

Emulating the 3278

Users need PCs that function both as stand-alone units and as workstations for mainframe communication. The choices currently available that provide 3278/79 terminal emulation are many.

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The trend in terminals is changing from the dedicated slave to the multipurpose workstation. As such, the PC provides local computing power and access to the mainframe for programs, databases, and electronic mail. The mainframe can act as a central data repository, enabling non-networked PCs to share information through file transfer.

The PC may be implemented as a workstation in several ways. Where the need exists and the topology is feasible, the local area network (LAN) connected via a gateway to the mainframe is a popular choice. Under a LAN, each workstation must function independently as both a mainframe terminal and a local PC. In cases where a LAN is not practical or necessary, 3278/79 terminal emulation may be the answer.

The 3278/79 terminal (information display system) is a workhorse for IBM mainframes. This high-speed intelligent terminal offers full-screen capability. Most corporate 3278/79 terminals are connected from host mainframes via coaxial cable to a 3274/76 cluster controller, which then communicates with the mainframe over a high-speed binary synchronous line. This communication often is accomplished under IBM's system network architecture (see "SNA Strategies," Art Krumrey, July 1985, p. 40.) Emulation of the 3278/79 is essential to workstations operating in an IBM mainframe environment. A PC can emulate a 3278/79 through

- a LAN gateway, where a device on the LAN serves as a 3274/76 controller and each PC emulates a 327x terminal. (See figure 1.)

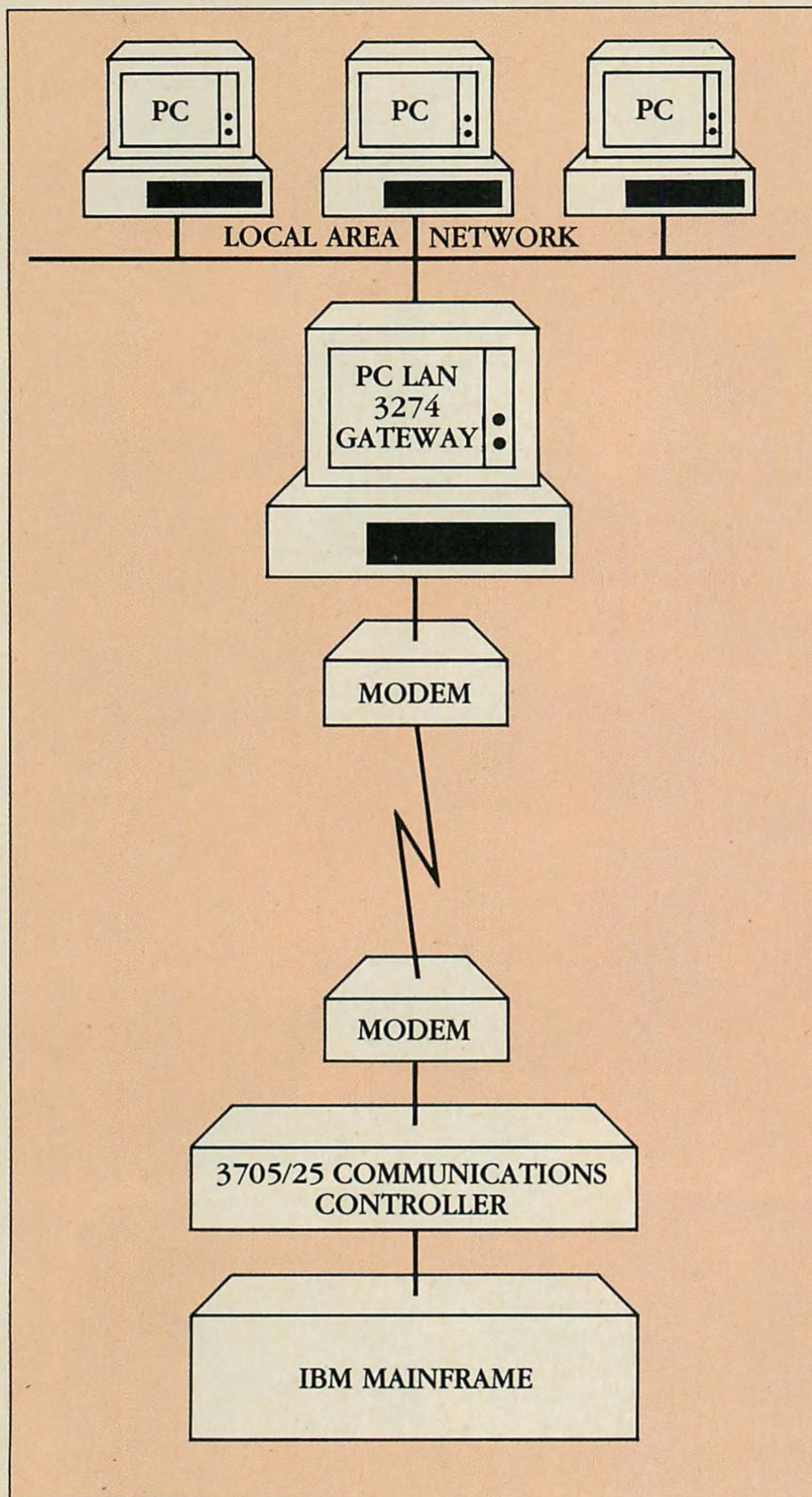
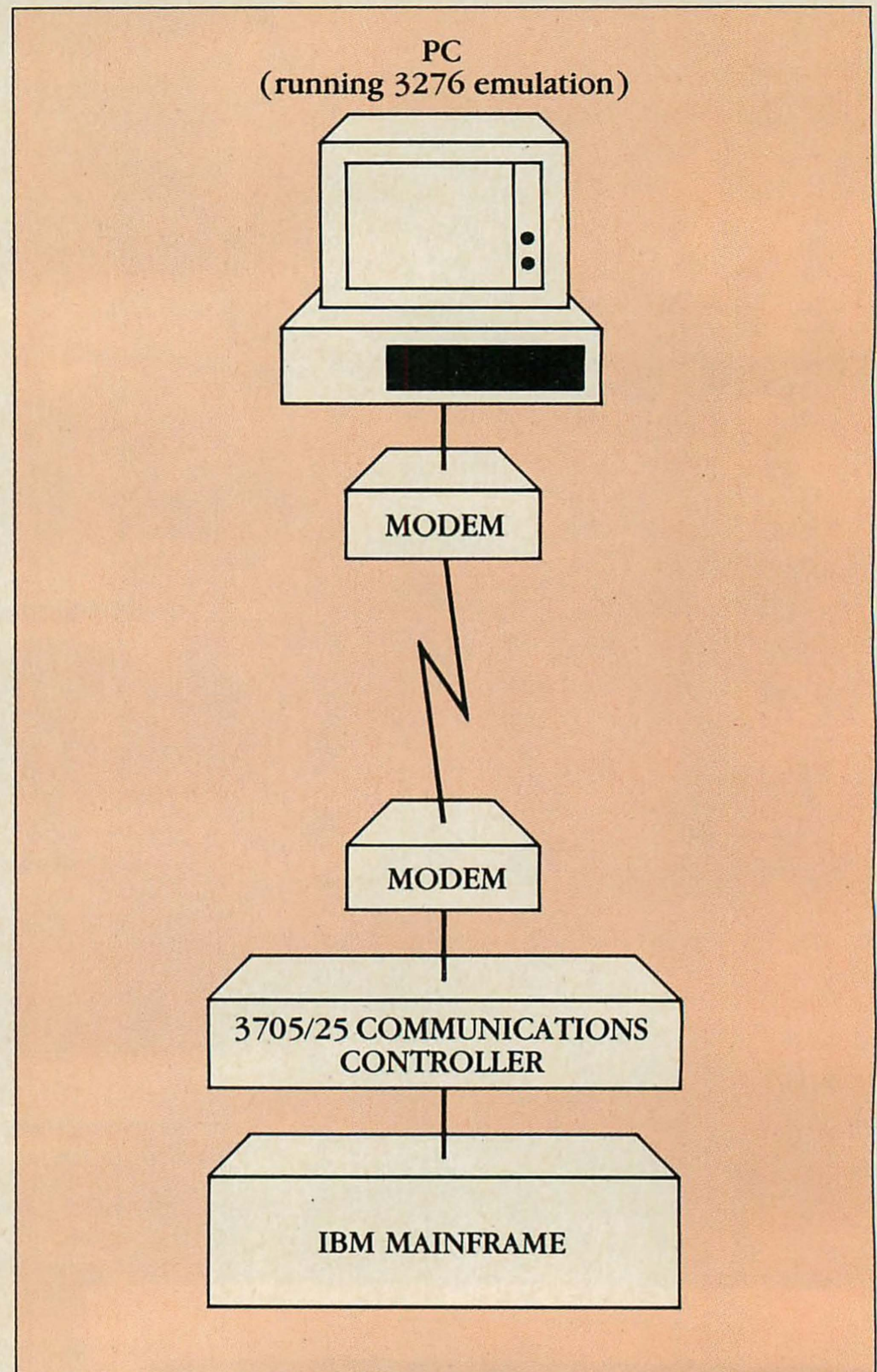
- dial-in 3276 emulation, where a single PC is used to emulate both a cluster controller and a 327x terminal. This option also uses telephone lines and modems. (See figure 2.)
- coaxially connected 327x terminal emulation, where a single PC is directly connected to a cluster controller and acts as a 327x device. (See figure 3.)

