Seventh Annual Extra All-IBM Edition

Display until January 18, 1991

BYTE

IBM SPECIAL EDITION

GUIDEPOSTS FOR THE 90s

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And last, but by no means least, the kind of award-winning service and support that has earned Dell the #1 rating in 6 out of 6 *PC Week* customer satisfaction polls for PC's. A *no questions asked* 30-day money-back

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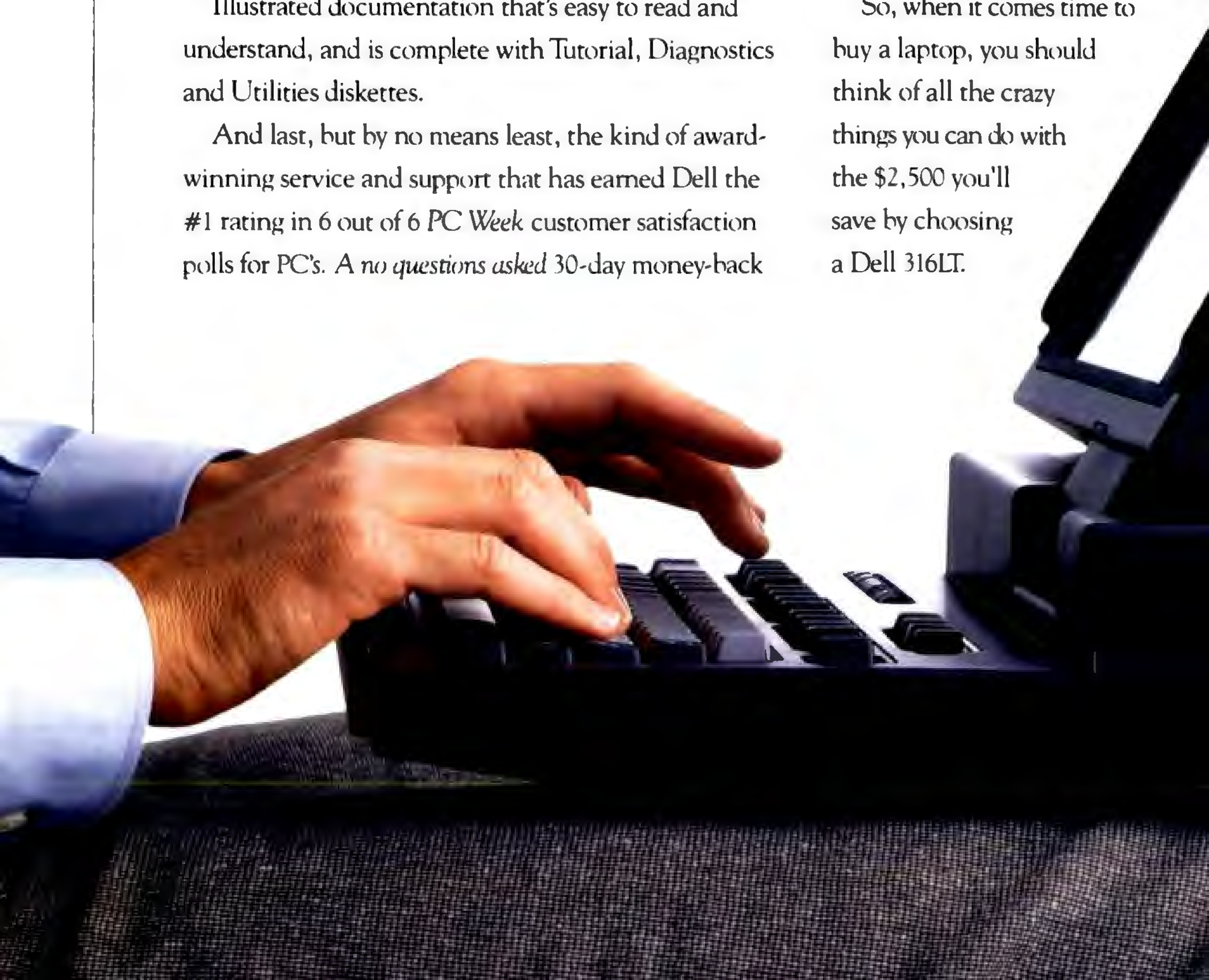
through many purchase and
lease plans that are available.

So, when it comes time to buy a laptop, you should think of all the crazy things you can do with the $2,500 you'll save by choosing a Dell 316LT.



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THE NEW DELL i486™ 33 MHz AND 25 MHz EISA SYSTEMS.

The best value in high performance PCs, combining i486 performance, 32-bit EISA I/O bus, and the industry's top rated service and support.

STANDARD FEATURES:

- i486 microprocessor running at 33 MHz or 25 MHz
- 32-bit EISA bus architecture (downward compatible with ISA)
- Standard 4 MB of RAM,* expandable to 16 MB on system board, using optional 1 MB and 2 MB SIMMs
- VGA systems video adapter
- Integrated 387 compatible math coprocessor
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive
- 5 half-height drive bays
- Dual diskette and hard drive controller.
- Six 32-bit EISA (ISA compatible), plus two 16-bit ISA expansion slots
- High-performance IDE (80 MB, 100 MB, 190 MB), and ESDI (330 MB, 650 MB) hard disk drives
- Enhanced 101-key keyboard
- 1 parallel and 2 serial ports
- 230-watt power supply
- 12-month On-Site Service Contract provided by Xerox.

*****Commercial Lease Plan. Lease for as low as $286/month (433E) and $232/month (425E†).***
Xerox Extended Service Plan pricing starts at $617 (425E) and $672 (433E).

	433E	425E
80 MB VGA Monochrome System	$7,899	$6,399
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330 MB Super VGA Color System (800 x 600)	$9,599	$8,099
650 MB Super VGA Color System (800 x 600)	$10,799	$9,299

Prices listed include 4 MB of RAM. 100 MB hard drive configurations also available.

THE DELL SYSTEM 325 25 MHz 386 AND DELL SYSTEM 310 20 MHz 386

The best combination of performance and value available in their class.

STANDARD FEATURES

- Intel® 80386 microprocessor running at 25 MHz (Dell 325) or 20 MHz (Dell 310).
- Standard 1 MB of RAM, optional 2 MB or 4 MB of RAM* expandable to 16 MB (using a dedicated high-speed 32-bit memory slot).
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high-speed static RAM cache
- Page mode interleaved memory architecture
- Socket for Intel 80387 or WEITEK 3167 math coprocessor
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports
- 200-watt power supply
- 8 industry standard expansion slots (6 available)
- 12-month On-Site Service Contract provided by Xerox.

*****Commercial Lease Plan. Lease for as low as $131/month (325) and $112/month (310).***
Xerox Extended Service Plan pricing starts at $370 (325) and $251 (310).

	325	310
40 MB VGA Monochrome System	$3,599	$2,999
80 MB VGA Color Plus System	$4,099	$3,499
80 MB Super VGA Color System (800 x 600)	$4,199	$3,599
190 MB Super VGA Color System (800 x 600)	$4,699	$4,099

Prices listed include 1 MB of RAM. 100, 330 and 650 MB hard drive configurations also available.

THE NEW DELL SYSTEM 320LX 20 MHz 386SX

One of the fastest SX's around.

STANDARD FEATURES

- Intel 80386SX microprocessor running at 20 MHz
- Standard 1 MB of RAM,* optional 2 MB or 4 MB expandable to 16 MB (8 MB on the system board)
- VGA systems include a high-performance 16-bit video adapter.
- LIM 4.0 support for memory over 1 MB
- Socket for Intel 20 MHz 80387SX math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive
- Integrated high-performance hard disk interface and diskette controller on system board (ESDI-based systems include a hard disk controller).
- 1 parallel and 2 serial ports
- Enhanced 101-key keyboard
- 200 watt power supply
- 8 industry standard expansion slots (7 available)
- 12-month On-Site Service Contract provided by Xerox.

*****Commercial Lease Plan. Lease for as low as $98/month.***
Xerox Extended Service Plan pricing starts at $261.

	320LX
40 MB VGA Monochrome System	$2,599
40 MB VGA Color Plus System	$2,899
80 MB Super VGA Color System (800 x 600)	$3,199
100 MB Super VGA Color System (800 x 600)	$3,399

Prices listed include 1 MB of RAM. 190, 330 and 650 MB hard drive configurations also available.

2-1-90

THE DELL SYSTEM 316SX 16 MHz 386SX and DELL SYSTEM 210 12.5 MHz 286

The perfect low profile mainstream computers

STANDARD FEATURES:

- Intel 80386SX microprocessor running at 16 MHz (Dell 316SX) or 80286 microprocessor running at 12.5 MHz (Dell 210)
- Standard 512 KB of RAM, optional 640 KB, 1 MB or 2 MB of RAM* expandable to 16 MB (8 MB [316SX] and 6 MB [210] on system board)
- Page mode interleaved memory architecture
- LIM 4.0 support for memory over 640 KB
- Socket for Intel 80387SX (316SX) and 80287 (210) math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive
- Enhanced 101-key keyboard
- 1 parallel and 2 serial ports
- 3 full-sized 16-bit AT expansion slots available
- 12-month On-Site Service Contract provided by Xerox

*****Commercial Lease Plan. Lease for as low as $73/month (316SX) and $62/month (210).***
Xerox Extended Service Plan pricing starts at $196 (316SX) and $158 (210).

	316SX	210
20 MB VGA Monochrome System	$1,949	$1,649
40 MB VGA Color Plus System	$2,449	$2,149
40 MB Super VGA Color System (800 x 600)	$2,549	$2,249
80 MB Super VGA Color System (800 x 600)	$2,749	$2,449

Prices listed include 1 MB of RAM. 2 MB versions of the above systems are available for an additional $100. 100 and 190 MB hard drive configurations also available.

THE DELL SYSTEM® 316LT 16 MHz 386SX.

This full-featured, battery-powered 386SX laptop costs less than most 286 laptops.

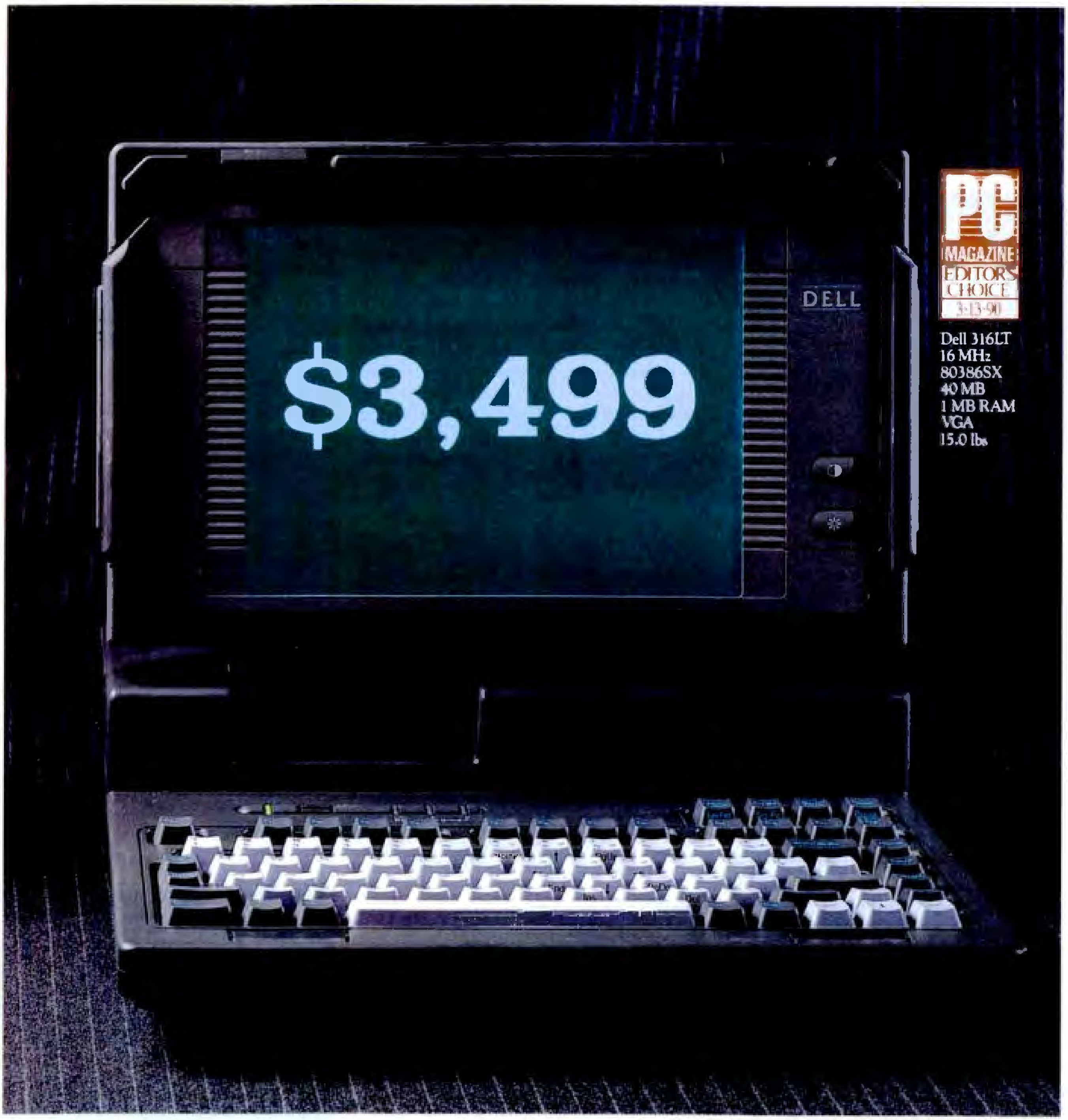
STANDARD FEATURES:

