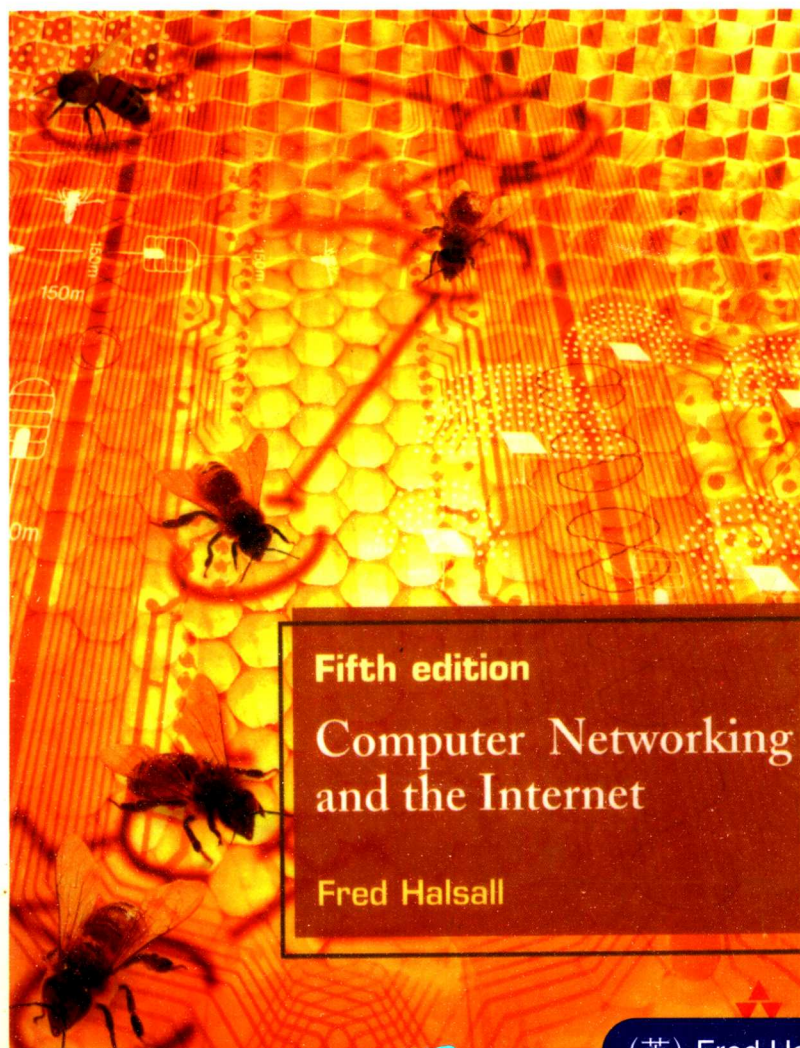


# 计算机网络与因特网教程

(英文版 · 第5版)



(英) Fred Halsall 著



机械工业出版社  
China Machine Press



经典原版书库

# 计算机网络与因特网教程

(英文版·第5版)

Computer Networking and the Internet  
(Fifth Edition)

江苏工业学院图书馆  
藏书章

(英) Fred Halsall 著



机械工业出版社  
China Machine Press

Fred Halsall: Computer Networking and the Internet, Fifth Edition (ISBN 0-321-26358-8).

Copyright © 2005 by Pearson Education Limited.

This edition of Computer Networking and the Internet, Fifth Edition is published by arrangement with Pearson Education Limited. Licensed for sale in the mainland territory of the People's Republic of China only, excluding Hong Kong, Macau, and Taiwan.

