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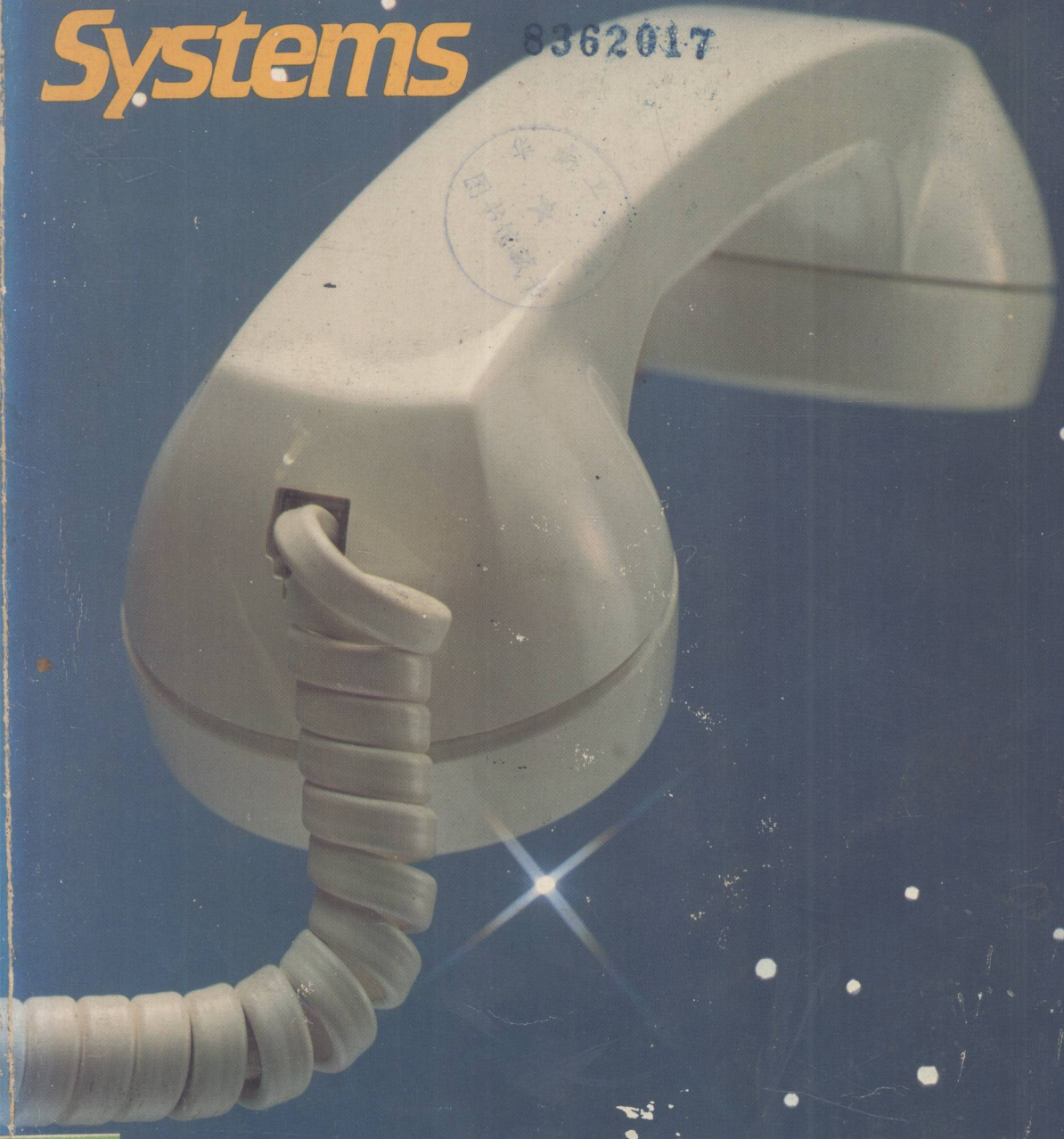
A SPECTRUM BOOK

Microcomputer DataCommunication Systems



e to the operations of modems, terminals, electronic
n boards, and information utilities for users of TRS-80,
l, Heath-89, and other systems

Frank J. Derfler

Microcomputer Data Communication Systems

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PRENTICE-HALL, INC., Englewood Cliffs, New Jersey 07632

Library of Congress Cataloging in Publication Data

Derfler, Frank J.
Microcomputer data communication systems.