The dial-in option provides the 3278/79 emulation—and is the only option when cluster controllers are not available—but the maximum transfer speed is only 2400 baud even with recently released modems. This can be frustrating with program files of 50KB to 100KB or full 1,920-character screens.

The last method is the obvious choice when LAN gateways are not present but 3274/6 cluster controllers are.

PHOTOGRAPH • MARC DAVID COHEN



FIGURE 1: *Emulation via LAN Gateway***FIGURE 2:** *Connection via 3276 Emulation*

In figure 1, a device on the LAN (not necessarily a PC) emulates a 3274/76 cluster controller and connects to the mainframe via a high-speed line. In figure 2, a PC emulates both 3278/79 terminal and 3276 cluster controller. This method is not economical if the cost of the line is high.

The coaxially connected emulators are attached to IBM 3274/6 cluster controllers and communicate with them at speeds of 2.63MB per second. The controllers communicate with the mainframe at speeds ranging from 9600 baud with a leased line to 56Kbaud on a T1 carrier to direct channel connect speeds of up to 3MB per second.

This article evaluates eight coaxially connected 3278/79 emulation hardware/software packages currently on the market. This review is confined to boards distributed by the original makers to avoid comparing a board with itself under another label.

SERVICES RENDERED

The basic service supplied by an emulator board with software is a functional duplication of the 3278/79 terminal on a

PC with monochrome or color adapters and monitors. The several terminal models available differ in the number of characters displayed: 1,920 (24 lines by 80 characters); 2,560 (32 lines by 80 characters); 3,564 (27 lines by 132 characters); or 3,640 (43 lines by 80 characters); with regular or extended attribute bytes for the 3278 and base (4) or enhanced (16) color for the 3279. Models 3278-2 and 3279-2A are the most common display systems and the most widely emulated. Some boards emulate several 3278/79 models.