本书英文影印版由英国Pearson Education (培生教育出版集团) 授权出版。未经出版者书面许可, 不得以任何方式复制或抄袭本书内容。

此影印版只限在中国大陆地区销售 (不包括香港、澳门、台湾地区)。

版权所有, 侵权必究。

本书法律顾问 北京市展达律师事务所

**本书版权登记号: 图字: 01-2005-3240**

### **图书在版编目 (CIP) 数据**

计算机网络与因特网教程 (英文版·第5版) / (英) 哈尔索尔 (Halsall, F.) 著. —北京: 机械工业出版社, 2005. 8

(经典原版书库)

书名原文: Computer Networking and the Internet, Fifth Edition

ISBN 7-111-16870-4

I. 计… II. 哈… III. ① 计算机网络—教材—英文 ② 因特网—教材—英文 IV. TP393

中国版本图书馆CIP数据核字 (2005) 第075103号

机械工业出版社 (北京市西城区百万庄大街22号 邮政编码 100037)

责任编辑: 迟振春

北京牛山世兴印刷厂印刷·新华书店北京发行所发行

2005年8月第1版第1次印刷

787mm × 1092mm 1/16 · 52印张

印数: 0 001-3 000 册

定价: 89.00元

凡购本书, 如有倒页、脱页、缺页, 由本社发行部调换

本社购书热线: (010) 68326294

# 出版者的话

文艺复兴以降，源远流长的科学精神和逐步形成的学术规范，使西方国家在自然科学的各个领域取得了垄断性的优势；也正是这样的传统，使美国在信息技术发展的六十多年间名家辈出、独领风骚。在商业化的进程中，美国的产业界与教育界越来越紧密地结合，计算机学科中的许多泰山北斗同时身处科研和教学的最前线，由此而产生的经典科学著作，不仅擘划了研究的范畴，还揭橥了学术的源变，既遵循学术规范，又自有学者个性，其价值并不会因年月的流逝而减退。

近年，在全球信息化大潮的推动下，我国的计算机产业发展迅猛，对专业人才的需求日益迫切。这对计算机教育界和出版界都既是机遇，也是挑战；而专业教材的建设在教育战略上显得举足轻重。在我国信息技术发展时间较短、从业人员较少的现状下，美国等发达国家在其计算机科学发展的几十年间积淀的经典教材仍有许多值得借鉴之处。因此，引进一批国外优秀计算机教材将对我国计算机教育事业的发展起积极的推动作用，也是与世界接轨、建设真正的世界一流大学的必由之路。

机械工业出版社华章图文信息有限公司较早意识到“出版要为教育服务”。自1998年开始，华章公司就将工作重点放在了遴选、移译国外优秀教材上。经过几年的不懈努力，我们与Prentice Hall, Addison-Wesley, McGraw-Hill, Morgan Kaufmann等世界著名出版公司建立了良好的合作关系，从它们现有的数百种教材中甄选出Tanenbaum, Stroustrup, Kernighan, Jim Gray等大师名家的一批经典作品，以“计算机科学丛书”为总称出版，供读者学习、研究及度藏。大理石纹理的封面，也正体现了这套丛书的品位和格调。

“计算机科学丛书”的出版工作得到了国内外学者的鼎力襄助，国内的专家不仅提供了中肯的选题指导，还不辞劳苦地担任了翻译和审校的工作；而原书的作者也相当关注其作品在中国的传播，有的还专程为其书的中译本作序。迄今，“计算机科学丛书”已经出版了近百个品种，这些书籍在读者中树立了良好的口碑，并被许多高校采用为正式教材和参考书籍，为进一步推广与发展打下了坚实的基础。

随着学科建设的初步完善和教材改革的逐渐深化，教育界对国外计算机教材的需求和应用都步入一个新的阶段。为此，华章公司将加大引进教材的力度，在“华章教育”的总规划之下出版三个系列的计算机教材：除“计算机科学丛书”之外，对影印版的教材，则单独开辟出“经典原版书库”；同时，引进全美通行的教学辅导书“Schaum's Outlines”系列组成“全美经典学习指导系列”。为了保证这三套丛书的权威性，同时也为了更好地为学校和老师服务，华章公司聘请了中国科学院、北京大学、清华大学、国防科技大学、复旦大学、上海交通大学、南京大学、浙江大学、中国科技大学、哈尔滨工业大学、西安交通大学、中国人民大学、北京航空航天大学、北京邮电大学、中山大学、解放军理工大学、郑州大学、湖北工学院、中国国家信息安全测评认证中心等国内重点大学和科研机构在计算机的各个领域的著名学者组成“专

