THE ELECTRONIC LINK: Using the IBM®PC to Communicate

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Rarely do one or two people single-handedly write a book. Although our names, Lawrence Magid and John Boeschen are cited as the authors of *The Electronic Link: Using the IBM®PC to Communicate*, we certainly weren't alone in the book's preparation.

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Finally our warmest appreciation goes to Sandra Boeschen and Patti Magid who not only helped us create this book, but gave birth to new additions to each of our families.

The Making of a Communications Book

The technology we write about was very much a part of the making of this book.

First, much of the research was done "on-line" via a variety of public data bases, computer bulletin boards and other services. This is reflected throughout the book with actual "screen dumps" and reference material taken directly from the various services.

The authors used their modems and cables to communicate with each other and send text between their two otherwise incompatible systems. John's Osborne and Larry's IBM PC learned how to "talk" to one another.

Because of the ability to telecommunicate, the authors were able to play a major role in the typesetting of this book. On a Saturday late in July, the final manuscript was sent, via modem, from one of the authors' homes in California to the Morrisville, Pennsylvania office of The Publisher's Network. The Publisher's Network "captured the author's keystrokes," formatted the file for its own typesetting equipment, and produced the final pages for manufacturing production by mid August.

And now you're part of the process. You can use your computer and modem to communicate with the authors. Please use your modem to send us your questions, corrections, and other comments. Lawrence Magid can be reached, on the Source (see chapter 4), via ST6191. John Boeschen's Source Account is TCB878.

Introduction

One of the most fascinating features of a personal computer is its ability to communicate with other computers. A small additional investment in hardware and software will transform the IBM Personal Computer into an "intelligent terminal," able to manipulate giant mainframe computers or send information to other computers anywhere in the world. Gaining access to all this power is a lot easier and less expensive than many people imagine.

The use of personal computers to "crunch" numbers and process words started the now famous *information revolution*. Today, the use of personal computers to communicate the results of their information processing to each other has started another revolution: telecommunications. Just as information processing is available to both corporations and individuals, so is telecommunication.

A COMPUTER-READY AMERICA

In California, a future-oriented contractor is building "computer-ready" homes. The feature that transports these homes into the future is no more complex than one extra phone jack and additional electrical outlets in two rooms. The builder has "designed" the outlets and phone jacks for computers, claiming that individuals, relying more and more on computers at work, can easily tap into their office computer from home, thereby saving energy, money, and time.

In reality, almost all homes are "computer ready." You don't need the services of a contractor. As long as you have electricity and a single-party telephone line, you can connect your PC to any of thousands of dial-up services.

Though it may be just a marketing gimmick, the contractor is, nevertheless, right in his far-sighted assumptions. People who learn to connect their computers and their phone lines can do things that would probably justify the extra cost of a "computer-ready" home.

With your properly outfitted PC and your phone line, you can have your PC pay your bills, send letters to your cousins in Albuquerque, find out what the front page of the Washington Post has to say before it hits the streets, buy a new car, barter for trips to exotic resorts, buy shares of quickly advancing stocks and much, much more.

At work in their more traditional offices, many folks who inhabit "computer-ready" homes are discovering that their PCs become much more efficient when wired together in powerful networks. Electronically sharing peripherals and information, these networked offices are easily able to outstrip their networked counterparts, in both productivity and creativity.

The Electronic Link: Using the IBM PC to Communicate is designed to help both the novice and the experienced computer user to enjoy the excitement and power of computer communications. This book can help you save money on equipment, software, telephone charges, time-sharing services, and consultants. It isn't necessary for example, to spend $300 for a communications program when one of the best can be obtained free. Your IBM PC can be used to wire a document to Europe for under $2 instead of up to $100 via Western Union. Instead of wasting money by entering data directly to an expensive time-sharing service, you can enter it on your micro off-line and have it automatically transferred, at 1,200 words per minute, to the main frame computer at off-peak rates.

HOW TO USE THIS BOOK

The Electronic Link: Using the IBM PC to Communicate contains both general and technical information. To make it as useful as possible to both novices and pros, it includes several helpful features in each chapter; a preview of each chapter's contents plus section headings and paragraph identifiers.

