

国外计算机科 学教材系列

局域网与城域网

(第六版)

Local and Metropolitan Area Networks
Sixth Edition

英文版

[美] William Stallings 著

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Hall



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内 容 简 介

这本英文原版教材对局域网/城域网技术进行了全面的探讨,既强调了基本原理,也注重在设计局域网/城域网时性能的重要性。本书还涉及了各种高速和无线局域网、与QoS相关的技术以及网络之间的互联和广域网。全书包括四个部分。第一部分提供必要的技术背景,内容包括对数据通信和网络中的一些论题的简要回顾以及对协议与TCP/IP协议栈的介绍。第二部分讨论局域网的一般性问题,内容包括局域网实现过程中常用的拓扑结构和传输介质、局域网协议体系结构以及LLC的详细内容。第三部分是本书的重点,主要介绍五种相关类型的局域网,内容包括以太网、令牌环网、光纤信道局域网与无线局域网以及异步传输模式(ATM)局域网。第四部分讨论有关局域网设计的一些问题,包括用网桥进行局域网互联、网际互联、网络管理及性能考虑等问题。

本书适合高等院校电子、计算机、通信类专业作为双语教学的教材,也适应专业技术人员参考。

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出版说明

21 世纪初的 5 至 10 年是我国国民经济和社会发展的关键时期,也是信息产业快速发展的关键时期。在我国加入 WTO 后的今天,培养一支适应国际化竞争的一流 IT 人才队伍是我国高等教育的重要任务之一。信息科学和技术方面人才的优劣与多寡,是我国面对国际竞争时成败的关键因素。

当前,正值我国高等教育特别是信息科学领域的教育调整、变革的重大时期,为使我国教育体制与国际化接轨,有条件的高等院校正在为某些信息学科和技术课程使用国外优秀教材和优秀原版教材,以使我国在计算机教学上尽快赶上国际先进水平。

电子工业出版社秉承多年来引进国外优秀图书的经验,翻译出版了“国外计算机科学教材系列”丛书,这套教材覆盖学科范围广、领域宽、层次多,既有本科专业课程教材,也有研究生课程教材,以适应不同院系、不同专业、不同层次的师生对教材的需求,广大师生可自由选择和自由组合使用。这些教材涉及的学科方向包括网络与通信、操作系统、计算机组织与结构、算法与数据结构、数据库与信息处理、编程语言、图形图像与多媒体、软件工程等。同时,我们也适当引进了一些优秀英文原版教材,本着翻译版本和英文原版并重的原则,对重点图书既提供英文原版又提供相应的翻译版本。

在图书选题上,我们大都选择国外著名出版公司出版的高校教材,如 Pearson Education 培生教育出版集团、麦格劳-希尔教育出版集团、麻省理工学院出版社、剑桥大学出版社等。撰写教材的许多作者都是蜚声世界的教授、学者,如道格拉斯·科默(Douglas E. Comer)、威廉·斯托林斯(William Stallings)、哈维·戴特尔(Harvey M. Deitel)、尤利斯·布莱克(Uyless Black)等。

为确保教材的选题质量和翻译质量,我们约请了清华大学、北京大学、北京航空航天大学、复旦大学、上海交通大学、南京大学、浙江大学、哈尔滨工业大学、华中科技大学、西安交通大学、国防科学技术大学、解放军理工大学等著名高校的教授和骨干教师参与了本系列教材的选题、翻译和审校工作。他们中既有讲授同类教材的骨干教师、博士,也有积累了几十年教学经验的老教授和博士生导师。

在该系列教材的选题、翻译和编辑加工过程中,为提高教材质量,我们做了大量细致的工作,包括对所选教材进行全面论证;选择编辑时力求达到专业对口;对排版、印制质量进行严格把关。对于英文教材中出现的错误,我们通过与作者联络和网上下载勘误表等方式,逐一进行了修订。

此外,我们还将与国外著名出版公司合作,提供一些教材的教学支持资料,希望能为授课老师提供帮助。今后,我们将继续加强与各高校教师的密切联系,为广大师生引进更多的国外优秀教材和参考书,为我国计算机科学教学体系与国际教学体系的接轨做出努力。

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Preface

Objectives

This book focuses on the broad and evolving field of local and metropolitan area networks. The aim of the text is to provide a reasoned balance among breadth, depth, and timeliness. The book emphasizes topics of fundamental importance concerning the technology and architecture of these networks. Certain key related areas, such as performance, internetworking, and network management, are also treated in some detail.