- Intel 80386SX microprocessor running at 16 MHz.
- Standard 1 MB of RAM, optional 2 MB of RAM* expandable to 8 MB (on the system board using 1 MB SIMMs).
- LIM 4.0 support for memory over 1 MB.
- Adjustable and detachable 640 x 480 VGA Liquid Crystal Display.
- One industry standard half-size 8-bit expansion slot.
- Socket for 16 MHz Intel 80387SX math coprocessor.
- 3.5" 1.44 MB diskette drive.
- 83-key keyboard with embedded numeric keypad and separate cursor control keys.
- 1 parallel, 1 serial, and external VGA monitor port.
- Connector for 101-key keyboard or numeric keypad.
- Connector for external 5.25" 1.2 MB diskette drive.
- Two removable and rechargeable NiCad battery packs utilizing Dell's "Continuous Power Battery System" (patent pending).
- AC Adapter.
- 12-month On-Site Service Contract provided by Xerox.△

*****Commercial Lease Plan. Lease for as low as $120/month.***
Xerox Extended Service Plan pricing starts at $303.

20 MB, 1 MB RAM	$3,199
20 MB, 2 MB RAM	$3,399
40 MB, 1 MB RAM	$3,499
40 MB, 2 MB RAM	$3,699

YOU'D HAVE TO BE CRAZY TO BUY ONE OF THESE AWARD WINNERS.



The laptop above is ours. The Dell™ 316LT. It comes with an Intel® 386™SX CPU running at 16 MHz. 1 MB of RAM, expandable to 8 MB, and a backlit VGA display. With a 40 MB hard drive it weighs 15 lbs. It won the *InfoWorld* Exceptional Value Award, and was one of only two 386SX laptops to win the *PC Magazine* Editor's Choice Award.

The one with the reddish screen on the opposite page is theirs. The Toshiba T3100SX. With the same configuration as our laptop. It didn't win the same award from *InfoWorld.* But it did tie with Dell for *PC Magazine* Editor's Choice Award.

Which is where the similarities stop.

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Circle 53 on Reader Service Card

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with the world's most popular, expandable, flexible

Multi-User Online Bulletin Board System

The Major BBS® starter system:

A complete BBS software package for your PC, PS/2, XT, AT, 386, 486, or compatible. Includes electronic mail with binary and ASCII file "attachments", SIG conferencing or "forum" areas with configurable security level access control, file upload/download, message keyword searching, "quickscans" for fast access to new messages, message and file "threading", real-time multi-user "chat" and teleconferencing, "classified ad" and "user registry" databases, etc. Also includes accounting, Audit Trail, and timed usage-metering features, and hundreds of convenience features for the Sysop (System Operator), such as a full-screen configuration editor, the ability to import/export files to/from floppy without system shutdown, "SIG-Op" privilege delegation, and much more. Supports up to 2 simultaneous users (from a database of thousands) on a single CPU. Works with standard Hayes-compatible COM1/2/3/4 internal or external modems, or with serial ports up to 38,400 bps. Minimum RAM requirement 512K. Minimum disk requirement 20MB. Requires PC-DOS or MS-DOS 3.1 or later.

The Major BBS Standard Edition ..... $ 59

When you're ready to expand:

No LAN or multi-tasking OS necessary! Double the number of simultaneous users that your system can support, from 2 to 4, or 4 to 8, or any number up to 64 simultaneous users on a single CPU, for a flat $300 software license fee per doubling. The upgrade process is quick, automatic, and fully upward-compatible – i.e. you can install an update or upgrade onto your existing system without disrupting any of your user account files, E-Mail messages, configuration variables, or any other aspect of your system. For up to 16 users, 640K RAM is sufficient; above 16 users, more than 640K may be necessary. Prerequisite: The Major BBS (any edition).

Users, per doubling (up to 64) ...... $ 300

If you need multi-modem hardware:

Our Model 2408 consists of up to 8 Hayes-compatible modems on a single circuit card, for the PC/XT/AT/386/486 family. Each modem operates independently at 300/1200/2400 bps (automatically switching to match the caller's bps rate). Built-in serial ports are not COM-port based, so this card can co-exist with other COM port hardware in the same machine (drivers for software other than The Major BBS are not included but may be written). RJ-11 telephone cables are included. MNP Class 4 (error correction) modems are available as an option.

	non-MNP	*MNP Class 4*
2408 w/2 modems	$ 1536	$ 1696
2408 w/4 modems	$ 2090	$ 2388
2408 w/6 modems	$ 2644	$ 3080
2408 w/8 modems	$ 3198	$ 3772

When you're ready for source code:

With the C source code to The Major BBS, you can add 3rd-party software, such as The Major Database (a general-purpose, configurable database manager), various multi-player real-time adventure games, dial-out utilities, global command utilities, accounting enhancements, and much more. Also, you can maintain your own copy of the BBS, or you can modify it to suit your own unique requirements. The Major BBS C source code package is fully documented, and it includes the Galacticomm Software Breakthrough Library, plus all of the utility object libraries, linker control files, and DOS "batch" files you will need, along with a detailed Programmer's Guide. Works with Turbo C 1.5, 2.0, or 2.01, Turbo C++, or Microsoft C 4.0, 5.1, or 6.0. Prerequisite: The Major BBS Standard Edition.

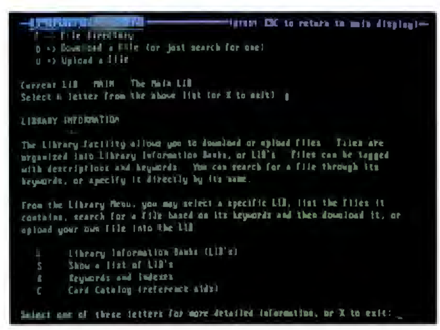
Standard Edition C source code ..... $ 285

For the ultimate in *file transfer flexibility:*

The File Library Edition of The Major BBS has everything that the starter system does, plus built-in ZMODEM, KERMIT, Super-KERMIT, YMODEM-g, and YMODEM (batch) file transfer protocols. Also, it offers super-fast pre-indexed keyword file searches, library-wide searches as well as constrained searches, special file upload/download accounting options, alternate DOS "paths" per sub-library, split paths for CD-ROM support, a transparent "DOS-only" sub-library option, and much more. This package is for you if the focus of your system will be the upload and download of large amounts of files. You can easily upgrade from the starter system to the File Library Edition, without losing any of your data files or configuration work you have already done. Prerequisite: The Major BBS Standard Edition.

File Library extensions .... $ 199

*File Library C source extensions** ... $ 159



If you decide to offer *online games and amusements:*

The Entertainment Edition of The Major BBS has everything that the starter system does, plus Quest for Magic (a multi-player interactive text adventure game), Androids! (a multi-player arcade-style ANSI-graphics game), Flash Attack (a futuristic tank and laser battle for multiple players with IBM PC's), and the Action Teleconference Link-Up, which includes private "chambers", action verbs (grin, wink, nudge, etc.), the ability to link to other systems for huge multi-system teleconferences, custom entry/exit strings, user-configurable profiles, and much more. This Edition supports the Flash™ Protocol (where most of the game functionality is on the user's end of the phone line), for which dozens of incredible new multi-user games are now being developed. Upgrading from the starter system to the Entertainment Edition is quick

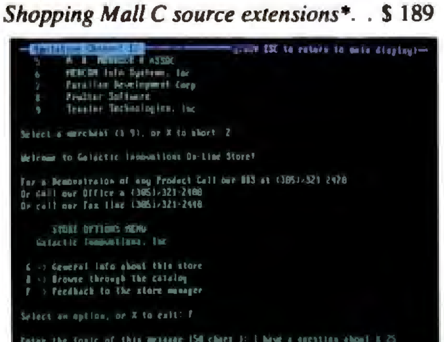
and easy and involves no loss of data or function. Prerequisite: The Major BBS Standard Edition.

Entertainment extensions .... $ 149
*Entertainment C source extensions** .. $ 129

If your requirements include *order entry and catalog sales:*

The Shopping Mall Edition of The Major BBS has everything that the starter system does, plus online shopping. Your online mall can have multiple "stores", each run by its own separate "merchant", if desired. Each merchant has control over his or her own product line, pricing, discount structure, store welcome message, sales tax handling, etc. Also, each merchant may create up to 6 different payment methods (e.g. VISA, MC, AMEX, C.O.D., "bill me", etc.), and up to 6 different shipping methods (e.g. UPS, FedEx, US Mail, etc.), each with its own rates (flat rate, percent of sale, 1st-ounce/add'l-ounce, or 1st-pound/add'l-pound). Users may browse product catalogs at no obligation, or order products and services directly online! Orders generate invoices that are posted to the individual merchant as attachments to E-Mail. To upgrade from the starter system to the Shopping Mall Edition takes only a few minutes. Prerequisite: The Major BBS Standard Edition.

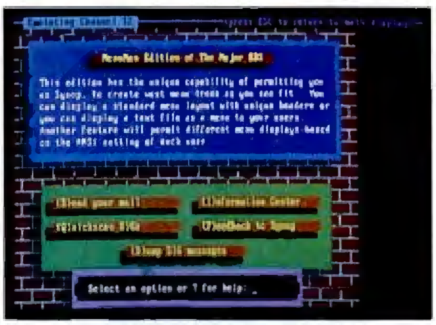
Shopping Mall extensions .... $ 249
*Shopping Mall C source extensions**. . $ 189



For super-flexibility of *menu trees and ANSI screens:*

The MenuMan Edition of The Major BBS can do everything that the starter system does, and in addition you as Sysop can create your own menu trees, with menus leading to menus leading to menus, as deeply "nested" as you like. The "leaves" of your menu trees can be ordinary ASCII or ANSI files, which are simply dumped to the user's display (with or without automatic screen breaks), or they can be any of the built-in functions of the BBS such as scanning the user's incoming E-Mail or firing up a SIG quickscan. Includes commands like *GO <pagename>*, *FIND <topic>*, *USERS*, and for the Sysop, the equivalent of the DOS commands *DIR*, *RENAME*, *COPY*, *DEL*, *MKDIR*, and *RMDIR*, as well as a set of privileged commands for editing and extending the menu trees, remotely, while the BBS remains fully online. Upgrading from the starter system to the MenuMan Edition takes only minutes. Prerequisite: The Major BBS Standard Edition.