To get the most from this book, look at the chapter previews to give you a feeling for the book's contents and organization. Then you can read through the book, concentrating on material you feel is essential to your understanding of the topics covered and skimming over information that is not as pertinent.

We hope this introduction to the world of telecommunications is both exciting and beneficial for you.

Contents

CHAPTER ONE
Communications Hardware

CHAPTER PREVIEW

The first part of this chapter presents a definition and description of modems to help you make the best selection for your communication needs. Topics include duplex, baud, Bell standards, varieties (acoustic coupled, direct connect, plug-in, short-haul), smart modems and their most common features. A section on trouble-shooting will help you unscramble hardware-related problems that occur during transmissions. In the latter portion of the chapter, you'll find a technical description of how information is transmitted between micros over standard voice-grade telephone lines. Topics covered: ASCII code, parallel and serial transmissions, asynchronous versus synchronous communication protocols, framing bits, parity, RS-232 standards, serial ports and cables, and the internal workings of modems.

A modem, which stands for MODulator/DEModulator, is a hardware device that serves as an interface between the computer and the phone system. It takes signals from the computer and turns them into audible tones that can travel the copper wire, microwave stations, satellites, and other facilities of the phone system. A modem on the other end translates the tones back into signals that the computer can respond to. All this is controlled by communications software which either comes with the modem or is available separately from a computer dealer. Most personal computer modems can work with standard telephone lines and can even transmit over long-distance phone networks such as Sprint or MCI. Some local phone companies are insisting that you lease special "data lines" to use your modem, but for most users, there is no technical reason to do so. The 1980's will see both technological and legislative battles regarding use of the now de-regulated phone networks for data communications. Stay tuned to your local phone company, state legislature, and congressional representative for the latest developments.

ASCII CODE

The various components of your computer communicate to each other in a special code made up of binary digits. Although you never see them, your computer reduces all the letters and numbers you type into numeric symbols represented by 1s and 0s. These are called binary numbers. For example, the binary equivalent of the letter "A" is 1000001.

Internally, your PC represents this sequence with one pulse of low voltage, five pulses of high voltage, and one final pulse of low voltage. When your modem gets hold of these high and low electrical pulses, it converts them into one low electrical note, five high electrical notes, and a final low electrical note. On the receiving end, the modem changes back (demodulates) the electric tones into pulses that your computer readily responds to.

The codes used to translate all this are called ASCII (pronounced ASKEY), an acronym for *American Standard Code for Information Interchange.* Almost all microcomputers and most brands of mainframe systems communicate in ASCII. To make life a little easier, ASCII has 128 combinations of binary units which are numbered as character strings (in computerese, "character string" is represented by CHR$). For example the letter A, represented as 1000001 in binary code, is referred to as ASCII CHR$(65). These codes will be familiar to those who program in BASIC and other languages.

If you want to see how ASCII codes can be displayed in actual letters and numbers, try the following exercise:

1. Insert your Disk Operating System (DOS) system disk that contains the BASIC language in your disk drive and type: BASIC [ENTER] (whenever you see [ENTER] in this book, it means to press the ENTER key).

2. When BASIC is loaded, type PRINT CHR$(65) [ENTER]. You'll see an "A."

3. Now, type PRINT CHR$(97) [ENTER] and notice the lower case "a."

4. To exit from BASIC back to DOS, type SYSTEM [ENTER].

You can experiment with other numbers and you'll soon see the relationship between ASCII and English (see Table 1.1). What's important here is to remember that your computer can translate between binary, ASCII, and English and that your modem can translate ASCII into audible tones that can travel through the phone network.