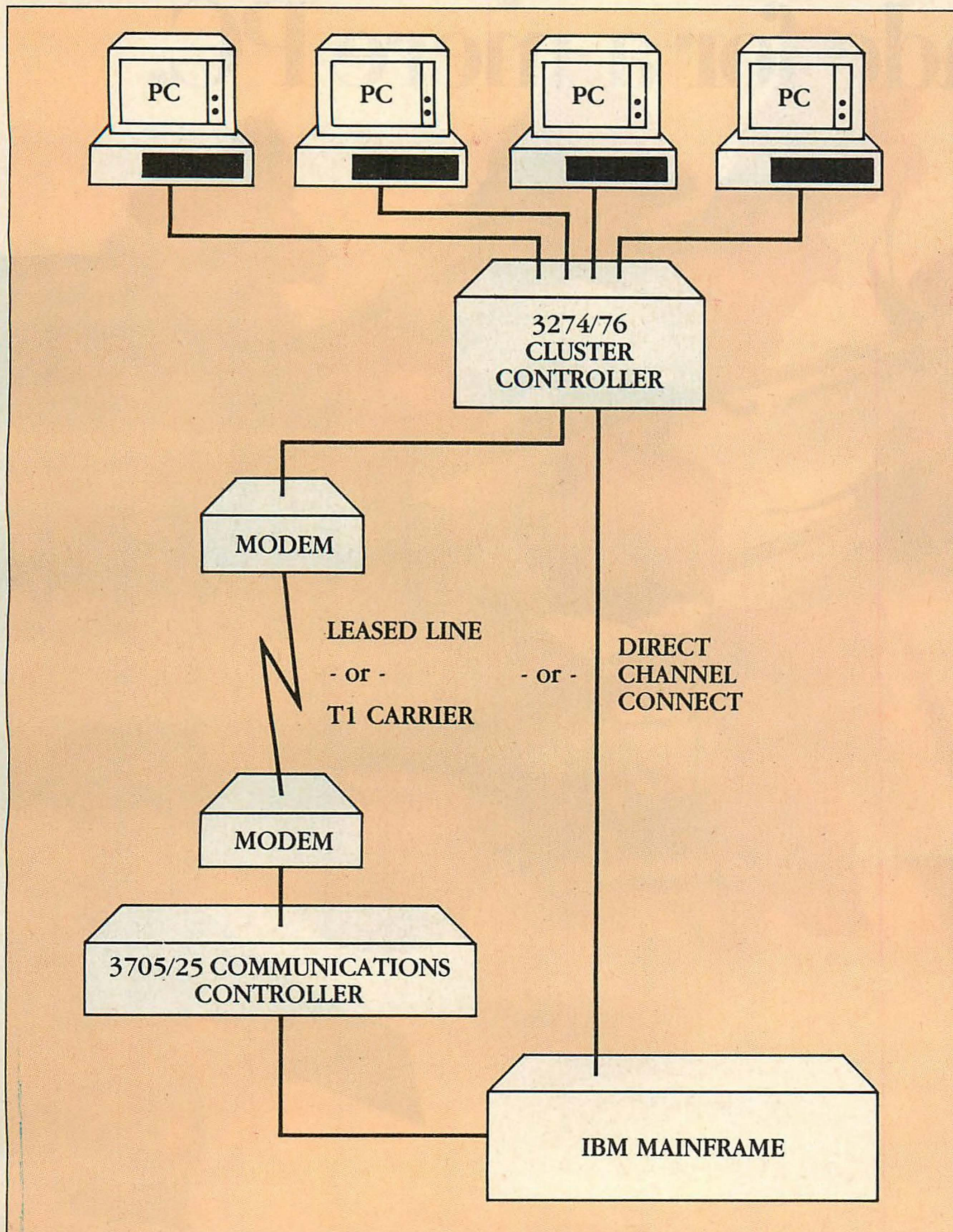
Some 3279 terminals also offer graphics adapter support, permitting terminal display of mainframe-generated color graphics. Some mainframe software packages (GDDM—Graphical Data Display Manager—and SAS GRAPH, for example) require this support; a few

of the 3279 emulators make it available as an added feature.

Users, however, also need to transfer local PC data to the host mainframe and vice versa. This raises many questions: Are file transfers supported under CMS? Under TSO? Can binary files such as load modules be transferred, or only text files? Because the files are stored in ASCII on the PC and in EBCDIC on the mainframe, are the data automatically translated between the two character encoding schemes? Is integrity (error) checking performed during the transfer? Is there a mainframe software component to the file transfer? If so, how is it installed? These and other questions are answered in various ways by the 3278/79 emulator packages.

Consider the PC keyboard. Its layout is different from that of the

FIGURE 3: Mainframe Connection through Cluster Controller



This configuration is common practice in large 3278/79 terminal installations. It permits 3278/79 terminals to be mixed with emulator-equipped PCs.

3278/79; therefore, each 3278/79 key must be mapped onto a corresponding key on the PC. If every 3278/79 key is not duplicated on the PC emulator, then a degree of 3278/79 functionality is lost. Most of the emulators duplicate 90 percent of the standard keys and functions, with the exception of the Cursor Select and Screen Print keys. Cursor Select allows a terminal without a light pen to simulate an entry in a pen-selectable field, an important factor in many CICS applications. Screen Print allows a 3278/79 to dump screen images to a printer connected to the 3274/6 controller. Most emulators do not support this function, but provide screen dumps to a printer connected directly to the PC.

A workstation PC must operate simultaneously as a 3278/79 terminal and a stand-alone computer. Most emulators

accomplish this through memory-resident software that allows the user to switch between 3278/79 sessions and DOS with a "hot key." DOS reentrancy problems limit the screen-image capture feature in resident emulator software; because of this, many packages also offer a nonresident mode, in which switching to a 3278/79 session requires reloading the emulation software each time. Note, however, that because most 3278/79 boards have on-board processors and memory, exiting a nonresident session does not mean a loss of connection or session with the host.

Ease of installation is an important consideration, particularly when specialized software must be installed on the mainframe. A user experienced only with applications programs on the PC needs clear, step-by-step documentation

on the mainframe file-transfer component. This job should fall under the realm of the systems software group; but in many cases, the PC user is unsupported by the MIS department.

The installation of the board itself is also a concern. Because all PCs are not configured identically, a unique interrupt level for the emulation board is not always possible, and neither is a unique address for the board's memory. Although the board may be set to a default interrupt level and address at the factory, it must permit easy reconfiguration during installation—generally with the use of DIP switches and jumpers. The documentation must be clear, pointing out potential conflicts with system resources such as serial or parallel ports or BIOS routines. The product should include diagnostics to test the emulator in case of initial malfunctions. Table 1 lists the products' features.

EMULATION EVALUATION

These 3278/79 emulation packages were tested on an IBM 3081-D mainframe running OS/MVS, TSO, and ISPF. They were attached to a 3274 cluster controller communicating via a T1 carrier to a remote 3705 communications controller using IBM's SNA protocol.

IBM 3278/79 Emulation Adapter. IBM sells the full-length, single-slot board, control program, and mainframe components of the file-transfer software separately. The package emulates only the 3278-2 and the 3279-2A/S2A, which means it is limited to four colors and does not support mainframe graphics in 3279 emulation. The installation of the mainframe software is better left to a systems specialist in spite of the clarity of the documentation. However, even the neophyte could handle the step-by-step instructions for creating a working diskette and starting up the emulation software.

The IBM file-transfer program is excellent. It is supported under both VM/CMS and MVS/TSO and uses the same protocol and mainframe software as the IBM 3270-PC. This protocol has been adopted by several other manufacturers of 3278/79 boards and has become a de facto standard. The program supports the transfer of both text and binary files of varying record lengths on both the mainframe host and the PC, and includes extensive validity checking. Files are transferred rapidly in 4,096-byte blocks. In addition, the program is able to perform ASCII/EBCDIC translations.

