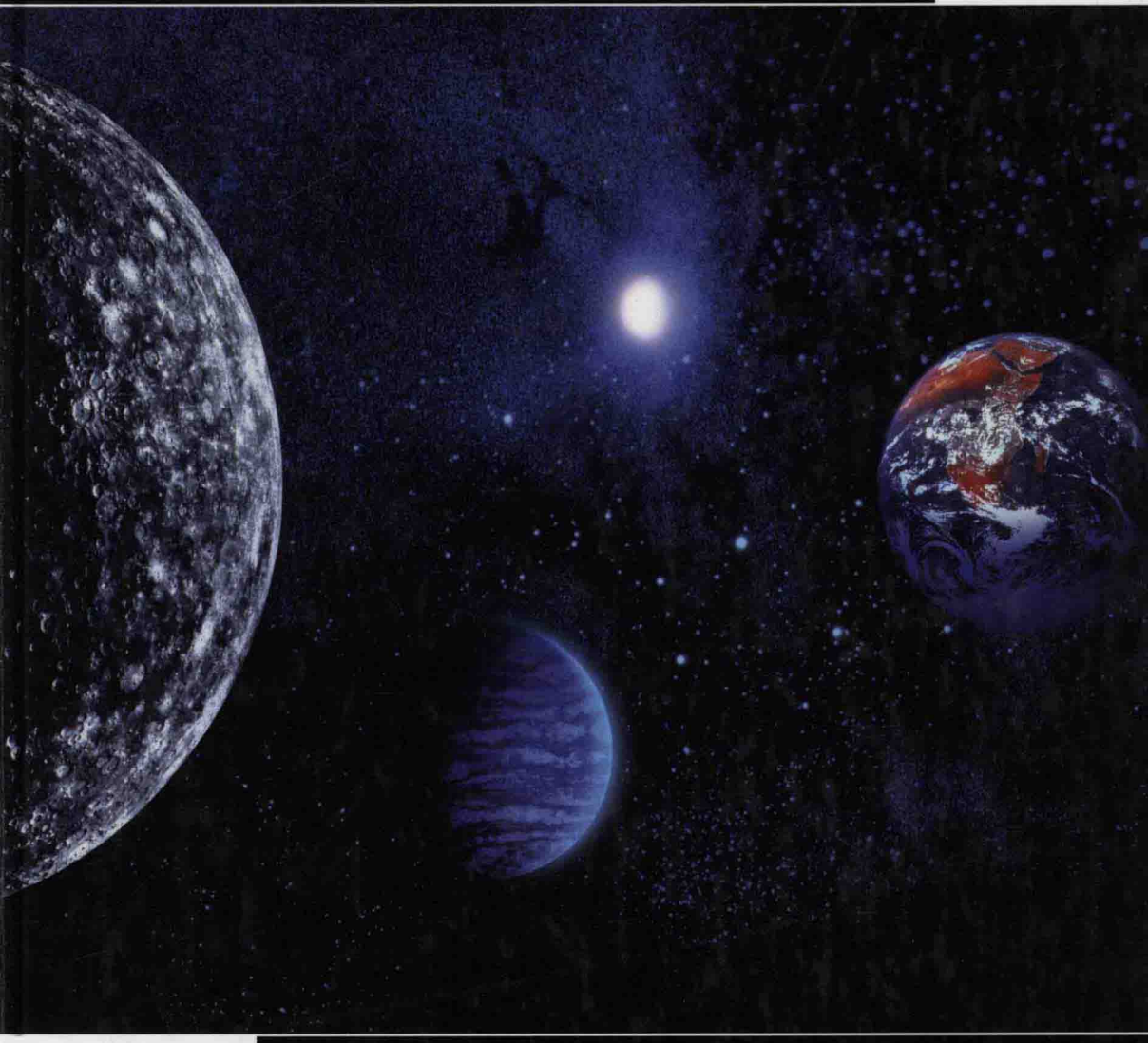
DATA AND COMPUTER COMMUNICATIONS

Seventh Edition



WILLIAM STALLINGS

Data and Computer Communications

Seventh Edition

William Stallings

Pearson Education
Upper Saddle River, New Jersey 07458

Library of Congress Cataloging-in-Publication Data Available

Vice President and Editorial Director, ECS: *Marcia Horton*
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Pearson Prentice Hall
Upper Saddle River, NJ 07458

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-100681-9

Pearson Education Ltd., *London*
Pearson Education Australia Pty. Ltd., *Sydney*
Pearson Education Singapore, Pte. Ltd.
Pearson Education North Asia Ltd., *Hong Kong*
Pearson Education Canada, Inc., *Toronto*
Pearson Educación de Mexico, S.A. de C.V.
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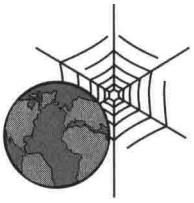


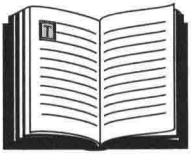
WEB SITE FOR DATA AND COMPUTER COMMUNICATIONS *Seventh Edition*

The Web site at WilliamStallings.com/DCC/DCC7e.html provides support for instructors and students using the book. It includes the following elements.

