Part 3 Communication and Telecommunication Technology

Text 1 Signals and Systems

(Signals and Systems, 1983)

This textbook provides an introduction to the tools and mathematical techniques necessary for understanding and analyzing both continuous-time and discrete-time linear systems. We have attempted to give an insight into the application of these tools and techniques for solving practical engineering problems. Our philosophy has been to adopt a systems approach throughout the book for the introduction of continuous-time signal and system analysis, rather than use the framework of traditional circuit theory. We believe that the systems viewpoint provides a more natural approach to introducing this material in addition to broadening the horizons of the student. Furthermore, the topics of discrete time signal and system analysis are most naturally introduced from a systems viewpoint, which lends overall consistency to the development. We have, of course, relied heavily on the students' circuit theory background to provide illustrative examples.

The organization of the book is straightforward. The first six chapters deal with continuous-time linear systems in both the time domain and the frequency domain. The principal tool developed for time-domain analysis is the convolution integral. Frequency-domain techniques include the Fourier and the Laplace transforms. An introduction to state variable techniques is also included. The remainder of the book deals with discrete-time systems including z-transform analysis techniques, digital filter analysis and synthesis, and the discrete Fourier transform and fast Fourier transform (FFT) algorithms.

This organization allows the book to be covered in two three-semester-hour courses, with the first course being devoted to continuous-time signals and systems and the second course being devoted to discrete-time signals and systems. Alternatively, the material can be used as a basis for three quarter length courses. With this formats the first course would cover time and frequency-domain analysis of continuous-time systems. The second course would cover state variables, sampling, and an introduction to the z-transform and discrete-time systems. The third course would deal with the analysis and synthesis of digital filters and provide an introduction to the discrete Fourier transform and its applications.

The assumed background of the student is mathematics through differential equations and the usual introductory circuit theory course or courses. Knowledge of the basic concepts of matrix algebra would be helpful but is not essential. Appendix A is included to bring together the pertinent matrix relations that are used in Chapters 5 and 6. We feel that in most electrical engineering curricula the material presented in this book is best taught at the junior level.

We begin the book by introducing the basic concepts of signal and system models and system classifications. The idea of spectral representations of periodic signals is first introduced in Chapter 1 because we feel that it is important for the student to think in terms of both the time and the frequency domains from the outset.

The convolution integral and its use in fixed, linear system analysis by means of the principle of superposition are treated in Chapter 2. The evaluation of the convolution integral is treated in detailed examples to provide reinforcement of the concepts. Calculation of the impulse response and its relation to the step and ramp responses of a system are discussed. Chapter 2 also contains optional sections and examples regarding writing the governing equations for lumped, fixed, linear systems and the solution of linear, constant coefficient differential equations. These are intended as review and may be omitted without loss of continuity.

The Fourier series and Fourier transform are introduced in Chapter 3. We have emphasized the elementary approach of approximating a periodic function by means of a trigonometric series and obtaining the expansion coefficients by using the orthogonality of sines and cosines. We do this because this is the first time most of our students have been introduced to Fourier series. The alternative generalized orthogonal function approach is included as a nonrequired reading section at the end of this chapter for those who prefer it. The concept of the transfer function in terms of sinusoidal steady-state response of a system is discussed in relation to signal distortion. The Fourier transform is introduced next, with its applications to spectral analysis and systems analysis in the frequency domain. The concept of an ideal filter, as motivated by the idea of distortion-less transmission, is also introduced at this point. The Gibbs Phenomenon, window functions, and convergence properties of the Fourier coefficients are treated in optional closing sections.

The Laplace transform and its properties are introduced in Chapter 4. Again, we have tried to keep the treatment as simple as possible because this is assumed to be a first exposure to the material for a majority of students, although a summary of complex variable theory is provided in Appendix B so that additional rigor may be used at the instructor’s option. The derivation of Laplace transforms from elementary pairs is illustrated by example, as is the technique of inverse Laplace transform using partial fraction expansion. Optional sections on the evaluation of inverse Laplace transforms by means of the complex inversion integral and an introduction to the two-sided Laplace transform are also provided.

The application of the Laplace transform to network analysis is treated in detail in Chapter 5. The technique of writing Laplace transformed network equations by inspection is covered and used to review the ideas of impedance and admittance matrices, which the student will have learned in earlier circuit courses for resistive networks. The transfer function is treated in detail, and the Routh test for determining stability is presented. The chapter closes with a treatment of Bode plots and block diagram algebra for fixed, linear systems.

In Chapter 6, the concepts of a state variable and the formulation of the state variable approach to system analysis are developed. The state equations are solved using both time-domain and Laplace transform techniques, and the important properties of the solution are examined. Finally, as an example, we show how the state-variable method can be applied to the analysis of circuits.

The final three chapters provide coverage of the topics of discrete-time signal and system analysis.

A complete solutions manual, which contains solutions to all problems, is available from the publisher as an aid to the instructor. Answers to selected problems are provided in Appendix E as an aid to the student.

The authors wish to express their thanks to the many people who have contributed, both knowingly and unknowingly, to the development of this textbook. First, thanks go to our long-suffering students, who have been forced to study from our notes, often while they were still in various stages of development. Their many comments and criticisms have been invaluable and are gratefully appreciated. Many of our colleagues in the Electrical Engineering Department at the University of Missouri-Rolla taught courses that used the book in note form and provided many suggestions for improvement. In this regard, we thank Professors Gordon E. Carlson, Kenneth H. Carpenter, and some others. Professor Carlson critically reviewed much of the manuscript and provided valuable suggestions for improvement. Additionally, we would like to thank the reviewers at other institutions who provided valuable criticism. However, any shortcomings of the final result are solely the responsibility of the authors. A most sincere thanks goes to our secretaries whose great care and expert typing skills allowed us to generate the final manuscript with a minimum of headaches. The National Engineering Consortium is also due thanks since it was through their series of seminars that much of the material in Chapters 7 and 8 was originally taught.