The memory-resident emulator software functions well, permitting the user to switch easily between a DOS

TABLE 1: 3278/79 Emulators Features Comparison

	IBM	PERSYST	LINKUP	FORTE	ATTACH.	IRMA	IDEA.	PCOX
3278/79 models emulated	2	2	2	2,3,4	2,3,4,5	2,3,4	2	2,3,4,5
Mainframe color graphics	No	No	No	Yes	No	No	No	No
3278 keyboard	Full ^a	Part. ^a	Full	Full	Full	Full	Full	Full
International keyboards	No	Yes	No	Yes	Yes	No	No	Yes
Keyboard reconfiguration	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Supports 3274 Entry Assist	Yes	No	No	No	No	Yes	No	Yes
Light-pen support	No	No	No	No	No	Yes	No	No
IBM compatible support	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Printer support								
On controller	Yes	No	No	No	Yes	Yes	Yes	Yes
Local	No	Yes	Yes	Yes ^b	Yes	Yes	Yes	Yes
Screen image to disk	No	Yes ^b	Yes ^b	Yes ^b	Yes	Yes	Yes	Yes
File transfer								
Slow—editor oriented	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Fast—mainframe program	Yes	No	No	Yes	Yes	Yes	No	Yes
Ease of installation								
Hardware	Good	Good	Fair	Good	Good	Good	Good	Good
Software	Good	Good	Fair	Good	Good	Good	Good	Good
FTP	Good ^c	Poor	Poor	Good ^c	Good ^c	Good ^c	Good	Good ^c
Changeable I/O address, memory address, interrupt	No	Yes	No	Yes	Yes	No	No	Yes
BASIC access to board	No	No	No	No	No	Yes	Yes	Yes
Diagnostic programs	No	Yes ^d	Yes ^d	Yes	Yes	No	Yes	Yes
Documentation								
Installation	Good	Good	Poor	Excel.	Good	Excel.	Excel.	Excel.
Operational	Good	Good	Poor	Excel.	Good	Excel.	Excel.	Excel.
Troubleshooting	Poor	Good	Poor	Excel.	Good	Poor	Excel.	Excel.
Overall performance	Good	Fair	Good	Good	Excel.	Excel.	Good	Excel.

^a No Cursor Select key.
^b Only in nonresident mode.
^c Requires mainframe knowledge.
^d Only on power-up.

IBM's emulator, while a good performer, is feature poor in comparison. Only FORTE PJ supports mainframe color graphics.

session and a 3278/79 session with Alt-Esc. Other key combinations let the user reboot DOS while retaining the emulation session or completely suspend the DOS session. The user also may start up the PC with only a 3278/79 session and initiate DOS later.

IBM's 3278/79 Emulation Control Program redefines the PC keyboard to include virtually all functions of the 3278/79 keyboard (U.S. English only, international versions are not supported). The only important key missing is Cursor Select, which prevents the use of this emulator in some CICS applications. The IBM emulator is one of the few that supports 3274 Entry Assists.

This package does have its shortcomings. For example, although the emulator permits output to a printer attached to the cluster controller, it has no provision for screen dumps from a 3278/79 session to a local printer attached to the PC. Another convenient feature offered by many emulators but absent in the IBM emulator is the ability to save screen images to the PC's disk.

Further, the interrupt vectors (50H through 57H) and I/O port (2D0H through 2DFH) used by the IBM board are permanently set. Any applications or other boards that use these addresses may not operate concurrently; applications that write directly to the video buffer also can cause conflicts. But a more serious problem is presented by the 3278/79 Emulation Control Program, which examines the ROM BIOS for the IBM copyright message. If the message is not found in ROM, the program returns to DOS with an error message—the product is incompatible with anything but an actual IBM PC.

The emulation package also falls short in another area: no diagnostic routines are provided and the troubleshooting documentation is at an elementary level. For example, if the answer to the question "Did the program load successfully?" is no, the user is advised to "Contact the point of purchase of your PC3278 Control Program." **Persyst/Emulex COAX/3270.** Persyst, a division of Emulex, Inc., produces the

COAX/3270, which includes a single-slot, full-sized board and emulation software. The COAX/3270 File Transfer Program, written by CDI Systems, Inc., is sold as a separate product. Like the IBM emulator, the COAX/3270 can duplicate but a few 3278/79 models, in this case, the 3278-2 or 3279-S2A/S2B. It provides base color support only and no mainframe graphics.

The file-transfer package comes on a diskette with an awkward copy-protection scheme. The first attempt to create a working disk, following the directions in the package, produced an unsuccessful copy—the program would not run. A second attempt was thwarted by the protection scheme, which allowed only one copy. A call to CDI Systems, Inc. (not Persyst) produced a code that permitted another copy. This time the batch files were examined and a minor error corrected; the working copy was made by executing each step manually.

The COAX/3270 file-transfer package works with both CMS and TSO. The CMS version supports only text files; the

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TSO version supports text and binary files. Both use the mainframe editor (XEDIT for CMS, EDIT for TSO). Each of these editors allows files of varying record lengths to be transferred. However, because this package has no host-based file-transfer software, validity checking is *not* performed during the transfer. Under the CMS option, files are transferred by records rather than in large blocks, which makes transfer much slower. Like IBM, COAX/3270 handles the ASCII/EDCDIC conversion. The speed of file transfer under TSO depends upon an installation's TSO EDITOR work-file size. The larger the work file, the faster the transfer. The rates can approach those of IBM.

The installation for this package is well documented. All of the files on the distribution diskette are explained, and instructions are given for backing up the files and creating a working disk. The emulation software is written by Persyst, not CDI, and it is *not* copy protected; its installation went smoothly. In addition, the user may reconfigure the address of the board's 32KB memory (initially C0000H-C7FFFH) and the interrupt level (initially level 3) via DIP switches and jumper blocks.

The emulator performed as promised, although the screen behaved strangely while capital letters were being entered. (The cursor went to the bottom left screen position after each keystroke of an uppercase character.) It includes some important features, such as screen image capture to the local printer, or, if the emulator is not memory resident, to disk; extensive on-line help; and the ability to run in resident or nonresident mode. In resident mode, the user may switch to and from the DOS session using the Shift-Shift combination. Note, however, that this poses a potential conflict with SideKick, which also uses Shift-Shift.

The COAX/3270 software comes with a redefinition of the PC keyboard to the functions of the 3278/79 keyboard (U.S. English edition). The package also includes definitions for the British, French, German, Italian, and Spanish keyboards. Or, the user may create keyboard definitions using a utility program provided in the package. In spite of all this, several important 3278/79 keyboard features are missing from the COAX/3270 keyboard definition, including Apostrophe, Attn, Ident, NumLock, Sys Req, and, as in the case of IBM, Cursor Select.

The hardware provides a self-test diagnostic feature at power-up, but this is as far as the diagnostics go. No rou-

tines are included to test for a correct installation. A brief appendix in the manual gives limited but well thought-out hints for troubleshooting.