家指导委员会”，为我们提供选题意见和出版监督。

这三套丛书是响应教育部提出的使用外版教材的号召，为国内高校的计算机及相关专业的教学度身订造的。其中许多教材均已为M. I. T., Stanford, U.C. Berkeley, C. M. U. 等世界名牌大学所采用。不仅涵盖了程序设计、数据结构、操作系统、计算机体系结构、数据库、编译原理、软件工程、图形学、通信与网络、离散数学等国内大学计算机专业普遍开设的核心课程，而且各具特色——有的出自语言设计者之手、有的历经三十年而不衰、有的已被全世界的几百所高校采用。在这些圆熟通博的名师大作的指引之下，读者必将在计算机科学的宫殿中由登堂而入室。

权威的作者、经典的教材、一流的译者、严格的审校、精细的编辑，这些因素使我们的图书有了质量的保证，但我们的目标是尽善尽美，而反馈的意见正是我们达到这一终极目标的重要帮助。教材的出版只是我们的后续服务的起点。华章公司欢迎老师和读者对我们的工作提出建议或给予指正，我们的联系方式如下：

电子邮件：hzjsj@hzbook.com

联系电话：(010) 68995264

联系地址：北京市西城区百万庄南街1号

邮政编码：100037

# 专家指导委员会

(按姓氏笔画顺序)

尤晋元  
石教英  
张立昂  
邵维忠  
周克定  
郑国梁  
高传善  
裘宗燕

王 珊  
吕 建  
李伟琴  
陆丽娜  
周傲英  
施伯乐  
梅 宏  
戴 葵

冯博琴  
孙玉芳  
李师贤  
陆鑫达  
孟小峰  
钟玉琢  
程 旭

史忠植  
吴世忠  
李建中  
陈向群  
岳丽华  
唐世渭  
程时端

史美林  
吴时霖  
杨冬青  
周伯生  
范 明  
袁崇义  
谢希仁

# Preface

## Objectives

Prior to the introduction of the World Wide Web, there were many different types of computer networks used to interconnect geographically distributed sets of computers. Many large corporations and businesses, for example, often used proprietary networks, each with its own protocols and networking infrastructure, while, at the same time, the Internet was used primarily to interconnect distributed sets of computers that were located at academic and research institutions around the world. Typical applications were electronic mail and more general file transfers between computers.

With the advent of the Web, however, since the Internet was the networking infrastructure used for the Web, the Internet has rapidly become the dominant computer network as people at home and at work started to use the Web. Typical applications are interactive entertainment, electronic commerce, and so on, which, of course, are in addition to the standard applications already supported by the Internet. As we can deduce from this, therefore, the subject of computer networking is now synonymous with the study of the Internet and its applications.

The combined effect of these developments means that the number of users of the Internet has expanded rapidly. To support this expansion, instead of most users accessing the Internet through an academic network, a number of different types of access network are now used. For example, most users at home and in small businesses gain access through their local switched telephone network using either a low bit rate modem or, more usually, a broadband modem. Alternatively, for cable television subscribers, access is often through a high bit rate cable modem. In practice, however, both access methods provide only a physical connection to a second network called an Internet service provider (ISP) network. This, as its name implies, provides the access point to the Internet for a set of users that fall within the field of coverage of a particular ISP network. Clearly, therefore, there are many ISPs each of which is a private, commercial company and hence access to the Internet through an ISP must be paid for.