The book explores the key topics in the field in the following general categories:

- **Technology and architecture:** There is a small collection of ingredients that serves to characterize and differentiate local and metropolitan area networks, including transmission medium, topology, communication protocols, and switching technique.
- **Network type:** This book covers the important types of networks, including those defined in the IEEE 802 standards, plus FDDI, Fibre Channel, ATM LANs, and wireless LANs.
- **Design approaches:** The book examines alternative design choices and assesses their relative merits.

Plan of the Text

The book is organized into four parts:

- Part One. Background.** This part provides a preview and context for the remainder of the book, covering basic topics in data communications as well as TCP/IP.
- Part Two. LAN/MAN Architecture.** This part examines technology areas common to all LAN and MAN systems. The various topologies and transmission media are discussed; this includes a consideration of cabling types and wiring layout. There is also a discussion of the communications protocol architecture within which LAN/MAN protocols are defined. Finally, logical link control (LLC), which is the common interface to upper-layer protocols, is described.
- Part Three. LAN/MAN Systems.** The major types of LANs and MANS are covered. These include Ethernet, token ring, Fibre Channel, wireless LANs, and ATM LANs.
- Part Four. Design Issues.** This part covers the use of bridges and routers for network interconnection. It also discusses network management and the use of SNMP. Finally, Part Four looks at issues relating to the relative performance of various LAN/MAN approaches.

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

Throughout, there is an emphasis on both technology and on standards. The book provides a compre-

hensive guide to understanding specific LAN and MAN standards, such as IEEE 802 and FDDI, and the specifications issued by the ATM Forum and the Fibre Channel Association. This emphasis reflects the importance of such standards in defining the available products and future research directions in this field.

Internet Services for Instructors and Students

There is a Web page for this book that provides support for students and instructors. The page includes links to relevant sites, transparency masters of figures in the book in PDF (Adobe Acrobat) format, and sign-up information for the book's Internet mailing list. The Web page is at WilliamStallings.com/LAN6e.html. 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. Finally, I maintain the Computer Science Student Support Site at WilliamStallings.com/StudentSupport.html.

What's New in the Sixth Edition

In the four years since the fifth edition of this book was published, the field has seen continued innovations and improvements. 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 fifth edition of this book was extensively reviewed by a number of professors who teach the subject and by professionals working in the field. 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, the most obvious change in the sixth edition is the increased emphasis on high-speed networks. A number of trends dictate the rapid move to high-speed technology in the LAN/MAN field: the continued, relentless increase in the speed and capacity of computer systems; the evolution of applications to include greater emphasis on graphic and video; and the increased volume of data generated by the move to client/server computing. The result of these trends has been the introduction in recent years of a number of new schemes for moving large volumes of data at high rates within the local area. These schemes are both complementary and competing, making it difficult for the observer to assess their relative merits and areas of application. This new edition covers these alternative approaches to high-speed local networking and addresses the issues relating to interconnecting these networks with each other and with wide area networks.

Some of the most noteworthy changes are the following:

- A new background chapter on TCP/IP has been added, pulling together material scattered throughout the fifth edition and adding material on IPv6. This material is vital to an understanding of LAN design.
- Chapter 7, on IEEE 802.3 and Ethernet, now includes coverage of Gigabit Ethernet.
- Chapter 8, on token ring, now includes coverage of 100-Mbps token ring and Gigabit token ring.
- Chapter 10 covers the increasingly important area of wireless LANs; this material has been updated to reflect the evolution of the 802.11 wireless LAN standards.
- Chapter 12, on bridges, now includes a discussion of the important topic of LAN traffic classes and the relationship between 802.1D traffic classes and layer 3 quality of service (QoS).
- Chapter 14, on network management, includes an updated description of SNMP, including the new SNMPv3 standard.

Reader's Guide to This Book

Chapter 1 introduces local area networks (LANs) and metropolitan area networks (MANs) and places them in context with each other and with wide area networks (WANs) and the Internet. The chapter also discusses typical applications of LANs and MANs and looks at the overall architecture of a LAN or MAN.

Part One of this book provides the necessary technical background for topics dealt with in other chapters. Chapter 2 provides a brief survey of topics in data communications and communication networks. Chapter 3 looks at protocols and the TCP/IP protocol suite. For the reader with a previous background in data communications, this chapter can be skimmed or skipped.