LINKUP System COAX. Information Technologies, Inc. produces this system, which includes a single-slot, full-sized board, emulation software, and file transfer software as an option (at extra cost). Although the documentation states that LINKUP emulates a 3278-2 display station only, 3279-S2A emulation can be achieved using the color redefinition utility provided in the package. However, ITI's emulator does not provide support for 3279 graphics.

As with the Persyst COAX/3270, LINKUP's optional file-transfer software was written by CDI Systems. The programs exhibit similar features and appear to function identically: the LINKUP program has a similar copy protection scheme and it supports both CMS (text only) and TSO (text and binary) via the

Through memory-resident software, most emulators allow the user to switch between 3278/79 sessions and DOS with a "hot-key" combination, typically Shift-Shift.

mainframe editors. Its limitations also are similar: it has no validity checking, and it operates slowly in CMS and only moderately faster in TSO.

The hardware installation instructions consist of two sentences: "Instructions for installing option boards, such as LINKUP Coax, in IBM Personal Computers are provided in the options section of the IBM Personal Computer Hardware Reference Library *Guide to Operations*. For installation of the LINKUP Coax in IBM-compatible personal computers, refer to the computer manufacturer's user documentation for specific instructions on installing option boards." No information about board addresses, interrupt levels, or possible conflicts with other peripherals or programs is provided; nor are instructions for backing up the diskette or making a working copy included. A neophyte may feel forced to use the distribution diskette, a dangerous situation.

Nevertheless, the LINKUP emulator is a versatile package. The appearance of

the 3270 status line is much like that of the IRMA board (see below), with excellent graphic representation of the status line symbols. The emulator operates in memory-resident and nonresident modes. In resident mode, some of the extended features, such as screen image capture to disk, do not function. The package provides hot keys for the conversion between modes, to switch between DOS and 3278 sessions, to convert from color to monochrome display, and to capture screen images to local printers in either mode.

The LINKUP software offers a rather complete U.S. English keyboard. Although it does not support international versions, it does include a utility that allows the user to redefine the 3270 keyboard in any manner. In addition to the standard keys offered, LINKUP includes such useful extras as Attn, Sys Req, Ident, Test, and (for CICS users) Cursor Select. It even has equivalents of the 3278 cursor fast movement keys.

The manual for this package is extremely poor. It has no information on error messages, diagnostics, or troubleshooting, but it does list a telephone number for technical support. The hardware does offer two innovative, firmware-based diagnostic tests: a power-on test (which was not seen in action because the evaluation board functioned properly) and a coax test that is invoked from the keyboard with the results displayed in the status line. **FORTE PJ (3278/79).** This product from Forte Data Systems includes a single-slot, full-sized board and software that allows the PC to emulate 3278 models 2, 3, and 4 and 3279 models S2A, S2B, or S3A with seven-color extended highlighting in all terminal modes. Only Attachmate (see below) offers a wider range of emulation. Options sold separately include file transfer packages under either CMS or TSO, multiple session windowing and 3270-PC emulation, and 3279-S3G emulation (which permits full color graphics support).

The optional file-transfer package includes a diskette for the PC software and a 1600-bpi magnetic tape for the mainframe software. The documentation includes well-written installation instructions for both. The mainframe instructions are presented in an orderly fashion, but knowledge of JCL, CLISTS, ISPF (if installed), and system specifics is required. Installation of the PC software also is straightforward and, in fact, is included as one step in the general installation of the FORTE PJ emulator.

Forte offers two separate file transfer products for CMS and TSO. This

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evaluation pertains only to the TSO product, TSO-Fortenet (although a Forte representative affirmed that CMS-Fortenet is similar.) TSO-Fortenet is the most powerful file-transfer package in this field. In addition to allowing both varying-length-text and binary-file transfer between the PC and the mainframe, it also supports transfer to the MVS SYSOUT and INTERNAL READER. Transfers to SYSOUT permit the user to send PC files directly to mainframe output devices such as laser printers or high-speed line printers. Transfers to the INTERNAL READER permit mainframe batch jobs stored on the PC to be submitted directly to the mainframe. The product supports both ACF2 and RACF security systems. TSO-Fortenet has only one major limitation: it will work only when FORTE PJ is running in non-memory-resident mode.

In spite of this, TSO-Fortenet offers a variety of special features. It functions in TSO's native READY mode and includes full support for ISPF with six easy-to-use menu screens. It includes a series of mainframe CLISTs for batch uploading and downloading, the most powerful of which is BACKUPHD, used to back up directly to the mainframe all the files in specific PC directories. As a result, streaming tape or any other PC-based backup systems are unnecessary.

Forte's file-transfer facility, with both mainframe and PC components, includes extensive validity checking during transfers. Its 4,096-byte block size permits a faster rate than some of the other record-oriented packages. The documentation includes descriptions of the ASCII-to-EBCDIC and EBCDIC-to-ASCII tables that Fortenet uses to accomplish all of its character translation.

The FORTE PJ emulator functions well and all of its features work as documented. When using a color graphics board and color monitor, the emulator comes up in 3279 mode without requiring the user to define the colors. The status line includes items not found on the 3278/79 line, such as a resident mode indicator, which shows if PJ is memory-resident, and a model number indicator, which shows the current emulation model. FORTE PJ uses the Shift-Shift hot key to switch between 327x and DOS sessions. Its emulator includes many of the extended features found in other packages: screen image capture to disk, local screen print, initiation of resident mode, and diagnostic tests. Users should note, however, that these extended features and file-transfer functions are available *only* in non-memory-resident mode.

FORTE PJ is one of the few emulators to provide all of the functions of a 3278/79 keyboard, including Cursor Select. With the custom configuration program FDSCONF, the user can change the model emulation, keyboard layout, video interface and monitor type specification, color, and attributes, base address, printer port, foreign country keyboard and display, extended attribute support, and PC model. In addition to the default U.S. English keyboard, FORTE PJ also supports the Austrian/German, Belgian, Brazilian, Danish, Finnish, international, Italian, Portuguese, Spanish, U.K. English, Norwegian, Swedish, and French keyboards.

This product's manual is one of the most complete. Offering detailed step-by-step instructions on both hardware and software installation, it takes the user through diskette backup and working copy generation. The system comes with standard default values for PC type,

FORTE PJ's TSO-Fortenet
*is the most powerful file
transfer product in the field,
but it runs only in
non-memory-resident mode.*

interrupt level, 3278/79 model type emulation, and other necessary parameters. It determines the base I/O address, video interface type, monitor type, and printer port from the motherboard DIP switch settings. Any of these parameters can be changed with FDSCONF.

