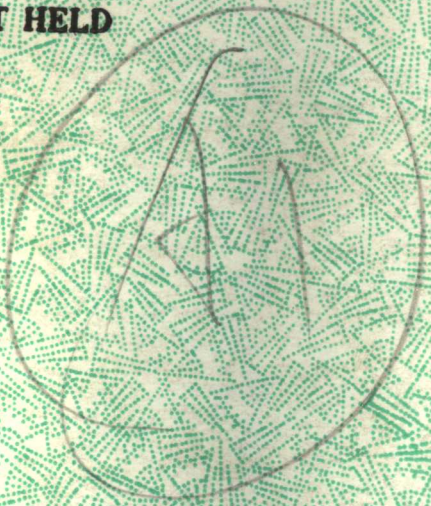
COMMUNICATING WITH THE IBM PC SERIES

Concepts, Hardware, Software, Networking

GILBERT HELD



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Preface

The purpose of this book as the title implies is fourfold: to explain the fundamental concepts associated with data communications, examine the communications hardware and software features that enable members of the IBM PC Series and compatible personal computers to communicate in a variety of ways and, using the preceding information as a foundation, to explore the various networking strategies associated with integrating personal computer communications requirements into data communications networks

Since the variety of personal computer users requiring communications can range from individuals to members of Fortune 500 corporations, I have purposely written this book in a modular fashion. By this concept, although each chapter builds upon a previous chapter, one may read each chapter as a separate entity if one so desires. Thus, an individual with limited or no knowledge of data communications might begin his or her reading with Chapter 1, while persons with a previous background in communications might wish to read one or more chapters of particular interest to them.

To assist readers in their communications hardware, software and information utility selection process, I have included several lists of features one should consider as well as an explanation of such features. In addition, I have included numerous examples illustrating the operational utilization of software programs and information utility services that can be used as a guide by the reader for selecting a product or service most appropriate to his or her particular requirement. Since data communications services is one of the most rapidly evolving technological areas, I have purposely avoided directly comparing the features and services of information utilities, packet networks and electronic mail vendors with one another. Instead, after explaining the utilization and operation of one or more systems in each category, I have included a list of vendors in each category as well as their addresses to provide readers with a mechanism to obtain product guides and other relevant information they may require.

Communications is truly a mechanism to obtain a 'window to the world'. In view of this, the author encourages readers with limited exposure to communications to consider purchasing the introductory packages of several vendors that typically permit five hours of on-line usage for a minimal

charge. Such introductory packages represent a low-cost mechanism for readers to obtain an understanding of the utilization of information utilities, the use of packet networks and electronic mail systems. For persons with communications experience, it is hoped that the detailed description of hardware, software and networking strategies will permit those readers to make more effective decisions regarding their individual or corporate communications.

Gilbert Held
Macon, GA

Acknowledgements

To write a book requires a tremendous effort, of which the author, although having the primary responsibility, is but one of numerous persons in the link between the initial concept and the book you are now reading.

First, I would like to thank the hardware and software vendors that were gracious enough to provide me with evaluation copies of their products, which I always managed to return prior to the end of the evaluation period, although this was difficult to do. While I would like to individually thank each organization, the responses to my requests so exceeded my expectations that rather than devote several pages to acknowledging their efforts I would like to issue a 'collective thank you', since the reader will become familiar with their products as he or she reads this book. In addition, I would like to express my appreciation to Auerbach Publishers and *Data Communications* magazine for permission to use extracts from a series of articles I previously authored covering intelligent modems and communications software.

As an old-fashioned writer I have not been able to break the habit of using a pen and pad which provides me with a mechanism to easily draw schematics and review each chapter several times, usually adding more material each time via a cryptic insertion process and forward and backward references, and somehow it all always gets proofed and typed correctly. Thus, once again I am indebted to Carol Ferrell for her fine effort in converting my notes and drawings into a manuscript.

Last but not least I must thank my family for their understanding during the evenings and weekends I closed the door to my study and wrote this book.