In addition to telephone and cable networks, with the introduction of Internet-enabled mobile phones and laptops with radio interfaces, many users on the move now gain access to the Internet using a regional/national/international cellular phone network. All of these different types of access network

are in addition, of course, to the conventional site networks used by large corporations and businesses. Because of the importance of the Web to their businesses, most of these site networks now use the same protocols as the Internet to facilitate interworking with it.

In many instances, the expanding range of applications supported by the Internet has come about through the technological advances in the way the user data associated with these applications is represented. For example, until relatively recently, a number of the access networks that are now used, in addition to providing their basic service such as telephony, only supported applications in which the application data was composed of text comprising strings of alphanumeric characters entered at a keyboard. As a result of the technological advances in the area of compression, however, the same access networks can now support a much richer set of applications involving multiple data types. These include, in addition to text, digitized images, photos/pictures, speech, audio and video.

As we can deduce from this brief overview, to study the technological issues relating to computer networking and the Internet requires an in-depth understanding not only of the operation of the Internet itself but also the operation of the different types of access network that are used and how they interface with the Internet. In addition, because many of the applications involve the transfer of sensitive information, the topic of security is now essential when describing the operation of the Internet. The aim of this book is to provide this body of knowledge. To do this, the book is divided into two logical parts. The first – Chapters 1 through 5 – is concerned with the fundamentals of digital transmission and communication protocols together with descriptions of the mode of operation of the different types of access network that are now used and how they interface with the global Internet. The second – Chapters 6 through 10 – describes the architecture and communication protocols used by the Internet and the applications that it supports. In addition, the second part describes the techniques that are used to ensure that all the data relating to these applications are transferred in a secure way.

The book has five appendices. In Appendix A we present descriptions of how the different types of data used in the various Internet applications are represented together with an overview of the operation of the compression algorithms that are employed with text, digitized images, photos/pictures, speech, audio and video.

As we shall explain, when transmitting digital data over a network, bit corruptions/errors are often introduced. Hence in Appendix B we describe a number of the different methods that are used to detect the presence of transmission/bit errors in a received block of data.

Normally, when a bit error within a block of data is detected, another copy of the block is requested by the receiving device. In some instances, however – for example when data is being transmitted over a radio/wireless link – the frequency of bit errors is such that the request message for a new copy of a corrupted block may also be corrupted and hence an alternative



approach must be used. This involves adding significantly more what are called *error control bits*. These are added in such a way that the receiver can use them to deduce what the original data block contained. This approach is called forward error control and an introduction to this topic is given in Appendix C.

Wireless networks – that is, networks that use radio as the transmission medium – are now widely used in a number of access networks. In Appendix D, therefore, we give a short introduction to the subject of radio propagation and transmission so that the standards relating to this type of network can be understood.

As we shall see, the global Internet is composed of many thousands of networks that are organized into hierarchical layers. At the higher layers, the networks must route data through them at very high rates and are called backbone networks. In Appendix E we describe the technology that is used to achieve these very high switching rates.

## Intended readership

The book has been written primarily as a course textbook for both university and college students studying courses relating to the technical issues associated with computer networking based on the Internet, its protocols and applications. Typically, the students will be studying in a computer science, computer systems, computer engineering or electronic engineering department/school. In addition, the book is suitable for computer professionals and engineers who wish to build up a working knowledge of this rapidly evolving subject. At one extreme this requires the reader to understand the techniques that are used to transmit a digital bitstream over the different types of transmission medium, such as copper wire, coaxial cable, radio and optical fiber. At the other extreme it requires an understanding of the software that is used in the different types of equipment – personal computers, workstations, laptops, mobile phones, set-top boxes, etc. – that are used to support Internet applications. The first is the domain of the electronics engineer and the second of the computer scientist. Care has been taken, however, to ensure that the book is suitable for use with courses for both types of student by ensuring that the level of detail required in each subject area is understandable by both categories of reader.