MenuMan extensions .... $ 149
*MenuMan C source extensions** .... $ 129



As your system grows larger...

The GalactiBox™ is our 16-slot "expansion chassis", for large-scale systems. It has the unique ability to address individual modems by slot number rather than just COM port address, so you can use up to 16 standard internal modems in it, side by side, without conflict. Includes built-in 150W power supply, interface card for your XT/AT/386/486, cables, and full documentation. Up to 4 boxes may be attached to one CPU, for a total of up to 64-channel expansion capacity. Prices shown below are for standard 300/1200/2400 bps Hayes-compatible internal modems. We also have 9600 bps V.32/V.42 MNP Class 5 modems available, call for prices.

GalactiBox (unpopulated) .... $ 1992
GalactiBox w/4 modems .... $ 2416
GalactiBox w/8 modems .... $ 2840
GalactiBox w/16 modems .... $ 3688

...and that's not all! For advanced applications, we also offer an X.25 direct-connect software option, a protected-mode development toolkit, and special licensing arrangements for up to 256 simultaneous users! And don't forget the smorgasbord of 3rd-party add-ons available, such as The Major Database from Galactic Innovations. Custom programming and integration services are also available. Your system can grow in power and sophistication, far into the future, with The Major BBS.

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Just dial (305) 583-5990 and say, "I'd like to place an order!" We can generally ship your order within 48 hours. We accept major credit cards, or we can ship C.O.D. Prices shown do not include shipping or insurance.

For more information, you may either call the main order number and ask for a sales engineer, or dial (305) 583-7808 with your modem (8-N-1) for a free demo of most of our products. This demo system also contains an online Shopping Mall with many of the 3rd-party add-ons available for The Major BBS, operated by the 3rd-party vendors themselves.

Give us a call today!

VISA MasterCard AMERICAN EXPRESS

**The C source code extensions are necessary, if you wish to combine multiple extended Editions together, or add 3rd-party software, or develop your own modifications. Prerequisites, in each case, are the Standard Edition C source code, and the corresponding extended Edition.*

GALACTICOMM

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Circle 103 on Reader Service Card

VOLUME 15, NUMBER 11, 1990

BYTE

IBM SPECIAL EDITION

FEATURES

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Combining great power and speed with the enhanced compatibility of EISA architecture, the PowerMate® 386/33E is just what farsighted businesses need. For CAD/CAM. Financial modeling.

C&C
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you'll need powerful specs.

CPU

Intel 386™ microprocessor
33 MHz processing speed
(zero wait states)
8 MHz compatibility mode
(1 wait state)
Optional Weitek WTL 3167
or Intel 387 math coprocessor
Calendar/clock (with battery backup)

MEMORY

4 MB or 8 MB (80 ns)
memory standard
Dedicated 32-bit high-speed
Concurrent Memory Bus
architecture (33 MHz)
Total high-speed memory
expandable to 32 MB
64 KB (20 ns) SRAM cache

INTERFACES

Parallel printer port
Two RS-232C serial ports
PS/2®-style mouse port
PS/2-style keyboard port

EXPANSION SLOTS

One 32-bit full-size memory slot
Five 8/16/32-bit ISA/EISA
full-size slots
One 8/16-bit full-size ISA slot
One 8/16-bit half-size ISA slot

STORAGE SLOTS

Five 5¼" half-height
Support for alternate two
full-height 5¼" and one
half-height configuration

KEYBOARD

101-key mechanical keyboard
Separate numeric and cursor
control pads

SYSTEM SECURITY

Power-on password
Keyboard password
Network password
System cover lock (optional)

SOFTWARE/NATIVE MODE SUPPORT

MS-DOS®
Windows™ 3.0
NEC-enhanced OS/2™ (optional)
SCO™ UNIX® System V (optional)
NEC-enhanced EISA
configuration utility

DATA STORAGE

Floppy disk drives
—1.2 MB 5¼"
—1.44 MB 3½" (5¼" form factor)
Hard disk drives
—100 MB 3½" ESDI
(< 23ms, 5¼" form factor)
—118 MB 3½" SCSI
(< 20ms, 5¼" form factor)
—140 MB 5¼" ESDI (< 18ms)
—300 MB 5¼" SCSI (< 18ms)
—300 MB 5¼" ESDI (< 18ms)
—600 MB 5¼" SCSI (< 16ms)
Tape drives
—40 MB 5¼"
—150 MB high-speed 5¼"

DISK SUBSYSTEMS

EISA SCSI host adaptor (optional)
—EISA bus master capability
—support for 7 SCSI devices
—32-bit EISA bus interface
—33 MB/second burst rate
—scatter-gather transfer
—SCSI command queuing
—auto configuration
ESDI controller (optional)

NEC DISPLAY OPTIONS*

—MultiSync 2A
—MultiSync 3D
—MultiSync 4D
—MultiSync 5D

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MultiSync® Graphics Engine™
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—325 watt maximum rated output

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Circle 134 on Reader Service Card

GUIDEPOSTS

We'll point out the grand vistas as well as the intriguing side trips

It's hard to believe that this is the *seventh* annual *IBM Special Edition*. But IBM, its worthy competitors, and third-party suppliers have been such a force in this complex industry that we are again offering a bonus edition of BYTE to provide you with some direction and guideposts along the way.

You'll find an eclectic mix of articles in this issue, ranging from general-interest updates on important industry segments to more-detailed technical pieces on a wide variety of topics.

And a wide variety it is. Just as the microcomputing industry's boundaries are expanding and overlapping—what with DOS and its extensions, OS/2, Windows, Unix, mountains of compatibles, new microprocessors, networking, the Mac, and other hardware and software contenders—so, too, are the demands on BYTE readers to understand the "big picture."

That's why there's such diversity in this year's *IBM Special Edition*, including information on the Mac and micro-to-mainframe communications.

The Big Picture

"IBM in the Nineties" is an overview of where the IBM world is heading. This article touches on key issues that will influence the way we work.

If you are wallowing in system manufacturers' endless claims about their hardware being fastest, "Benchmarks at a Glance: 1990" is for you. The BYTE benchmarks rank the top PCs, Macs, and Unix platforms, using comprehensive, unbiased testing from the pros in the BYTE Lab.

With all the hoopla and volumes of material being written about OS/2 and Windows 3.0, just what are the crucial differences to users? The graphical presentation of these two graphical user interfaces found in "PC GUIs Go Head to Head" makes it easy to compare their approaches.

Although once completely isolated from the IBM world, today the Mac fits in quite nicely, part of the expanding idea of communications among dissimilar platforms. If you work with Macs and PCs, the practical information provided in "Stranger in a Strange Land" will help you smooth out the data sharing.

And speaking of cooperative efforts, we also have "Making the Micro-to-Mainframe Connection" and "Don't Worry, Use HLLAPI," a language that helps you work out shared processing tasks among PCs and mainframes. Along with those, "Adding Value to Your Data" delves into hardware and software approaches for moving data.

Finally, our man in London, Colin Barker, senior editor, surveys the European computing scene with particular emphasis on IBM in "Continental Computing." He concludes that things are different from the U.S. when it comes to computing perceptions and expectations for both buyers and sellers.

Software Development

Microsoft's OS/2 2.0 Software Development Kit is going to affect future OS/2 software development that we'll all use. "Programming 32-bit OS/2" digs deep into this developing environment.

Maybe you need to run other operating systems within an operating system? "Creating Virtual PCs on the 386" by Matt Trask shows you how to do that and lots more. If you are curious about what 32-bit DOS means, Andrew Schulman's "DOS Unbound: Uses of Protected Mode" is a hands-on C tutorial for producing 32-bit protected-mode applications that run under our old friend, DOS!

Optical Report

Optical devices continue to climb onto the microcomputing juggernaut. In "Optical Storage Primer," find out about different devices and how they and the available applications software performed. Also, the tremendous potential of digital video interactive is explored in "Multimedia: DVI Arrives."

Desktop Publishing and Printing

First-hand business experiences and a desktop publishing wish list make up "Laying Out the Future," which profiles the state of DTP today. For the DTP of the future, a deep look at color printing technology, its capabilities, and its costs, appears in "Color for the Desktop."

Trends and Standards

In "Notebook PCs Set the Portable Standard," you can find out where all this miniaturization is taking us, and when we will get there.

If you're interested in the world of graphics, "Looking at the Graphical User Interface" by Bill Nicholls covers hardware, software, and GUIs for today and tomorrow. Ever wonder why Structured Query Language hasn't caught on? Read about an emerging specification in "Data to the Desktop: The SQL Advantage."

SCSI contributes widely to device compatibility. The latest incarnation emerges in "SCSI: The I/O Standard Evolves," along with a hint at SCSI-3. "DPMI: The DOS Protected Mode Interface" is a revised Virtual Control Program Interface that tries to provide binary compatibility in software applications across many different platforms.

Despite the deserved attention to Windows 3.0, another windowing scheme is quietly growing in Unix-land and headed our way: "The Migration of the X Window System."

—Gene Smarte
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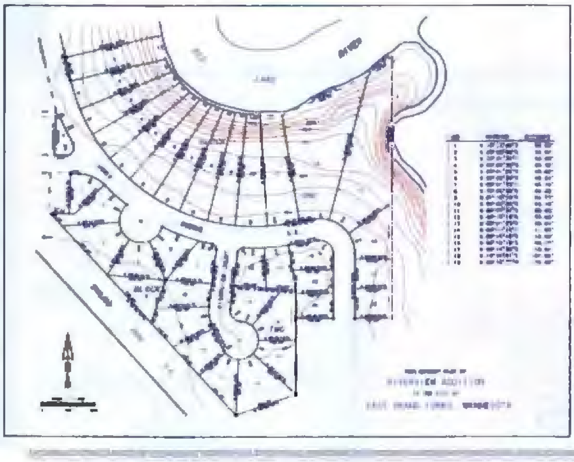

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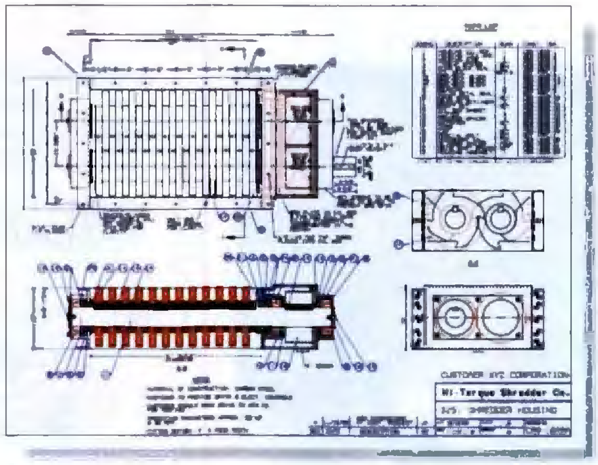

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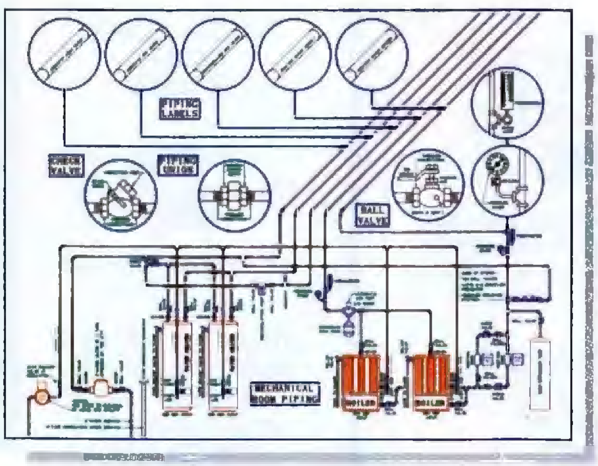

