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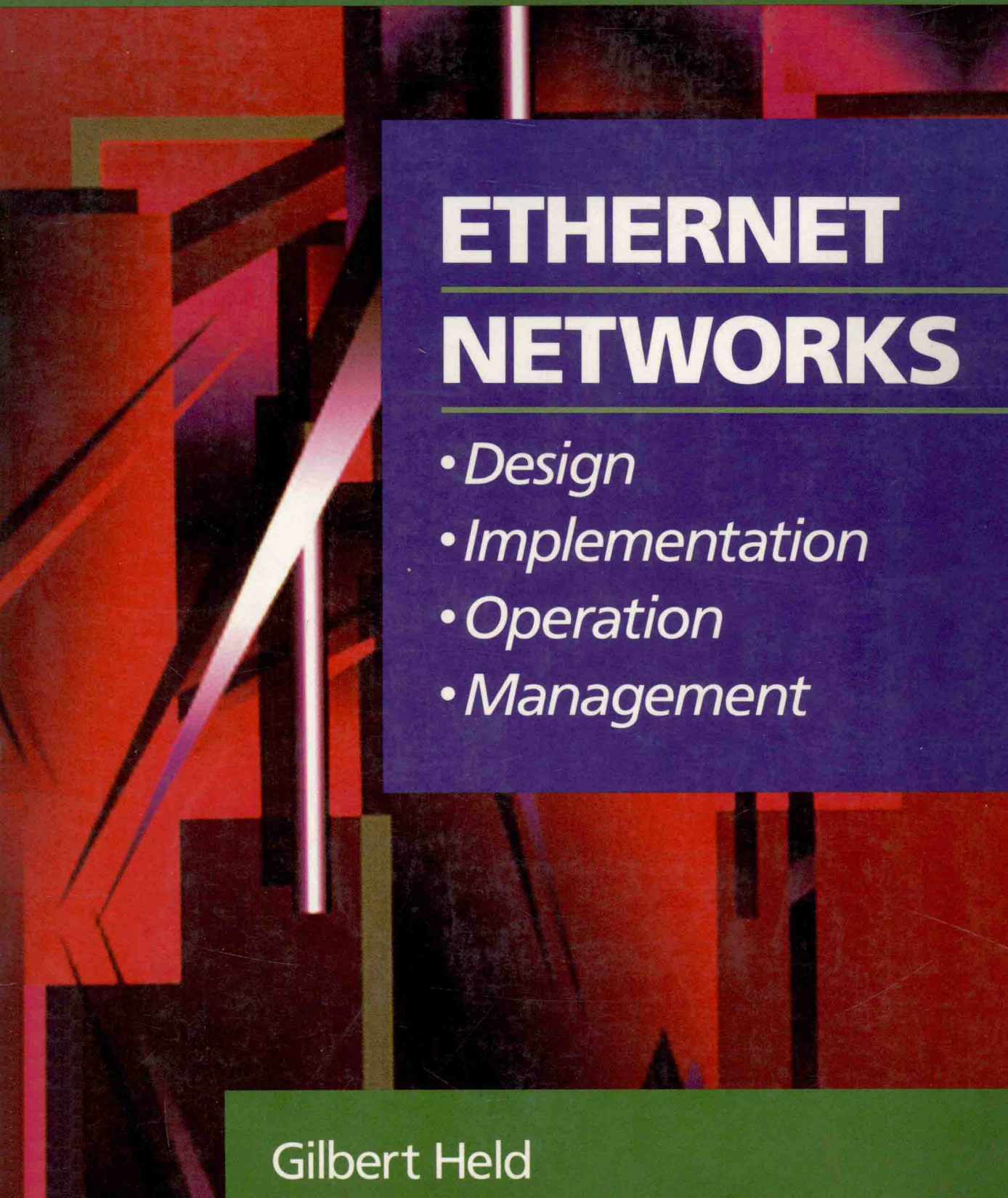

ETHERNET NETWORKS

- *Design*
- *Implementation*
- *Operation*
- *Management*

Gilbert Held

Ethernet Networks

- Design
- Implementation
- Operation
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Preface

The objective of this book is to incorporate into one reference source the material that readers will need to understand how Ethernet networks operate, the constraints and performance issues that affect their design and implementation, and how their growth and use can be managed both locally and as part of an enterprise network. I assume that readers have varied backgrounds in communications terms and technology. Thus, to maximize the use of material presented in this book, the first two chapters are designed to provide all readers with a common foundation of knowledge. Those chapters cover networking concepts and network standards—two topics on which material in succeeding chapters is based. Succeeding chapters examine Ethernet concepts: frame operations; network construc-

tion; the use of bridges, routers, and gateways; and the management and future of Ethernet networks.

Chapter 3 covers Ethernet concepts. This chapter provides a detailed examination of different types of Ethernet networks, their hardware components, and the general methods by which this type of local area network is constructed. The following chapter examines the composition and flow of Ethernet frames that transport data on the network. This chapter provides a foundation for an in-depth examination of the use of bridges, routers, and gateways, and of the tools and techniques you can use to expand and manage your network.

In writing this book, I have attempted to incorporate practical information you can readily use in designing, operating, implementing, and managing an Ethernet network. Although Ethernet had its origins in the 1970s and can be considered a relatively "old" technology, in reality, the technology is anything but old. Only a few years ago, the standardization of what is now known as 10BASE-T (a twisted-wire version of Ethernet) resulted in a considerable expansion in the use of this type of local area network. In 1993, several vendors were developing prototype hardware for a 100-Mbps Ethernet that would provide an operating rate an order of magnitude higher than that of a 10BASE-T network. This technology, then, is still relatively new, and can be expected to continue to evolve to satisfy the communications requirements of business, government, and academia.