Last, but not least, we thank our wives and families for putting up with a project whose end at times seemed nonexistent.

New Words and Expressions

algorithm *n.* 算法
coefficient *n.* 系数
convergence *n.* 收敛，集中
convolution *n.* 卷积
derivation *n.* 推导
evaluation *n.* 求值，评估
impedance *n.* 阻抗
invariance *n.* 不变性

lumped *adj.* 集总的
matrix *n.* 矩阵
motivate *v.* 激发，促动
orthogonal *adj.* [数学]直角的，矩形的，直交的
pertinent *adj.* 恰当的
prototype *n.* 原型，样机
reinforcement *n.* 加强
synthesis *n.* 综合，合成

Exercises to the Text

1．Translate the following words and phrases into English.

（1）复变量 （2）围线积分 （3）差分方程 （4）傅里叶级数 （5）冲击响应 （6）拉普拉斯逆变换 （7）斜坡响应 （8）频谱表示 （9）阶跃响应 （10）时域 （11）伯德图

2．Translate the following paragraphs into Chinese.

(1) We begin the book by introducing the basic concepts of signal and system models and system classifications. The idea of spectral representations of periodic signals is first introduced in Chapter 1 because we feel that it is important for the student to think in terms of both the time and the frequency domains from the outset.

(2) The Laplace transform and its properties are introduced in Chapter 4. Again, we have tried to keep the treatment as simple as possible because this is assumed to be a first exposure to the material for a majority of students, although a summary of complex variable theory is provided in Appendix B so that additional rigor may be used at the instructor's option. The derivation of Laplace transforms from elementary pairs is illustrated by example, as is the technique of inverse Laplace transform using partial fraction expansion. Optional sections on the evaluation of inverse Laplace transforms by means of the complex inversion integral and an introduction to the two-sided Laplace transform are also provided.

(3) In Chapter 6, the concepts of a state variable and the formulation of the state variable approach to system analysis are developed. The state equations are solved using both time-domain and Laplace transform techniques, and the important properties of the solution are examined. Finally, as an example, we show how the state-variable method can be applied to the analysis of circuits.

Text 2 Data Communication

（通信专业英语，2007）

The need to communicate is part of man's inherent being. Since the beginning of time man has used different techniques and methods to communicate. Circumstances and available technology have dictated the method and means of communications. Data communications concerns itself with the transmission (sending and receiving) of information between two parties. Now let's learn the foundation knowledge of data communication.

1. Signals

1s and 0s can't be sent as such across network links. They must be further converted into a form that transmission media can accept. Transmission media works by conducting energy along a physical path. So, a data stream of 1s and 0s must be turned into energy in the form of electromagnetic signals.

2. Analog and Digital

Both data and the signals that represent them can take either analog or digital form. Analog refers to something that is continuous—a set of specific points of data and all possible points between. Digital refers to something that is discrete.

Information can be analog or digital. Analog information is continuous. Digital information is discrete.

Signals can be analog or digital. Analog signals can have any value in a range; digital signals can have only a limited number of values.

3. Characteristics of Communications Channels

The first is transmission rate. The transmission rate of a communication channel is determined by its bandwidth and its speed. The bandwidth is the range of frequencies that a channel can carry. Since transmitted data can be assigned to different frequencies, the wider the bandwidth, the more frequencies, and the more data can be transmitted at the same time.

The speed at which data is transmitted is usually expressed as bits per second or as a baud rate. Bits-per second (b/s) is the number of bits that can be transmitted in one second. The baud rate is the number of times per second that signal being transmitted changes. Usually only one bit is transmitted per signal change and, thus, the bits per second and the baud rate are the same.

The second is direction of transmission. The direction of data transmission is classified as simplex, half duplex, or full duplex. In simplex transmission, data flows in one direction only. Simplex is used only when the sending device, such as radio, never requires a response from the computer. In half-duplex transmission, data can flow in both directions but in only one direction at a time. Half-duplex is often used between terminals and a central computer. For example, interphone. In full-duplex transmission, data can be sent in both directions at the same time. A normal telephone line is an example of full-duplex transmission. Both parties can talk at the same time. Full-duplex transmission is used for most interactive computer applications and for computer-to-computer data transmission.

The third is transmission mode. The transmission mode includes asynchronous and synchron-ous. In asynchronous transmission mode, individual characters (made up of bits) are transmitted at irregular intervals, for example, when a user enters data. To distinguish where one character stops and another starts, the asynchronous communication mode used a start and a stop bit. An additional bit called a parity bit is sometimes included at the end of each character. Parity bits are used for error checking, asynchronous transmission mode is used for lower speed data transmission and is used with most communications equipment designed for personal computers.

4．Serial and Parallel Transmission

Data travels in two ways: in serial and in parallel, in serial data transmission, bits flow in a series or continuous stream, like cars crossing a one-lane bridge. Serial transmission is the way most data is sent over telephone lines. For this reason, external modems typically connect to a microcomputer through a serial port. More technical names for the serial port are RS-232C connector and asynchronous communications port.