Course Support Materials

The course support materials include

- Copies of figures from the book in PDF format
- A detailed set of course notes in PDF format suitable for student handout or for use as viewgraphs
- A set of PowerPoint slides for use as lecture aids
- Computer Science Student Support Site: contains a number of links and documents that the student may find useful in his/her ongoing computer science education. The site includes a review of basic, relevant mathematics; advice on research, writing, and doing homework problems; links to computer science research resources, such as report repositories and bibliographies; and other useful links.
- An errata sheet for the book, updated at most monthly

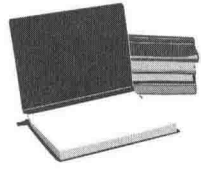


DCC Courses

The DCC7e Web site includes links to Web sites for courses taught using the book. These sites can provide useful ideas about scheduling and topic ordering, as well as a number of useful handouts and other materials.

Useful Web Sites

The DCC7e Web site includes links to relevant Web sites, organized by chapter. The links cover a broad spectrum of topics and will enable students to explore timely issues in greater depth.



Supplemental Documents

The DCC7e Web site includes a number of documents that expand on the treatment in the book. Topics include standards organizations, Sockets, TCP/IP checksum, ASCII, and the sampling theorem.

Internet Mailing List

An Internet mailing list is maintained so that instructors using this book can exchange information, suggestions, and questions with each other and the author. Subscription information is provided at the book's Web site.

Simulation and Modeling Tools

The Web site includes links to the *cnet* Web site and the *modeling tools* Web site. These packages can be used to analyze and experiment with protocol and network design issues. Each site includes downloadable software and background information. The instructor's manual includes more information on loading and using the software and suggested student projects. See Appendix D for more information.

PREFACE

OBJECTIVES

This book attempts to provide a unified overview of the broad field of data and computer communications. The organization of the book reflects an attempt to break this massive subject into comprehensible parts and to build, piece by piece, a survey of the state of the art. The book emphasizes basic principles and topics of fundamental importance concerning the technology and architecture of this field and provides a detailed discussion of leading-edge topics.

The following basic themes serve to unify the discussion:

- **Principles:** Although the scope of this book is broad, there are a number of basic principles that appear repeatedly as themes and that unify this field. Examples are multiplexing, flow control, and error control. The book highlights these principles and contrasts their application in specific areas of technology.
- **Design approaches:** The book examines alternative approaches to meeting specific communication requirements.
- **Standards:** Standards have come to assume an increasingly important, indeed dominant, role in this field. An understanding of the current status and future direction of technology requires a comprehensive discussion of the related standards.

PLAN OF THE TEXT

The book is divided into five parts:

In addition, the book includes an extensive glossary, a list of frequently used acronyms, and a bibliography. Each chapter includes problems and suggestions for further reading.

The book is intended for both an academic and a professional audience. For the professional interested in this field, the book serves as a basic reference volume and is suitable for self-study. As a textbook, it can be used for a one-semester or two-semester course. It covers the material in the Communication and Networking core course of the joint ACM/IEEE Computing

Curricula 2001. The chapters and parts of the book are sufficiently modular to provide a great deal of flexibility in the design of courses. The following are suggestions for course design:

- **Fundamentals of Data Communications:** Parts One (overview) and Two (data communications) and Chapters 10 and 11 (circuit switching, packet switching, and ATM).
- **Communications Networks:** If the student has a basic background in data communications, then this course could cover Parts One (overview), Three (WAN), and Four (LAN).
- **Computer Networks:** If the student has a basic background in data communications, then this course could cover Part One (overview), Chapters 6 and 7 (data communication techniques and data link control), and Part Five (protocols).