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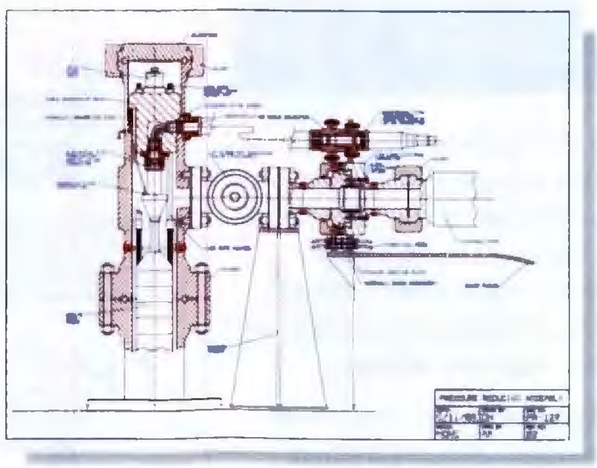

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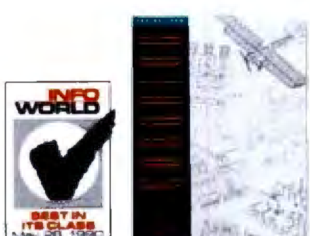

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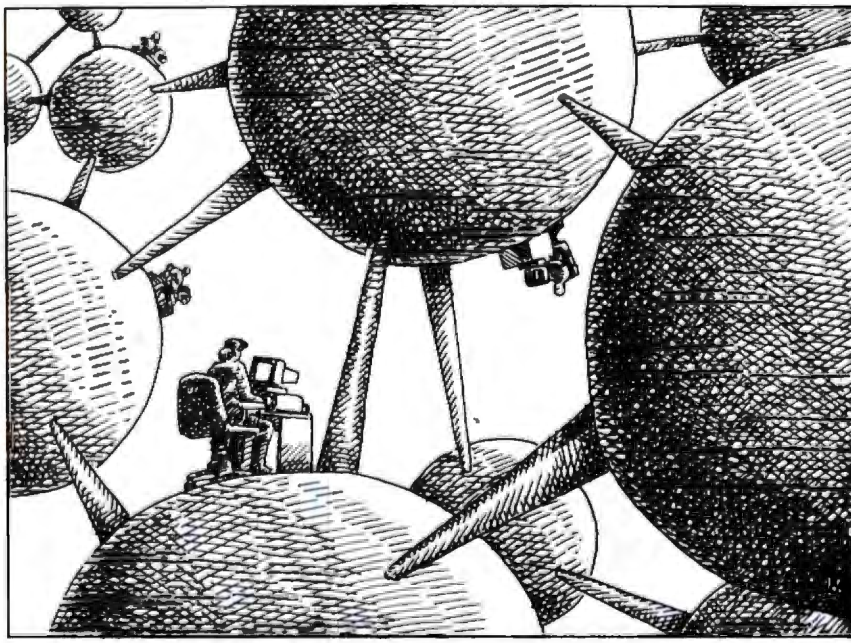
CASTING A CHAOTIC NETWORK

I think this is a first. Certainly I don't usually make shareware my lead item, but this time it's appropriate, since I usually look at some aspect of the state of the art in the annual IBM issue, and this is certainly state-of-the-art shareware.



If you happened to see *The Hunt for Red October*, you may have noticed a peculiar display on the wall behind the admiral: a Mercator world chart, with an odd curved shape of light and shadow splashed across it. It is, in fact, a clock, and quite authentic; just about every senior CIA officer has one. What it shows is which areas of the world are in light and darkness just at the moment. Naturally, those responsible for controlling the U.S. spy satellites find this interesting.

The odd curved shape, representing the parts of the world that are in sunlight, changes over the course of the year, being concave southward when it's summer in the northern hemisphere, and concave northward when the sun travels south.

There was a clock like this in the science room of the Los Angeles Public Library. That clock was electromechanical, and it worked by moving the Mercator map on a continuous strip. I don't know how accurate it was. I always wanted one, but I found that the cost was higher than I cared to pay.

Now I have one, and it's better than the original.

Geoclock

Geoclock is a computer simulation of the mechanical clock. I have seen only the EGA and VGA versions, but I understand there's a CGA version as well. In EGA it's plain gorgeous, and I often put it up on the 19-inch Electrohome monitor just to have it as eye candy in the Great Hall.

The shareware version is plenty good enough, but when you send in your $30 registration, you get a new version with a whole raft of extra features. Some, such as city names, I don't much care for, but most of that can be turned off. One warning: the program needs to be installed, since it comes with compressed files; but, unfortunately, it won't install from the B drive. It happens that I got 5¼-inch floppy disks, and the A drive of the Zenith 386/33 that drives the Electrohome monitor is a 3½-inch drive, so I had to copy the 5¼-inch floppy disks over to 3½-inch floppy disks. That worked fine.

I'll have a downloadable copy of the shareware version in my BIX conference, but my advice is not to bother with it; send the $30 and be done with it. It's inconceivable that you won't like this program. The graphics are great; every check I can make on the accuracy of the sunlight shape indicates that the programmer has it spot on; and there's even a little circle to indicate the exact spot that the sun is over at any given time.

Try Geoclock; you'll like it. It definitely gets a User's Choice Award. Highly recommended.

High End and Low End

It's understandable that most writers like to talk about high-end stuff. I know I do, because that's where the fun is. My latest toys are a Cheetah Gold 486, with a Perceptive Solutions disk drive controller and 15 megabytes of memory. It's so fast, it scares me. If that weren't enough, there's the Premier 9000 and an Arche Rival 33-MHz 386 system with a 300-MB hard disk drive and a tape backup unit. These machines rival anything on the market, and they're fun.

There's a point to writing about high-end equipment: we help drive the industry. Brit Hume, in a recent essay, says this is a conflict of interest. I don't see it that way; what possible conflict of interest have I? I don't own high-tech stocks, and I already have more computer equipment than I need. More than I want. Nearly more than I can endure. There's not *room* for much more. I can't sell the

continued

stuff, and returning it or giving it to schools or institutions takes time away from writing. What I can do is use it, determine what I like and dislike, and tell everyone in the hopes that the next models will be even easier to use. Today's Chaos Manor Dream Machine is tomorrow's mail-order special. I paid $12,000 in 1977 for Ezekial, my friend who happened to be a microcomputer; think what that would buy today!

True, most of the PCs out there are not ultrafast 386s, or even 386SX machines. The number of XTs is steadily falling, but there are a fair number of them left, while the majority of PCs are 286 AT systems. However, nearly all the really neat new software is designed for the 386 machines; if we're to have an influence on where the industry goes, we've little choice on what to write about. The new software may work on a 286, but it will be slow and clunky.

Take Windows 3.0. This is pretty nifty on a fast 386 with a big hard disk and lots of extra memory. It's acceptable (but just barely) on a very fast 286. It's impossible on a standard 286.

Then there's Word for Windows. On something like the 33-MHz Premier 9000 with Windows 3.0, Word for Windows screams along. It has a different philosophy from my current word processor and more features than I have any need for—my writing needs are pretty simple—but some people need the ability to print out text in fancy ways, while others figure they may need to do that some day. What Word for Windows will not do is run acceptably on a 286—or, for that matter, on a slow 386.

If you don't like Word, there's Ami Professional for Windows. It's an excellent word processor, with good feel, and I like it; but, once again, you need a fast 386 and adequate memory to run it. Put it on a clunky old 286, and I guarantee you'll hate it.

Moreover, despite the number of older and slower 286 machines out there, there's not going to be much in the way of new software for them. Just about all the development resources of the industry and by far most of the talent are aimed at software for the 386. Windows 3.0 has attracted the largest single block of that effort. Microsoft has come out with a winner, and there's a scramble to get on the bandwagon. But you can't write off Quarterdeck, which makes both Desqview, which lets you do task switching and some multitasking, and the QEMM-386 memory management package, which is in many ways superior to both the Microsoft and Digital Research memory managers.

Desqview is not a graphical user interface; for that, Quarterdeck is working on a version of the X Window System. I've seen it at the company's annual Desqview seminar, and it looks pretty good. The company is shipping a toolkit for developers, but it won't be out for a few months. X was developed for Unix, but Desqview X is a program that runs under Desqview under DOS. However, I don't need a GUI, and some people don't much like them. I don't find the DOS C:\ prompt all that intimidating, and I suspect most of my readers don't; and there are plenty of programs being written for plain old DOS. Just about all of them work fine on a 386 running QEMM and Desqview; in fact, that's what I'm using as I write this. I like Windows 3.0 well enough, but I find I'm more productive

continued

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when I'm running Desqview.

Desqview will also run many plain-DOS programs on a 286. You don't get real multitasking on a 286, but then, you don't get very good multitasking on a 386 either. Multitasking DOS programs is somewhat better with Desqview than it is with Windows 3.0, but neither is all that great. On the other hand, most of us don't really want true multitasking. What we want is rapid task switching, and you can get fairly rapid task switching on a 286, particularly if you have a fair amount of extended memory to swap the programs in and out of. Desqview will also swap to a RAM disk, or to your hard disk.

SemiDisk

One way to update a 286 is to add memory. I've elsewhere discussed the difference between expanded memory, which follows the EMS memory standard and can be used by programs written to use it (but only by them), and extended memory, which is extremely useful in a 386 but has limited utility in a 286. Desqview can make use of extended memory as an area into which it can swap programs, and if you have a 286 machine with extended memory, this is a good thing to do with that memory. You can also turn extended memory into a RAM disk.

The advantage of a RAM disk, especially on an older machine that is likely to have a slow hard disk drive and an even slower floppy disk drive, is that it is fast. The problem with a RAM disk is that it's not really a disk, and thus isn't permanent: any power-down, including a minor power failure, will cause everything in the RAM disk to go away.

There are a couple of ways out of that dilemma. One, of course, is an uninterruptable power supply; these are getting cheaper every year, and they save not only what's on a RAM disk, but anything you're currently working on. I'm on record as saying that anyone who does serious creative work on a computer is mad not to have a UPS, but then I'm known to be a bit monomaniacal on the subject.

The other solution is SemiDisk from SemiDisk Systems. Very longtime readers will recall that I used to use SemiDisk cards in Old Zeke, my S-100 computer. SemiDisk's great rival in S-100 times was Bill Godbout's M-Drive H, which did much the same job. The difference was that SemiDisk had a connection for an external battery backup.

SemiDisk Systems has retained that feature with its PCompatible cards. What this means is that if you have a power failure, you'll lose what's in memory, but, provided that your power is restored within a matter of hours, you'll be able to save what's on the SemiDisk.

SemiDisk is fast, a lot faster than the hard disk drives you'll find on a 286 system. It's pretty speedy on a 386, too, but there it's up against much faster hard disk drives. The SemiDisk can hold up to 8 MB and can transfer all that data in a few seconds, one-half to one-quarter the time required by a good hard disk drive. Of course, a fast 386 system can turn extended memory into a RAM disk, so the only real advantage of SemiDisk over extended memory on a 386 is the battery backup.

What to Do?

A year ago, I advocated that 286 owners try to sell their systems for as much as they could get, and buy a 386. It's too late for that now. You can't get much for a 286 computer.

This year, my recommendation is that you keep your old machine.

First, it may be good enough for a while. There's not a lot of new software being written for it, and I predict that you'll get tired of hearing about all the neat new stuff you won't be able to play with, but, in fact, a 286 AT with the software available at present is more machine than most of us had for the most critical years of the computer revolution. It ain't all that fancy, but for a while it may well be good enough.

Second, I don't recommend that you spend a lot upgrading it. Instead, save that money for the 386 you'll buy. Incidentally, I have no strong advice on the 386 versus the 486; I don't think there will be any great differences except for price. Think of the 486 as a combination 386/80387. Many think they don't need the 80387, but if you do any number crunching at all—as in simulations, cellular life experiments, playing with fractals, CAD, or big spreadsheets—you'll definitely want a math chip.