With parallel data transmission, bits flow through separate lines simultaneously. In other words, they resemble cars moving together at same speed on a multilane freeway. Parallel transmission is typically limited to communications over short distances and typically is not used over telephone lines. It is, however, a standard method of sending data from the system unit to a printer.

New Words and Expressions

technique *n.* 方法，技术
electromagnetic *adj.* 电磁的
analog *n.* 模拟 *adj.* [计算机]模拟的
continuous *adj.* 继续的，连续的，持续的，延伸的
discrete *adj.* 离散的，分立的，不连续的
characteristic *adj.* 表示特性的，典型的，特有的
frequency *n.* 屡次，频繁，频率
baud *n.* 波特
duplex *adj.* [电信、计算机]双工的，双向的
simplex *n.* 单工
interphone *n.* 对讲机
asynchronous *adj.* 不同时的，异步的
synchronous *adj.* 同时发生的，同步的
parity *n.* 同等，平等，[计算机]奇偶校验
serial *adj.* 连续的
parallel *adj.* 平行的，并行的
resemble *v.* 看起来像
simultaneously *adv.* 同时地

Exercises to the Text

1．Translate the following words and phases into English

（1）信号 （2）波特率 （3）单工 （4）同步 （5）信道 （6）模拟 （7）数字 （8）电磁的 （9）串行口 （10）带宽

2．Translate the following words and phrases into Chinese.

(1) baud (2) asynchronous (3) full duplex (4) parallel (5) electromagnetic (6) discrete

(7) simultaneously

3. Translate the following paragraph into Chinese.

Third is transmission mode. The transmission mode includes asynchronous and synchronous. In asynchronous transmission mode, individual characters (made up of bits) are transmitted at irregular intervals, for example, when a user enters data. To distinguish where one character stops and another starts, the asynchronous communication mode used a start and a stop bit. An additional bit called a parity bit is sometimes included at the end of each character. Parity bits are used for error checking, asynchronous transmission mode is used for lower speed data transmission and is used with most communications equipment designed for personal computers.

Text 3 Data Transmission Media

（通信专业英语，2007）

To go from here to there, data must move through something. A telephone line, cable, or the atmosphere can be called transmission medium or channel. But before the data can be communicated, it must be converted into a form suitable for communication. The three basic forms into which data can be converted for communication are:

(1) Electrical pulses or charges (used to transmit voice and data over telephone lines);

(2) Electromagnetic waves (similar to radio waves);

(3) Pulses of light.

The form or method of communications affects the maximum rate at which data can be moved through the channel and the level of noise that will exist—for example, light pulses travel faster than electromagnetic waves, and some types of satellite transmission systems are less noisy than transmission over telephone wires, Obviously, some situations require that data be moved as fast as possible; others don't. Channels that move data relatively slowly, like telegraph lines, are narrow-band channels. Most telephone lines are voice band channels, and they have a wider bandwidth than narrow band channels. Broadband channels (like coaxial cable, fiber optic cable, microwave circuits, and satellite systems) transmit large volumes of data at high speeds.

The transmission media used to support data transmission are telephone lines, coaxial cables, microwave systems, satellites systems, and fiber optic cables. Understanding how these media function will help you sort out the various rates and charges for them and determine which is the most appropriate in a given situation.

1. Telephone Lines

The earliest type of telephone line was referred to as open wire-unsheathed copper wires strung on telephone poles and secured by glass insulators. Because it was uninsulated, this type of telephone line was highly susceptible to electromagnetic interference; the wires had to be spaced about 12 inches apart to minimize the problem. Although open wire can still be found in a few places, it has almost entirely been replaced with cable and other types of communications media. Cable is insulated wire. Insulated pairs of wires twisted around each other—called twisted-pair wire or cable—can be packed into bundles of a thousand or more pairs. These wide-diameter cables are commonly used as telephone lines today and are often found in large buildings and under city streets. Even though this type of line is a major improvement over open wire, it still has many limitations. Twisted-pair cable is susceptible to a variety of types of electrical interference (noise), which limits the practical distance that data can be transmitted without being garbled (to be received intact, digital signals must be “refreshed” every one to two miles through the use of an amplifier and related circuits, which together are called repeaters. Although repeaters do increase the signal strength, which tends to weaken over long distances, they can be very expensive). Twisted-pair cable has been used for years for voice and data transmission; however, more advanced media are replacing it.

2. Coaxial Cable

More expensive than twisted-pair wire, coaxial cable (also called shielded cable) is a type of thickly insulated copper wire that can carry a larger volume of data—about 100 million bits per second, or about 1800 to 3600 voice calls at once. The insulation is composed of a nonconductive material covered by a layer of woven wire mesh and heavy-duty rubber or plastic. Coaxial cable, which is laid underground and underwater, is similar to the cable used to connect your TV set to a cable TV services. Coaxial cables can also be bundled together into a much larger cable; this type of communications line has become very popular because of its capacity and reduced need for signals to be “refreshed”, or strengthened, every two to four miles. Coaxial cables are most often used as the primary communications medium for locally connected networks in which all computer communication is within a limited geographic area, such as in the same building. Coaxial cable is also used for undersea telephone lines.

