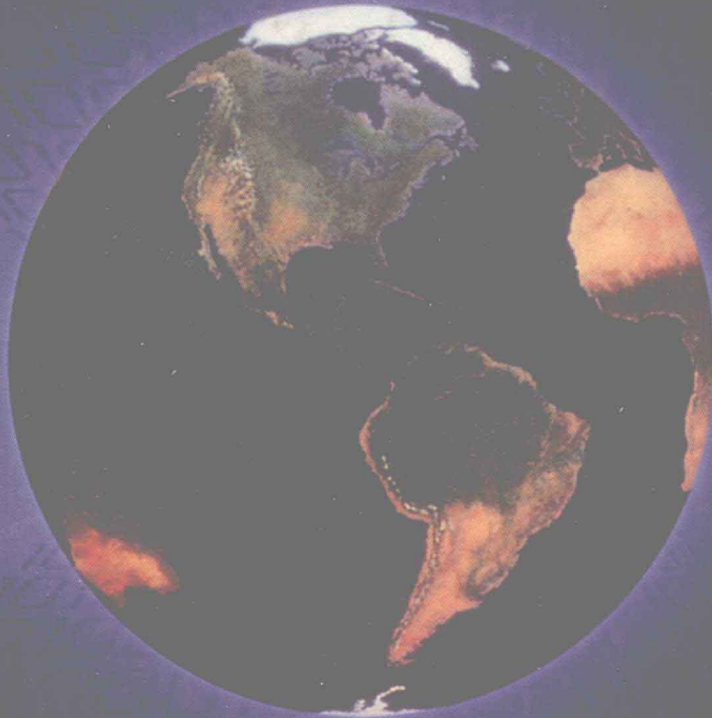


Introduction to Telecommunications

Voice, Data, and the Internet



Marion Cole

Introduction to Telecommunications

Voice, Data, and the Internet

Marion Cole

DeVry Institute of Technology

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Dedication

I dedicate this book to my daughter Kim. Her unwavering love and support are more than any father could wish for. She is a treasure. Thanks for all the Father's Day, Birthday, Christmas, and special occasion cards and gifts. I can always count on Kim to brighten my day.

Preface

This book was written at the suggestion of my associates in the telecommunications and educational communities. My first book, *Telecommunications*, placed much of its emphasis on the public switched telephone (or telecommunications) network (PSTN) used to connect telephones together for voice calls. Extensive details were provided on how the switching systems in PSTN work. Details were also provided on how the same technology used in switching systems, called private automatic branch exchanges (PABXs) and automatic call distributors (ACDs) sold to private businesses. This book provides less detail about switching systems and network design, and more information on data communication and the Internet. It is designed to support an entry-level class in a telecommunications management degree program. It provides both an overview of the technologies used in telecommunications, and additional in-depth discussions on voice, data, technology, and the Internet.

The telecommunications industry has experienced tremendous changes during the last 25 years on both the legislative and technical fronts. This book was written to cover some of the most important changes that have occurred. Older technologies are covered briefly but with enough depth to show readers how the technologies have changed and what benefits the new developments offer. The sections on voice, data, and the Internet are written for nontechnical individuals. These sections will give you an excellent overview of existing technology to allow you to better manage voice and data networks.

This book provides information on the various components that make up the PSTN, the packet (or public) data network (PDN), and the Internet. The PSTN has evolved from a voice-only analog network to a digital network handling both voice and data. The on-ramp to the PSTN remains mostly an analog twisted copper wire pair. Technologies such as Integrated Services Digital Network (ISDN) and Asymmetric Digital Subscriber Line (ADSL) are being implemented to change this last remaining analog component to a digital-access medium. Many analog and digital technologies are discussed in depth, but the primary focus is on how the technology works, not how to repair systems or components. That level of detail can be found in an electronics engineering curriculum or in a manufacturing school.

Technicians must attend a manufacturer's school to learn a particular system and how to perform diagnostics on it. The technology behind a particular component in the PSTN is basically the same for all manufacturers of the component. Each manufacturer puts its own twist on a particular generic technology to turn it into a

proprietary system with its brand name on it. This book will help you understand many telecommunications technologies in the generic sense. A technician with a basic understanding of technology, will easily understand and gain much more from the manufactured training program.

OVERVIEW

The first introductory chapters of *Introduction to Telecommunications: Voice, Data, and the Internet* deal with the evolution of telecommunications (Chapters 1 and 3) and with the relevant legislative history (Chapter 2). Chapter 4 discusses station equipment, Chapter 5 covers multiplexing, and Chapter 6 focuses on the twisted-pair local loop and other media. Chapter 7 treats analog and digital signals. Chapter 8 covers data communication, and Chapter 9 discusses ISDN and ADSL. Chapters 10 and 11 take up local area networks and wide area networks, respectively. Chapter 12 surveys Internet services, Chapter 13 is devoted to mobile telephones and personal communication systems, and Chapter 14 turns to management issues. A half dozen appendices round out the book by providing an in-depth treatment of basic electricity and other topics.