"A Spectrum Book."
Includes index.
1. Data transmission systems. 2. Microcomputers.
I. Title.
TK5105. D48 001.64'404 81-17725
AACR2

ISBN 0-13-580720-4

ISBN 0-13-580712-3 {PBK.}

Editorial/production supervision by Louise M. Marcewicz
Cover design by Jeannette Jacobs
Manufacturing buyer: Cathie Lenard

10 9 8 7 6 5 4 3 2 1

This Spectrum Book can be made available to businesses and organizations at a special discount when ordered in large quantities. For more information, contact Prentice-Hall, Inc., General Book Marketing, Special Sales Division, Englewood Cliffs, New Jersey 07632.

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FRANK J. DERFLER, JR., a communications manager with the United States Department of Defense, has published several articles in magazines and journals related to technology and computer systems. He currently writes a monthly column about microcomputer-based data systems for Kilobaud Microcomputing magazine.

For Marlene and Shandra: Thank you for the time.

Acknowledgments

Many terms used in this book are the registered trademarks of various corporations or individuals. Here are the most common terms used:

APPLE II: Apple Computer, Inc.
ASCII Express: Bill Blue and Southwestern Data Systems
CAT: Novation, Inc.
CP/M: Digital Research, Inc.
Crosstalk: Microstuf, Inc.
Dumb Terminal: Lear Siegler, Inc.
Horizon: North Star Computers, Inc.
H-89: Heath Company
LYNX: Emtrol Systems, Inc.
Microconnection: Microperipheral Corporation
MICROMODEM II: Hayes Microcomputer Products
MNET: CompuServe
North Star: North Star Computers, Inc.
OMNITERM: Lindbergh Systems
PET: Commodore Business Machines, Inc.
REACH: The Software Toolworks
Smartmodem: Hayes Microcomputer Products
Source: Source Telecomputing Corp.
ST80, ST80-CC, ST80-PBB, ST80-X10: Lance Micklus, Inc.
TRS-80: Tandy Corporation
Z-TERM: Bill Blue and Southwestern Data Systems
Z80: Zilog, Inc.

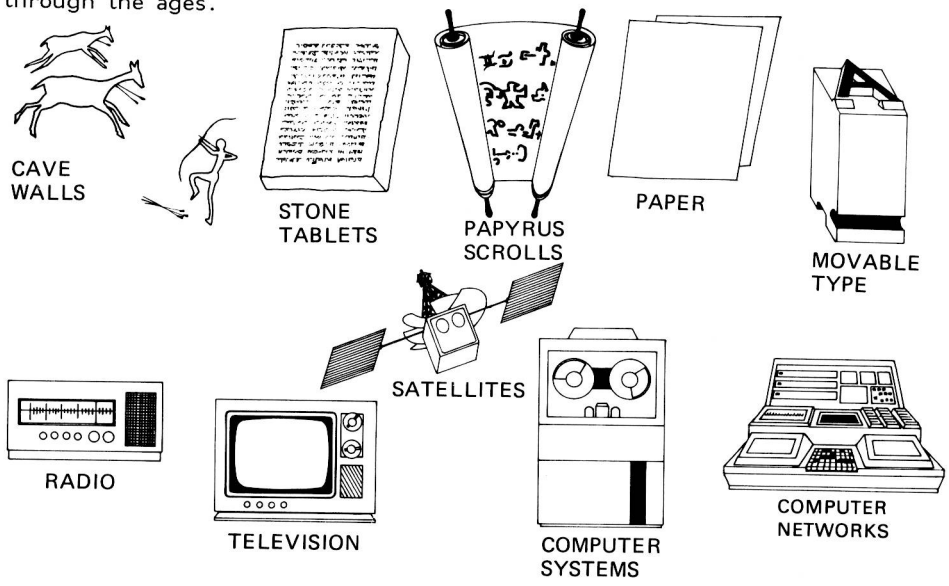
Contents

chapter one

Introduction

We are in the middle of humanity's second great information explosion. The first great explosion came with the invention of movable metal type. The second great explosion is being fueled by the marriage of computers and communications. Many experts believe the availability of inexpensive data communication systems will make as large an impact on our culture as did the development of the printing press in the fifteenth century. More things have been invented since World War II than during the total prior history of mankind. Information pours out of newspapers, books, and electronic media, but the individual often finds that this information must be arranged in a usable form and transmitted in a timely manner if it is to be useful. Sorting, arranging, and transmitting information are the strong features of data communication systems.