In order to achieve this goal, an introductory chapter has been included that describes the basic hardware and software techniques that are used to achieve the reliable transfer of a block/stream of digital data over a transmission channel. These include the different methods that are used to detect the presence of transmission errors – bit corruptions – in a received block/stream of data and the procedures that are followed to obtain another copy of the block/stream when this occurs. The latter form what is called a communications protocol. Hence this chapter also includes an introduction to the

subject of protocols to give the reader who has no previous knowledge of this subject the necessary foundation for the later chapters that describe the operation of the different types of access networks and the protocols and applications of the Internet.

## Intended usage

### To the instructor

As we can see from the list of contents, the book covers a range of topics each of which is to a depth that makes it interesting and academically challenging. As a result, the book can be used for a number of different courses relating to computer networking and the Internet. Ideally, in order to obtain an in-depth technical understanding of the subject area, a set of courses should be used to collectively cover the total contents of the book from the principles of data communications through to details of the different types of access networks and the protocols and applications of the Internet. Alternatively, it can be used for one or two courses each of which covers a subset of this subject area. For example, one course may cover the basics of digital communications and an overview of the operation of the different types of access network that are used with the Internet. The second course can then cover the architecture and detailed operation of the Internet and its protocols together with its applications including the World Wide Web and the topic of security. The book is considered to be suitable for both undergraduate and taught masters courses.

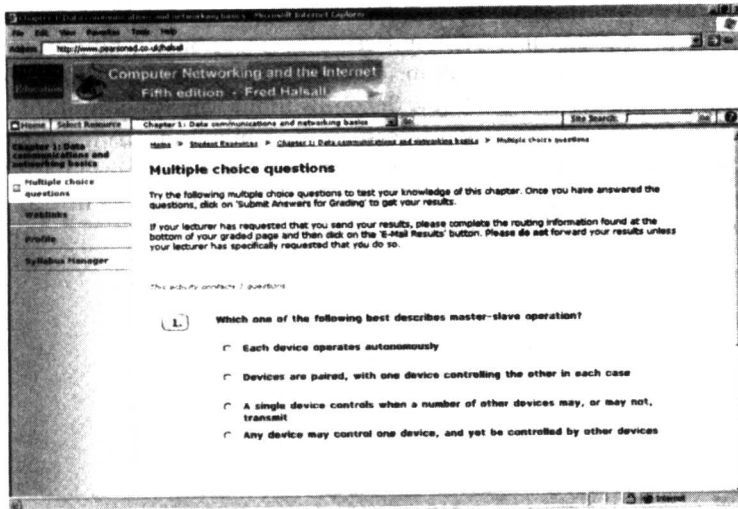
As indicated earlier, all of the topics are covered to a depth that enables the reader to build up an in-depth technical understanding of the subject. Hence because of the technical nature of the subject, to help the reader to understand each topic within an area, either a worked example or a relatively detailed diagram is used to illustrate the concepts involved. This is considered to be one of the main advantages of the book over competing texts owing to the technical detail associated with many of the diagrams. Also, both the examples and diagrams are seen as being particularly useful for instructors as they can be used directly for lectures. To facilitate this, therefore, both the worked examples and all the diagrams are available to instructors in their electronic form so reducing considerably the time required to prepare a set of lectures for a course. These can be downloaded from [www.booksites.net/halsall](http://www.booksites.net/halsall). In addition, each chapter has a comprehensive set of exercises that have been structured to help the student to revise the topics covered in that chapter in a systematic way.

