

A Two-Semester Course for IS Students

A small but growing number of schools have the luxury of a two-semester course. This leaves much more time for hands-on work. It also allows more advanced modules to be covered. My experience is that it is best to cover advanced modules at the same time as the basic material. In other words, after TCP/IP in Chapter 3, follow with Module A (More on TCP/IP). Another option is to cover core chapters first, and then advanced modules. This has the advantage of reinforcement and is theoretically better, although it may require the extensive review of earlier material.

About the Author

Dr. Raymond R. Panko (Ray) is a professor of information technology and management at the University of Hawaii. Before coming to the University, he was a project manager at Stanford Research Institute. He received his doctorate, in communication, from Stanford. At Stanford, he had the good fortune to do early work on VSATs with Prof. Bruce Lusignan and broadband LAN planning with Prof. Ed Parker and Paul Baran. His doctoral dissertation was done under contract to the Office of the President of the United States. At SRI, he had the good fortune to do early work on videoconferencing, electronic mail, and the ARPANET. He had the especially good fortune to work for Dr. Doug Engelbart, who invented the mouse and built the first hypertext system. His current research focuses on risks in information technology. His greatest pleasure is seeing the excitement in his students' eyes when they master difficult material and then realize that this is how the Internet, a PC network, or some other network they have long been using really works. His home page is www.panko.com. His e-mail is Ray@Panko.com.

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