3. Microwave Systems

Instead of using wire or cable, microwave systems can use the atmosphere as the medium through which to transmit signals. These systems are extensively used for high-volume as well as long-distance communication of both data and voice in the form of electromagnetic waves similar to radio waves but in a higher frequency range. Microwave signals are often referred to as “line of sight” signals because they cannot bend around the curvature of the earth; instead, they must be relayed from point to point by microwave towers, or relay stations, placed 20 to 30 miles apart. The distance between the towers depends on the curvature of the surface terrain in the vicinity. The surface of the earth typically curves about 8 inches every mile. The towers have either a dish or a horn-shaped antenna. The size of the antenna varies according to the distance signals must cover. A long-distance antenna could easily be 10 feet or larger in size; a dish of 2 to 4 feet in diameter, which you often see on city buildings, is large enough for small distances. Each tower facility receives incoming traffic, boots the signal strength, and sends the signal to the next station.

The primary advantage of using microwave systems for voice and data communication is that direct cabling is not required (obviously, telephone lines and coaxial cable must physically connect all points in a communication system). More than one half of the telephone systems now use microwave transmission. However, the saturation of the airwaves with microwave transmissions has reached the point where future needs will have to be satisfied by other communications methods, such as fiber optic cables or satellite systems.

4. Satellite Systems

Satellite communications systems transmit signals in the gigahertz range—billions of cycles per second. The satellite usually must be placed in a geosynchronous orbit, 22,330 miles above the earth's surface, so it revolves once a day with the earth. To an observer, it appears to be fixed over one place at all times. A satellite is a solar-powered electronic device that has up to 100 transponders (a transponder is a small, specialized radio) that receive, and retransmit signal; the satellite acts as a relay station between satellite transmission stations on the ground (called earth station).

Although establishing satellite systems is costly (owing to the cost of a satellite and the problems associated with getting it into orbit above the earth's surface and compensating for failures), satellite communications systems have become the most popular and cost-effective method for moving large quantities of data over long distances. The primary advantage of satellite communications is the amount of area that can be covered by a single satellite. Three satellites placed in particular orbits can cover the entire surface of the earth, with some overlap.

However, satellite transmission does have some problems:

(1) The signals can weaken over the long distances, and weather conditions and solar activity can cause noise interference.

(2) A satellite is useful for only 7 to 10 years, after which it loses its orbit.

(3) Anyone can listen in on satellite signals, so sensitive data must be sent in a secret or encrypted form.

(4) Depending on the satellite's transmission frequency, microwave stations on earth can "jam", or prevent transmission by operating at the same frequency.

Of course there is a very important data transmission media—fiber optics, we will learn in more detail next.

New Words and Expressions

coaxial *adj.* 同轴的，共轴的
unsheathed *adj.* 未覆盖的
insulator *n.* 绝缘体，绝热器
interference *n.* 冲突，干涉
susceptible *adj.* 易受影响的，易感动的；容许……的
intact *adj.* 完整无缺的
conductive *adj.* 传导的
curvature *n.* 弯曲，曲率
vicinity *n.* 邻近，附近，接近
antenna *n.* 天线

saturation　*n.* 饱和（状态），浸润，浸透
gigahertz　*n.* 千兆赫
geosynchronous　*adj.* 与地球的相对位置不变的，相对地球是静止的
transponders　*n.* 异频雷达收发机
encrypt　*v.* 加密，将……译成密码

Exercises to the Text

1．Translate the following words and phrases into English.

（1）声波信道　（2）双绞线　（3）微波塔　（4）电脉冲和电荷　（5）同步轨道

2．Translate the following words and phrases into Chinese.

(1) pulses of light　(2) coaxial cable　(3) electromagnetic interference　(4) twisted-pair cable　(5) the saturation of the airwaves

3．Translate the following paragraphs into Chinese.

(1) Obviously, some situations require that data be moved as fast as possible; others don't. Channels that move data relatively slowly, like telegraph lines, are narrow-band channels. Most telephone lines are voice band channels, and they have a wider bandwidth than narrow band channels. Broadband channels (like coaxial cable, fiber optic cable, microwave circuits, and satellite systems) transmit large volumes of data at high speeds.

(2) More than one half of the telephone systems now use microwave transmission. However, the saturation of the airwaves with microwave transmissions has reached the point where future needs will have to be satisfied by other communications methods, such as fiber optic cables or satellite systems.

Text 4　Switching Technologies

（通信专业英语，2007）

Whether they provide connection between one computer and another or between terminals and computers, communication networks can be divided into two basic types: circuit-switched (sometimes called connection oriented) and packet-switched (a variation of message switching is packet switching, sometimes called connectionless). Circuit-switched networks operate by forming a dedicated connection (circuit) between two points. The U.S. telephone system uses circuit switching technology, a telephone call establishes a circuit from the originating phone through the local switching office, across trunk lines, to a remote switching office, and finally to the destination telephone. While a circuit is in place, the phone equipment samples the microphone repeatedly, encodes the samples digitally, and transmits them across the circuit to the receiver. The sender is guaranteed that the samples can be delivered and reproduced because the circuit provides a guaranteed data path of 64 kb/s (thousand bits per second), the rate needed to send digitized voice. The advantage of circuit switching lies in its guaranteed capacity: once a circuit is established, no other network activity will decrease the capacity of the circuit. One disadvantage of circuit switching is cost: circuit costs are fixed, independent of traffic. For example, one pays a fixed rate for a phone call, even when the two parties do not have a talk.