The manual also has extensive, well thought out sections on diagnostics, troubleshooting, and error messages, including an excellent discussion of potential base I/O address conflicts with other boards. The package contains an installation diagnostic program and troubleshooting routines.

Attachmate 3-N-1 3270 COAX Adapter. Attachmate offers the most versatile emulation boards and software on the market. Its 3-N-1 adapter is so named because it will run not only Attachmate's own software, but also software for the IBM 3278/79 emulator board and the IRMA board. (Some features of IBM's and DCA's software are not available when running on the 3-N-1; tables summarizing supported and unsupported features are included in the manual.) The documentation indicates that 3-N-1

will run PC-Focus from Information Builders, Goldengate from Cullinet, Interactive PC Link from McCormack & Dodge, and Tempus Link from Micro Tempus. Attachmate's 3270-PC emulation software also is interchangeable with the IBM adapter and the IRMA board. The 3-N-1 adapter with Attachmate's emulation program will emulate models 2, 3, 4, and 5 of both the 3278 and 3279, thus providing the widest emulation range of all packages tested. Its only significant shortcoming is that it does not offer the 3279 graphics support available with the FORTE PJ.

The file-transfer routine, included with the package's PC 3270 Emulation Program, offers support both for a proprietary file-transfer protocol using TSO's EDIT or CMS's XEDIT (similar to LINKUP or Persyst COAX/3270) and the host-supported protocol that is available with IBM's 3278/79 Emulation Control Program and 3270-PC. IBM host programs required are number 5664-281 for CMS, 5665-311 for MVS TSO, and 5798-DHQ for CICS (MVS/VM DOS). The editor-based transfers are slow, have no validity checking, and only provide support for text file transfers; they require no additional software and no mainframe installation. The host-supported routines are fast and include extensive validity checking, but they require the additional IBM programs and mainframe expertise for installation.

The Attachmate PC 3270 emulation program offers many features beyond the standard 3278/79 emulation. Because it also emulates a 3270-PC, it can accommodate seven active windows, including four simultaneous host terminal and printer sessions, two notepads, and a PC window running DOS (any version from 2.0 to 3.1). The emulation software is always resident, and rather than using traditional hot keys to move between DOS and 3278/79 sessions, the user jumps among the seven windows using the 3270-PC-style window management keys. However, it will function at a similar level to the other products using only two active windows: one for DOS and one for the host.

Attachmate's emulator includes many other extended features, such as 3270 printer emulation (LU3 print controls for a 3287 with a 2,048-byte buffer size), screen-image capture to either disk or local printer, and data block copying between windows. Its window management commands—jump, corner, size, add, delete—are virtually identical to those for the 3270-PC.

The Attachmate software has a unique copy-protection scheme. If the

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software is being used with an IBM or IRMA board, a key disk is required in drive A. If it is being used with the 3-N-1 board, the key is located in the firmware on the board. The 3270-PC emulation program includes an extensive configuration utility that covers many languages (U.K. English, French, Italian, Austrian/German, and Spanish, in addition to the default, U.S. English), user keyboard mapping, adapter board and host window session parameter selection, and window profiles. All 3278/79 keys are supported except Cursor Select and the fast arrow keys.

The installation goes smoothly because of complete and well-written documentation. Instructions for both hardware and software discuss I/O and memory address considerations and compatibility limitations. When emulating the IRMA board, 3-N-1 uses I/O addresses 220H-227H and memory addresses CE000-CFFFF; for the IBM board, it uses I/O addresses 2D0H-2D7H (the IBM board has no on-board memory, hence no memory mapping). The 3-N-1's I/O and memory addresses can be changed via jumper blocks.

The two manuals contain well-written sections on troubleshooting and error handling. The 3-N-1 diagnostic test program, provided with the board, lets the user verify installation and pinpoint operational problems that occur afterward. The diagnostic has both a stand-alone and on-line mode and tests all major functional areas of the adapter, including PC-to-adapter I/O control, shared memory, the coax processor, and the coax-peripheral interface. Attachmate's diagnostic program is the most thorough of those tested.

IRMA 3270 board. Digital Communications Associates' IRMA board, with its E78 Emulation Software, was the first 3278/79 emulator on the market. It has evolved into one of the most complete packages available. The IRMA package can emulate 3278/79 models 2, 3, and 4, which equals or surpasses all boards except the Attachmate 3-N-1.

In addition to the extended features (such as screen-image capture to disk and printer, keyboard configuration, and file transfer) offered on many boards, IRMA is the only product to provide full light-pen support. It does so through emulation of Cursor Select to simulate a light-pen selection. In addition, when the E78 terminal emulator is used with the IBM Color Graphics Adapter and a light pen (such as the pen by FTG Data Systems) is connected to the adapter, it fully emulates the IBM selector pen option on the 3279.

IRMA supports data entry to IBM mainframes through character-oriented serial devices attached to the COM1 serial port. The interface permits such options as bar code or optical character readers and touch input screens (such as the one manufactured by Touch Technology). For displays equipped with special character generator ROMs (which are available from DCA or STSC), IRMA supports the IBM APL/1 character set and keyboard.

Like 3-N-1, IRMA offers two file-transfer protocols. IRMAlink FT78X, a program that comes standard with the E78 software, uses XEDIT on the host running VM/CMS and TSO EDIT on an MVS/TSO host. It operates similarly to the editor-based file-transfer programs provided by other manufacturers, and supports text and limited binary file transfers. Editor-based transfers are nat-

D*CA's IRMA has evolved into one of the most complete 3278/79 emulation packages available.*

urally slow, but IRMAlink uses POWER-INPUT in XEDIT to improve performance on file uploads. (POWERINPUT allows "stream" character input without waiting for prompts.) The binary mode is used for transfers from PC to PC by uploading to the host from one PC and downloading to another. Archival storage of PC files on the mainframe is done in the same way. However, the transfer of binary files that the host can recognize is *not* supported.

The problem is that 8-bit bytes cannot be transmitted through mainframe editors, which deal only in 7-bit characters. (The high bit usually is usurped in some sort of parity-checking scheme.) PC binary files must be converted into two 7-bit characters before uploading through XEDIT or TSO EDIT. The character files stored on the mainframe are restored automatically to binary form when they are downloaded to a PC. For the mainframe to use them, a conversion utility must be written on the mainframe end to reassemble the character pairs into the original 8-bit bytes. DCA does not provide such a utility, nor do any of the other vendors employing a similar conversion scheme.