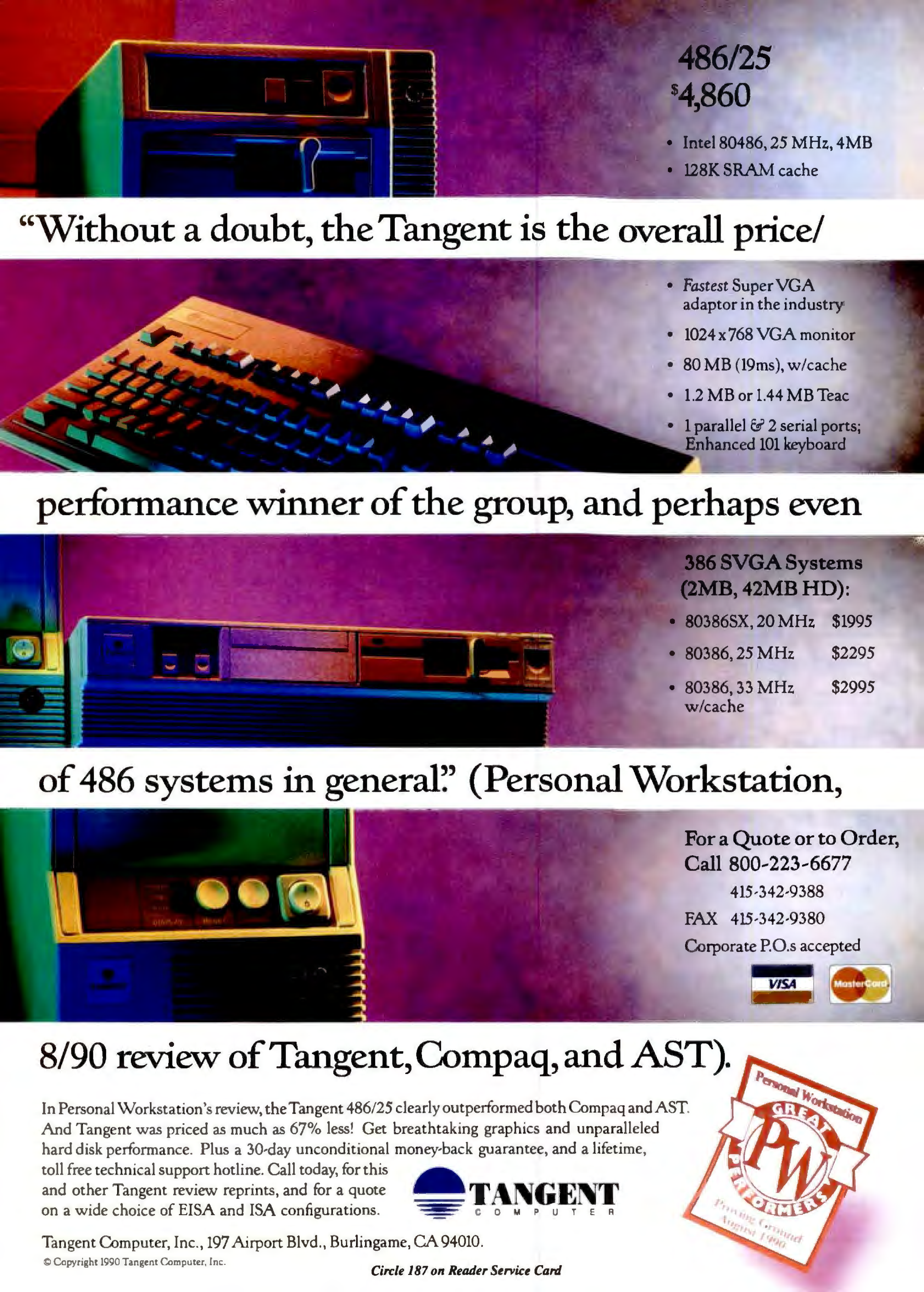
Third, when you get your 386, use the 286 as a network server where you can hang all your peripheral equipment. Give it the CD-ROM, voice mail, a modem, a fax if you use a computer for fax, a tape backup unit, and possibly even a WORM (write once, read many times) drive.

Here's how.

LANtastic

Artisoft's LANtastic is *not* the network you need if you have to connect a number of minicomputers, big workstations, and suchlike. But it is more than adequate for

continued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a surprising number of jobs. In particular, it's plenty good enough to give you a lot of use out of your old 286.

The simplest network involves only two machines. Setting that up is fairly simple. I say "fairly"; but do understand that all network setups are more difficult than you think they are, and even a simple two-station LANtastic network will take you all afternoon before it's done satisfactorily.

Moreover, I strongly recommend that before you begin work, you take an hour or two off to read the LANtastic documents—not only the installation sections, but those on network management. Mind you, I understand that's not how you generally work. It's not how I work. We have, in the past few years, become accustomed to just mucking about when it comes to new software and hardware; we don't need no stinking documents, except as reference works when something goes wrong. Alas, that's exceedingly unlikely to work here. Networks are complicated.

That's the bad news. The good news is that if you're diligent, LANtastic will eventually work to give you some real power capabilities; and once you understand how it operates, it's very easy to reconfigure the network.

Decisions

The first thing you must decide is whether you are going for speed or memory savings. LANtastic comes in two flavors: Ethernet, and the company's older proprietary twisted-pair system. (*Twisted-pair* refers to the cable, which is actually nine-wire cable terminating in DB-9 connectors.) The decision is a nontrivial one, involving quite different hardware and software; while Ethernet LANtastic looks to the user much the same as the older LANtastic, the user interface is about all the two have in common.

The advantages of Ethernet are speed and a thin, standard, coaxial cable. Ethernet communications are about five times faster than twisted-pair. If you access a remote system's hard disk drive via Ethernet, you may not notice that you're working over a network at all. With twisted-pair you might, depending on the disk speeds you're used to.

The advantage of twisted-pair is memory savings: the twisted-pair LANtastic network software is installed in dual-ported RAM and runs on a Z180, which are both right on the network board. Ethernet software must be installed as a TSR program in your computer, where it eats 16K bytes of memory.

continued

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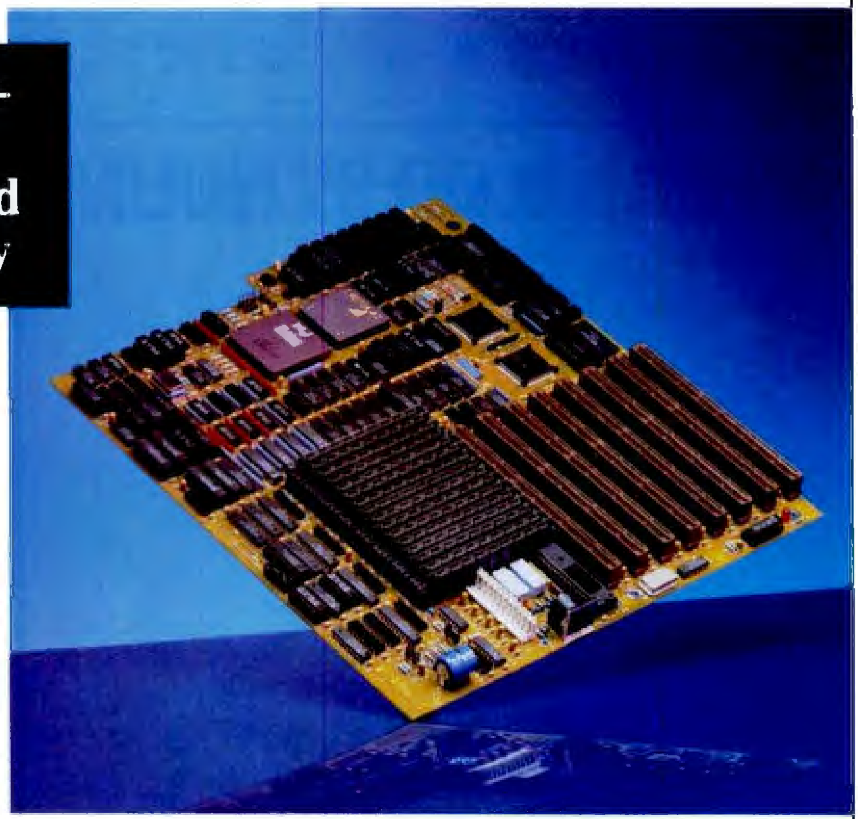

Fast. Micronics' 486 system board is designed for true 33MHz operation. The Micronics design also supports both the 80486 CPU burst mode and EISA burst mode for maximum CPU performance. It has write-through cache, which is essential for EISA bus architecture where DMA is frequently used. The write-through cache continually updates both cache memory and RAM memory so that after a DMA operation, the cache memory is always validated.

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Now, slow and fast are relative: the twisted-pair network can run at over 1 megabit per second. It is faster than modem communications. It is faster than CD-ROM or WORM drives. It's about as fast as some of the older hard disk drives in 286 machines. Thus, if your intention is to use LANtastic to network CD-ROM and WORM drives, and you don't care that remote hard disk drive access might be a bit slower, you will probably want the twisted-pair arrangement, which will save you 16K bytes in each of the machines you use it in.

IRQ, Anyone?

LANtastic boards are well designed, but they come set up wrong.

PCompatible machines are "interrupt-driven," meaning that any device—keyboard, hard disk drive, communications ports, floppy disk drive—that has a task to perform must first get the computer's attention. That is done by interrupts. What's important here is that each device—including LANtastic—must have its own unique hardware interrupt channel, called IRQ (for interrupt request). This is a physical channel on the bus, and it connects to computer boards, such as disk drive controllers, through the bus connector. Original PC (and XT) computers made use of, I think, six IRQ channels, and no more than that were carried on the old 8088 bus.

However, when the AT came along, the bus was extended, and additional IRQs were made available. Alas, most hardware boards still make use of only the original group, and that crowds things a lot. However, some companies have got smart and added the capability to use additional IRQs. LANtastic is one of these: the company has physically connected IRQ 7, 10, and 15, as well as the original group. Which IRQ your board uses is set by a jumper on the LANtastic card. Unfortunately, the factory setting is IRQ 3, which is recognized by DOS as the COM2 interrupt. Thus, if you want to have more than one serial port on your machine—as in a modem and a serial mouse—you can't use IRQ 3. Fortunately, it's easy enough to set the board to use IRQ 10, which is what we've done.

Next, if you're using LANtastic to network a remote system hung with peripherals like CD-ROMs, WORM drives, and Bernoulli Boxes, it's likely that the LANtastic I/O port address will have to be changed, because two devices cannot use the same I/O port address settings. The factory default setting is 300 hexadecimal, but there's a provision for setting it to 320h, 340h, or 360h.

I now have a dilemma: for some readers, the above is old hat and boring. For others, it's incomprehensible; worse, while the Artisoft manual is remarkably clear in explaining *how* to set the IRQ and I/O port address, it has almost nothing to say about *why* you'd want to do that. My dilemma is that if I go into a long explanation, I'll lose two-thirds of my readers, and I hate it when that happens. Thus, a blanket statement: have faith. Even if all the above means very little to you, you *can* set up a LANtastic network. Just be prepared to spend a day at it, and understand that there'll be a lot of trial and error.

On that score: before you start, make up a "panic" floppy boot disk for your machine. Get it right, so that your system comes up recognizing all your peripherals. Test it. Now make a *copy* of that floppy disk, and use that copy to experiment with changes in CONFIG.SYS and

continued

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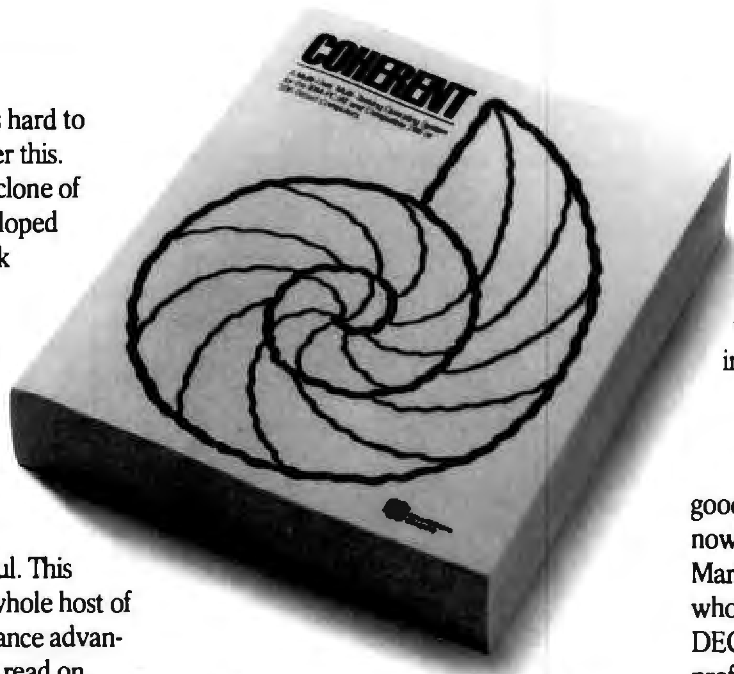

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AUTOEXEC.BAT. It will take longer for your machine to boot up those experiments from a floppy disk, but you won't be worried that you've done something awful to your machine—and you will worry about that. Installing a network takes patience, great gobs of patience. And when you've locked up your system so thoroughly that only complete power-down will restore it to life, the rule is, Don't Panic.