In message switching, the transmission unit is a well-defined block of data called a message. In addition to the text to be transmitted, a message comprises a header and a checksum. The header contains information regarding the source and destination addresses as well as other control information; the checksum is used for error control purpose. The switching element is a computer referred to as a message processor, with processing and storage capabilities. Messages travel independently and asynchronously, finding their own way from source to destination. First the message is transmitted from the host to the message processor to which it is attached. Once the message is entirely received, the message processor to which it is attached. Once the message is entirely received, the message processor examines its header, and accordingly decides on the next outgoing channel on which to transmit it. If this selected channel is busy, the message waits in queue until the channel becomes free, at which time transmission begins. At the next message processor, the message is again received, stored, examined, and transmitted on some outgoing channel and the same process continues until the message is delivered to its destination. This transmission technique is also referred to as the store-and-forward transmission technique.

A variation of message switching is packet switching. Here the message is broken up into several pieces of a given maximum length, called packets. As with message switching, each packet contains a header and a checksum. Packets are transmitted independently in a store-and-forward manner.

Packet-switched networks, the type usually used to connect computers, take an entirely different approach. In a packet-switched network, data to be transferred across a network is divided into small pieces called packets that multiplexed onto high capacity inter-machine connections. A packet, which usually contains only a few hundred bytes of data, carries identification that enables the network hardware to know how to send it to the specified destination. For example, a large file to be transmitted between two machines must be broken into many packets that are sent across the network one at a time, the network hardware delivers the packets to the specified destination, where software reassembles them into a single file again. The chief advantage of packet-switching is that multiple communications among computers can proceed concurrently, with inter-machine connections shared by all pairs of machines that are communicating.

With circuit switching, there is always an initial connection cost incurred in setting up the circuit, it is cost-effective only in those situations where once the circuit is set up there is a guaranteed steady flow of information transfer to amortize the initial cost. This is certainly the case with voice communication in the traditional way, and indeed circuit switching is the technique used in the telephone system. Communication among computers, however, is characterized as bursty. Burstiness is a result of high degree of randomness encountered in the message-generation process and message size, and of the low delay constraint required by the user. The users and devices require the communicate resources relatively infrequently; but when they do, they require a relatively rapid response. If a fixed dedicated end-to-end circuit were to be set up connecting the end users, then one must assign enough transmission bandwidth to the circuit in order to meet the delay constraint with the consequence that the resulting channel utilization is low. If the circuit of high bandwidth were set up and released at each message transmission request, then the set-up time would be large compared to the transmission time of the message, resulting again in low channel utilization. Therefore, for bursty users (which can also be characterized by high peak-to-average data rate requirements), store-and-forward transmission techniques offer a more cost-effective solution, since a message occupies a particular communications link only for the duration of its transmission on that link; the rest of the time it is stored at some intermediate message switch mid the link is available for other transmissions. Thus the main advantage of store-and-forward transmission over circuit switching is that the communication bandwidth is dynamically allocated, and the allocation is done on the fine basis of a particular link in the network and a particular message (for a particular source - destination pair).

Packet switching achieves the benefits discussed so far and offers added disadvantage. The disadvantage, of course, is that as activity increases, a given pair of communicating computers receives less of the network capacity. That is, whenever a packet switched network becomes overloaded, computers using the network must wait before they can send additional packets.

Despite the potential drawback of not being able to guarantee network capacity, packet-switched networks have become extremely popular. The motivations for adopting packet switching are cost and performance. Because multiple machines can share the network hardware, fewer connections are required and cost is kept now. Because engineers have been able to build high speed network hardware, capacity is not usually a problem. So many computer interconnections use packet-switching that, throughout the remainder of this text, the term network will refer only to packets-switched networks.

New Words and Expressions

dedicated *adj.* 专用的
destination *n.* 目的地，终点
microphone *n.* 麦克风，话筒，扩音器（也作 mike）
guaranteed *n.* 有保证的，被担保的
decrease *v.* 减少，变少，降低
comprise *v.* 包括，包含，构成
checksum *n.* 检验（校验）和，核对和
outgoing *adj.* 往外去的，即将离任的，好交往的
maximum *n.& adj.* 最大量（的），最大值（的）
multiplex *adj.* 复合的，多重的
identification *n.* 认明，识别，鉴定
concurrent *adj.* 同时发生的，同时存在的

incurred *v.* 招致，遭受
amortize *v.* 摊销，摊还，分期偿付
burst *v.* 爆炸，胀裂
constraint *n.* 约束，限制
randomness *n.* 随意，无安排
relatively *adv.* 相对地，比较地
utilization *n.* 利用
intermediate *adj.* 中间的，居中的
whenever *adv.* 随便什么时候
motivation *n.* 动机
remainder *n.* 剩余物，其余（的人）

Exercises to the Text

1. Translate the following words and phrases into English.

（1）交换技术 （2）存储转发技术 （3）数据块 （4）分组交换 （5）电路交换 （6）带宽 （7）多路通信 （8）面向连接

2. Translate the following paragraph into Chinese.

Packet-switched networks, the type usually used to connect computers, take an entirely different approach. In a packet-switched network, data to be transferred across a network is divided into small pieces called packets that multiplexed onto high capacity intermachine connections. A packet, which usually contains only a few hundred bytes of data, carries identification that enables the network hardware to know how to send it to the specified destination. For example, a large file to be transmitted between two machines must be broken into many packets that are sent across the network one at a time, the network hardware delivers the packets to the specified destination, where software reassembles them into a single file again. The chief advantage of packet-switching is that multiple communications among computers can proceed concurrently, with inter-machine connections shared by all pairs of machines that are communicating.

Text 5 ATM

（通信专业英语，2007）

ATM (asynchronous transfer mode) is based on the efforts of the ITU-T broadband integrated services digital network (B-ISDN) standard. It was originally conceived as a high-speed transfer technology for voice, video and data over public networks.

