电子·教育

新编21世纪高等职业教育电子信息类规划教材

·通信技术专业

通信与网络技术专业英语

黎楷模 主 编

夏明华 副主编

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電子工業出版社
PUBLISHING HOUSE OF ELECTRONICS INDUSTRY

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内 容 简 介

《通信与网络技术专业英语》是高职高专通信专业与网络专业的规划教材之一。

本教材分为两大部分：通信和计算机网络。全书共12章，内容包括通信基础、多路复用、电话系统、7号信令系统、光纤技术、移动通信技术GSM、网络协议与结构、局域网、广域网、网络互联、因特网以及网络管理与安全。各章均附有注释、词汇和短语及阅读材料。本教材注重高等职业教育的特点，力求用浅显易懂的英语阐述通信与网络的基本知识和基本应用，同时尽可能多地介绍专业方面的新技术和发展前沿。全书结构清晰合理，论述简明扼要，图文并茂，注重实用。

本教材适合通信、网络、计算机与信息专业的高职高专学生使用，同时也适于相关行业的技术人员和本科学生自学与参考，以提高自身的专业英语水平和阅读专业书籍及手册的能力。

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出版说明

高等职业教育是我国高等教育的重要组成部分。其根本任务是培养和造就适应生产、建设、管理、服务第一线需要的德、智、体、美全面发展的高等技术应用型人才。近年来，高等职业教育发展迅猛，其宏观规模发生了历史性变化。为适应我国社会进步和经济发展的需要，高等职业教育的教学模式、教学方法需要不断改革，高职教材也必须与之相适应，进行重新调整与定位，突出自身的特色。为此，在国家教育部、信息产业部有关司局的支持、指导和帮助下，电子工业出版社在全国范围内筹建成立"全国高职高专教育教材建设领导小组"，下设"应用电子技术"、"机电一体化技术"、"电气自动化技术"和"通信技术"等专业的多个编委会。各专业编委会成员由电子信息战线辛勤耕耘、功绩卓著的专家、教授、高工和富有高职教学经验的一线优秀教师组成。

2002 年 10 月，"应用电子技术"、"机电一体化技术"、"电气自动化技术"和"通信技术"等四个专业的编委会精心组织全国范围内的优秀一线教师编写了《新编 21 世纪高等职业教育电子信息类规划教材》60 余种。这批教材的主要特点是：

1. 在编写方法上打破了以往教材过于注重"系统性"的倾向，摒弃了一些一般内容和烦琐的数学推导，采用阶跃式、有选择的编写模式，强调实践和实践属性，精炼理论，突出实用技能，内容体系更加合理；

2. 注重现实社会发展和就业需求，以培养职业岗位群的综合能力为目标，充实训练模块的内容，强化应用，有针对性地培养学生较强的职业技能；

3. 教材内容的设置有利于扩展学生的思维空间和学生的自主学习；着力于培养和提高学生的综合素质，使学生具有较强的创新能力，促进学生的个性发展；

4. 教材内容充分反映新知识、新技术、新工艺和新方法，具有超前性、先进性。

首批教材共有 60 余种，将于 2003 年 8 月陆续出版。所有参加教材编写的高职院校都有一个共同的愿望：希望通过教材建设领导小组、编委会和全体作者的共同努力，使这批教材在编写指导思想、编写内容和编写方法上具有新意，突出高等职业教育的特点，满足高职学生学习和就业的需要。

高等职业教育改革与教材建设是一项长期的任务，不会一蹴而就，而是要经历一个发展过程。这批高职教材的问世，还有许多不尽人意之处。随着教育改革的不断深化，我国经济和科学技术的不断发展，高职教材的改革与开发将长期与之相伴而行。在教育部和信息产业部的指导和帮助下，我们将一如既往地依靠本行业的专家，与科研、教学第一线的教研人员紧密联系，加强合作，与时俱进，不断开拓，逐步完善各类专业课教材、专业基础课教材、实训指导书、电子教案、电子课件及配套教材，为高等职业教育提供优质的教学资源和服务。