In addition, a more streamlined course that covers the entire book is possible by eliminating certain chapters that are not essential on a first reading. Chapters that could be optional are Chapters 3 (data transmission) and 4 (transmission media), if the student has a basic understanding of these topics; Chapter 8 (multiplexing); Chapter 9 (spread spectrum); Chapters 12 through 14 (routing, congestion control, cellular networks); Chapter 18 (internetworking); and Chapter 21 (network security).

INTERNET SERVICES FOR INSTRUCTORS AND STUDENTS

There is a Web site for this book that provides support for students and instructors. The site includes links to other relevant sites, transparency masters of figures in the book, and sign-up information for the book's Internet mailing list. The Web page is at WilliamStallings.com/DCC/DCC7e.html; see the section, "Web Site for Data and Computer Communications," preceding the Table of Contents, for more information. An Internet mailing list has been set up so that instructors using this book can exchange information, suggestions, and questions with each other and with the author. As soon as typos or other errors are discovered, an errata list for this book will be available at WilliamStallings.com.

PROJECTS FOR TEACHING DATA AND COMPUTER COMMUNICATIONS

For many instructors, an important component of a data communications or networking course is a project or set of projects by which the student gets hands-on experience to reinforce concepts from the text. This book provides an unparalleled degree of support for including a projects component in the course. The instructor's manual not only includes guidance on how to assign and structure the projects, but also includes a set of suggested projects that covers a broad range of topics from the text, including research projects, simulation projects, analytic modeling projects, and reading/report assignments. See Appendix D for details.

SOCKETS PROGRAMMING

The book includes a brief description of Sockets (Appendix C), with a more detailed description available at the book's Web site. The Instructors manual includes a set of programming projects. Sockets programming is an "easy" topic and one that can result in very satisfying hands-on projects for students.

WHAT'S NEW IN THE SEVENTH EDITION

This seventh edition is seeing the light of day less than 4 years after the publication of the sixth edition. During that time, the pace of change in this field continues unabated. In this new edition, I try to capture these changes while maintaining a broad and comprehensive coverage of the entire field. To begin the process of revision, the sixth edition of this book was extensively reviewed by a number of professors who teach the subject. The result is that, in many places, the narrative has been clarified and tightened, and illustrations have been improved. Also, a number of new "field-tested" problems have been added.

Beyond these refinements to improve pedagogy and user-friendliness, there have been major substantive changes throughout the book. Every chapter has been revised, new chapters have been added, and the overall organization of the book has changed. Highlights include:

- **Wireless communications and networking:** There is a significant increase in the amount of material on wireless communications, wireless networks, and wireless standards. The book now devotes one chapter each to spread spectrum technology, cellular wireless networks, and wireless LANs.
- **Gigabit Ethernet:** The discussion on Gigabit Ethernet has been updated and an introduction to 10-Gbps Ethernet has been added.
- **Differentiated services:** There have been substantial developments since the publication of the sixth edition in enhancements to the Internet to support a variety of multimedia and time-sensitive traffic. The most important development, and perhaps the most important vehicle for providing QoS in IP-based networks, is Differentiated Services (DS). This edition provides thorough coverage of DS.
- **Guaranteed frame rate (GFR):** Since the sixth edition, a new ATM service has been standardized: GFR. GFR is designed specifically to support IP backbone subnetworks. This edition provides an explanation of GFR and examines the mechanisms underlying the GFR service.
- **Multiprotocol label switching (MPLS):** MPLS has emerged as a fundamentally important technology in the Internet and is covered in this edition.
- **TCP/IP details:** A new background chapter on TCP and IP has been added, pulling together material scattered throughout the sixth edition. This material is vital to an understanding of QoS and performance issues in IP-based networks.

In addition, throughout the book, virtually every topic has been updated to reflect the developments in standards and technology that have occurred since the publication of the fifth edition.

ACKNOWLEDGMENTS

This new edition has benefited from review by a number of people, who gave generously of their time and expertise. The following people reviewed all or a large part of the manuscript: Michael J. Donahoo (Baylor University), Gary Harkin (Montana State University), Larry Owens (California State U. Fresno), S. Hossein Hosseini (U. of Wisconsin-Milwaukee), and Dr. Charles Baker (Southern Methodist University).

Thanks also to the many people who provided detailed technical reviews of a single chapter: Dave Tweed, Bruce Lane, Denis McMahon, Charles Freund, Paul Hoadley, Stephen Ma, Sandeep Subramaniam, Dragan Cvetkovic, Fernando Gont, Neil Giles, Rajesh Thundil, and Rick Jones.