Contents

CHAPTER ONE

Introduction

Although the IBM Personal Computer was introduced during the summer of 1981, its effect upon users requiring desktop computational capability is probably as pronounced as the effect of the telephone and duplicating machine upon the typical office worker. In only a few short years, the IBM PC became a *de facto* personal computer standard to which over 50 hardware vendors measure their products' compatibility. Today it is difficult to find a business, education institution or government agency that does not have a large and growing base of IBM PCs or compatible devices.

The variety of applications for which the members of the IBM PC family and compatible computers can be used is limited only by one's imagination and the physical constraints of one's system. By introducing a series of personal computer products to include the original PC, the PC XT, the Portable Personal Computer, the Personal Computer Advanced Technology, which is referred to as the PCAT, the PC Convertible and the PS/2 series, IBM has provided personal computing systems to satisfy the requirements of users in the home and in business, as well as the executive on the go. While word processing and electronic spreadsheet programs are by far the primary software applications utilized with personal computers, no less important is the computer's ability to transfer and receive information via the process known as data communications. In fact, the variety of personal computer applications that are dependent upon a data-communications capability is so pervasive that in a few years time it will be hard to imagine any personal computer being sold without this capability included as a standard feature.

In this chapter, we will explore the rationale for obtaining a communications capability for one's personal computer by investigating a few of the many applications that are dependent upon this capability. While these applications are but a small example of the diverse scope by which data communications extends one's computational and processing power, they illustrate the fact that this capability, in effect, opens a 'window to the world' for the personal computer user.

Information utilities

A modern phenomenon of the personal computing age, information utilities can best be described as vendors that have constructed elaborate databases of information as well as developed a diversity of functions that can be accessed via data communications. Today such vendors as CompuServe, The Source and Dow Jones, to name but a few information utilities, provide the capability for subscribers to retrieve information as diverse as encyclopedia data from keyword searches to the latest financial information. Access to these information utilities is as simple as dialing a telephone number and entering one's user identification and password, resulting in the growth in their subscriber base to several million persons.

Bulletin boards

In early 1978, the first electronic bulletin board was established in Chicago. Known as the Computerized Bulletin Board System, this electronic bulletin board was designed to promote the exchange of information and software among members of the Chicago Area Computer Hobbyists Exchange Club. Since then, the number of electronic bulletin board systems has proliferated in proportion to the growth in the installed base of personal computers, with well over 1000 systems currently providing access to personal computer users via the direct dial telephone network. Today personal computer users can access general purpose and specialized bulletin boards to transmit and receive messages, obtain news about club meetings, new software reviews and similar subjects; buy and sell all types of goods in addition to computer hardware and software; and exchange programs by uploading their files into the bulletin board system and downloading programs from the bulletin board into their system. Specialized bulletin board areas of interest run the gamut from public domain software exchange to computer games and dating services.

Accessing the corporate mainframe

While the primary purpose for obtaining a personal computer resides in its computational capability, it can also be used to replace a conventional terminal connected to the corporate mainframe. In doing so, the personal computer user can obtain access to the corporate database as well as retain the ability to communicate with information utilities and bulletin boards by the appropriate selection of hardware and software. Although at first glance the replacement of a terminal by a personal computer may appear to be a simple process, in actuality this task can be a complex selection of the appropriate hardware and software based upon the structure of one's existing data communications network and the requirement to interface one's

personal computer in an economical and efficient manner. As an example of this complexity, consider an organization that desires to utilize a member of the IBM PC Series as an IBM 3278 terminal. A few of the networking options available for consideration to connect the personal computer to the mainframe include the use of a protocol converter and emulation software on the personal computer; the use of specialized software on both the personal computer and the mainframe; the installation of a hardware board into the system unit of the personal computer to obtain a coaxial connection from the personal computer to a control unit, which in turn is connected to a mainframe; the use of a value-added carrier which performs protocol conversion via software and the interconnection of a personal computer to a local area network where the network has a gateway to the mainframe.

In this book, each of the previously mentioned networking techniques as well as other methods that can be employed to interconnect personal computers, personal computers and minicomputers and personal computers and mainframe computers will be covered. The examples illustrating these networking techniques were developed to provide the reader with a firm indication of the advantages and disadvantages associated with each networking strategy and should serve as a practical guide for integrating personal computer communications requirements into existing and planned corporate networks.

