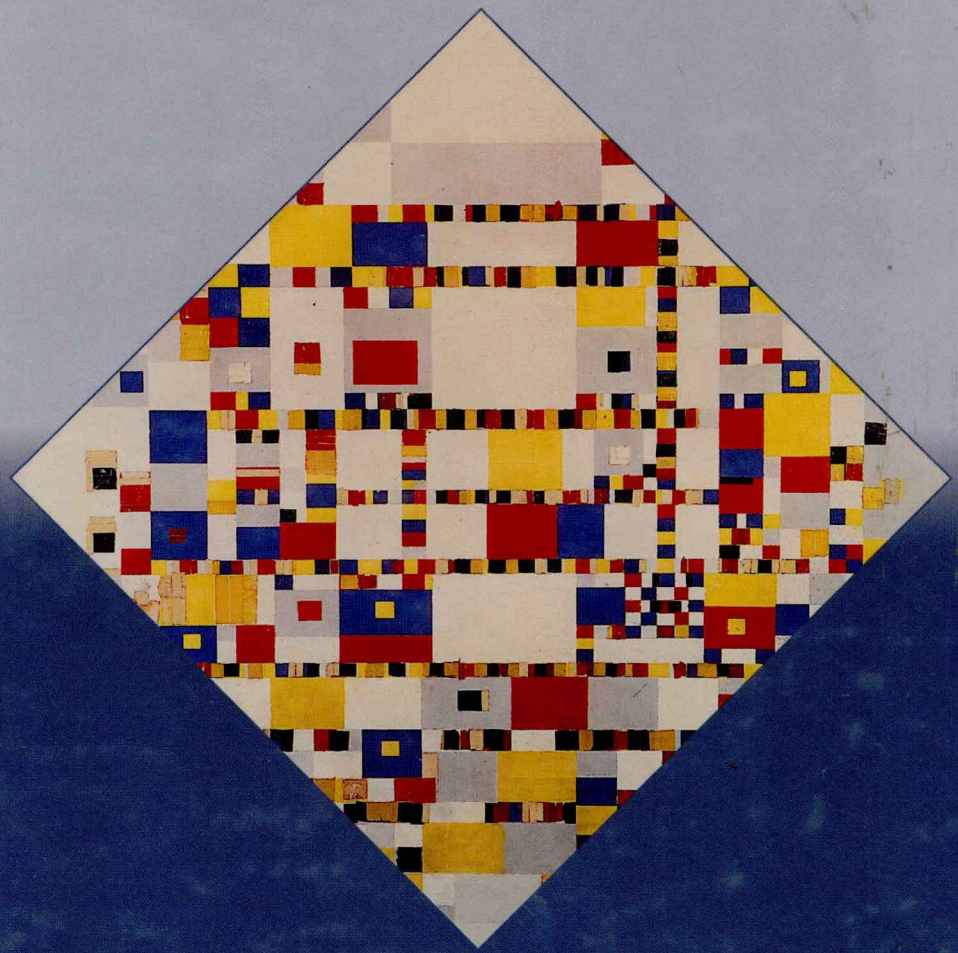
Fifth Edition

Business Data Communications and Networking



Jerry FitzGerald
Alan Dennis

BUSINESS DATA COMMUNICATIONS AND NETWORKING

FIFTH EDITION

JERRY FITZGERALD
Jerry FitzGerald & Associates

ALAN DENNIS
The University of Georgia

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To Eileen and Alec

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His current research focuses on the design and use of network-based software to improve group decision making. His theoretical research has examined the fundamental aspects of idea generation, information sharing, and media richness, while his applied research has developed new approaches for strategic planning, business process re-engineering, and information systems requirements definition. Dr. Dennis has published more than 60 business and research articles, including those in *Management Science, MIS Quarterly, Information Systems Research, Academy of Management Journal, Organizational Behavior and Human Decision Making, Journal of Applied Psychology, Communications of the ACM,* and *IEEE Transactions on Systems, Man, and Cybernetics.* His first book, co-authored with his wife, Eileen Dennis, was *Getting Started with Microcomputers,* published in 1986.

PREFACE

Over the past three years, fundamental changes have occurred in data communications and networking that will shape the future for decades to come. Networking applications such as the Internet, World Wide Web, and groupware have exploded into the computing world. We believe that by the turn of the century, these applications will have become as common as word processing is today. Many fundamental technological changes have occurred, or are about to happen. High speed modems providing 200 Kbps data rates over regular telephone lines are entering the market. New backbone network technologies such as ATM, fast ethernet, and switched ethernet will replace today's slower token ring and ethernet LANs. SONET, SMDS, and broadband ISDN that provide 100 Mbps to 10 Gbps will replace current T-1 and T-3 WANs and MANs. Deregulation of the telecommunications industry will also have dramatic effects on how we communicate, obtain information, and access entertainment. Voice, data, and image communication will become integrated, and entrepreneurs will create new applications and entirely new technologies more rapidly than ever before.

Perhaps the most important change has been the recognition of the strategic importance of communications and networking in both the public and private sector. Today, most computers are networked; by the end of the century, *all* will be. We will look back at the 1990s and realize that this was the decade in which the importance of the computer was surpassed by the importance of communications.

Purpose of This Book

Our goal is to combine the fundamental concepts of data communications and networking with practical applications. While technologies and applications change rapidly, the fundamental concepts evolve much more slowly; they provide the foundation from which new technologies and applications can be understood, evaluated, and compared.