Finally, I would like to thank the many people responsible for the publication of the book, all of whom did their usual excellent job. This includes the staff at Prentice Hall, particularly my editor Alan Apt, his assistant Patrick Lindner, and production manager Rose Kernan. Also, Jake Warde of Warde Publishers managed the supplements and reviews; and Patricia M. Daly did the copyediting.

CONTENTS

Preface xiii

Chapter 0 **Reader's Guide** 1
0.1 Outline of the Book 2
0.2 Internet and Web Resources 2
0.3 Standards 4

PART ONE OVERVIEW 7

Chapter 1 **Data Communications and Networking Overview** 9
1.1 A Communications Model 10
1.2 Data Communications 13
1.3 Data Communication Networking 14
1.4 An Example Configuration 17

Chapter 2 **Protocol Architecture** 19
2.1 The Need for a Protocol Architecture 20
2.2 A Simple Protocol Architecture 21
2.3 OSI 27
2.4 The TCP/IP Protocol Architecture 38
2.5 Recommended Reading and Web Site 44
2.6 Key Terms, Review Questions, and Problems 45
Appendix 2A The Trivial File Transfer Protocol 47

PART TWO DATA COMMUNICATIONS 51

Chapter 3 **Data Transmission** 55
3.1 Concepts and Terminology 57
3.2 Analog and Digital Data Transmission 68
3.3 Transmission Impairments 76
3.4 Channel Capacity 81
3.5 Recommended Reading 87
3.6 Key Terms, Review Questions, and Problems 87
Appendix 3A Decibels and Signal Strength 90

Chapter 4 Guided and Wireless Transmission 93
4.1 Guided Transmission Media 95
4.2 Wireless Transmission 107
4.3 Wireless Propagation 115
4.4 Line-of-Sight Transmission 119
4.5 Recommended Reading and Web Sites 124
4.6 Key Terms, Review Questions, and Problems 125

Chapter 5 Signal Encoding Techniques 129
5.1 Digital Data, Digital Signals 131
5.2 Digital Data, Analog Signals 142
5.3 Analog Data, Digital Signals 152
5.4 Analog Data, Analog Signals 159
5.5 Recommended Reading 165
5.6 Key Terms, Review Questions, and Problems 166

Chapter 6 Digital Data Communication Techniques 171
6.1 Asynchronous and Synchronous Transmission 173
6.2 Types of Errors 176
6.3 Error Detection 177
6.4 Error Correction 185
6.5 Line Configurations 191
6.6 Interfacing 193
6.7 Recommended Reading 203
6.8 Key Terms, Review Questions, and Problems 204

Chapter 7 Data Link Control 207
7.1 Flow Control 209
7.2 Error Control 215
7.3 High-Level Data Link Control (HDLC) 221
7.4 Recommended Reading 228
7.5 Key Terms, Review Questions, and Problems 229
Appendix 7A Performance Issues 232

Chapter 8 Multiplexing 241
8.1 Frequency Division Multiplexing 243
8.2 Synchronous Time Division Multiplexing 250
8.3 Statistical Time Division Multiplexing 260
8.4 Asymmetric Digital Subscriber Line 267
8.5 xDSL 270
8.6 Recommended Reading and Web Sites 272
8.7 Key Terms, Review Questions, and Problems 272

Chapter 9 Spread Spectrum 275

9.1 The Concept of Spread Spectrum 276
9.2 Frequency-Hopping Spread Spectrum 277
9.3 Direct Sequence Spread Spectrum 282
9.4 Code-Division Multiple Access 287
9.5 Recommended Reading 291
9.6 Key Terms, Review Questions, and Problems 291

PART THREE WIDE AREA NETWORKS 295

Chapter 10 Circuit Switching and Packet Switching 297

10.1 Switching Networks 299
10.2 Circuit-Switching Networks 300
10.3 Circuit-Switching Concepts 304
10.4 Control Signaling 307
10.5 Softswitch Architecture 316
10.6 Packet-Switching Principles 318
10.7 X.25 326
10.8 Frame Relay 328
10.9 Recommended Reading and Web Sites 333
10.10 Key Terms, Review Questions, and Problems 334

Chapter 11 Asynchronous Transfer Mode 337

11.1 Protocol Architecture 338
11.2 ATM Logical Connections 339
11.3 ATM Cells 344
11.4 Transmission of ATM Cells 350
11.5 ATM Service Categories 353
11.6 ATM Adaptation Layer 357
11.7 Recommended Reading and Web Sites 364
11.8 Key Terms, Review Questions, and Problems 364