Workstations and Servers

LANtastic is a "peer" network, but that doesn't mean that every machine in the network is equal. What "peer network" means is that any node on the network can be either a workstation or a server. Moreover, that status can be changed at any time. For the network to operate, at least one machine must be designated as a server, but it doesn't matter which one it is. Moreover, the server needn't be confined to being just a server, although in my own network it is.

What distinguishes a workstation from a server is that a server makes designated assets available to the network, while a workstation does not. Thus, a workstation may send to or take files from any device, including the hard disk, of a suitably configured server, but the server can neither send to nor access files of that workstation. This can have important security implications for businesses. In my own case, for example, I can set up the network so that I can send files to my children's machine, but no one can access my machine from theirs. Even more important for our present discussion, though, is that the workstation isn't running as much memory-resident network software as the server, and better yet, every bit of the workstation software can (on a 386) be stuffed up into high memory, either with QEMM.SYS, LOADHI.SYS for running with Desqview, or HIMEM.SYS for running with Windows.

Thus, what I have is Big Cheetah set up as a workstation, networked to the Zenith 386/25 as a server. The Zenith has a 150-MB hard disk drive, which I can use to store files, and as a place for backing up anything I write on the Cheetah. It has a pair of daisy-chained Denon CD-ROM drives, both completely accessible over the network. There's no reason why I can't add other peripherals, like a scanner, a Bernoulli Box, and a Complete PC Phone System, all available over the network, and none of them taking up memory in the primary machine.

Setting Things Up

I don't have room to describe everything I had to do to get the network working. Devices conflict with each other and with the network. Desqview (which I run only on the Cheetah workstation, not on the Zenith server) adds complications; so does Windows. Seemingly minor changes have crashed the system, leaving me totally baffled for an hour as I tried to figure out why. A complete account of my experiences would fill this column and more.

I can assure you that it's worth it. You can, given time and patience, set up a bulletproof network. The results are well worth the effort, because you'll end up with much larger windows—Desqview or Windows 3.0—while still having access to CD-ROM and other memory-eating peripherals. I won't pretend that getting there won't be a frustrating experience.

continued

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With that caution, here are some tips and principles.

First, *please* make sure that you have "panic" boot-up floppy disks for *each* machine that you'll be working with. Moreover, as you learn how to make things work, make updated boot floppy disks, but keep a copy of whatever worked last. There's nothing so frustrating as having to go back three steps because you forgot how you made something work.

First, make sure you have "panic" boot-up floppy disks for each machine that you'll be working with. Second, proceed systematically.

Second, be sure to proceed systematically. When I was in the aerospace industry, I acquired a hefty reputation as a troubleshooter, even though much of the time I was working with technology I didn't understand very well. My secret was what I called "the relentless application of logic." I never assumed anything was working until I'd tested it, and if I ran into trouble, I'd go back to a configuration that worked and add features until it failed; that way, I knew precisely what had caused the problem. From there, it was no great trick to find a solution.

My advice for setting up a network is to do much the same thing: reduce both computers to bare bones, and get the network working between them. Then add assets to the server, and fancy stuff like QEMM and Desqview to the workstation. When something crashes—and it will—go back a step and proceed a different way. Make use of Quarterdeck's Manifest, or System Sleuth, to look at what is going on in system memory. Eventually, you'll figure it all out. Many have. Retiring Science Fiction Writers of America president Greg Bear knows almost nothing about computers, but he was willing to experiment until he got things right. He now uses Microsoft Bookshelf inside WordPerfect 5.0, and he loves it. Have faith.

Finally, if you're connecting up CD-ROM assets, you should read the entire CD-ROM section in the LANtastic manual. Even then, the manual won't make it clear that you do *not* need to run any CD-ROM software whatsoever—including MSCDEX.EXE—in the workstation. The only machine that is required to run MSCDEX is the server on which the CD-ROM is located. You *must* tell the network software (on the server) that the asset in question is a CD-ROM; if you don't, there's no way it will work. How to do this is explained in the manual, but not very well.

NetWORM

One thing that doesn't work very well over the network is the Maximum Storage WORM drive.

The first big problem is getting the WORM drive to work with the Denon CD-ROM drives. That can be done, but since the DENON drives are true SCSI, while the Maximum Storage WORM is "almost scuzzy," it's a bit tricky addressing each properly. That, however, is a minor detail. LANtastic and the Maximum Storage WORM drive won't work together even if the WORM drive is the only asset on the server.

When you set up a LANtastic network, you use the network manager software to tell the server what devices it will make available to remote workstations. That's when you tell the system if the asset is a CD-ROM. Of course, a WORM isn't a CD-ROM, so in my first attempt I didn't describe it as one.

The network appeared to work fine. The WORM worked fine when accessed on its own machine. The network software at the workstation told me I could access all the assets on the server, and I could, all but one; but when I asked for a directory of files on the WORM drive, I got nonsense. I then went back to the network manager software and designated the WORM as a CD-ROM; the next time I tried to get a WORM directory from the workstation, I still got garbage, although not as unintelligible as before. Frustratingly, it *almost* worked.

Almost isn't good enough. As I understand it, Artisoft and Maximum Storage are working together to correct the difficulty, but so far they haven't done it. However, I do have a way to use the WORM drive on the network. Alas, it's a kludge.

Recall that the WORM drive works fine when run from the machine that it's on. That is, if I bring the Premier 9000

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with its APX-5200 WORM drive into the network as a server, the Premier doesn't lose the WORM drive. Thus, if I run server software on Big Cheetah, making his hard disk drive accessible by the Premier, I can then walk over to the Premier 9000 and *from there* send files from the WORM to the Cheetah and copy files from the Cheetah to the WORM. Big Cheetah cannot find the Premier's WORM, but the Premier can. I hope that's all clear. If not, read it again, because the next step is where the real kludge comes in.

The Network Eye

Artisoft has another program, Network Eye, that works across LANtastic, and apparently any other network, to let you control one computer from another. That sounds simpler than it is, or at least I found myself confused when I first thought about it.

Let's drop back a step. Suppose I log onto the network, using Big Cheetah as a workstation, and through the network invoke Geoclock, which is on the Zenith's hard disk drive but not on Big Cheetah's. Big Cheetah reaches out through the network; the network software accesses the Zenith's hard disk drive; and the Geoclock file is peeled off the Zenith's disk and brought into Big Cheetah, which runs it. Take another example: suppose I access MicroProse Railroad Tycoon across the network. Once again, the workstation is running the program; but this time, since Railroad Tycoon needs continuous access to disk files, from time to time the workstation will ask the network, and the network will ask the server, for disk information. Since the server has to provide that disk access, there's a sense in which the server is being remotely controlled; but the important thing to remember is that the only control you have over the remote machine is to order it to access its various assets. You can't tell it to run a particular program.

With Network Eye, you *can* tell the remote machine to run another program.

A second point of confusion: Network Eye designates machines as masters and slaves, and these terms have *nothing* to do with whether a machine is a workstation or a server. Thus, a server machine can be a master, and through Network Eye, that server can control a workstation. A server can't demand files from a workstation, but a server that's designated as a master can order the workstation to *send* files that the server could not itself access.

Sounds like Big Brother, doesn't it? Actually, a machine cannot become a slave without its own permission; you cannot remotely order a machine to run the slave software. That task must be done from the machine's own keyboard. Moreover, when you configure LANtastic and Network Eye, you can set up passwords for either or both (i.e., the password for logging onto the network may be one thing, and that for accessing a slave machine may be another).

Thus, the kludge: I bring up the Premier with the WORM drive and other peripherals and run the LANtastic software—for remote WORM access, it doesn't matter whether as workstation or server. The Premier also runs Network Eye and designates itself as a slave. Now I set up Big Cheetah as a LANtastic *server* and run the Network Eye master program. Then, as master, I access the Premier and tell it to do whatever I want

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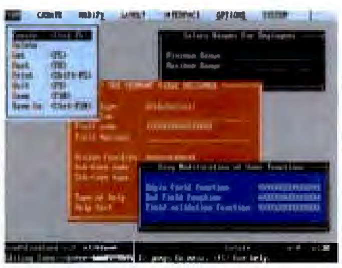

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done with the WORM. Since Big Cheetah is at the moment a server, the Premier can access Cheetah's disk; but while Cheetah can't access the Premier's WORM, the Premier can, and thus can send and receive from it. Except, of course, I'm using Network Eye to have the Cheetah tell the Premier what to make the Cheetah send and receive.

If you read that about three times, it will make sense.

Systat has become the standard statistics tool for everything from law-enforcement agencies to economics shops to psychology labs.

As I said, it's a kludge, and not one I like; but it does illustrate the power of LANtastic and Network Eye.

The bottom line is that with LANtastic, you can use your old machine to add significantly to the power of your new machine.

Systat

Back in 1986, I got a letter from Leland Wilkinson of the Department of Psychology at the University of Illinois at Chicago. It accompanied a copy of Systat for the IBM PC. I set letter and program aside to be looked at later, and they fell into the chaos stream and disappeared from view. Then a couple of weeks ago, I was talking with Milt Stevens, who cochaired the First Annual Space Development Conference with me many years ago. Milt works for the L.A. Police Department as a civilian analyst. "Well," he told me, "your microcomputers are finally having an effect on law enforcement. We're getting some PC compatibles in, and I've been learning Systat. Got some other people in the department looking at it, too."

I nodded sagely, and I dimly remembered that I had a copy of Systat somewhere, and I ought to look at it. In fact, it wasn't hard to find, since it had gravitated to a high shelf in (nearly) plain view. It was also easy to see why this program has become the standard statistics tool for everything from law-enforcement agencies to economics shops to psychology labs. Even in the version I have, Systat is fast, accurate, and relatively simple to use. More than that, it's *complete*: it includes everything from the simplest possible statistics to factor analysis with rotations, stationary time series, cluster analysis, and a whole raft of stuff I would have lusted for back in the days when I ran an operations research shop.

The manual is complete, too: it varies in approach from simple conversational to academic with references and footnotes, but in all cases the approach is to get you to use the stuff and see what happens. I can see why Stevens and his associates find this package attractive. It's powerful enough to do anything they're likely to need, but well enough explained to let you, with effort, learn complex statistical analysis. I must say I found the manual a better course on the subject than some of the ones I took as a graduate student.

Wilkinson's letter from 1986 was interesting: he tells me that the original Systat was written on a CompuPro CP/M system remarkably similar to Old Zeke. He also asks that I not quote him, because many nonstatistician customers are frightened away when they discover that Systat was largely written by one person, while "a CP/M heritage can be a handicap." Now it can be told, since Systat has become darned near the standard in both academia and the business world. This is one I should have written about long ago. If you need a statistics package, the 1986 version I have here will more than do; I'm sure that it has been much improved since.

Short Shrift for Three Models

It's always a dilemma: I'm running out of space, and there's a huge stack of nifty stuff I want to tell people about. Now what? If I give it a brief paragraph, it looks as if I am slighting it, but it's worse if I don't mention it at all. Therefore, assume that I wish I could have written more about everything in this section.