DCA does, however, bundle IRMAlink FT/TSO and FT/CMS with the IRMA

board to handle binary file transfers. IRMAlink is a high-speed file-transfer software package with both micro and mainframe components. The mainframe portion is distributed via two media: diskette and 1600-bpi magnetic tape. The diskette-based software can be uploaded using FT78X; the tape-based files can be unloaded using mainframe utilities. TEST.TXT, a file that is included on the distribution diskette, tests the file-transfer function.

FT/TSO can be run using either menu or single-command format. The former makes FT/TSO menu driven and allows access to the transfer type assigned by FT/TSO and to the transfer parameters. The latter makes FT/TSO command driven, and does not allow changing transfer types or parameters.

IRMAlink FT/TSO provides for the transfer of binary and text files of varying lengths. It supports both sequential and partitioned data sets. Through the use of predefined parameters (block size, LRECL, record size, and so on) each transfer requires only a fairly simple command. The predefined parameter file can be modified via a menu screen invoked by a function key.

IRMA's E78 emulator program can be activated with four options: basic E78 program, E78 with screen-save capabilities, E78 with screen-store and recall capabilities, and E78 with both screen save and screen store. Screen save records the screen image on disk; screen store stores the screen image in dynamic memory for recall anytime while E78 is active. Once activated, E78 defaults to nonresident mode. It is switched to resident using a hot key. In resident mode, the user can switch between 3278/79 and DOS sessions using another hot key. Like other packages, E78 does not offer the screen-image save function in resident mode. However, DCA is the only firm to compensate for this by allowing the user to activate simultaneously both the resident and non-resident forms of the emulator program. In resident mode, the user simply switches to the DOS session and initiates E78 again and is in nonresident mode. (When in simultaneous mode, the emulator uses twice the amount of memory, that is, 192KB.)

IRMA's E78 software provides complete 3278/79 emulation of the U.S. English keyboard. Using the GENX utility the keyboard and screen type can be reconfigured for APL, TEXT, and DATA ENTRY ASSIST (the latter is supported by IRMA and IBM only). GENX also defines the light pen, 3278/79 model, color, COM port, and PC look-alike

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patches for the 8086. IRMA does not support international keyboards.

For operations assistance, DCA's manuals are among the best. They take the user from elementary instructions for diskette duplication to an extensive technical reference outlining the board's architecture and the internal workings of the E78 software. The documentation contains BASICA subroutines for accessing IRMA's screen buffer. The board is addressed as an I/O device on the system unit bus with device code of 220H through 227H; one drawback is that these addresses are fixed and cannot be changed.

Another of the very few disappointments is IRMA's minimal troubleshooting support. The package contains no diagnostic programs and the manual devotes only three sparse pages to diagnostics, troubleshooting, and error conditions. The conditions discussed were too general, even though the discussions themselves are good.

IDEAcomm 3278. This package from IDEAssociates, Inc. includes a full-size, single-slot 3278 emulator board, emulation software, and a file-transfer package that supports MVS/TSO and VM/CMS. IDEAcomm 3278 enables the PC to emulate a 3278-2 or a 3279-S2A/S2B with eight-color support. It does not support mainframe color graphics.

The file-transfer facility, XFER, allows transfers in both directions in a MVS/TSO or VM/CMS mainframe environment. This program, as other emulators, performs transfers using the mainframe editors and therefore provides no mainframe component for validity checking. The file-transfer program is menu driven, allowing the user to select send or receive, text or binary files, record length and format, host data-set name, and PC file name.

Binary transfers are accomplished by converting each 8-bit byte into two 7-bit characters and transmitting the characters. If the remote system is a PC also running XFER, XFER will convert the two characters back into the original 8-bit byte. Otherwise, the transmitted data must be converted into binary data by a translator program (which is not supplied—it must be written by the user). As described earlier, the binary mode may be used to store PC binary files on the host for later downloads, but uploaded files cannot be used on the host itself. IDEAcomm also has a batch file-transfer facility, RUNFER, with which the user creates RUNFER.BAT, a file that contains information on multiple files to be uploaded and downloaded. This feature is helpful since the

file-transfer facility is editor based and therefore relatively slow.

IDEAcomm 3278 includes some unique and excellent features. From a 3278/79 session and without switching to DOS, the user can print and display PC files, obtain a PC directory listing, and access on-line help. The emulator also supports such features as screen-image capture to disk, locally connected printers, and controller-connected printers. With this product's screen capture to disk, the screen image is captured in a single 1,920-byte file complete with all the 3278/79 screen attribute bytes.

These bytes are the same as IBM's except that the second-highest order bit (bit 6) of the attribute byte is always 1.

In addition to the stand-alone non-memory-resident mode, IDEAcomm 3278 also has a memory-resident mode. This mode makes the IDEAcomm program part of DOS, thus allowing the user to switch between 3278/79 sessions and DOS using a hot key.

The software emulates a full 3278 keyboard, including Cursor Select. The configuration utility supports keyboard remapping, but does not include support for international versions. This utility also allows the emulator to simulate power off when the IDEAcomm is exited, define the printer (local or con-

With the IDEAcomm 3278 emulator package, the user can print and display PC files from a 3278 session without switching to DOS.

troller connected), and define the color for screen attributes.

The well-written documentation made installation easy for both hardware and software. It includes extensive descriptions of the interface between the IDEAcomm board and the PC, which uses I/O ports 3E8H through 3EAH and memory address E000H through EFFFH. The structure used to pass information between the two is described, and tips are offered on writing low-level application program drivers to interface to the 3270 display on the board. The manual also discusses the BASICA support subroutine included on the distribution diskette.

The manual has several sections on diagnostic testing using software in-

cluded in the package. The program is thorough and easy to use, and its documentation well written, although quite technical for the novice.

PCOX/PLUS. CXI's PCOX was among the earliest 3278/79 emulators on the market. PCOX/PLUS is a significantly enhanced version of the original product. The hardware is reduced to a half-size board, the only one tested. CXI's package is quite versatile, emulating 3278/79 models 2, 3, 4, and 5. Like IRMA and the IBM board, PCOX/PLUS supports the Entry Assist feature. It does not, however, support mainframe graphics or the PC light pen.

The control program partially emulates the 3270-PC with one host session, one DOS session, and two notepad sessions. Notepad data may be cut and pasted to other sessions or windows, and may be combined with keyboard entries. The contents of the notepad windows may be saved to disk or sent to a local (PC) printer.

CXI sells the PCOX 3270 Series File Transfer package separately. Like Attachmate's 3-N-1, the PCOX/PLUS offers support for basic file transfer based on TSO EDIT and CMS XEDIT, and an advanced protocol running on the mainframe under TSO and CMS. CXI does *not* support CICS-based file transfers.

