



Academic Press Library in Mobile and Wireless Communications:

Transmission Techniques for Digital Communications

Edited by
Sarah Kate Wilson
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To Paul

SKW

To the memory of CES

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Introduction

Digital transmission is constantly evolving. Yet many fundamentals within the field of digital transmission remain constant. This book serves as an introduction both to digital transmission theory and to current applications.

Since early times people have used digital transmission as a way to send important messages: from signaling with beacons of light to today's cellular systems and the Internet. Digital transmission is a way to send messages over various media with the minimal amount of confusion at the receiver. The earliest electronic communications system, the telegraph, was digital using Morse code. Using digital communications with the early telegraph was necessary to avoid the problem of electronic noise and its effect on a low-power signal. It is much easier to distinguish between a dot and a dash and then to reconstruct alphanumeric messages, than it is an analog voice message. Moreover, digital transmission easily admits encryption for security and message routing in networks. Twentieth-century analog communications is in some ways an anomaly in the history of communications and has mostly, although not entirely, been replaced by digital transmission.

This book provides both a foundation in modern digital communications as well as an exploration of current digital transmission issues. Chapters 1–5 present the basics of digital communications theory and would represent material covered in a graduate course in digital communications. Chapters 6–10 delve deeper into the field of communications by exploring particular types of digital communications, (spread-spectrum, single-carrier, multicarrier) as well as required receiver methods such as synchronization and equalization. Chapters 11–16 focus on more specific applications of communications, for example, power line and optical communications. This book should serve both as an introduction and reference to the field of digital transmission.

Chapter 1 by Stephen Weinstein introduces the history and general issues associated with digital information. It provides context for the rest of the book and the field in general. Chapter 2 by Stephen Wilson and Tingjun Xie outlines the principle of baseband (low-frequency) representation of passband (assigned carrier frequency) modulation in digital communications. Michael Rice introduces single-carrier modulation in Chapter 3; this is a basis for all other types of communications and provides a fundamental lesson in how to send digital signals. Chapter 4 by Erik Strom explains how to optimally demodulate/decode these signals in an additive white Gaussian noise environment. Chapter 5 by Matthew Valenti and Mohammed Fanaei explains how coding and modulation relate. Note that a more complete book on error control coding can be found in our sister book, *Error Control Coding*.

Chapter 6 by Henry Bertoni and Saul Torrico describes the propagation issues and challenges associated with the radio channel. This leads to two chapters on how to resolve issues due to channel conditions: Chapter 7 by Marc Moeneclaey and Nele Noels, and Chapter 8 by John Barry. Chapter 7 focuses on how to synchronize a digital transmission signal while Chapter 8 focuses on how to compensate for

frequency-selective channels with equalization. Chapter 9 by Sarah Kate Wilson and Octavia Dobre focuses on multicarrier modulation, a technique that simplifies the equalization that is required for single-carrier signals found in Chapter 8. Chapter 10 by Scott Miller introduces spread-spectrum modulation, a technique developed in military communication, but now used in the third-generation cellular system.

Chapter 11 on MIMO by Constantinos Papadias expands on how to increase the efficiency of digital communications through the use of multiple antennas at the transmitter and/or the receiver. Chapter 12 by Henk Wymeersch and Attila Eryilmaz discusses how to accommodate several users in communications system.

Chapter 13, Cognitive Radio and Spectrum Sensing, by Ekram Hossain shows how we can further increase the number of users in a communications system through smart sensing and use of the radio spectrum. Chapters 14 and 15, by Steven Gorshe and Ahmad Sassani respectively, are devoted to communications standards. Chapter 14 focuses on wireline standards while Chapter 15 focuses on wireless standards. Chapters 16 and 17 focus on power line transmission and optical transmission. In Chapter 16 Maite Brandt-Pearce and Mohammad Noshad focus on the issues associated with digital transmission in an optical channel. In Chapter 17, Lutz Lampe and Lars Berger discuss the issues associated with another challenging channel, the power line. Finally, Alan Gatherer addresses issues associated with building transceivers in a cellular system in Chapter 18.

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