电子工业出版社高职高专教育教材事业部的全体成员殷切地希望全国高职高专院校的教师们能够踊跃投稿，提出选题建议，并对已出版的教材从多方面提出修改建议。除以上四个专业外，我们还设立了"计算机技术"、"电子商务"、"物流管理"、"会计类"、"金融类"、"环保类"等专业的编委会。我们衷心欢迎更多的志士仁人加入到各个编委会中来。

电子工业出版社的全体员工将竭诚为教育服务，为高等职业教育战线的广大师生服务。

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参加“新编21世纪高等职业教育电子信息类规划教材”编写的院校名单（排名不分先后）

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前　言

根据教育部《关于加强高职高专教育人才培养工作的意见》精神，为满足高职高专电子信息类专业教学基本建设的需要，在教育部高教司和教育部高职高专教育教学指导委员会的关心和指导下，于2002年11月在杭州召开了由电子工业出版社牵头组织的全国高职高专电子信息类专业教材建设研讨会。全国近百所高职高专院校的约150位专家学者经过充分讨论，一致确定新世纪高职高专教材应该遵循“淡化理论、加强应用、联系实际、突出特色”的总体编写原则，慎重落实了近60本教材的编写规划和编写任务，组织了编审班子并审定了编写大纲。本教材就是这次会议审定的高职高专规划教材之一。

由于全球信息化的飞速发展，通信专业与计算机网络专业的人才需求一直在不断持续增长。随着中国加入 WTO，中国的教育应与世界接轨，加强外语教学尤其是专业英语的教学是高等教育的重点工作之一。面对通信、计算机网络和信息类专业不断涌入的大量新理论和新技术——这些信息绝大部分是以英语为载体的——如何提高高校学生的英语水平尤其是专业英语水平就成为教育界刻不容缓的研究任务。编写一本实用性强、系统性好、前瞻性好的通信与网络技术专业英语教材就是我们编写本书的目的。

在本教材编写过程中，我们查阅了大量有关通信和网络的英语原版书籍，参考了大量的网上论坛的讲座和论文，反复斟酌修改才定此稿。我们的目的是使学过这门课程的读者从英语角度获得较宽的专业知识面，掌握较多的专业英语词汇，具有直接从第一手原文资料上获得所需信息的能力，从而改变高职高专学生甚至本科生都只能在有限的、滞后的中文译本出版后才能了解本专业发展趋势的弊端。

本教材分两大部分：第1～6章介绍通信原理和技术，第7～12章介绍计算机网络。通信部分介绍了通信史、通信原理、多路复用、电话系统、7号信令系统、光纤技术以及移动通信技术 GSM，阅读材料还介绍了蓝牙技术等先进技术。网络部分阐述了网络协议与结构、OSI 参考模型与 TCP/IP 协议、局域网、广域网、网络互联、因特网以及网络管理与网络安全，阅读材料还补充了英语求职信、英语简历和成绩单的范文，供学生参考。为了方便使用，每章后均附有该章出现的专业词汇和短语，并对章节中的难点做了注释。本书建议讲授50学时。

本书适合通信专业和计算机网络专业的高职高专学生使用，也适于计算机、信息、电子、自动化等相关专业的技术人员和本科学生参考学习，还可给希望阅读通信与计算机网络专业原文资料的广大师生、技术人员和相关管理人员教学、培训或自学使用。

本书由张元教授任主审，黎楷模副教授任主编，夏明华老师任副主编。第1～6章由夏明华老师编写，第7～12章由黎楷模老师编写。本书编写过程中主要参考的书目和论文列在本书最后，它们对于本书的完成提供了很重要的帮助，对于这些书籍和论文的作者，我们在此表示诚挚的感谢和敬意。

由于作者的水平和编写时间有限，书中难免存在缺点和错误，恳请专家和读者批评指正。

编　者

2003年5月

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CHAPTER 1 Fundamentals of Telecommunications

1.1 History and Regulation of the Telephone Industry

"Mr. Watson, come here, I want you." With these historic words Alexander Graham Bell called to his assistant Thomas Augustus Watson over the so-called "telephone", and an industry was born.