TABLE 1-1 ASCII conversion table

Decimal	Binary	ASCII	Decimal	Binary	ASCII
0	0000000	NUL	18	0010010	DC2
1	0000001	SOH	19	0010010	DC2
2	0000010	STX	20	0010100	DC4
3	0000011	ETX	21	0010101	NAK
4	0000100	EOT	22	0010110	SYN
5	0000101	ENQ	23	0010111	ETB
6	0000110	ACK	24	0011000	CAN
7	0000111	BEL	25	0011001	EM
8	0001000	BS	26	0011010	SUB
9	0001001	HT	27	0011011	ESC
10	0001010	LF	28	0011100	FS
11	0001011	VT	29	0011101	GS
12	0001100	FF	30	0011110	RS
13	0001101	CR	31	0011111	US
14	0001110	SO	32	0100000	SP
15	0001111	SI	33	0100001	!
16	0010000	DLE	34	0100010	"
17	001001	DC1	35	0100011	#
36	0100100	$	82	1010010	R
37	0100101	%	83	1010011	S
38	0100110	&	84	1010100	T
39	0100111	'	85	1010101	U
40	0101000	(	86	1010110	V
41	0101001	)	87	1010111	W
42	0101010	*	88	1011000	X
43	0101011	+	89	1011001	Y
44	0101100	,	90	1011010	Z
45	0101101	-	91	1011011	[
46	0101110	.	92	1011100	\
47	0101111	/	93	1011101	]
48	0110000	0	94	1011110	^
49	0110001	1	95	1011111	
50	0110010	2	96	1100000	`
51	0110011	3	97	1100001	a

(continued)

TABLE 1-1 ASCII conversion table (continued)

Decimal	Binary	ASCII	Decimal	Binary	ASCII
52	0110100	4	98	1100010	b
53	0110101	5	99	1100011	c
54	0110110	6	100	1100100	d
55	0110111	7	101	1100101	e
56	0111000	8	102	11100110	f
57	0111001	9	103	1100111	g
58	0111010	:	104	1101000	h
59	0111011	;	105	1101001	i
60	0111100	<	106	1101010	j
61	0111101	=	107	1101011	k
62	0111110	>	108	1101100	l
63	0111111	?	109	1101101	m
64	1000000	@	110	1101110	n
65	1000001	A	111	1101111	o
66	1000010	B	112	1110000	p
67	1000011	C	113	1110001	q
68	1000100	D	114	1110010	r
69	1000101	E	115	1110011	s
70	1000110	F	116	1110100	t
71	1000111	G	117	1110101	u
72	1001000	H	118	1110110	v
73	1001001	I	119	1110111	w
74	1001010	J	120	1111000	x
75	1001011	K	121	1111001	y
76	1001100	L	122	1111010	z
77	1001101	M	123	1111011	{
78	1001110	N	124	1111100	|
79	1001111	O	125	1111101	}
80	1010000	P	126	1111110	
81	1010001	Q	127	1111111	DEL

Ironically, IBM mainframes are the one major brand that speak a different tongue. They use EBCDIC *(Extended Binary Coded Decimal Interchange Code)* which is why a PC requires a translating device when communicating with IBM mainframes.

CLASSIFYING MODEMS

There are a number of ways to classify modems. The allowable directions of data transfer and the speed of transmission are two popular classifications.

DUPLEX

If you look up the word "duplex" in the dictionary, you'll find a definition similar to "a simultaneous two-way and independent transmission in both directions." Simple enough, but further investigation reveals that modems can operate according to one or both of two duplex transmission modes. One is called half duplex and follows the dictionary definition only part-way: half duplex allows two-way communications over the same channel, but not at the same time. The other mode is full duplex and obediently abides by the dictionary definition.

Half duplex. When the CB radio craze struck in the late 1970s, lots of us were chattering away in half duplex. "White Fang, this is Big Moose. Are you there? Over." Hearing the signal word "over," White Fang switches from receive to transmit mode and answers Big Moose: "I read you loud and clear, old buddy. Over." And so it goes, each CB'er talking and listening in turn. Transmitting digital information in half duplex follows the same procedures; first one machine relays its message and the other receives; when a signal is sent indicating end of message, the roles are switched.

Full duplex. Full duplex, on the other hand, is more similar to a phone conversation. Who talks and who listens is up for grabs. One person can break into the middle of another's conversation at any time. This simultaneous, two-way format is much less formal than artificially signaling when the second party can interject its two cents worth. Full duplex also is faster because there's no coded overhead, signaling when the listener can begin its half of the dialog.

