OLIVER C. IBE

FUNDAMENTALS OF DATA COMMUNICATION NETWORKS

WILEY

WHAT EVERY ELECTRICAL ENGINEERING STUDENT AND TECHNICAL PROFESSIONAL NEEDS TO KNOW ABOUT DATA EXCHANGE ACROSS NETWORKS

While most electrical engineering students learn how the individual components that make up data communication technologies work, they rarely learn how the parts work together in complete data communication networks. In part, this is due to the fact that until now there have been no texts on data communication networking written for undergraduate electrical engineering students. Based on the author's years of classroom experience, *Fundamentals of Data Communication Networks* fills that gap in the pedagogical literature, providing readers with a much-needed overview of all relevant aspects of data communication networking, addressed from the perspective of the various technologies involved.

The demand for information exchange in networks continues to grow at a staggering rate, and that demand will continue to mount exponentially as the number of interconnected IoT-enabled devices grows to an expected twenty-six billion by the year 2020. Never has it been more urgent for engineering students to understand the fundamental science and technology behind data communication, and this book, the first of its kind, gives them that understanding. To achieve this goal, the book:

- Combines signal theory, data protocols, and wireless networking concepts into one text
- Explores the full range of issues that affect common processes such as media downloads and online games
- Addresses services for the network layer, the transport layer, and the application layer
- Investigates multiple access schemes and local area networks with coverage of services for the physical layer and the data link layer
- Describes mobile communication networks and critical issues in network security
- Includes problem sets in each chapter to test and fine-tune readers' understanding

Fundamentals of Data Communication Networks is a must-read for advanced undergraduates and graduate students in electrical and computer engineering. It is also a valuable working resource for researchers, electrical engineers, and technical professionals.

OLIVER C. IBE, ScD, is a Professor of Electrical Engineering and the Associate Dean of Engineering for Undergraduate Studies at the University of Massachusetts, Lowell, Massachusetts, USA. He has sixteen years of experience in the telecommunication industry including stints as Chief Technology Officer and cofounder of Sineria Networks, and the Director of Network Architecture at both Spike Broadband Systems and Adaptive Broadband Corporation. Dr. Ibe has published numerous books on the subjects of telecommunication technologies and applied probability.

Cover Design: Wiley
Cover Image: © hywards/Shutterstock

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Also available as an e-book

ISBN 978-1-119-43625-6

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This edition first published 2018

Registered Office
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

Editorial Office
111 River Street, Hoboken, NJ 07030, USA

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Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Library of Congress Cataloging-in-Publication Data applied for

ISBN: 9781119436256

Cover design by Wiley
Cover image: © hywards/Shutterstock

Set in 10/12pt WarnockPro by SPi Global, Chennai, India

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Fundamentals of Data Communication Networks

Preface

There are many books on data communication networks, and so one would ask why write another one. Almost all the books written so far are written for graduate students. The few that are written for an undergraduate audience are aimed at business students who need to understand the buzzwords that they will be encountering in the marketing and sale of data communication equipment. There is no book written for undergraduate electrical engineering students who study the different components of the data communication technologies in isolation. Thus, this book grew out of the following observations:

1. While electrical and computer engineering students study how to build filters in circuit theory class and Fourier analysis, sampling theorem, and modulation in signal and systems, no concerted effort is made to combine these topics into one system that they can relate to.
2. In this information age, most undergraduate electrical and computer engineering students do not know what an IP address is, how to design a data network, or how domain name system (DNS) works.
3. While every student uses a mobile device, most undergraduate engineering students in general and undergraduate electrical and computer engineering students in particular do not know what 2G, 3G, and 4G networks are. To them these are mere buzzwords.
4. Data security is a very important issue and still many undergraduate electrical and computer engineering students do not understand the basic concepts of data security.

This book seeks to address these issues and grew out of the lecture notes for a class with a similar title as this book that I have been teaching in the Department of Electrical and Computer Engineering at the University of Massachusetts Lowell. Most of the students are juniors and seniors who have taken signals and systems, calculus II, and circuit theory I.

The book is organized along the seven-layer framework of the open systems interconnection (OSI) model, which is a conceptual hierarchical model that specifies the communication functions of each layer in a communication system. The lowest layer of the hierarchy is called the physical layer (or Layer 1), while the highest layer is called the application layer (or Layer 7). Specifically, Chapter 1 gives an overview of data communication networks, including how they are classified, and a discussion of the OSI model. Chapter 2 discusses the lowest layer of the OSI model, which is the physical layer (or Layer 1). The different topics covered in signals and systems as well as circuit theory are discussed, including Fourier series, Fourier transform, the different multiplexing and modulation schemes, sampling theorem, different media types, and channel impairments.

Chapters 3–5 discuss topics related to the data link layer or Layer 2. Chapter 3 discusses data link layer protocols. Chapter 4 discusses techniques called multiple access schemes that are used to access data communication networks, while Chapter 5 discusses local area networks that use Layer 2 protocols.

Chapters 6 and 7 discuss the network layer or Layer 3. Chapter 6 discusses IP addressing, while Chapter 7 discusses how information is sent from source to destination, a process that is called routing. Different routing protocols are discussed, where a protocol is a defined set of rules that ensure an effective communication.

Chapters 8 and 9 discuss the transport layer or Layer 4. Chapter 8 discusses two protocols that were defined in the early days of the Internet. These are the transmission control protocol (TCP) and the user datagram protocol (UDP). These two protocols were defined when the Internet, which is a data communication network, was expected to be used mainly for non-real-time applications. Thus, they are optimized for file transfers. With the Internet being used for both traditional non-real-time applications and new real-time applications such as streaming video and voice over IP, two new transport-layer protocols have been defined to deal with this new environment. These protocols are the stream control transmission protocol (SCTP) and the datagram congestion control protocol (DCCP), and they are discussed in Chapter 9.

Chapter 10 discusses two protocols that are used in the highest layer called the application layer. These are the dynamic host configuration protocol (DHCP) and the DNS.

Chapter 11 provides an introduction to mobile communication networks. It discusses the different generations of the mobile communication network called 1G, 2G, 3G, 4G, and 5G networks, where 1G stands for first-generation network, 2G stands for second-generation network, and so on.

Finally, Chapter 12 gives an introduction to network security. It discusses the security threats that are encountered in a data communication network and the steps used to overcome them. There are exercises at the end of each chapter.

We have been able to cover these chapters in one semester, but the instructor is free to skip some chapters that they believe that the students are not equipped to handle. However, it is strongly recommended that Chapters 1 through 9 be covered, while Chapters 10–12 will be covered when time permits.

May 2017

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Acknowledgments

I would like to thank my editor at Wiley, Brett Kurzman, for his whole-hearted support of this book from the beginning. I also want to thank the anonymous reviewers for their useful comments that helped to improve the presentation of the material in the book. I would like to thank my colleagues in the Electrical and Computer Engineering (ECE) Department at UMass Lowell for encouraging me to develop the course. The course is taught every semester with an enrollment of more than 50 students each semester. I would like to thank all my students who have taken so much interest in the course, thereby justifying the effort that has gone into preparing the material at the undergraduate level. I would like to thank the Dean of the Francis College of Engineering, Dr. Joseph Hartman, for his keen interest in my career development and for appointing me the acting chair of ECE at the time the decision to develop this course was made. Finally, I would like to thank my wife Christie for her support and encouragement, and our children Chidinma, Ogechi, Amanze, and Ugonna for the joy they bring into my life.

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