Figure 1-1. Development of data communication through the ages.



THE MICROCOMPUTER: A COMMUNICATIONS DOORWAY

If you own a microcomputer, you have the prime element in a data communications terminal. It can allow you access to the world's information when and how you want it. On a practical level, giving your microcomputer a communications capability can make it easy to transfer programs from one system to another--even if the systems have different disk or cassette storage devices. On a broader scope, a microcomputer acting as a terminal can bring in current news, transportation schedules, shopping and stocks information, and mail--at the speed of light.

The information network we used until the early 1980s had not changed much since the 1930s. It was based on the newspaper and supplemented by magazines, telephones, radio, and, later, television. This sort of network ties its users into certain conditions. The major condition or prerequisite for receiving information from the network is this: You must be connected to the network at the specific time the information is being sent. You must get the right issue of the newspaper to read the story you want. You must be ready to listen to or watch the evening news at the time it is being transmitted or you will miss the item you want to see. You must be ready to answer the telephone within the 30-second period of the typical seven-ring attempted call or you will not be connected. Studies show that the number of successfully completed telephone calls in the business world is regularly as low as a miserable 15%. The demand that you be plugged into the system at the right time to receive a transmitted message is a kind of tyranny. I refer to it as the "Time Tyranny of Telecommunications."

Figure 1-2. The Time Tyranny of Telecommunications.

THE TYRANNY OF TIME

A great deal of research and money has been spent on products to break the Time Tyranny of Telecommunications. Telephone answering machines and video tape recorders are devices that automatically

connect into the network at the right time and save the transmitted messages until you are ready to play them back. They act as a kind of storage buffer between you and the distribution network. They buffer, or hold, the information until you are ready to receive it, but the network still transmits or broadcasts the information only when it is convenient or expedient for the individuals who provide the information. The network does not know or care if the user is ready to listen.

A more modern approach is through modification of the network itself. The information network can be changed so that it becomes an interactive system instead of just a broadcast into the blind. Information (messages, orders, news, sports, and so on) is loaded into an interactive system at the convenience of the information provider. The system delivers that information at the convenience of the information receiver and in the order and format suiting his needs.

These modern networks take many forms. Several telephone companies now provide centralized storage of voice messages. Voice messages are digitally recorded and played back when the person to whom they are addressed checks into his central mailbox Voice message storage systems do not require any specialized equipment to send and receive, but the messages cannot be sorted, filed, or stored by the receiver in any easy way. The most effective modern information networks or systems can do all these things and more.

Three general kinds of systems are becoming popular: electronic message systems, information utilities, and teletext systems.

ELECTRONIC MESSAGE SYSTEMS

There are many kinds of electronic message systems. Among them are Computer Bulletin Board Systems (CBBS), Apple Bulletin Board Systems (ABBS), Forum 80 systems, PET Message Systems, and others. All these systems operate in a similar manner, but they differ in the hardware and software used by the central computer and in the specific features they may provide.

Physically, an electronic message system is usually a standard microcomputer from one of the popular manufacturers. The computer probably has 48K (kilobytes) or more of random access memory and several disk drives. Most importantly, it has a device called an auto-answer modem. A modem (which will be described more thoroughly in Chapter 3) is a device that converts the electrical output of a computer or terminal into audio tones which can be transmitted and received over standard telephone lines. This modem picks up or "answers" the telephone line when it rings. The caller on the distant end is automatically connected to the computer that is running the message system program.

Message system programs differ in detail, but they usually perform several standard functions. They normally ask the caller first to complete a sign-on routine for purposes of identification. The sign-on routine may include many details such as name,

location, and telephone number of the caller, or it may be as simple as a coded serial number transmitted automatically by the caller's microcomputer terminal.

After the sign-on, the message program gives the user several options. The first microcomputer-based message systems were little more than places where users could "pin up" notes to their friends. The most advanced systems now allow their users to run programs, play games, use higher order programming languages (such as Pascal), keep private "mailboxes," read interesting articles or editorials, order products from other users, and exchange programs with the host system. These services are usually provided free of charge. Often they are operated by private individuals, but many businesses selling computer products have found that a message system is a valuable link to their customers.