Local area networking

As a mechanism for moving information between devices located on the same premises, local area networks can play a key role in the total telecommunications requirements of organizations that have multiple personal computers. Such networks permit businesses and educational institutions as well as other organizations to easily transfer data between personal computers. In addition, some local area networks provide the capability to integrate voice, facsimile and video information with data on a common cable system while other local area networks provide the additional capability of linking different types of personal computers and large mainframes throughout a building or a campus.

By providing a common data-transport mechanism, local area networks permit personal computer users to share the use of peripheral devices to include letter-quality printers and large-capacity fixed disks. In such situations, multiple copies of application programs may become unnecessary as a personal computer user may be able to download a particular program he or she wishes to use into his or her computer from a central repository on the network. In addition, such features as electronic messaging between users becomes possible, which can be used to enhance the productivity of most office workers.

Electronic mail

While local area networks may provide a mechanism for the transfer of electronic messages between users on the net, such transfers are obviously localized to the network. For the traveling executive, company personnel at distributed locations, or individuals who wish to communicate with each other through the facilities of a third party that acts as a message relay service, an alternative means of messaging is required. This alternative mechanism will most likely consist of the facilities of one or more of the numerous electronic mail services that have commenced operation during the early 1980s. Subscribers to these services can perform a variety of tasks to include sending messages to the electronic mailboxes of other subscribers, sending mailgrams and interfacing to the worldwide Telex system.

Summary

The five application areas previously discussed represent some of the major communications-related uses of personal computers and form a firm basis for obtaining a communications capability for one's personal computer. Prior to discussing each of these data-communications-based applications in detail we will first focus our attention upon fundamental communications concepts and the hardware characteristics of the IBM PC product series as well as the various aspects of communications devices and software programs one must consider. This information is designed to provide the reader with a foundation of knowledge concerning the hardware and software required to enable personal computers to communicate as well as the concepts to enable the reader to understand the various methods by which personal computers can be linked into a communications network and the advantages, disadvantages, constraints and economics associated with these methods.

Each of the following chapters in this book was written as a separate entity, permitting readers to skim over or skip chapters whose contents they may be familiar with. Thus, as an example, a reader with a basic understanding of communications concepts might wish to skim through Chapter 2. Although this 'chapter modularity' was incorporated in this book to accommodate persons with a fundamental knowledge of communications, readers with limited exposure to data communications can also take advantage of its structure by reading chapters in the order of interest once Chapter 2 is read.

CHAPTER TWO

Fundamental Concepts

To transmit information between two locations it is necessary to have a transmitter, a receiver, and a transmission medium which provides a path between the transmitter and the receiver. In addition to transmitting signals, a transmitter must be capable of translating information from a form created by humans or machines into a signal suitable for transmission over the transmission medium. The transmission medium provides a path to convey the information to the receiver without introducing a prohibitive amount of signal distortion that could change the meaning of the transmitted signal. The receiver then converts the signal from its transmitted form into a form intelligible to humans or machines.

While the transmission of data may appear to be a simple process, many factors govern the success or failure of a communications session. In addition, the performance and economics associated with the use of an IBM Personal Computer in a data-communications environment can vary considerably, depending upon numerous variables. Such variables can include the type of communications hardware and software used with one's personal computer, the transmission medium employed and the method by which the personal computer is connected to other network devices that may be required to integrate the computer into an existing network. In this chapter, we will review the fundamental concepts associated with data communications. This will provide us with a background in data-communication concepts which will build a foundation for examining the various options one can consider in a networking environment which will be presented later in this book. Since a PC with appropriate hardware and software can function as a terminal connected to a mainframe computer, we will use these terms interchangeably throughout this chapter. In later chapters, we will discuss the PC hardware and software requirements necessary for these microcomputer-based systems to emulate or function as a specific type of terminal. In addition, unless a specific PC model is referenced we will use the term 'PC' to denote all members of the IBM PC series to include the original PC, the PC'XT, the Portable PC, the PCAT, and the PS/2 family of computers.

2.1 LINE CONNECTIONS

Three basic types of line connections are available to connect personal computers to other computers: dedicated, switched and leased lines.