A time for half duplex. Just as simultaneous, two-way voice communications are more widely preferred than one-way, so full duplex is the preferred mode among computer users; but that preference doesn't relegate half duplex to obscurity. At times you'll discover that you don't or can't transmit without it. One example is when phone line conditions become too turbulent and noisy; the simplified approach of sending half duplex may be more successful than full duplex. Another is on those occasions when you have to communicate with a system that uses only half duplex. The solution, in each case, is to purchase a modem that transmits in both half and full duplex modes. Never purchase a modem that works only in half duplex.

BAUD

The term most frequently used to describe how fast your modem sends data is termed the baud rate (sounds like the slang word "bod"). A more meaningful and accurate measure of information transfer is *bits per second* (bps); but baud has become the most common rating for the quantity of information modems can transmit in a given time period.

If you know the baud rate, you can approximate how many characters per second your computer is sending and receiving by dividing the baud rate by 10. The current baud rates for the most commonly used modems are 300 and 1,200. At 1,200 baud, your computer is transmitting approximately 120 characters per second (1,200 divided by 10 = 120). At 300 baud, the rate is 30 characters per second—a sizable difference.

To calculate how long it will take to ship a single document, all you need to know is the size of the file in bytes (or characters). You can determine that from the Disk Operating System by typing DIR FILENAME. DOS responds with the filename plus its size in bytes. To find out how long it would take to telecommunicate one iteration of this chapter, you would type the following at your keyboard:

```
(DOS)        A>
(You)        DIR B:CH2.TEL
(DOS)        CH2       TEL     46720
```

If you were sending the text at 1,200 baud, you would divide 46,720 by 120 to find out how many seconds it would take (46,720/120 = 389). To find the number of minutes, divide the character count by 7,200 (120 x 60) for 1,200 baud or 1,800 (30 x 60) for 300 baud. Thus, to send this document it would take 6.49 minutes (46,720/7,200) at 1,200 baud or 25.96 minutes (46,720/1,800) at 300 baud.

You can also calculate transmission in terms of words per minute. The average length of a word is six characters (depending on your vocabulary); 1,200 baud equals about 20 words per second (120 characters divided by 6 = 20). Three hundred baud equals five words per second. To figure the number of words per minute, simply multiply the words per second by 60. The results are easy to remember. Transmitting at 1,200 baud (20 x 60) equals 1,200 words per minute (roughly three single-spaced, typed pages), and 300 baud transmission equals about 300 words per minute.

If you like to use your computer to do all your work, you can type in the following BASIC program to calculate the speed of transmission. Note that anything following REM is a remark that doesn't affect the program's operation.

BASIC Program to Calculate Transmission Speed

```
10 CLS:REM CLEARS THE SCREEN
20 REM TRANSMISSION CALCULATOR
30 PRINT "SIZE OF FILE (IN BYTES)"
40 INPUT SIZE:
50 BAUD=300:REM CHANGE TO 1,200 FOR 1,200 BAUD
60 RATE=BAUD/10
70 LET SECONDS=SIZE/RATE
80 LET MINUTES=SECONDS/60
90 PRINT MINUTES;"MINUTES AT";BAUD;"BAUD"
```

FUTURE BAUD RATES

When home computers began to proliferate in the late 1970s, almost all were transmitting at 300 baud. Now that 1,200 baud modems are coming down in price, this rate is becoming the industry standard. It is possible to transmit at faster speeds, 4800 baud and more, but such modems are considerably more expensive; but this, too, shall pass. If you can bypass standard phone lines, you can transmit at significantly higher rates. In fact, many businesses today use all-digital circuits that transfer several million bits per second. New satellite services and conditioned lines from your local phone company are available for this purpose, but they are considerably more expensive than standard phone lines.

BELL STANDARDS

When the need arose to transmit digital communications over the Bell telephone network, Bell scientists designed and built the modem. Later, the company established several standards that still hold their places of honor. The Bell standards, in effect, established the frequency of tones that modems could use over the phone lines. Of the five standards used in North America, two directly affect PC owners.

BELL 100 SERIES

The most commonly mimicked modem has been the *Bell 103*. This modem operates at speeds up to 300 baud and can transmit and receive information simultaneously (full duplex). Standards 113A and 113B also communicate at 300 baud, but in half duplex only. Modems compatible with these Bell benchmarks are satisfactory for sending or receiving small amounts of information. At 300 baud, text scrolls across your screen at a fairly comfort-