ATM is a cell-switching and multiplexing technology that combines the benefits of circuit switching (guaranteed capacity and constant transmission delay) with those of packet switching (flexibility and efficiency for intermittent traffic). It provides scalable bandwidth from a few megabits per second (Mbps) to many gigabits per second (Gbps). Because of its asynchronous nature, ATM is more efficient than synchronous technologies, such as time-division multiplexing (TDM).

ATM is both a multiplexing and switching technique. It was initially intended to handle high bit rates, but it has in fact proved to be a universal technique for transporting and switching any type of digitized information at a wide variety of bit rates.

ATM transfers information in short packets called “cells” with a fixed length of 48 bytes plus five header bytes, irrespective of the underlying type of transmission. Cell routing is based on the principle of logical channels with dual identification: the cell header contains the identifier of the basic connection to which the cell belongs—called a virtual circuit (VC) and the identifier of the group of VCs to which the connection belongs—called a virtual path (VP).

ATM is related to both circuit and packet modes. Because of the simplicity of the protocol used, the transfer of cells to the network nodes can be handled entirely by hardware, which leads to very short transit time and high usage of transmission paths, even at bit rates of several hundred megabits a second. On the other hand, ATM retains all the flexibility of the packet mode, enabling only required information to be conveyed, offering a simple, unique multiplexing method irrespective of the bit rates of the different information flows, and allowing these bit rates to be varied.

An ATM network can be considered, in a first approximation, as being three overlaid functional levels: a services and applications level, an ATM network level and a transmission level. The applications provide an end-to-end service. They use the logical connections of ATM network level which in turn multiplexes and logically mutes the information flow as ATM cells go through the transmission links shared by logical connections called virtual connections. The transmission level provides these physical links and handles the actual physical transport of the cells.

An ATM network can transport and switch voice, data and video which, seen from the access, use traditional digital interfaces with the same quality of service. This means that a physical connection between any two terminals can be replaced with an equivalent logical connection which is multiplexed with others in a common transmission link. The resource is shared dynamically among all the connections.

Compared with the synchronous time division multiplexing techniques which rigidly link service to resource, the asynchronous technique has the advantage of occupying the transmission link only in proportion to the exact requirement.

The ATM technique completely separates the applications and services transported over a network from the transmission resources used. The ability to construct virtual networks means that the physical network can be shared by many users dynamically and in real time, thereby achieving cost-effective use of infrastructure, for high bit rate services too. Investments at all levels are also future-proofed, because the different applications can be reallocated in time over the same network infrastructure as requirements arise. ATM offers a unique way of coordinating different networks carrying different services into a single physical network.

As digitization and image encoding progress, interactive video services, and more generally multimedia services, are starting to emerge. Their impact on the network will be considerable. Today, ATM is the only transfer technique to offer the high bit rates and flexibility required by these services.

ATM, much more than any other telecommunications technique, is able to meet the current and the future requirements of both operators and users. Compared with other techniques that may compete in certain applications, ATM is special mainly due to its universal nature, both in terms of bit rate and type of information transferred. ATM offers a switching function for all bit rates and this is particularly suitable for high and variable bit rates.

ATM's specific features will make it the preeminent nature vehicle for multimedia services, and especially for varying bit rate video, and will make it one of the essential components of future information superhighways offering new services such as video on demand. In the short term, ATM is also proving of great interests to the operators, because of the flexibility and virtuality that it can introduce into networks, by separating the concept of connection from that of physical resources. This simplifies network management functions and makes optimum use of resources, particularly through statistical multiplexing and the creation of virtual private networks.

Of course, there is still a long way to go before the ATM techniques is in general use, but a revolution is underway which will deeply affect the world of telecommunications, data processing and video. The impact of this upheaval will without any doubt be greater than the advent of digital techniques in analogue networks.

In conclusion, ATM, much more than any other telecommunications technique, is able to meet the current and the future requirements of both operators and users.

New Words and Expressions

intermittent *adj.* 间歇的，断断续续的

scalable *adj.* 可攀登的，可升级的

megabit *n.* 兆位，百万位

gigabit *n.* 吉（咖）比特

irrespective *adj.*（与 of 连用）不顾……的，不考虑……的，不论……的

identifier *n.* 标志（标识，识别）符

simplicity *n.* 简单，简易，朴素，朴实，单纯

convey *v.* 运送，运输

approximation *n.* 近似，近似值

equivalent *adj.* （常与 to 连用）相同的，同等的

proportion *n.* 比例，比率

thereby *adv.* 因此，从而，由此

infrastructure *n.* 基本设施

considerable *adj.* 相当大的，相当多的

telecommunication *n.* 电信，远程通信
variable *adj.* 易变的，不稳定的
preeminent *adj.* 卓越的，杰出的，出类拔萃的
essential *adj.* 必需的，基本的
optimum *adj.* 最好的，最佳的，最有利的
underway *adj.* 起步的，进行中的，航行中的
upheaval *n.* 动乱，剧变

Exercises to the Text

1. Translate the following words and phrases into English.

（1）传输延迟 （2）统计多路复用 （3）虚拟专用网络 （4）交互视频业务 （5）同步时分复用技术

2. Please give a brief definition of the following terms.

(1) ATM (2) B-ISDN (3) Gb/s (4) VC (5) VP (6) TDM

3. Decide whether each of the following statements is true or false according to the text.

(1) ATM is based on the efforts of the ITU-T broadband integrated services digital network (B-ISDN) standard.

(2) ATM is both a multiplexing and switching technique.