Chapter 12 Routing in Switched Networks 367

12.1 Routing in Circuit-Switching Networks 368
12.2 Routing in Packet-Switching Networks 370
12.3 Least-Cost Algorithms 385
12.4 Recommended Reading 390
12.5 Key Terms, Review Questions, and Problems 390

Chapter 13 Congestion Control in Switched Data Networks 395

13.1 Effects of Congestion 397
13.2 Congestion Control 401
13.3 Traffic Management 404
13.4 Congestion Control in Packet-Switching Networks 406

13.5 Frame Relay Congestion Control 406
13.6 ATM Traffic Management 412
13.7 ATM-GFR Traffic Management 425
13.8 Recommended Reading 427
13.9 Key Terms, Review Questions, and Problems 428

Chapter 14 Cellular Wireless Networks 431

14.1 Principles of Cellular Networks 432
14.2 First-Generation Analog 445
14.3 Second-Generation CDMA 447
14.4 Third-Generation Systems 455
14.5 Recommended Reading and Web Sites 459
14.6 Key Terms, Review Questions, and Problems 460

PART FOUR LOCAL AREA NETWORKS 463

Chapter 15 Local Area Network Overview 465

15.1 Background 466
15.2 Topologies and Transmission Media 470
15.3 LAN Protocol Architecture 475
15.4 Bridges 483
15.5 Layer 2 and Layer 3 Switches 490
15.6 Recommended Reading and Web Site 496
15.7 Key Terms, Review Questions, and Problems 496

Chapter 16 High-Speed LANs 499

16.1 The Emergence of High-Speed LANs 500
16.2 Ethernet 502
16.3 Token Ring 516
16.4 Fibre Channel 520
16.5 Recommended Reading and Web Sites 525
16.6 Key Terms, Review Questions, and Problems 526
Appendix 16A Digital Signal Encoding for LANs 528
Appendix 16B Performance Issues 535

Chapter 17 Wireless LANs 543

17.1 Overview 544
17.2 Wireless LAN Technology 549
17.3 IEEE 802.11 Architecture and Services 553
17.4 IEEE 802.11 Medium Access Control 558
17.5 IEEE 802.11 Physical Layer 565
17.6 Recommended Reading and Web Sites 567
17.7 Key Terms and Review Questions 568

PART FIVE COMMUNICATIONS ARCHITECTURE AND PROTOCOLS 569

Chapter 18 Internetwork Protocols 571

18.1 Basic Protocol Functions 572
18.2 Principles of Internetworking 580
18.3 Connectionless Internetworking 584
18.4 Internet Protocol 592
18.5 IPv6 600
18.6 Recommended Reading and Web Sites 610
18.7 Key Terms, Review Questions, and Problems 611

Chapter 19 Internetwork Operation 615

19.1 Multicasting 617
19.2 Routing Protocols 626
19.3 Integrated Services Architecture 637
19.4 Differentiated Services 648
19.5 Recommended Reading and Web Sites 657
19.6 Key Terms, Review Questions, and Problems 659

Chapter 20 Transport Protocols 663

20.1 Connection-Oriented Transport Protocol Mechanisms 664
20.2 TCP 683
20.3 TCP Congestion Control 691
20.4 UDP 700
20.5 Recommended Reading 702
20.6 Key Terms, Review Questions, and Problems 702

Chapter 21 Network Security 705

21.1 Security Requirements and Attacks 707
21.2 Confidentiality with Symmetric Encryption 708
21.3 Message Authentication and Hash Functions 717
21.4 Public-Key Encryption and Digital Signatures 724
21.5 Secure Socket Layer and Transport Layer Security 731
21.6 IPv4 and IPv6 Security 736
21.7 Recommended Reading and Web Sites 741
21.8 Key Terms, Review Questions, and Problems 741

Chapter 22 Distributed Applications 745

22.1 Electronic Mail—SMTP and MIME 746
22.2 Hypertext Transfer Protocol (HTTP) 762
22.3 Network Management—SNMP 775
22.4 Recommended Reading and Web Sites 785
22.5 Key Terms, Review Questions, and Problems 786

Appendix A RFCs Cited in This Book 789

Appendix B Fourier Analysis
- B.1 Fourier Series Representation of Periodic Signals 791
- B.2 Fourier Transform Representation of Aperiodic Signals 792
- B.3 Recommended Reading 796

Appendix C Sockets Programming 797

Appendix D Projects for Teaching Data and Computer Communications 799
- D.1 Simulation Projects 799
- D.2 Performance Modeling 800
- D.3 Research Projects 801
- D.4 Reading/Report Assignments 801

Glossary 803

References 815

Index 823