First, CellMaster from Sintar Software is an instructive game that lets you set up cellular automata on your PC. Ever wonder what would happen in Conway's Game of Life if you could change one of the rules? This will let you do it. Simulate electronic circuits. Invent artificial life forms. It's not as addicting as

continued

ITEMS DISCUSSED

CellMaster $45
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Seattle, WA 98154
(206) 625-1213
Inquiry 1105.

Crescent QuickPak Professional Library (QuickBASIC version) $169
Crescent Software
32 Seventy Acres
West Redding, CT 06896
(203) 438-5300
Inquiry 1106.

Desktop Molecular Modeler $495
Oxford Electronic Publishing
Oxford University Press
200 Madison Ave.
New York, NY 10016
(212) 679-7300
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Oxford Electronic Publishing
Oxford University Press
Walton St.
Oxford OX2 6DP, UK
011-44-865-56767
Inquiry 1107.

DOS Systat 5.0 ....$895
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Evanston, IL 60201
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MicroProse Railroad Tycoon, but you'll learn more. Recommended.

Next up the scale is the Olmsted Brain Simulation Series. This is an odd but interesting software simulation of multivalued logic and neural networks that will let you build and manipulate simple brain models. Your first impression of this package is that it's a bit disorganized. Then, on reflection, you realize that the subject matter itself is disorganized. It's strictly for learning purposes, but there's a lot here worth learning. I enjoyed fooling around with it, and I learned something about brain models and multivalued logic.

Finally, we have a full-fledged professional program, Desktop Molecular Modeler from Oxford University Press. This program is largely for chemists, student and professional, and it runs on CGA and better PCompatible systems. You use it to build molecules on-screen, atom by atom: the program makes the atoms available. Once you have a molecule, you may validate its possibility and save it, or optionally output your molecule on a Hewlett-Packard plotter. Rotate and rescale, substitute different kinds of atoms, create new bonds, or alter bond lengths; what you have here is a sort of ultimate Tinkertoy set for playing with chemical models. It's not as much fun as my old chemistry set was, but it's a lot safer.

Winding Down

I'd meant to say some good words about Crescent Software's QuickPak Professional Library of routines, which you can graft into Microsoft QuickBASIC programs. This kit has saved me many hours of time. No one ever describes the company's software as being for amateurs; but while QuickPak Professional Library lives up to its name, it has certainly made life a lot easier for this amateur programmer.

I also need to talk about both Willow and US Video boards, which let you combine video images (as from a camcorder) with what comes out of a computer program; and the Video ChalkBoard and Video Titler programs from Entropy Engineering, which mix in titles and freehand drawings.

It has been a good year for microcomputers. Next year may be even better: maybe we'll get software that can challenge the new capabilities of our hardware. We'll see. ■

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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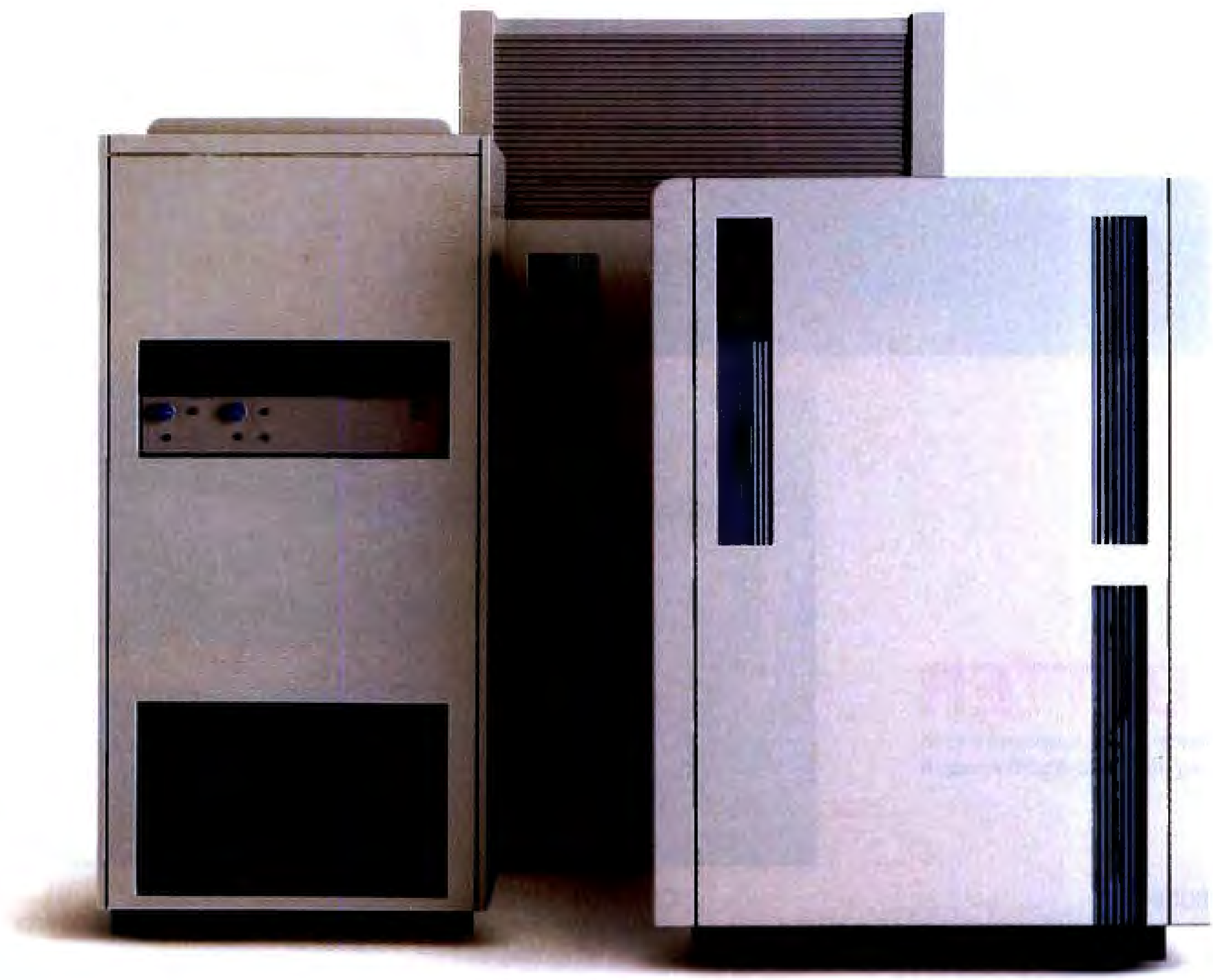
The Joneses.



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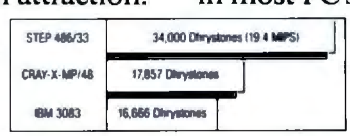

There are two reasons. The first, of course, is the 486™chip. The other is AMMA,™ Everex's proprietary Advanced Memory Management Architecture.

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And how to keep up with them.

That's because write-through forces you to write to main memory much more often. And main memory is slower than the cache.

This is especially important in 486 computing, where the CPU performs as many as four times the write operations as in 386. Which makes AMMA's write-back architecture, combined with the 486's embedded cache, a powerful combination indeed.

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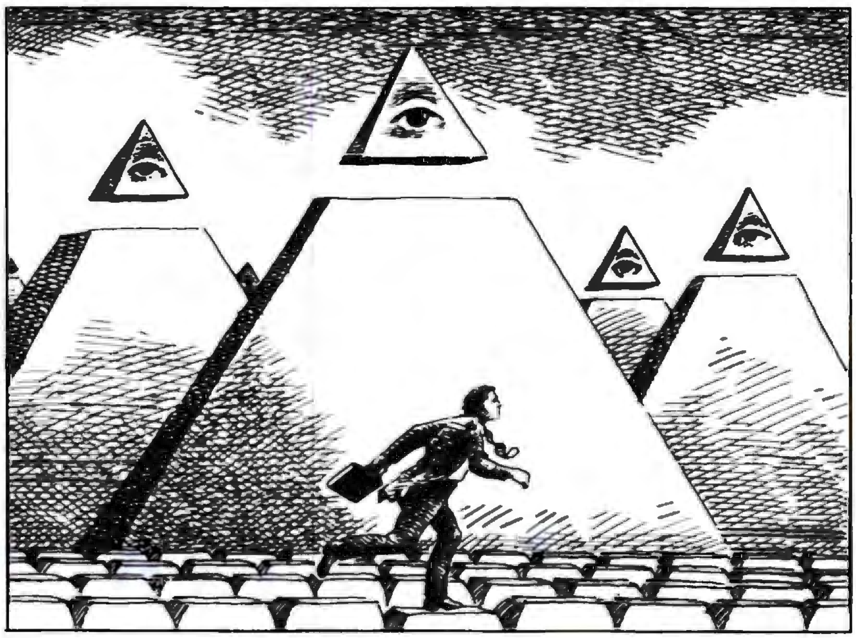
A few OS/2 products let your spreadsheet talk SQL

MONEY, SQL, AND SPREADSHEETS



A client (a bank) approached my company for help with something called "SQL" that it had heard would solve all its data-sharing problems. "We've got a little problem, and we're wondering if you can help us."

There were, it turned out, a few stumbling blocks.

Like many firms, this bank relies heavily on Lotus 1-2-3. And, again like many firms, it has data at a centralized point (originally a mainframe, but it's moving to a LAN with a souped-up PC server) that it needs to get *into* 1-2-3.

Finally, like too many firms, it already has a kludgy solution: Download some data, run it through a program to massage it, and import it into 1-2-3. The bank had heard that Structured Query Language could help. That's where I came in, to determine which SQL-based product to buy and how to get 1-2-3 to talk to it.

One approach is to use a client program written in C, Pascal, COBOL, or any other language that can communicate with the SQL server by way of a SQL support library. (Generally, the database lives on the server machine, and the program that accesses it lives on the client machine.)

But my client (the human kind), like most PC users, is decidedly not interested in hiring C programmers. So to make a spreadsheet use the SQL-based server, I must make the spreadsheet a client process or somehow attach a client (the computer variety) process to the spreadsheet.

Furthermore, the client must be compatible with the server. Not every SQL client can talk to every SQL server. Given that SQL is billed as the lingua franca of the database world, this is surprising, but it's true. One of the leading SQL vendors, Gupta Technologies, counts among one of its greatest features the wide variety of SQL server products that it supports *besides* its own SQLBase server. (That's what its SQLNetwork gateways do.) In general, you're best off getting your spreadsheet client code from the same folks who wrote your SQL server code.

In general, you've got to worry about three things:

- What spreadsheet does the client talk to, and is it DOS- or OS/2-based?
- What SQL server does the client talk to?
- What network/communications link do the client and server share?

I'll now look at these in a bit more detail.

Making Your Spreadsheet Speak SQL

There isn't, at least not yet, a "@SQL()" function in 1-2-3. So what's out there to solve the problems? There are three ways to do this: Use an add-in or patch, redesign the spreadsheet to support SQL directly, or use a language that the spreadsheet already understands and a translator program to handle SQL.

The most direct method is a patch or, in the case of 1-2-3, an add-in. Releases 2.x and 3.0 don't directly support SQL. But two products—Gupta Technologies' SQLVision and Oracle's SQL Add-In for 1-2-3—can extend 1-2-3 to accommodate SQL.

Gupta's SQLVision works straightforwardly. You just type SQL commands into a range in your spreadsheet, load your add-in, and go. Users of 1-2-3 will like the fact that it also offers a /Data Query-like mode. SQLBase also comes with an interactive front end called SQLTalk, which I have found quite nice for trying out SQL. So the bank's techies just stuff some SQL into the 1-2-3 macros that get distributed to the users, and

continued

their problem is solved.

These Gupta products support only 1-2-3 release 2.x and Windows Excel, however, so you're going to end up leaving your workstations under DOS using this system.

SQLVision can talk to servers that are not Gupta products (including Extended Edition soon), so presumably your network could be LAN Manager-based, but having to stay in a networked DOS environment may make you gag.