## **To the student**

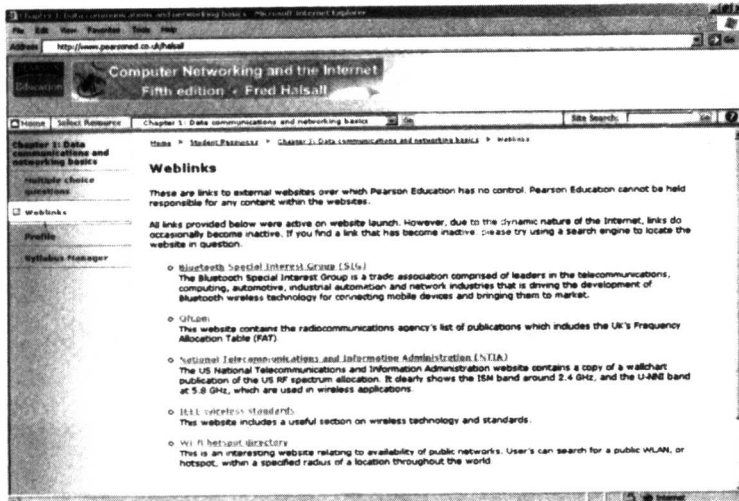
The book has been structured to be used for self-study. Worked examples are included in most chapters and, to aid understanding of all the topics that are covered, associated with each topic is a relatively detailed diagram that illustrates the concepts involved. These you should find particularly useful since they facilitate understanding the technical details relating to the many topics covered. In addition, the comprehensive set of exercises at the end of each chapter have been structured to help you to test your knowledge and understanding of each of the topics covered in that chapter in a systematic way. In order to aid self-study, there is an exercise for each topic discussed within a section. Hence for each question within a section heading, you can relate back to the topic within that section of the book to find the answer.



# Guided Tour of the Website



Multiple choice questions



Weblinks

# Acknowledgments

I should like to take this opportunity to thank various people for their help during the period I was preparing the manuscript. Firstly to Simon Plumtree and Keith Mansfield at Pearson Education for their enthusiasm and motivation that encouraged me to write the book. Secondly to my wife Rhiannon for her unwavering support, patience, and understanding while I was writing the book. Finally, to our first grandchild Annelie Grace; I promise that now I have finished writing my book, I shall take you out much more frequently. It is to Annelie and her mother Lisa that I dedicate the book.

Fred Halsall  
December 2004

# Acronyms

3G	Third generation	BTS	Base transceiver subsystem
AAL	ATM adaptation layer	BUS	Broadcast and unknown address server
ABM	Asynchronous balanced mode	BWB	Bandwidth balancing
ABR	Available bit rate	CA	Certification authority
AC	Alternating current/Authentication center	CAC	Channel access code
ACK	Acknowledgment	CAS	Channel-associated signaling
ACL	Asynchronous connectionless link	CATV	Cable television
ADC	Analog-to-digital conversion/converter	CBC	Chain block cipher
ADM	Add-drop multiplexer	CBDS	Connectionless broadband data service
ADPCM	Adaptive differential PCM	CBR	Constant bit rate
ADSL	Asymmetric DSL	CCA	Clear channel assessment
AH	Authentication header	CCD	Charge-coupled device
AMA	Active member address	CCITT	International Telegraph and Telephone Consultative Committee (now ITU-T)
AMI	Alternate mark inversion	CCK	Complementary code keying
ANSI	American National Standards Institute	CCS	Common-channel signaling
AP	Application process/program/protocol	CD	Carrier detect/Collision detect
APC	Adaptive predictive coding	CDC	Countdown counter
API	Application program interface	CELP	Code-excited linear prediction
ARM	Asynchronous response mode	CFI	Canonical format identifier
ARP	Address resolution protocol	CGI	Common gateway interface
ARPA	Advanced Research Projects Agency	CID	Channel identifier
ARQ	Automatic repeat request	CIDR	Classless inter-domain routing
AS	Autonomous system	CIF	Common intermediate format
ASCII	American Standards Committee for Information Interchange	CIR	Committed information rate
ASI	Alternate space inversion	CL	Connectionless
ASK	Amplitude-shift keying	CLP	Cell loss priority
ASN.1	Abstract syntax notation one	CLUT	Color look-up table
ATM	Asynchronous transfer mode	CM	Cable modem
ATV	Advanced television	CMTS	Cable modem termination system
AVO	Audio-visual object	CO	Connection-oriented
BA	Behavior aggregate	COFDM	Coded orthogonal FDM
BCC	Block check character	COM	Continuation message
BER	Bit error rate/ratio	CPE	Customer premises equipment
BGCF	Breakout gateway control functions	CR	Carriage return
BGP	Border gateway protocol	CRC	Cyclic redundancy check
BISDN	Broadband ISDN	CS	Carrier sense/Convergence sublayer
BOM	Beginning of message	CSCF	Call/session control function
BPDU	Bridge PDU	CSCW	Computer-supported cooperative working
BPSK	Binary phase shift keying	CSMA	Carrier-sense multiple-access
BRI	Basic rate interface	CSMA/CA	CSMA with collision avoidance
BS	Backspace	CSMA/CD	CSMA with collision detection
BSC	Base station controller	CTI	Computer telephony integration
BSS	Basic service set	CTS	Clear-to-send
BSSID	BSS identifier	CW	Contention window
		DA	Destination address