Part Two covers some general topics that relate to all LANs.¹ Chapter 4 looks at the topologies and transmission media that are commonly used to implement LANs. Chapter 5 looks at the overall protocol architecture of LANS, which consists of the physical, medium access control (MAC), and logical link control (LLC) layers. This chapter also provides an overview of the important IEEE 802 standards. Chapter 6 provides a more detailed look at LLC; the reader may safely skip this chapter on a first reading.

Dozens of different approaches to LAN design have been defined and/or implemented based on standards or proprietary vendor specifications. Many of these are obsolete and of only theoretical interest.

Part Three focuses on five types of LANs that are the most relevant, in terms of both current commercial acceptance and future prospects. By far the most important category of LAN is the Ethernet family, which includes various physical configurations and data rates ranging from 10 Mbps to 1 Gbps. The reader is urged to study Chapter 7, which covers this type of LAN, in depth. The remaining chapters of Part Three cover LANs of lesser importance, and the reader may skip or devote limited time to each chapter based on his or her interest. Chapter 8 covers the various token ring LANs. While token ring has never enjoyed the popularity of Ethernet, it is an important LAN type for two reasons. First, until relatively recently, IBM promoted token ring as its sole LAN product. This endorsement resulted in a large installed token ring LAN base, which remains today. Second, the FDDI (fiber distributed data interface) version of token ring has until recently been seen as the best approach for both high-speed LANs and for MANs. Although FDDI's popularity is fast fading, a large installed base remains.

A LAN type of increasing importance is Fibre Channel, covered in Chapter 9. Fiber Channel provides very high-speed connections with a small area and is the LAN of choice for storage area networks (SANs). Another increasingly important type of LAN is the wireless LAN, covered in Chapter 10. Wireless LANs eliminate the need for cable installation and provide mobility advantages. Finally, Chapter 11 covers ATM (asynchronous transfer mode) LANs. Although ATMs have not lived up to their early promise, which was to be the most cost-effective solution for high-speed LANs and to provide seamless integration with wide

¹ For the sake of brevity, the term *LANs* will be used typically to include both LANs and Mans throughout this book. If a distinction is needed, this is made clear in the text.

area ATM networks, they occupy an important niche and employ an increasingly important technology.

Part Four deals with a number of design issues related to LANs. These include the use of bridges to interconnect LANs, internetworking issues, network management, and performance. The reader may focus on those topics of special interest.

Throughout the book, chapter appendices are used to separate some of the more technical discussion from the main flow of the text. The reader not interested in particular detailed technical topics can concentrate on the main body of each chapter and refer to the appendices as needed.

Acronyms

AAL	ATM Adaptation Layer	ISO	International Organization for Standardization
ANSI	American National Standards Institute		
ASK	Amplitude-Shift Keying	ITU	International Telecommunication Union
ATM	Asynchronous Transfer Mode		
CCITT	Consultative Committee on International Telegraphy and Telephony	LAN	Local Area Network
CLNP	Connectionless Network Protocol	LLC	Logical Link Control
CRC	Cyclic Redundancy Check	LSAP	LLC Service Access Point
CSMA	Carrier Sense Multiple Access	MAC	Medium Access Control
CSMA/CD	Carrier Sense Multiple Access with Collision Detection	MAN	Metropolitan Area Network
DCE	Data Circuit-Terminating Equipment	OSI	Open Systems Interconnection
DQDB	Distributed Queue, Dual Bus	PDU	Protocol Data Unit
DTE	Data Terminal Equipment	PSK	Phase-Shift Keying
ES	End System	SAN	Storage Area Network
FCS	Frame Check Sequence	SAP	Service Access Point
FDDI	Fiber Distributed Data Interface	SMDS	Switched Multimegabit Data Service
FDM	Frequency-Division Multiplexing	SNMP	Simple Network Management Protocol
FSK	Frequency-Shift Keying	SRT	Source Routing/Transparent
HDLC	High-Level Data Link Control	STP	Shielded Twisted Pair
HIPPI	High-Performance Parallel Interface	SDU	Service Data Unit
IEEE	Institute of Electrical and Electronics Engineers	TCP	Transmission Control Protocol
IP	Internet Protocol	TDM	Time Division Multiplexing
IR	Infrared	UTP	Unshielded Twisted Pair
IS	Intermediate System	VCC	Virtual Channel Connection
ISM	Industrial, Scientific, and Medical	VPC	Virtual Path Connection
		WAN	Wide Area Network
		WDM	Wavelength Division Multiplexing

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