The place: 5 Exeter Place, Boston, Massachusetts

The time: evening, March 10, 1876

As with all inventions, the road had not been smooth. For years, Graham Bell (as he liked to be called) had been experimenting with a harmonic telegraph. It should be possible, he reasoned, to send six tones over the same wire at the same time and cause six reeds attached to the receiving end to be operated. Furthermore, if all worked well, varied combinations of these six pitches could reproduce human speech.

Simultaneously he was working on a scheme that utilized the varying resistance of a wire. A diaphragm, which would be vibrated by the human voice, was attached to a wire that was dipped into a mixture of acid and water. In theory, as the diaphragm moved downward, forcing more wire into the acid, the resistance of the wire would be decreased. As the diaphragm moved upward, the wire would be withdrawn from the conducting liquid, and its resistance would be increased. It was this device that was ultimately successful and that formed the basis for the telephone industry for many years.

A year later, on July 9, 1877, the Bell Telephone Company was formed, and Alexander Graham Bell became the company's electrician, at a salary of $3 000, and Watson became superintendent in charge of research and manufacturing. Unfortunately for Bell, the basic patents were due to run out in 1893 and 1894. But by this time, Theodore Newton Vail had been brought in as general manager, and he immediately set about establishing an organization strong enough to survive without a monopoly. "What we wanted to do was to get possession of the field in such a way that, patent or no patent, we could control it," Vail said. The first step was to obtain a captive manufacturing facility, and this was accomplished in 1881 with the purchase of Western Electric Company.

Vail also sent his salesmen into the field to set up telephone exchanges in virgin territory. Generally, local promoters were encouraged to organize a local telephone company and sell stock. Thus, by 1885 Vail had established a vertically integrated supply division, a network of companies licensed by the parent, and a strong research and development arm ①. The expiration of Bell's basic patents in 1893 and 1894 was the starting signal for open competition. Independent telephone operating companies sprang up throughout the country; by the turn of the century there were approximately 6000 of them, and these 6000 provided service to some 600000 subscribers. Through the years, mergers and acquisitions took their toll; at the present time there are approximately 1300 local exchange carriers.

Unfortunately for the general public, all of these telephones were not interconnected. Therefore, it was necessary for a subscriber to have two or three instruments to communicate with the total population of the city. However, the great asset of AT&T, which became the official name of the company at the end of 1899, was the control of all the long-distance circuits and its steadfast refusal to interconnect any other company to it ②.

This would never do, and the Justice Department filed suit in 1912. The world was angry with AT&T, and an AT&T vice president—Nathan C. Kingsbury— realized it. He recognized that the best demonstration of AT&T not being in a monopoly position was to point to thousands of independents apparently operating in harmony ③. To this end, AT&T agreed to provide interconnection arrangements to all independents. This 1913 agreement was henceforth called the Kingsbury Commitment.

By 1934 telecommunications had become so important to the country that Congress passed a Communications Act and, simultaneously, created the Federal Communications Commission (FCC). The section of this Act that has turned out to be most important has to do with what we now call universal service. It said: "For the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges."

As a result of this principle, a support structure has been established whereby certain groups of subscribers (e.g. long-distance users, business subscribers, subscribers in locations where telephone service can be provided with relative ease, etc.) will pay more than true costs, and other groups of subscribers (e.g. subscribers in rural and other high-cost locations) will pay less than true costs.

In 1949 the Justice Department again filed suit against AT&T, claiming that Western Electric charged inordinately high prices from their customers (i.e. the operating telephone companies owned by AT&T), thus making it possible for the operating telephone companies to charge their subscribers inappropriately high rates. The suit dragged on, and a consent decree was reached in 1956. AT&T won; Western Electric need not be divested from AT&T, the Bell System would engage only in telecommunications business, and nonexclusive licenses would be granted to any applicant on fair terms. This was the final judgment. The eventual breakup of the Bell System in 1984 was accomplished through a modification of this final judgment, hence the modification of final judgment (MFJ).