INFORMATION UTILITIES

Would you like to have the complete reports of a national news wire service in your home? Would you like to have stock market reports, business analyses, government publications, home and garden articles, shopping tips, merchandise ordering, train and airline schedules, and mail service at your fingertips? Would you also like to have the option of using programs requiring large memories and programming languages not normally available on a microcomputer? Information utilities can provide you with all these capabilities and more.

Information utilities are a specialized form of what has been known for years as time sharing services. In a time sharing service, a large central computer--or often a cluster of medium-sized computers--serves customers in remote locations over telephone lines. The service allows each customer to feel as if the computer is dedicated to him alone. The time sharing services entering the information utility market have provided some very unique programs for their customers to run. These programs provide the kinds of "electronic Sunday newspaper" and reference library services described above.

Your microcomputer can be used as an access device to these information utilities. A communicating microcomputer can enhance the operation of these subscription services by saving information and files locally, preparing messages and files for transmission to the bigger system, and speaking to the bigger system in quick shorthand codes.

Two major information utilities are marketing their services especially for microcomputer users. The Source is the name of one service provided by Source Telecomputing Corporation in McLean, Virginia. A competing service is marketed by CompuServe of Columbus, Ohio. Both of these services are described in detail in Chapter 11. While the Source and CompuServe compete with each other, they both face growing competition from another form of information utility: teletext and videotext services.

TELETEXT AND VIDEOTEXT

Teletext and videotext systems also provide interactive delivery of information into the homes and offices of their subscribers. Since their services are not designed especially for microcomputer users, I will not spend much time describing them. However, anyone interested in data communications should understand basically how these systems work and what their impact might be.

Teletext and videotext are both centered on the same kind of centralized information-loaded computer used by the information utilities. These systems rely on terminal devices that are more common in the home than are microcomputers.

Teletext uses the home telephone line and a specially modified television set to link the subscriber to the central computer. The typical user has a small keypad which allows selections from displayed menus. The central computer is informed of the selection by a short message transmitted over the telephone line from the television terminal. The selected page of information is sent from the central computer to the home user over the telephone line at a high rate of speed.

Videotext also uses a modified television set, but not the telephone line. The pages of information are transmitted by a local television station during idle milliseconds in the regular transmission signal. The information is sent in short high-speed bursts repeated in a regular pattern. Videotext is not truly an interactive system. There are no transmissions from the television terminal to the central computer. Instead, the user's television set waits for the desired page of information to be transmitted; then it captures and displays it. This wait is usually less than a minute.

Videotext and teletext systems are similar to information utilities, but they aim at slightly different markets. Videotext and teletext want to serve the average American family at home. Information utilities are probably aimed at more sophisticated users at home and in business. Both videotext and teletext systems make use of graphic color displays. They provide information quickly and in standard formats. They are simple to use, but they lack the flexibility and power gained from teaming centralized information utilities with remote microcomputer terminals.

TRANSMISSION SYSTEMS

The new modern interactive information networks are possible only because of the availability of modern transmission systems. Transmission systems carry the electronic messages between the communicating microcomputers and the terminals or computers to whom they are talking. The only pieces of the transmission systems we normally think of or see are the home telephone instruments and the wires going from pole to pole. These instruments and local wires are common to all the systems we use, but after our voice or the computer modem tone leaves the local telephone office, it may go by many routes.

Frequently, users of electronic message systems find they make many long distance telephone calls to get on the systems interesting to them. The cost of these calls can mount quickly. The most common long distance routes are those provided by American Telephone and Telegraph. Over the past few years, however, some competition has developed due to the deregulation of the telecommunications industry in the United States. This means you may be able to call long distance more cheaply by using an alternative to the traditional telephone service. Two such companies are competing strongly in providing this service.

Southern Pacific Communications offers a service called "Sprint" to private customers. MCI Communications Corporation was the first company to challenge the American Telephone and Telegraph monopoly in long distance communications: their service is known as Execunet. In Chapter 11, the geographic areas served by these carriers--and the rate structures--will be described. This is important information for the microcomputer communicator who wants to use electronic message systems around the country.

The information utilities also make use of special communications carriers to route the great volume of data they transmit and receive. Tymnet and Telenet are two telecommunications networks especially dedicated to computer communications. Carriers dedicated to a special purpose such as data communications are called value-added carriers because of the message processing, error detection and correction, and other specialized services they provide. These networks are not normally noticed by information utility users, but they function in very special ways to connect digital communications systems.