For over 20 years I have worked as a network manager responsible for the design, operation, and management of an enterprise network in which local area networks throughout the United States are interconnected through the use of different wide area network transmission facilities. This challenging position has provided me with the

opportunity to obtain practical experience in designing, operating, and interconnecting Ethernet networks to Token-Ring, SNA, and other types of networks—experience which I have attempted to share with you. This book will help you consider the practicality of different types of routing protocols and gateway methods. These and other network design issues are crucial to the efficient and effective expansion of a local Ethernet so that users on that network can access resources on other networks.

As a professional author, I very much value readers' comments. Those comments provide me with feedback necessary to revise future editions so that they better reflect the information requirements of readers. I look forward to receiving your comments, as well as suggestions for information you would like to see in a future edition of this book. You can write to me directly or through my publisher, whose address is on the back cover of this book.

Gilbert Held
Macon, GA

Acknowledgments

This book would not have been possible without the work of two people whose foresight and pioneering efforts were instrumental in the development of the technology upon which Ethernet is based.

One of the key concepts behind Ethernet—that of allocating the use of a shared channel—can be traced to the pioneering efforts of Dr. Norman Abramson and his colleagues at the University of Hawaii during the early 1970s. The actual development of Ethernet is due to the foresight of Dr. Robert Metcalfe. Working at the Xerox Palo Alto Research Center in Palo Alto, CA, Dr. Metcalfe headed a development team that interconnected over 100 computers on a 1-km cable using a carrier sense multiple access colli-

sion detection (CSMA/CD) protocol. In addition to pioneering the technical development of Ethernet, Dr. Metcalfe coined its name, after the luminiferous ether through which electromagnetic radiation was once thought to propagate. I would be remiss if I did not thank Dr. Abramson, Dr. Metcalfe, and their colleagues for their visionary efforts in developing the technology through which millions of people now communicate.

Writing and producing a book about technology requires not only the technology itself, but also the efforts of many individuals. First and foremost, I would like to thank my family for their understanding for the nights and weekends I disappeared to write this book. Once again, I am indebted to Mrs. Carol Ferrell for taking my notes and drawings and converting them into a manuscript. Last, but not least, I would like to thank Paul Farrell, Katherine Schowalter, and the many other persons at John Wiley & Sons who were instrumental in backing this project and in facilitating the conversion of my manuscript into the book you are reading.

Contents

CHAPTER 1

Introduction to Networking Concepts

One of the most logical assumptions an author can make is that readers will have diverse backgrounds of knowledge and experience. Making this book as valuable as possible to persons with different backgrounds requires an introductory chapter that covers basic networking concepts. Unfortunately, basic concepts for one person may not be the same as basic concepts for another person, which presents an interesting challenge for an author.

To meet this challenge, this book takes two courses of action. First, it assumes that some readers will have limited knowledge about the different types of communications systems available for transporting information, the relationship between wide area networks (WANs) and

local area networks (LANs), and the relationships among different types of local area networks. Thus, this introductory chapter was written to provide those readers with a basic level of knowledge concerning these important topics. Secondly, readers who are already familiar with these basic concepts may wish to consult individual chapters separately, rather than reading through the entire book. To satisfy those readers, each chapter was written to be as independent as possible from preceding and succeeding chapters. Thus, readers who are familiar with wide and local area networking concepts, as well as the technical characteristics of LANs, may elect to skim or bypass this chapter. For other readers, information contained in this chapter will provide a level of knowledge that will make succeeding chapters more meaningful.

In this introductory chapter, we will first focus our attention on the key concepts behind the construction of wide area networks and local area networks. In doing so, we will examine each type of network to obtain an understanding of its primary design goal. Next, we will compare and contrast their operations and utilizations to obtain an appreciation for the rationale behind the use of different types of local area networks.

Although this book is about Ethernet networks, there are other types of local area networks that provide a viable data transportation highway for millions of users. By reviewing the technological characteristics of different types of LANs, we will obtain an appreciation for the governing characteristics behind the use of different local area networks. In addition, because many local area networks are connected to other LANs and WANs, we will conclude this chapter by focusing on the technological characteristics of local area networks. This will form a foundation for discussing a variety of Ethernet networking issues in succeeding chapters of this book.

1.1 Wide Area Networks

The evolution of wide area networks can be considered to have originated in the mid- to late 1950s, commensurate with the development of the first generation of computers. Based on the use of vacuum tube technology, the first generation of computers were large, power-hungry devices whose placement resulted in a focal point for data processing and the coinage of the term *data center*.

Computer-Communications Evolution

Originally, access to the computational capability of first-generation computers was through the use of punched cards. After an employee of the organization used a keypunch to create a deck of cards, that card deck was submitted to a window in the data center, typically labeled input/output (I/O) control. An employee behind the window would accept the card deck and complete a form that contained instructions for running the submitted job. The card deck and instructions would then be sent to a person in production control, who would schedule the job and turn it over to operations for execution at a predefined time. Once the job was completed, the card deck and any resulting output would be sent back to I/O control, enabling the job originator to return to the window in the data center to retrieve his or her card deck and the resulting output. With a little bit of luck, programmers might see the results of their efforts on the same day that they submitted their jobs.

Since the computer represented a considerable financial investment for most organizations, it was understandable that these organizations would be receptive to the possibility of extending their computers' accessibility. By the mid-1960s, several computer manufacturers had added remote access capabilities to one or more of their computers.