Although the Bell System appeared to be the winner in this 1956 suit, over the next two decades it would lose battles, one at a time. There was the Hush-Aphone case in 1955; the Carterfone case in 1968; MCI's "above 890" case in 1959, and the MCI case dealing with a long-distance route from Chicago to St. Louis in 1969. In November, 1974, the Justice Department once again filed suit to break up the Bell System. The case trudged on until 1978, when Judge Harold Greene took over. He moved things quickly, and on January 4, 1982, a terse announcement was issued by the Justice Department and AT&T saying that negotiations had been reopened. Then, on January 8, 1982, the news broke: AT&T had agreed to break up its $136.8 billion empire. It was agreed that AT&T would divest the local parts of the Bell operating telephone companies. It would keep its manufacturing facilities and its long-distance network. The agreement would take effect on January 1, 1984.

The 22 regional Bell operating companies (RBOCs) agreed to form 7 regional holding companies (Bell Atlantic, NYNEX, BellSouth, Ameritech, U S WEST, Pacific Telesis, and Southwestern Bell). The agreement also said that the Bell operating companies would not be allowed to manufacture nor would they be allowed to get in the long-distance business within their territories. AT&T would not be allowed to get in the local-exchange business nor to acquire the stock or assets of any RBOC.

That remained the state of affairs until the passage of the 1996 Telecommunications Act. This Act threw most of the rules established in 1984 out the window and left the implementation of the Act to the FCC. There have been problems ever since. What did the Congress mean by "promote competition"? Should AT&T be allowed to get in the local-exchange business? (Answer: yes.) Should the RBOCs be allowed to get in the long-distance business? (Answer: yes, but only after passing a 14-point checklist.) What did "expanded universal service" mean? Should the RBOCs be allowed to merge? (Answer: yes. Bell Atlantic has merged with NYNEX; Southwestern Bell [SBC] has merged with Pacific Telesis and is planning to merge with Ameritech. Bell Atlantic intends to merge with GTE. If all of these are ultimately approved, there will remain four RBOCs). To date, many questions remain, and there is no assurance that they will be answered in the foreseeable future.

1.2 A Communication System Model

DEFINITION. A *communication system* is that designed to transmit information ④.

A simple model of communication system is illustrated by the block diagram in *Figure 1.1*.

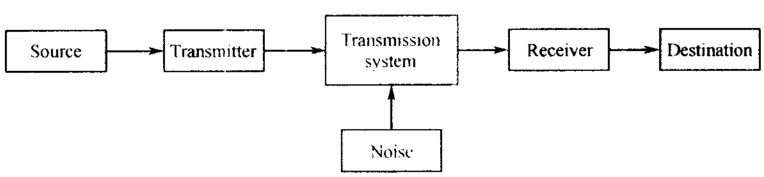

Figure 1.1 Simplified Communication System Model

The fundamental purpose of a communication system is the exchange of data between two parties. One example is the exchange of voice signals between two telephones over the same network. The key elements of the model are:

- **Source**. This device generate the data to be transmitted, examples are telephones and personal computers.

- **Transmitter**. Usually, the data generated by a source system are not transmitted directly in the form in which they are generated. Rather, a transmitter transforms and encodes the information in such a way as to produce electric signals that can be transmitted across some sort of transmission system. For example, a modem ⑤ takes a digital bits stream from an attached device such as a personal computer and transforms that bit stream into an analog signal that can be handled by the telephone network.
- **Transmission System**. This can be a single transmission line or a complex network connecting source and destination.
- **Receiver**. The receiver accepts the signal from the transmission system and converts it into a form that can be handled by the destination device. For example, a modem will accept an analog signal coming from a network or transmission line and convert it into a digital bit streams.
- **Destination**. Takes the incoming data form the receiver.

1.3 Transmission Technology

Most transmission—at least most transmission in the local exchange plant—is analog in nature. That is, the signal being transmitted varies continuously, both in frequency and in amplitude. A high-pitched voice mostly contains high frequencies; a low-pitched voice contains low frequencies. A loud voice contains a high-amplitude signal; a soft voice contains a low-amplitude signal.