(3) ATM transfers information in short packets called “cells” with a fixed length of 48 bytes plus five header bytes, irrespective of the underlying type of transmission.

(4) Neither circuit nor packet mode is ATM related to.

(5) An ATM network can be considered, in a first approximation, as being three overlaid functional levels: a services and applications level, an ATM network level and a transmission level.

Text 6 Fiber Optics

（通信专业英语，2007）

Although satellite systems are expected to be the dominant communication medium for long distances during this decade, fiber optics technology is expected to revolutionize the communications industry because of its low cost, high transmission volume, low arrogate, and message security. Fiber optic cables are replacing copper wire as the major communication medium in buildings and cities; major communications companies are currently investing huge sums of money in fiber optics communications networks that can carry digital signals, thus increasing communications and capacity.

In fiber optics communications, signals are converted to light form and fired by laser in bursts through insulated, very thin (1/2000 of an inch) glass or plastic fibers. The pulses of light represent the “on” state in electronic data representation and can occur nearly 1 billion times per second—nearly 1 billion bits can be communicated through a fiber optic cable per second.

Equally important, fiber optic cables aren't cumbersome in size: A fiber optic cable (insulated fibers bound together) that is only 1/2-inch thick is capable of supporting nearly 250,000 voice conversation at the same time (soon to be doubled to 500,000). However, since the data is communicated in the form of pulses of light, specialized communications equipment must be used.

Fiber optic cables are not susceptible to electronic noise and so have much lower error rates than normal telephone wire and cable. In addition, their potential speed for data communications is up to 10,000 times faster than that of microwave and satellite systems. Fiber optics communications are also very resistant to illegal data theft, because taps into it to listen to or change the data being transmitted can be easily detected. In fact, it is currently being used by the U. S. Central Intelligence Agency.

Fiber looks like a common glass cylinder consisting of core and cladding regions. Nowadays, there are three types of fiber optic cable commonly used: single mode, multimode and plastic optical fiber (POF).

Single mode cable is made up of one or a number of quartz fibers with a diameter of 8.3 μm to l0 μm that has one mode of transmission. Single mode fiber with a relatively narrow diameter, will propagate typically 1310 nm or 1550 nm. It carries higher bandwidth than multimode fiber, but requires a light source with a narrow spectral width.

Single mode fiber, as is shown in Figure 3-1, gives you a higher transmission rate and up to 50 times more distance than multimode, but it also costs more. Single mode fiber has a much smaller core than multimode. The small core and single light-wave virtually eliminate any distortion that could result from overlapping light pulses, providing the least signal attenuation and the highest transmission speeds of any fiber cable type.

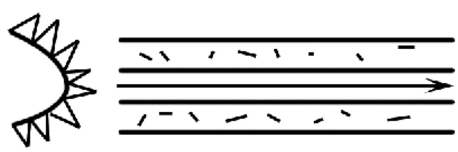

Figure 3-1 Single mode fiber

By contrast, multimode fiber has a core diameter that is much larger than the wavelength of light transmitted. (The most common size is 62.5 μm). Light waves are dispersed into numerous paths, or modes, as they travel through the cable's core typically 850 nm or 1300 nm. However, in long cable runs (greater than 3000 m), multiple paths of light can cause signal distortion at the receiving end, resulting in an unclear and incomplete data transmission.

Multimode fiber can be divided into two types: step index multimode fiber and graded index multimode fiber. Step index multimode was the first fiber design but is too slow for most uses, due to the dispersion caused by the different path lengths of the various modes. Step index fiber is rare-only POF uses a step index design today. Graded index multimode fiber, as the name implies, the refractive index of this fiber gradually decreases from the core out through the cladding to compensate for the different path lengths of the modes. It offers hundreds of times more bandwidth than step index fiber—up to about 2 gigahertz.

POF is a newer plastic-based cable which promises performance similar to glass cable on very short runs, but at a lower cost.

New Words and Expressions

dominant *adj.* 最重要的；有统治权的
revolutionize *v.* 使革命化
arrogate *v.* 非法霸占
volume *n.* 卷，册，（与 of 连用）体积，容量
inch *n.* 寸，英寸
susceptible *adj.* （与 to 连用）易受影响的
cylinder *n.* 圆柱体
cladding *n.* 包层，镀层
multimode *n.* [计算机]多模态（光纤的一种传输方式）
quartz *n.* 石英
propagate *v.* 繁殖，增殖
spectral *adj.* 光谱的
eliminate *v.* 除去
attenuation *n.* 变薄，稀薄化，变细，衰减
distortion *n.* 扭曲，变形，曲解，失真
wavelength *n.* [无线电]波长
dispersed *adj.* 分散的，散开的，漫布的
refractive *adj.* 折射的

Exercises to the Text

1．Translate the following words and phrases into English.

（1）光纤 （2）光脉冲 （3）单模光纤 （4）多模光纤 （5）塑料光纤

2．Translate the following paragraphs into Chinese.

(1) Fiber optic cables are not susceptible to electronic noise and so have much lower error rates than normal telephone wire and cable. In addition, their potential speed for data communications is up to 10,000 times faster than that of microwave and satellite systems. Fiber optics communications are also very resistant to illegal data theft, because taps into it to listen to or change the data being transmitted can be easily detected. In fact, it is currently being used by the U. S. Central Intelligence Agency.

(2) By contrast, multimode fiber has a core diameter that is much larger than the wavelength of light transmitted. (The most common size is 62.5 μm). Light waves are dispersed into numerous paths, or modes, as they travel through the cable’s core typically 850 nm or

1 300 nm. However, in long cable runs (greater than 3 000 m), multiple paths of light can cause signal distortion at the receiving end, resulting in an unclear and incomplete data transmission.