This book has two intended audiences. First and foremost, it is a university textbook. Each chapter introduces, describes, and then summarizes fundamental concepts and applications. Management focus boxes highlight key issues and describe how networks are actually being used today. Technical focus boxes highlight key technical issues and provide additional detail. An ongoing case study at the end of the book provides the opportunity to apply these technical and management concepts. Moreover, the text is accompanied by a detailed *Instructor's Manual,* that provides additional background information, teaching tips, and sources of material for student exercises, assignments, and exams.

Second, this book is intended for the professional who works in data communications and networking. The book has many detailed descriptions of the technical aspects of communications, along with illustrations, where appropriate. Moreover, managerial, technical, and sales personnel can use this book to gain a better understanding of fundamental concepts and trade-offs not presented in technical books or product summaries.

What's New in this Edition

Because communications technology and applications have changed dramatically over the past few years, we felt it was time for a major revision. The fifth edition includes numerous new technologies, applications, and examples, as well as chapter objectives, outlines, and summaries, and management and technology focus boxes. We have also increased the management focus of the book by including sections such as selecting network hardware and software, writing RFPs, managing networks, and improving network performance.

The fifth edition is about 25 percent shorter than the fourth edition, despite the added material and two new chapters on network applications and Novell Netware. Much of this reduction was achieved by organizing the book into four major sections.

The first section, *Introduction,* has two chapters. The major change from the fourth edition is the addition of Chapter 2, that discusses network applications. This chapter describes groupware and the Internet and examines their impact on organizations. It provides a brief introduction to Internet services, such as e-mail, gopher, newsgroups, and especially, the World Wide Web. We will use the Web to publish regular updates to this book, teaching tips, and free software. Our goal is to keep users abreast of the very latest developments in technology and applications. (See our home page at http://www.cba.uga.edu/groupware/telecom/home.html.)

As the name suggests, the second section, *Fundamentals of Data Communications and Networking,* presents fundamental concepts. This section (Chapters 3 through 6) covers much of the same issues as Chapters 2 through 5 (and parts of Chapters 9 and 13) in the fourth edition: voice and data communication hardware, data transmission, and the data link layer. There are two major changes in this section. First, two key concepts (client-server versus host-based network architectures; and the use of data communications layers similar to the OSI model) are introduced early and used as organizing themes throughout the rest of the book. By introducing these concepts initially, students can use them as organizing frameworks to integrate the many technical details that follow; without such frameworks, students are left to integrate laundry lists of facts on their own.

Second, new technologies have been added and their implications for management are discussed. New technologies include: client-server computing and middleware; new satellite technologies such as VSAT and DBS; multiplexing, including SLIP, PPP, bonding, inverse multiplexing, and wavelength division multiplexing; modems, such as wireless modems, V.34, and V.34 bis modems; and protocols such as LAP-M and LAP-B. Additions to the management focus include the increasing importance of mi-

crocomputers and LANs; the economics of client-server and host-based network architectures and their advantages and disadvantages; advice on media selection; modem pooling; and techniques to reduce transmission errors.

The third section, *Networking,* introduces the network layer and LANs, MANs, WANs, and backbone networks. The chapters in this section, Chapters 7 through 10, correspond to Chapters 6, 7, 9, and 11 in the fourth edition. The major change is the new chapter on backbone networks, the most rapidly changing technology in networking. This chapter summarizes the major components in backbone networks (e.g., bridges, routers, switches), and then focuses on the multitude of new backbone technologies such as fast ethernet (e.g., 100BaseT, 100VG-AnyLAN, full duplex ethernet, and ISO-ENET); FDDI, FDDI-II, and FDDI-C; ATM (ATM25 and ATM51); collapsed backbones; switched ethernet; and dedicated token ring.

The other chapters in this section also have been updated to reflect new technologies, or the increased importance of older ones, such as TCP/IP; SPX/IPX; broadband ISDN; cellular packet networks; frame relay; ATM; and RAID. This section also provides detailed management advice on improving network performance and selecting LAN, WAN/MAN, and BN components.

In the final section on *Network Management,* Chapters 11 through 14 discuss network design, network management, network security, and Novell Netware. They correspond to Chapters 8, 12, and 13 in the fourth edition. The major changes are the addition of a short chapter on Netware's architecture and principal commands, and the elimination of the fourth edition's Chapter 10 on the basics of microcomputers. Once again, new technologies have been added including: intelligent devices, SNMP, RMON, CMIP, NMS, and network agents; firewalls and IP spoofing; call-back modems and pager-based login techniques; and clipper and capstone. Additional management topics include: the shift to LANs and the differences between LAN and WAN managers; the functions of network management; the sources of security threats; and elements of a disaster recovery plan.

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CHAPTER ONE

INTRODUCTION TO DATA COMMUNICATIONS

This chapter introduces the concepts of data communications and shows how we have progressed from paper-based systems to modern computer networks. It begins by describing why it is important to study data communications and how the invention of the telephone and the computer has transformed the way we communicate. Next, the basic components of a data communication network are discussed. The chapter concludes with an overview of future trends in communications.

Objectives

- Become familiar with the history of communications and information systems,
- Become familiar with the applications of data communication networks,
- Become familiar with the major components of networks,
- Become familiar with the future trends in communications.

Chapter Outline

Why Study Data Communications?
    A Brief History of Communications in the United States
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Purpose and Scope of this Book
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Components of a Communication Network
    A Wide Area Network Example
    A Local Area Network Example
    Network Model

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