In the long-distance network, and more and more in the local exchange plant, digital transmission is being used. A digital signal is comprised of a stream of 1s and 0s that portray the analog voice signal by means of a code.

Analog signals can be combined (i.e. multiplexed) by combining them with a carrier frequency. When there is more than one channel, this is called frequency division multiplexing (FDM). FDM was used extensively in the past but now has generally been replaced with the digital equivalent: time division multiplexing (TDM). The most popular TDM system is known as tier 1 (T1). In a T1 system, an analog voice channel is sampled 8 000 times per second, and each sample is encoded into a 7-bit byte. Twenty-four such channels are mixed on these two copper pairs and transmitted at a bit rate of 1.544 megabits per second ⑥. T1 remains an important method of transmitting voice and data in the PSTN (see *Figure 1.2*).

Such a digital transmission scheme (and certainly there are modifications of it that improve efficiency, capacity, or quality, etc.) works hand in glove with the digital-switching schemes we will talk about later. Those 1s and 0s need not be transmitted through an actual circuit in that switch; rather, one can simply turn on and off the various electronic devices that make up that switch.

Thus a talking path (i.e. a switched circuit) in the PSTN can be either analog or digital or a combination thereof. In fact, a digital signal can be transmitted over a packet-switched network as easily as a circuit-switched network. Now if we consider the next step, we see that digitized voice is not very different from data, and if data can be transmitted over a packet network, then so can digitized voice. This, of course, is now known as voice over the Internet. The challenge, of course, is to get the transmitted signal to the destination fast enough. After all, this may well be a time-sensitive voice conversation. A second challenge is to get each packet, which is a small piece of a voice conversation, to the destination in the proper order. Progress is being made, and we can well believe that packet switching will play an important role in the PSTN of tomorrow.

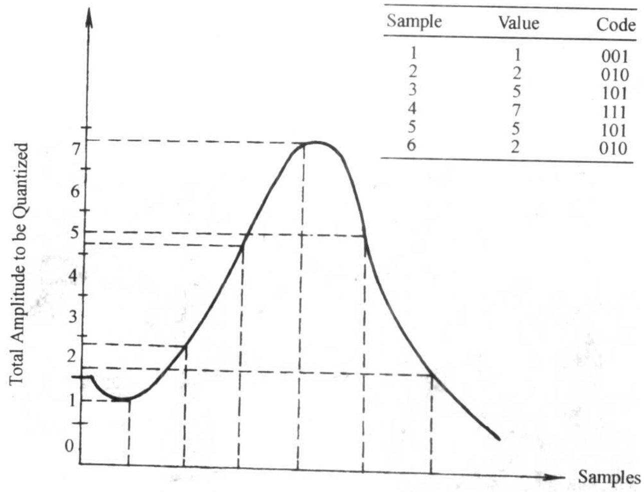

Figure 1.2 Pulse Code Modulation (PCM) Sampling, Quantizing, and Encoding Process: In This Example, a 3-Bit Encoding Scheme Is Used for Quantizing the Total Amplitude

1.4 Switching Technology

The PSTN we will talk about in detail in chapter 3 has a star configuration. Local loops (usually one per subscriber) terminate in a CO. This CO completes connections from one local loop to another local loop, or from one local loop to a trunk that terminates on some other CO. This CO has gone through a number of fundamental technological changes (see *Table 1.1*).

Switching System	Operation	Method of Switching	Type of Control	Type of Network
1878 manual operator	manual	space/analog	human	plug/cord/jack
1892 step-by-step	electromechanical	space/analog	distributed stage-by-stage	stepping switch train
1918 cross-bar	electromechanical	space/analog	common control	X-bar switch
1960 ESS-first generation	semielectronic	space/analog	common control	reed switch
1972 ESS-second generation	semielectronic	space/analog	stored program control	reed switch
1976 ESS-third generation	electronic	time/digital	stored program common control	pulse code modulation

Table 1.1 Types of End-Office Switching and Their Evolution

The manual system required, of course, constant attention from operators (see *Figure 1.3*). In the late 1800s, telephone calls were connected manually at the CO. When a call came in, an attendant would plug into a horizontal bar line. He then would yell to the operator who handled the customer being called, and that second operator would connect to the bar and finish setting up the call. When the call was completed, another operator would yell to all in the room that the line was clear again. The step-by-step system, which is still in operation in many parts of the country, utilized what is known as the Strowger switch. The intelligence in the system was located in relays mounted on each switch. The switch itself responded to the dial pulses of the rotary dial.