Finally, the spread of cable television services and the possibility of direct satellite transmissions are creating new opportunities for videotext and modified teletext services. Several two-way cable television systems are operating around the country with exciting results. Presidential candidates, local elected officials, and professional athletic coaches have all experienced the instant feedback of two-way cable.

THE DIGITAL DATA FUTURE

Data communications networks are rapidly changing the way we conduct our lives. These networks have made a tremendous impact on banking, publishing, travel, and government services. The microcomputer in your home or office can be an important part of one or several data networks. Opening the door to the information explosion is an easy and pleasant thing to do. The following chapters will give you the technical and practical keys to microcomputer communications.

chapter two

The Fundamentals

It is not necessary to understand the internal combustion engine in order to drive a car; similarly it is not necessary to understand anything technical about data communications to use an electronic message system or information utility. Knowing what is going on "under the hood," however, can greatly increase your enjoyment and possibly reduce maintenance and repair bills. Some technical understanding is also needed when you are trying to customize your own machine.

SERIAL DATA

The data transmission systems used by microcomputers are referred to as serial systems. This means that data comes out bit by bit in a serial stream, rather than--the way some printers and other devices are fed--by the parallel transmission of eight bits of data simultaneously. The telephone line is not a big enough creek bed to hold the wide wash of parallel transmission, so we will concentrate on the serial stream. Let's start at the headwaters of all data and float on down.

Every microcomputer has some input and output ports. The keyboard feeds an input port and the video monitor or RF modulator receives signals from an output port. The cassette or disk controller moves data both in and out and is therefore called an I/O port. It is possible to use the cassette port of most microcomputers to communicate over limited distances by connecting the audio signals to the telephone lines. This can only be done with two identical model computers, however, because cassette systems are not standard. But even when identical computers are used, the cassette coding system is very sensitive to the changes imposed on the signal by the telephone circuit. Many computer users experience problems trying to load programs from a local recorder. Minor changes in audio level or the phase of the signal can make loading difficult. These problems are compounded when telephone lines are used. Use of the cassette port as a communications port can be a very limited and frustrating way to try and communicate.

RS-232-C

A standard and practical I/O coding scheme is needed for long distance data communications. Computers communicate internally and externally in digital signals. Inside every system, direct current voltages are being switched from high to low voltage many times a second. These changes in voltage represent digital bits of information. However, the voltages used differ between the systems. Even in the microcomputer family, different microprocessors are different voltage levels. If all systems are to communicate on a common network, some standard for external voltage levels must be set. We need a solid definition of the electrical standards to be used. This has been supplied by the Electronic Industries Association (EIA): standard code RS-232-C. Outside the United States this code is known as the Consultive Committee International Telephone and Telegraph (CCITT) code V.24. This code provides a common description of what the signal coming out of and going into the serial port will look like electrically. Specifically, RS-232-C provides for a signal swinging from a nominal +12 to a nominal -12 volts at certain specified current levels and resistive loads.

Table 2-1. RS-232-C Electrical Standards

Signal Name	Logic	Control State	Electrical Parameter
MARK	ONE	OFF	-24 TO + 3 VOLTS
SPACE	ZERO	ON	+3 TO + 24 VOLTS

The RS-232-C electrical standard limits the length of the connecting cable to fifty feet. In practice, cables many times that length can be used if they are routed away from appliances and other sources of electrical interference. The timing signals used in synchronous transmission are particularly susceptible to noise.

The voltage area between +3 and -3 volts is a transition area, and signals should not rest in this zone or they will cause erratic operation of the logic circuits. The positive and negative signals do not have to be of the same amplitude. Positive voltages of 12 volts and negative voltages of -5 or -18 volts are commonly found working together. The change in voltage state is the actual signaling function. The standard also defines the cables and connectors used to connect data communications devices together. This will become quite important when we discuss the hook-up of actual hardware. Using this standard code simplifies the job of getting information in and out of a computer, terminal, or peripheral device. A new standard, called RS-449, has been adopted which will eventually be a replacement or an alternative to RS-232-C, but compatibility with RS-232-C is specified in RS-449. RS-232-C will continue to be a useful signaling standard for many years to come.