A dedicated line is similar to a leased line in that the personal computer is always connected to the device on the distant end, transmission always occurs on the same path, and, if required, the line can be easily tuned to increase transmission performance. The key difference between a dedicated and a leased line is that a dedicated line refers to a transmission medium internal to a user's facility, where the customer has the right of way for cable laying, whereas a leased line provides an interconnection between separate facilities. The term 'facility' is usually employed to denote a building, office, or industrial plant. Dedicated lines are also referenced as direct connect lines and normally link a personal computer, terminal or business machine on a direct path through the facility to another personal computer, terminal or computer located at that facility. The dedicated line can be a wire conductor installed by the employees of a company or by the computer manufacturer's personnel, or it can be a local line installed by the telephone company. Normally, the only cost associated with a dedicated line in addition to its installation cost is the cost of the cable required to connect the devices that are to communicate with one another.

A leased line is commonly called a private line and is obtained from a communications company to provide a transmission medium between two facilities which could be in separate buildings in one city or in distant cities. In addition to a one-time installation charge, the communications carrier normally bills the user on a monthly basis for the leased line, with the cost of the line usually based upon the distance between the locations connected by the line.

A switched line, often referred to as a dial-up line, permits contact with all parties having access to the public switched telephone network (PSTN). If the operator of a personal computer wants access to another computer, he or she dials the telephone number associated with a telephone line which, in turn, is connected to the other computer. In using switched or dial-up transmission, telephone company switching centers establish a connection between the dialing party and the dialed party. After the connection is set up, the devices at each end of the line conduct their communications. When communications are completed, the switching centers disconnect the path that was established for the connection and restore all paths used so that they become available for other connections.

The cost of a call on the PSTN is based upon many factors to include the time of day when the call was made, the distance between called and calling parties, the duration of the call and whether or not operator assistance was required in placing the call. Direct-dial calls made from a residence or business telephone without operator assistance are billed at a lower rate than calls requiring operator assistance. In addition, most telephone

companies have three categories of rates: 'weekday', 'evening' and 'night and weekend'. Calls made between 8 a.m. and 5 p.m. Monday through Friday are normally billed at a weekday rate, while calls between 5 p.m. and 11 p.m. on weekdays are usually billed at an evening rate, which reflects a discount of approximately 25% over the weekday rate. The last category, 'night and weekend', is applicable to calls made between 11 p.m. and 8 a.m. on weekdays as well as any time on weekends and holidays. Calls during this rate period are usually discounted 50% from the weekday rate.

Table 2.1 contains a sample PSTN Rate Table which is included for illustrative purpose but which should not be used by readers for determining the actual cost of a PSTN call. This is due to the fact that the cost of intrastate calls by state and interstate calls vary. In addition, the cost of using different communications carriers to place a call between similar locations will typically vary from vendor to vendor and readers should obtain a current rate schedule of the vendor they plan to use to determine or project the cost of PSTN facilities.

Cost, speed of transmission and degradation of transmission are the primary factors used in the selection process between leased and switched lines. As an example of the economics associated with comparing the cost of PSTN and leased-line usage, assume a personal computer located 50 miles from a mainframe has a requirement to communicate between 8 a.m. and 5 p.m. with the mainframe once each business day for a period of 30 minutes. Using the data in Table 2.1, each call would cost $0.31 \times 1 + 0.19 \times 29$ or $5.82. Assuming there are 22 working days each month, the monthly PSTN cost for communications between the PC and the mainframe would be $\$5.82 \times 22$ or $128.04. If the monthly cost of a leased line between the two locations was $250, it is obviously less expensive to use the PSTN for communications. Suppose the communications application lengthened in duration to 2 hours per day. Then, from Table 2.1, the cost per call would become $0.31 \times 1 + 0.19 \times 119$ or $22.92. Again assuming 22 workdays per month, the monthly PSTN charge would increase to $504.24, making the leased line more economical. Thus, if data communications requirements to a mainframe computer involve occasional random contact from a number

Table 2.1 Sample PSTN Rate Table (cost per minute in cents)

Mileage between locations	RATE CATEGORY: Weekend First min.	Weekend Each add' 1 minute	Evening First min.	Evening Each add' 1 minute	Night and weekend First min.	Night and weekend Each add' 1 minute
1–100	0.31	0.19	0.23	0.15	0.15	0.10
101–200	0.35	0.23	0.26	0.18	0.17	0.12
201–400	0.48	0.30	0.36	0.23	0.24	0.15

of personal computers and terminals at different locations and each call is of short duration, dial-up service is normally employed. If a large amount of transmission occurs between a personal computer and another computer, leased lines are usually installed between the two devices.