DAC	Digital-to-analog conversion/converter	FF	Form feed
DBS	Digital broadcast satellite	FHSS	Frequency-hopping spread spectrum
DC	Direct current	FIFO	First-in, first-out
DCE	Data circuit terminating equipment	FM	Frequency modulation
DCF	Distributed coordination function	FN	Fiber node
DCT	Discrete cosine transform	FQDN	Fully-qualified DN
DEL	Delete	FRA	Frame relay adapter
DES	Data encryption standard	FS	File separator
DFT	Discrete Fourier transform	FSK	Frequency-shift keying
DHCP	Dynamic host configuration protocol	FTP	File transfer protocol
DIFS	DCF inter-frame spacing	FTTB	Fiber-to-the-building
DLC	Data link control	FTTC/K	Fiber-to-the-curb/kerb
DLE	Data link escape (character)	FTTcab	Fiber-to-the-cabinet
DMPDU	Derived MAC PDU	FTTH	Fiber-to-the-home
DMT	Discrete multitone		
DN	Distinguished name	GA	Grand Alliance
DNS	Domain name server	GB	Guard-band
DOCSIS	Data-over-cable service interface specification	GEO	Geostationary/geosynchronous earth orbit
DPC	Designated port cost	GGSN	Gateway GPRS support node
DPCM	Differential PCM	GIF	Graphics interchange format
DPLL	Digital phase-locked line	GLP	Gateway location protocol
DQDB	Distributed queue dual bus	GOB	Group of blocks
DS	Differentiated services/Downstream	GOP	Group of pictures
DSL	Digital subscriber line	GPRS	General packet radio service
DSLAM	Digital subscriber line access multiplexer	GSM	Global system for mobile communications
DSSS	Direct sequence spread spectrum	GSTN	General switched telephone network
DTE	Data terminal equipment	GTP	GPRS tunneling protocol
DTMF	Dual-tone multiple frequency	GW	Gateway
DVA	Distance vector algorithm		
DVB	Digital video broadcast	HDB3	High density bipolar 3
DVB-S/T	DVB-satellite/terrestrial	HDLC	High-level data link control
DVD	Digital versatile disk	HDSL	High-speed DSL
DVMRP	Distance vector MRP	HDTV	High-definition television
		HE	Headend
EBCDIC	Extended binary coded decimal interchange code	HEC	Header error checksum
ECB	Electronic code book/Event control block	HFC	Hybrid fiber coax
ECN	Explicit congestion notification	HLR	Home location register
ED	End delimiter	HMAC	Hash message authentication code
EF	Expedited forwarding	HS	Home subscriber server
EGP	Exterior gateway protocol	HTML	HyperText Markup Language
EIA	Electrical Industries Association	HTTP	HyperText Transfer Protocol
EIR	Equipment identity register	HTTPD	HTTP daemon
EMS	Enhanced message service		
EOM	End of message	IA5	International alphabet number five
EOS	End of stream	IAC	Inquiry access code
ES	End system	ICANN	Internet Corporation for Assigned Names and Numbers
ESC	Escape		
ESP	Encryption security payload	ICMP	Internet control message protocol
ETX	End of text	IDCT	Inverse DCT
		IDEA	International data encryption algorithm
FCS	Frame check sequence	IDFT	Inverse DFT
FDD	Frequency division duplex	IDSL	ISDN-DSL
FDDI	Fiber distributed data interface	IEE	Institution of Electrical Engineers
FDM	Frequency-division multiplexing	IEEE	Institute of Electrical and Electronics Engineers