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First, I must thank Charles Stewart of Prentice Hall for his encouragement to write this book. I also want to thank Kate Linsner of Prentice Hall for her support and encouragement. In addition, I thank Elizabeth Judd for her tremendous help in bringing the manuscript in line with standard publishing conventions. The book would have taken a very different form without her editorial expertise.

I drew on my knowledge of telecommunications technology and experience in managing telecommunications operations to write this book. My knowledge of telecommunications was gained from reading books, attending company and manufacturers' schools, and on-the-job training. What I know, I learned from other people. I thank all of my past teachers and coworkers.

I also thank my wife Mary and my son Mark for their encouragement and understanding. I have spent much of the past year getting this book together. This took a lot of time away from my family, and I simply could not do the work without their support and understanding.

Please e-mail me at mcole@kc.devry.edu with any recommendations to improve future editions. Thanks for your interest in telecommunications.

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Introduction to Telecommunications

KEY TERMS

Analog Signal	Hypertext Markup Language (HTML)	Private Branch Exchange (PBX)
Automatic Call Distributor (ACD)	Interactive-Voice-Response (IVR)	Public Switched Telephone Network (PSTN)
Binary Signal	Interexchange Carrier (IEC)	Radio Waves
Central Office	Internet	Relay Center
Codec	Internet Protocol (IP)	Request for Comments (RFC)
Computer Inquiry II Ruling of 1981	Internet Service Providers (ISPs)	RJ-11 Jack
Computer Telephony Integrated (CTI)	Keysystem	RJ-45 Connectors
Data Communication	Line Circuit	Signaling System 7 (SS7)
Dense Wave Division Multiplexer (DWDM)	Local Area Network (LAN)	Tags
Digital Signal	Local Exchange Carrier (LEC)	Telecommunications
Electronic Data Interexchange (EDI)	Microwave Radio	Teletype
Electronic Mail (e-mail)	Modem	Transmission Control Protocol (TCP)
Ethernet	Multiplexing	Voice Communication
	Network Interface Card (NIC)	Voice-Over IP (VOIP)
	Packet (or Public) Data Network (PDN)	Wiring Hub

OBJECTIVES

On completion of this chapter, you should:

- 1 Be able to explain what telecommunications is.
- 2 Have a basic understanding of the various networks used to transmit voice, video, and data signals from one location to another.
- 3 Know how the competing technologies of the telegraph and telephone evolved over time.
- 4 Know the types of media used to convey telecommunications signals between a sender and a receiver.
- 5 Understand the basics of the three major voice communication technologies (keysystem, private branch exchange, and automatic call distributor) available to a business enterprise and the type of business best served by each of these technologies.

- 6 Have a basic understanding of personal computer-based voice communication systems, referred to as computer telephony integrated (CTI) systems.
- 7 Have a basic understanding of what a local area network and a wide area network are and how a business uses them to meet data communication needs.
- 8 Understand how the Internet has evolved, its importance to a business concern, and the technologies used to form the Internet.
- 9 Have a basic understanding of Hypertext Markup Language and web browsers.
- 10 Understand how deregulation of telecommunications has affected the telecommunications industry and the growth of job opportunities within the industry.

Telecommunications is communication over a distance. It encompasses all forms of communications and includes communication by voice, video, and data. Telecommunications signals carry the voice, video, or data that we wish to transmit from one point to another. People often separate the communication of voice and data into two categories, using the term *telecommunications* to denote the transmission of voice signals and *data communication* to refer to the transmission of data signals.

In today's **public switched telephone network (PSTN)**, voice signals emerge from a telephone as **analog signals**. The word *analog* is related to *analogous*. The electrical signals caused by a voice wave hitting the diaphragm of a telephone set's transmitter are analogous (similar) to the shape of the voice wave. All telephones connect to a local **central office**, which has an automated switching system that connects callers to their desired destination. The local central office contains a **line circuit** for every telephone connected to it. The line circuit in turn contains a device called a **codec** (coder/decoder) that converts analog voice signals received from the telephone into **digital signals**. These digital voice signals are then carried over the digital circuits that comprise the PSTN (see Figure 1-1).

Data is converted into digital codes when it is stored inside computers. The transmission of these digital codes results in a digital signal. Digital data can be transmitted over the PSTN by using **modems** or can be transmitted over a **packet** (also known as **public data network (PDN)**). The PDN is a wide area network and is discussed in Chapter 11. The PDN actually uses facilities in the PSTN that have been reserved for data transmission (see Figure 1-2). All circuits in the PSTN are digital circuits and can carry digitized voice, data, and video. It is appropriate today, therefore, to consider telecommunications as including voice, data, and video. It is also appropriate to break these components out into separate categories for study purposes. Thus, we can study **voice communication**, **data communication**, and video communication, but they all belong to a larger group or classification: telecommunications.

1.1 BEGINNING OF TELECOMMUNICATIONS

Telecommunications basically had its beginnings with the invention of the telegraph by Samuel F. B. Morse (1791–1872) in 1837. Morse formed a telegraph company based on his technology in 1845. The Western Union Telegraph Company was established in 1856 and within ten years had bought out its competitors, becoming the single largest telecommunications company in the world. Morse had developed a