Since a leased line is fixed as to its routeing, it can be conditioned to reduce errors in transmission as well as permit ease in determining the location of error conditions since its routeing is known. Normally, switched circuits are used for transmission at speeds up to 9600 bits per second (bps); however, in certain situations data rates as high as 19200 bps are achievable when transmission on the PSTN occurs through telephone company offices equipped with modern electronic switches.

Some of the limiting factors involved in determing the type of line to use for transmission between personal computers and other computers are listed in Table 2.2.

Table 2.2 Line Selection Guide

Line type	Distance between transmission points	Speed of transmission	Use for transmission
Dedicated (direct connect)	Local	Limited by conductor	Short or long duration
Switched (dial-up)	Limited by telephone access availability	Normally less than 9600 bps	Short-duration transmission
Leased (private)	Limited by telephone company availability	Limited by type of facility	Long-duration or many short-duration calls

2.2. TYPES OF SERVICE AND TRANSMISSION DEVICES

Digital devices which include terminals, mainframe computers, and personal computers transmit data as unipolar digital signals as indicated in Figure 2.1(a). When the distance between a personal computer and another computer is relatively short, the transmission of digital information between the two devices may be obtained by cabling the devices together. As the distance between the two devices increases, the pulses of the digital signals become distorted due to the resistance, inductance and capacitance of the cable used as a transmission medium. At a certain distance between the two devices the pulses of the digital data will distort, such that they are unrecognizable by the receiver as illustrated in Figure 2.1(b). To extend the transmission distance between devices specialized equipment must be employed, with the type of equipment used dependent upon the type of transmission medium employed.

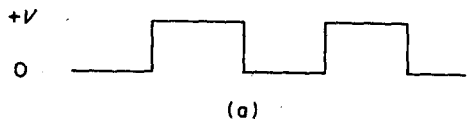

Figure 2.1(a) Digital Signaling

Digital devices to include terminals and computers transmit data as unipolar digital signals

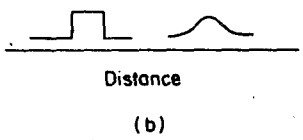

Figure 2.1(b) Digital Signal Distortion

As the distance between the transmitter and receiver increases digital signals become distorted due to the resistance, inductance and capacitance of the cable used as a transmission medium

Basically, one can transmit data in a digital or analog form. To transmit data long distances in digital form requires repeaters to be placed on the line at selected intervals to reconstruct the digital signals. The repeater is a device that essentially scans the line looking for the occurrence of a pulse and then regenerates the pulse into its original form. Thus, another name for the repeater is a data regenerator. As illustrated in Figure 2.2, a repeater extends the communications distance between terminal devices to include personal computers and mainframe computers or other business machines.

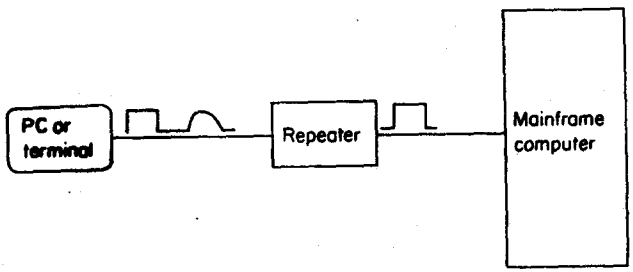

Figure 2.2 Transmitting Data in Digital Format

To transmit data long distances in digital format requires repeaters to be placed on the line to reconstruct the digital signals