IETF	Internet Engineering Task Force	MA	Multiple access
IGE	International gateway exchange	MAC	Medium access control
IGMP	Internet group management protocol	MAN	Metropolitan area network
IGP	Interior gateway protocol	MAT	Multicast address table
IKE	Internet key exchange	M-bone	Multicast (Internet) backbone
IMEI	International mobile equipment identity	MCM	Multi-carrier modulation
IMG	IMS media gateway	MCU	Multipoint control unit
IMS	IP multimedia services	MD	Message digest
INIC	Internet Network Information Center	MDS	Multipoint distribution system
IP	Internet protocol	MFN	Multifrequency network
IPsec	IP security	MGCF	Media gateway control function
IS	Integrated services/ Intermediate system	MGW	Media gateway
ISDN	Integrated services digital network	MIB	Management information base
ISI	Intersymbol interference	MIDI	Music Instrument Digital Interface
ISO	International Standards Organization	MII	Media-independent interface
ISP	Internet service provider	MIME	Multipurpose Internet mail extension
ITU-T	International Telecommunications Union - Telecommunications (Sector)	MIT	Management information tree
IV	Initialization vector	MMDS	Multichannel MDS
IWF	Interworking function	MMR	Modified-modified read
IWU	Interworking unit	MMS	Multimedia message service
IXC	Interexchange carrier	MO	Managed object
		MOD	Movie on demand
JPEG	Joint Photographic Experts Group	MOSPF	Multicast OSPF
Kc	Cipher key	MP3	MPEG layer 3 (audio)
ki	Authentication key	MPEG	Motion Picture Experts Group
		MPLS	MultiProtocol Label Switching
L2CAP	Logical link control and adaptation protocol	MRFC	Media resource function controller
LA	Location area	MRFP	Media resource function processor
LAI	Location area identification	MRP	Multicast routing protocol
LAN	Local area network	MS	Message store/Mobile station
LAPB	Link access procedure, balanced	MSC	Mobile switching center
LAPM	Link access procedure for modems	MSISDN	Mobile subscriber ISDN number
LCN	Logical channel number	MSL	Maximum segment lifetime
LCP	Link control protocol	MSRN	Mobile subscriber roaming number
LE	LAN emulation	MSS	MAN switching system
LEC	LE client	MTA	Message transfer agent
LECS	LE configuration server	MUX	Multiplexer
LED	Light-emitting diode	NAK	Negative acknowledgment
LEP	LE protocol	NAP	Network access point
LES	LE server	NAPT	Network address and port translation
LF	Line feed	NAV	Network allocation vector
LGN	Logical group number	NBS	National Bureau of Standards
LL	Link layer	NCP	Network control protocol
LLC	Logical link control	NEXT	Near-end crosstalk
LMDS	Local MDS	NMOD	Near movie-on-demand
LNB/C	Low noise block/converter	NMS	Network management system
LPC	Linear predictive coding	NNTP	Network news transfer protocol
LS	Link state	NOP	No operation
LWE	Lower window edge	NPA	Network point of attachment
LXC	Local exchange carrier	NRM	(Unbalanced) normal response mode
LZ	Lempel-Ziv	NRZ	Non-return to zero
LZW	Lempel-Ziv-Welsh	NRZI	Non-return to zero inverted
		NSAP	Network service access point