(3) Multimode fiber can be divided into two types: step index multimode fiber and graded index multimode fiber. Step index multimode was the first fiber design but is too slow for most uses, due to the dispersion caused by the different path lengths of the various modes.

Text 7 Passive Optical Networks (PONs)

This article describes the advances made in broadband access network architectures employing passive optical networks (PONs). The potential of PONs to deliver high bandwidths to users in access networks and their advantages over current access technologies have been widely recognized. PONs has made strong progress in terms of standardization and deployment over the past years.

The access network, also known as the “first mile” network, connects the service provider central offices to businesses and residential subscribers. This network is also referred to in the literature as the subscriber access network, or the local loop. Residential subscribers demand first-mile access solutions that have high bandwidth, offer media-rich Internet services, and are comparable in price with existing networks. Similarly, corporate users demand broadband infrastructure through which they can connect their local-area networks to the Internet backbone.

1. Challenges in Access Networks

Much of the focus and emphasis over the years has been on developing high-capacity backbone networks. The access network is truly the bottleneck for providing broadband services such as video-on-demand, interactive games, and video conferencing to end users.

An alternative available for broadband access to end users is through cable television (CATV) networks. CATV networks provide Internet services by dedicating some radio frequency (RF) channels in coaxial cable for data. However, CATV networks are mainly built for delivering broadcast services, so they don’t fit well for distributing access bandwidth. At high load, the network’s performance is usually frustrating to end users.

Faster access-network technologies are clearly desired for next-generation broadband applications. The next wave of access networks promises to bring fiber closer to the home. The FTTx model—Fiber to the Home (FTTH), Fiber to the Curb (FTTC), Fiber to the Building (FTTB), etc.—offers the potential for unprecedented access bandwidth to end users. These technologies aim at providing fiber directly to the home, or very near the home, from where technologies such as VDSL can take over. FTTx solutions are mainly based on the PON. In this article, we shall review major developments in PON in recent years—EPON, APON, GPON and the WDM PON.

2. PON Architectures

A PON is a point-to-multipoint optical network. An optical line terminal (OLT) at the central office is connected to many optical network units (ONUs) at remote nodes through one or multiple 1: *N* optical splitters. The network between the OLT and the ONU is passive, meaning that it doesn't require any power supply. An example of a PON using a single optical splitter is shown in Figure 3-2. The presence of only passive elements in the network makes it relatively more fault tolerant, and decreases its operational and maintenance costs once the infrastructure has been laid down.

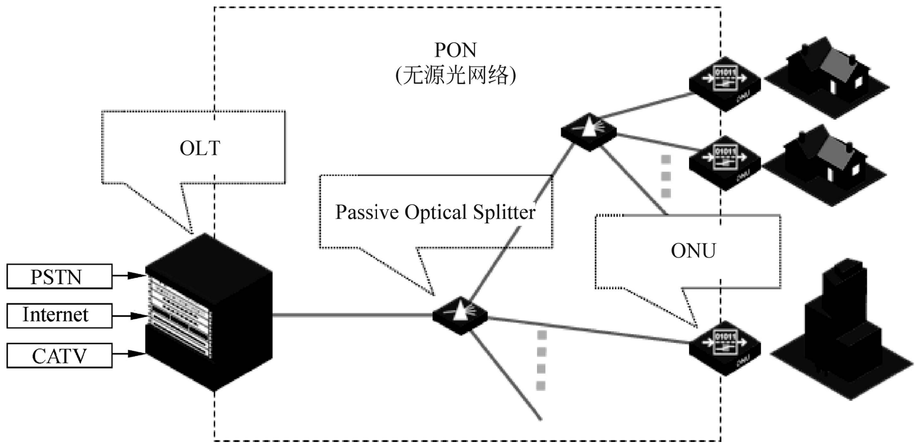

Figure 3-2　A PON connecting a central office to residential customers and business establishments

PONs have been considered for the access network for quite some time. A typical PON uses a single wavelength for all downstream transmissions (from OLT to ONUs), and another wavelength for all upstream transmissions (from ONUs to OLT), multiplexed on a single fiber through coarse wavelength-division multiplexing (CWDM).

3. Ethernet PON (EPON)

Ethernet PON is a PON-based network that carries data traffic encapsulated in Ethernet frames (defined in the IEEE 802.3 standard). It uses a standard 8b/10b line coding (in which 8 user bits are encoded as 10 line bits), and it operates at standard Ethernet data rates.

4. Why Ethernet is Gaining Prominence?

The first-generation PON standardized by ITU-T G.983 employed ATM as the medium-access control (MAC) layer protocol. When its standardization effort was started in 1995, the telecom community believed that ATM would be the prevalent technology in backbone networks. ATM had the advantages of streamlining voice and data services while providing operational and performance guarantees. However, since then, Ethernet has grown vastly popular. Ethernet line cards are cheap, and they are widely deployed in LANs. Since access networks are focused towards end users and LANs, ATM has turned out to be not the best choice to connect to Ethernet-based LANs.

In addition high-speed Gigabit Ethernet deployment is widely accelerating and 10 Gigabit Ethernet products are becoming available. Ethernet is a very efficient MAC protocol to use compared to ATM which imposes a considerable amount of overhead on variable-length Internet protocol (IP) packets. Quality-of-service (QoS) techniques have made Ethernet networks capable