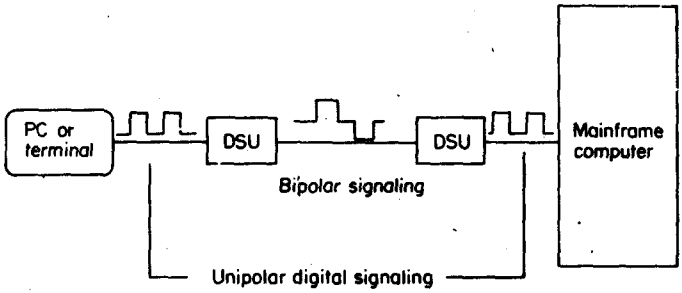

Figure 2.3 Transmitting Data on a Digital Network

To transmit data on a digital network, the unipolar digital signals of terminal devices to include personal computers and mainframe computers must be converted into a bipolar signal

Since unipolar signaling results in a d.c. voltage buildup when transmitting over long distance, digital networks require unipolar signals to be converted into a modified bipolar format for transmission on this type of network. This requires the installation at each end of the circuit of a device known as a digital service unit (DSU) in the United States and a network terminating unit (NTU) in the United Kingdom. The utilization of DSUs for transmission of data on a digital network is illustrated in Figure 2.3. Later in this chapter we will examine digital facilities in more detail.

Modems

Since telephone lines were originally designed to carry analog or voice signals, the digital signals transmitted from a terminal to another digital device must be converted into a signal that is acceptable for transmission by the telephone line. To effect transmission between distant points, a data set or modem is used. A modem is a contraction of the compound term 'modulator–demodulator' and is an electronic device used to convert the digital signals generated by computers and terminal devices into analog tones for transmission over telephone network analog facilities. At the receiving end, a similar device accepts the transmitted tones, reconverts them to digital signals, and delivers these signals to the connected device.

Signal conversion performed by modems is illustrated in Figure 2.4. This illustration shows the interrelationship of personal computers, mainframe computers, and transmission lines when analog transmission service is used. Both leased lines and switched lines employ analog service; therefore, modems can be used for transmission of data over both types of analog line connections. Although an analog transmission medium used to provide a

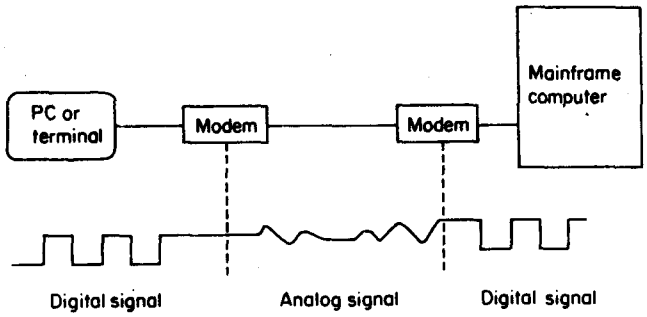

Figure 2.4 Signal Conversion Performed by Modems

A modem converts (modulates) the digital signal produced by a personal computer, terminal or business machine into an analog tone for transmission over an analog facility

transmission path between modems can be a direct-connect, leased, or switched line, modems are directly connected (hard wired) to direct-connect and leased lines, whereas they are interfaced to a switched facility. Thus, a terminal user can only communicate with the one distant location on a leased line, but can communicate with many devices when he or she has access to a switched line.

Acoustic couplers

Although acoustic couplers were popular with data terminal and personal computer users in the early 1980s, today only a small percentage of persons use them for communications. The acoustic coupler is a modem whose connection to the telephone line is obtained by acoustically coupling the telephone headset to the coupler. The primary advantage of the acoustic coupler is the fact that it requires no hard-wired connection to the switched telephone network, enabling terminals and personal computers to be portable with respect to their data transmission capability. Due to the growth in modular telephone jacks, modems that interface the switched telephone network via a plug, in effect, are portable devices. Since many hotels and older office buildings still have hard-wired telephones, the acoustic coupler permits terminal and personal computer users to communicate regardless of the method used to connect a telephone set to the telephone network. network.

The acoustic coupler converts the signals generated by a terminal or personal computer into a series of audible tones, which are then passed to the mouthpiece or transmitter of the telephone and in turn onto the switched telephone network. Information transmitted from the device at the other