Figure 1.3 A Depiction of an Early CO

The crossbar system was still electromechanical in nature, but the intelligence of the system was separated from the actual switch. Thus, this common control could be used repeatedly to set up and tear down calls and never sit idle.

When electronics came along, the electromechanical control of the common control system was replaced with electronics, and the network, or matrix, was usually replaced with tiny glass-encapsulated reed switches. Hence, only a part of the switch was electronic. In the next generation, the stored program operation of a digital computer was applied to the switch, although the network remained a complex of reed switches. In the final generation, called a digital switch, the talking path was no longer an electrically continuous circuit; rather the speech being carried was digitized into a stream of "1s" and "0s". Notice that this final generation depicted a significant change from the previous generations in that there was no longer an electrical talking path through the switch. We were, in fact, operating in a digital (rather than analog) domain.

However, whether the system was analog or digital, one thing must be recognized: there was an actual talking path—a circuit—from the calling party to the called party. This talking path was established at the beginning of a call and held for the duration of a call. We call it circuit switching. This system is not actually efficient. When I am talking, you are listening, and the circuit is being used in only one direction—that is, 50 percent. When you are talking and I am listening, it is still 50 percent. When neither of us is talking, or when there is silence between words, the efficiency is 0 percent.

There is, however, a different kind of connection, and we see it today in a number of applications:

- credit-card verification
- automated teller machine
- SS7
- Internet and the World Wide Web

This system is called packet switching (as opposed to circuit switching). In a packet-switching system, the information being transmitted (be it data or digitized voice) is not sent in real time over a dedicated circuit; rather it is stored in a nearby computer until a sufficiently sized packet is on hand. Then a very smart computer seizes a channel heading in the general direction of the destination, and that packet of data is transmitted at very high speeds. Then the channel is released. So, except for some necessary supervisory information (destination, error checking codes, etc.) the channel is 100 percent efficient. When the distant station gets that message no more than a few milliseconds later, it responds with the necessary handshaking information—again, by accumulating a packet of data, seizing a channel, and bursting the information out over that channel. Again, 100 percent efficient.

As mentioned earlier, the packet networks in the world (actually overlay networks to the PSTN) are being used extensively for data; only recently are we seeing them being used for voice. As systems are perfected, this also will change.

Notes

① Thus, by 1885 Vail had established a vertically integrated supply division, a network of companies licensed by the parent, and a strong research and development arm.

译文：因此，到 1885 年，Vail 已经建立了一个垂直化的综合性供应公司，这是一个由母公司授权成立的公司网络，它具有强大的研发力量。

② However, the great asset of AT&T, which became the official name of the company at the end of 1899, was the control of all the long-distance circuits and its steadfast refusal to interconnect any other company to it.

译文：然而，AT&T 最庞大的资产在于它对所有长途线路的控制，同时，它还坚定拒绝与别的公司进行互连。在 1899 年底，AT&T 成为该公司的正式名称。

③ He recognized that the best demonstration of AT&T not being in a monopoly position was to point to thousands of independents apparently operating in harmony.

译文：他（指 AT&T 的副总裁 Nathan C. Kingsbury）认识到对 AT&T 没有处于垄断地位的最佳证据是指出成千上万的独立公司在协同运作。

④ A communication system is that designed to transmit information.

译文：设计通信系统的目的是为了传递信息。

⑤ modem，调制解调器，相当于调制器（modulator）和解调器（demodulator）。

⑥ In a T1 system, an analog voice channel is sampled 8 000 times per second, and each sample is encoded into a 7-bit byte. Twenty-four such channels are mixed on these two copper pairs