The editor-oriented file transfer programs are easily implemented using TSO CLISTS or CMS XEDIT scripts. The basic protocol is slow, has no error checking, and does not handle binary files. Installations using ACF/VTAM support for data communications can take advantage of the default maximum record size for the TRANSFER LIMIT.

The advanced file-transfer protocol is well thought out and fast. Installation is complex and should be attempted only with the help of systems programmers. CLISTS, JCL, and some 370 source code and object code must be uploaded using the basic file-transfer routines. Modification of the CLISTSs, JCL, library, and data set names and assembly and link editing must be done in order to complete installation.

Although this advanced protocol does not follow the IBM standard, it is very versatile. It supports standard ASCII text transfers (like the basic protocol) and several other modes. The compressed mode replaces up to 64 successive occurrences of the same character by a three-character sequence: escape, count, and character. On the host, this sequence is expanded to the original string. The binary (transparent) mode transfers an exact image of each byte. The file-transfer program translates each

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three-byte group to four bytes of 3270 buffer codes, which are translated by the 3274/76 cluster controller (or cluster control program if in DFT mode) to EBCDIC. This is reconverted by the host-end software to the original three-byte groups. The user may specify compressed mode on this operation before three-byte translation to further speed up transfers. Finally, CXI offers an offset transfer mode for files that will be processed by ISPF. This replaces the first six or eight bytes of each record for some file types (COBOL, for example) with a sequence number.

Like many of the others, the PCOX/PLUS emulator program cannot save screen images to disk while memory resident. The advanced file-transfer package must be loaded from the host session to save screen images. In addition to interactive file transfers, PCOX/PLUS also supports command-mode transfers via PC batch files created by the CXI Batch File Generator.

The PCOX 3278/79 Control Program supports many of the 3270-PC's functions, including windows, jumping and enlarging windows, cut and paste, and changing screens. The control program functions only in memory-resident mode. Like Attachmate, hot keys for moving between emulation sessions do not apply because the software allows jumping among windows. The program supports complete 3278/79 keyboard emulation, including Cursor Select, all entry assist features, and most 3270-PC keys. CXI defines many international keyboards, including U.S. English, Austrian/German, Belgian, Canadian French, Danish, Finnish, French, Italian, Japanese-English, Norwegian, Spanish, Swedish, and U.K. English. It does *not* support user-defined keyboards.

Installation instructions are complete and the operation went smoothly. The board is factory set to IRQ level 2, DMA 1, and I/O ports 3EE and 3EF. These specifications can be changed to avoid conflicts with other boards.

The manuals are well written and offer a complete section on diagnostics. The emulation software contains a menu of excellent maintenance functions including interface reset, diagnostics, and a memory-dump facility. The diagnostics also can be accessed from the File Transfer Program.


PCOX/PLUS is a solid product with excellent file transfer and the best diagnostic functions of any board tested.

A STRONG FIELD

IBM's 3278/79 emulator has a fast, industry-standard file-transfer package and the mainframe component also supports the 3270-PC. However, because the software does an environment check, it cannot be used on non-IBM machines. In this case, the Attachmate 3-N-1 is a good alternative; it supports the IBM file-transfer protocol, runs in non-IBM compatibles, and simulates the 3270-PC as well. In configurations where slots are scarce, CXI's PCOX/PLUS could be the only choice.

Another board that deserves recognition is the FORTE PJ emulator. Although many other vendors offer better packages overall, two features distinguish the FORTE PJ: it is the *only* board that offers 3279 color graphics, and it has the fastest and most versatile file transfer program. It should be given serious consideration by the user who performs numerous transfers, who is interested in hard disk backup, or who needs to transfer files directly to SYSOUT of the mainframe's internal reader.

An evaluation such as this cannot overlook the progenitor of all 3278/79 emulators, the IRMA board. IRMA has evolved into the best board on the market overall. It supports most of the features found in the other packages and is the only board to fully support light pens. It is also one of only three that supports Entry Assist. Its file-transfer routines are solid and quick, even though they are proprietary and run only on the IRMA and 3-N-1 boards. IRMA's only other significant flaws are its poor troubleshooting and lack of diagnostic routines. However, DCA's support line was easily accessible and the personnel knowledgeable.

Emulation of 3278/79 display stations can be effected with many variations. Some users require color to support customized mainframe software; others may need or want 3279 color graphics or light-pen support. Virtually every 3278/79 feature is offered by one or more of these packages; this is a matter of selecting the combination that best answers needs. Of course, an important part of any purchase is making sure the product does what it says it will do. The manufacturing quality for each of these boards is quite high, as might be expected in a maturing micro-computer hardware market. IBM has set high standards, and because they are being met so boldly by third party vendors, users may select from among many quality products, such as the packages in this field. 

Techland Systems' BLUELYNX 3270 will be reviewed in an upcoming issue.

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Attachmate 3-N-1 3270 COAX Adapter:
\$1,195

Attachmate Corporation
3241 118th SE
Bellevue, WA 98005
206/644-4010
CIRCLE 309 ON READER SERVICE CARD

FORTE PJ (3278/79): \$1,195
CMS/TSO file-transfer package per CPU:
\$1,000

Corporate license: \$5,000
Forte Data Systems
2205 Fortune Drive
San Jose, CA 95131
800/233-3278; 408/945-9111
CIRCLE 311 ON READER SERVICE CARD

IBM 3278/79 Emulation
Adapter: \$905

IBM Corporation
P.O. Box 1328
Boca Raton, FL 33429-1328
Contact the local IBM dealer;
800/426-2468
CIRCLE 312 ON READER SERVICE CARD

IDEAcomm 3278: \$995
IDEAssociates, Inc.
35 Dunham Road
Billerica, MA 01821
617/663-6878
CIRCLE 313 ON READER SERVICE CARD

IRMA 3270 board: \$1,195
Digital Communications Associates, Inc.
1000 Alderman Drive
Alpharetta, GA 30201
404/442-4000
CIRCLE 314 ON READER SERVICE CARD

LINKUP System Coax: \$495
ITI—Information Technologies, Inc.
7850 E. Evans Road
Scottsdale, AZ 85260
800/431-3460; 602/998-1033
CIRCLE 315 ON READER SERVICE CARD

PCOX/PLUS: \$1,145
CXI, Inc.
3606 W. Baysshore Road
Palo Alto, CA 94303-4229
800/225-PCOX; 415/424-0700
CIRCLE 310 ON READER SERVICE CARD

Persyst/Emulex COAX/3270: \$1,095
Emulex Corporation
3545 Harbor Blvd.
Costa Mesa, CA 92626
714/662-5600
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