Gupta, then, gets onions for offering only DOS clients for DOS spreadsheets. But it earns orchids for supporting a variety of networks (e.g., LAN Manager and NetWare) and a large range of servers, from its own SQLBase to IBM OS/2 Extended Edition, DB2, and Oracle.

Oracle's Add-In is basically the same story: No support for 1-2-3 release 3.0 yet, but it's coming, and no OS/2 support except, of course, on the server side.

WingZ-DataLink Skips the Clients

The second answer is to find another spreadsheet, one that supports SQL directly. Informix has been building SQL databases for a while, so it's no surprise that its WingZ spreadsheet comes with SQL hooks. For those who haven't seen it, WingZ is fantastic: the usual spreadsheet stuff, nice statistical and matrix capabilities, more graphics awareness than Excel, and its HyperScript command language. I used HyperScript to put together a hexadecimal calculator for Presentation Manager (PM) in less than an hour.

If my client had more time, WingZ could be the answer. But the folks at the bank are leery of WingZ's newness, and since Informix doesn't provide for 1-2-3 clients, the SQL linkage won't do the bank any good. Moreover, it's limited in terms of the servers it can talk to. Too bad, because WingZ-DataLink—it's part of HyperScript—is a nifty tool. You can either punch straight SQL into your HyperScript program or direct HyperScript to put a query box on the screen. DataLink puts up query boxes, your users fill them in, and DataLink converts the queries to SQL.

Again, HyperScript is a pretty neat language, tons better than 1-2-3 macro language. It supports any TCP/IP network for server connection, and most of the big network vendors support TCP/IP in some way, so that's good. But there's bad news on the server front. WingZ links PCs only to Informix SQL servers. And there's no SQL-to-Lotus link from Informix.

DDE Links Excel to SQL

The final approach is to avoid major surgery on the spreadsheet and instead use a built-in data exchange language that the spreadsheet already knows.

The best example here (in the Windows and OS/2 world) is the Dynamic Data Exchange facility. Microsoft's Excel supports DDE. A database client process running in the same machine as Excel can transmit SQL requests to the server via DDE; when the server returns the data, it is forwarded to Excel, again via DDE.

In fact, Gupta's SQLVision for Excel works like this, although I did not look at that specific product. Unfortunately, it's offered only for *Windows* Excel. Alternatively, Microsoft's OS/2 SQL Server talks DDE and thus has been massaged into talking to Excel. There is no turnkey

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OS/2 Excel-to-SQL server product that I'm aware of, however, so that looked to be quite a bit of work.

In the long run, though, this could be the best answer. The client talks to the PM application through DDE, a documented (and supported) interface. DDE, in turn, communicates through either a DOS-based SMB (Server Message Block) protocol or a named pipes interface (the preferred application-to-application method in LAN Manager). That would open the door to either Microsoft's SQL Server or, by DDE and APPC (Advanced Program to Program Communication, IBM's alternative to named pipes), to OS/2 Extended Edition's Database Manager.

What Did I Do?

I was disappointed. WingZ would have been a nice answer, but the people at the bank know 1-2-3 and are loath to change. I can't blame them. Also, they're a True Blue shop and would prefer to use IBM OS/2 Extended Edition or something like it as the SQL server. They suspect that they may end up keeping the data on an AS/400; WingZ talks only to Informix servers.

DDE and PM look good, too, but there are no turnkey systems yet (I'm sure there will be in a year or so, however), and I've learned all the DDE I want to for the moment. Some vendors raised an objection to DDE, however. They suggest that it can hamper performance.

It looks like they're going to put OS/2 SQLBase or Extended Edition Database Manager on an OS/2-based database server and have the 55 SX workstations run 1-2-3 release 2.2 under DOS 3.3 and Windows 3.0. It's not OS/2, but it's close. And I'll look at it again in about a year.

Choosing Your Own Path

How do you choose a spreadsheet/SQL client interface product? Consider these issues.

Does it support your spreadsheet? If you haven't picked a spreadsheet yet, this is irrelevant. Is it, like Gupta, limited to DOS spreadsheets?

Does it support your SQL server? In many cases, you won't presently have a SQL server, so there's no problem—you just buy the SQL client and server as a pair.

Alternatively, you may be forced to support an existing SQL server (OS/2 Extended Edition, in the case of the bank). Then a system like Gupta's would be attractive, because it supports Extended Edition, Oracle, Gupta, DB2, and more.

Does the client support your communications system? It may support only LANs, not Systems Network Architecture (SNA) or asynchronous links.

Do you have to write SQL code on the spreadsheet side, or is there a simplified user interface? If you're doing the same kind of queries all the time ("get customer X's balance"), there's no point at all in spending a lot of money on query by example—you should just have your systems people code the common queries into SQL. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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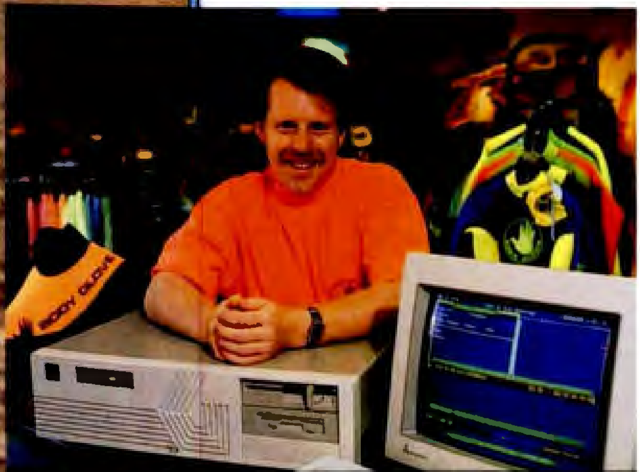

Graham Pask, Computer Systems Manager for Dive 'N Surf, and his Gateway 2000 25 MHZ 386 network server.

member of the growing family of Gateway 2000 customers in California. Dive 'N Surf Computer Systems Manager Graham Pask chose a Gateway 25 MHZ 386 machine for his network server. The system runs point-of-sale, inventory control, word processing and desktop publishing software.

"I decided to buy a Gateway 2000 system because they had everything I wanted for a good price," said Graham. "But what really impressed me was the service. I had a problem with my 3 1/2 inch drive so they sent me a new drive the very next day."

Graham said he was so happy with his Gateway system at work that he bought a Gateway 2000 25 MHZ 386 Cache machine for his home.

Until well after sunset, surfers ride the big waves on the Pacific Ocean near Redondo Beach, California.

And In Barrow, Alaska . . .

Over 300 miles north of the Arctic Circle, you'll find polar bears, seals, whales, walrus, lemmings, snowy owls and what appear to be the largest mosquitoes in existence. On a summer afternoon you'll also see parka-clad tourists walking among local residents in shorts. And of course you'll find a good Mexican restaurant and Gateway 2000 computers.

Jeff Frier, Cape Smythe Air Service, with his Gateway 2000 386SX.

Cape Smythe Air Service, a regional commuter airline serving Barrow, Kotzebue, Nome and remote villages in Alaska, has one of several Gateway 2000 computers operating in Barrow. Jeff Frier, Cape Smythe's accountant, chose a Gateway 2000 386SX to run spreadsheet, data base and accounting applications.

"I was trying to decide between Gateway 2000 and a competitor," Jeff commented, "so I talked to a person who owns the competitor's system. He was disgruntled about the service he received from them. Then I talked to another person in Barrow who has a Gateway and she was happy with the product and service. The choice was pretty obvious -- when you're doing business in a remote area, the most important things a vendor can offer are reliability and good service."

Jeff said he also appreciated Gateway's features and price. "When you have to pay $6 a gallon for milk, it's nice to find a bargain somewhere." Jeff plans to buy another Gateway 2000 computer in a few months .

On a mid-July day in Barrow, Alaska, fishing boats weave in and out of icebergs on the Chukchi Sea.

In Bradford, Pennsylvania . . .

You'll find a charming small city nestled in the Allegheny National Forest. The city's most prominent local business is the Zippo Manufacturing Company, where you'll find 18 Gateway 2000 computers in use.

Fred Gronemeyer, Zippo Manufacturing Company, and his Gateway 2000 20 MHZ 386 system.

Zippo is known around the world for its windproof lighter made famous during the second World War, although today the company's product line includes many other specialty advertising items. Fred Gronemeyer, Systems Analyst for Zippo, chose Gateway 2000 as the company's standard PC.

"We needed to set standards for PC's and software to make the most efficient use of these tools," Fred remarked. "We started out with PC's from different manufacturers, but once I tried Gateway I was convinced we could get the highest quality, most reliable machines at the best price from Gateway 2000. I was also impressed by my salesman and the tech support people I've dealt with at Gateway."

Fred said by the end of the year Zippo will be running every system Gateway 2000 makes, from 286's up to a 486 and everything in between.

Main Street, U.S.A., is located in Bradford, Pennsylvania.

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You'll find your senses overwhelmed by the countless sights and sounds of this one-of-a-kind city. And of course you'll find thousands of Gateway 2000 computers here.

One New York City Gateway 2000 owner is independent record producer and engineer Jim Rondinelli. Jim uses his Gateway 2000 386SX with a sophisticated player piano sequencer to compose music.

Jim Rondinelli, independent record producer and engineer, with his Gateway 2000 386SX.

"The software I use is written for the Mac and for IBM compatibles," Jim said, "but it runs much better on IBM compatibles. And it runs best of all on my Gateway. I travel often and I've used my software on a lot of other machines. They don't even compare with my Gateway 2000."

Jim said he bought his Gateway 2000 because it was equipped for the real world with ample hard drive capacity and RAM, both sizes of disk drives and color VGA graphics.

"It's the fastest file transfer computer I've ever used," continued Jim, "plus it ran right out of the box. One afternoon and I was fully functional on a brand new system."

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Near Camp Verde, Texas . . .

You'll find the magnificent Hill Country of Texas with rattlesnakes, prickly pear cactus and huge cattle ranches. You'll also find Larry Mahan and his Gateway 2000 computer.

Larry Mahan is to rodeo what Jack Nicklaus is to golf. He is Six Times World Champion All-Around Cowboy and is a member of the Cowboy Hall of Fame. But Larry also runs a cattle and horse ranch and is involved in a western apparel manufacturing company and a new Southwestern foods company. His Gateway 2000 20 MHZ 386 system is an integral part of his business operations. "We run cow and calf software for our Longhorn cattle herd," Larry said. "You can't really manage a livestock business efficiently without it. Plus we do accounting, spreadsheets and word processing on our Gateway 2000 computer."

Larry Mahan, rodeo star, and his Gateway 2000 20 MHZ 386 system.

Asked why he chose Gateway 2000, Larry said, "They had the best features and price – and I thought a computer company that puts pictures of cattle in their ads had to be my kind of people. And I was right. The people I've talked with at Gateway 2000 are honest-to-goodness nice folks. It's a pleasure doing business with them."

Larry Mahan raises registered Texas Longhorn cattle.

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You'll find so many Gateway 2000 computers in so many places today because people everywhere know a good value when they see one. In all 50 states and in over 70 foreign countries, thousands of people are comparing prices, quality and service – and choosing Gateway 2000.

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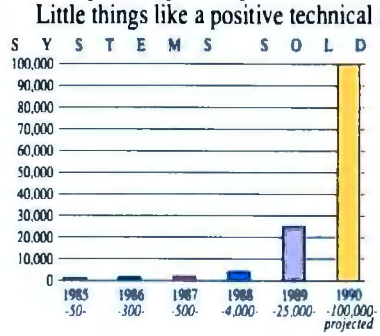
The explanation is that the company has always maintained a small company attitude. With Gateway 2000, you still get the little things you'd expect only from a small firm.

Little things like a positive technical support department. When



Graham Pask told his Gateway 2000 tech rep that his 3 1/2" drive didn't work, he received a new drive the very next day.

Little things like the way Gateway 2000 systems are fully loaded with all the features you want. Jim Rondinelli bought a Gateway

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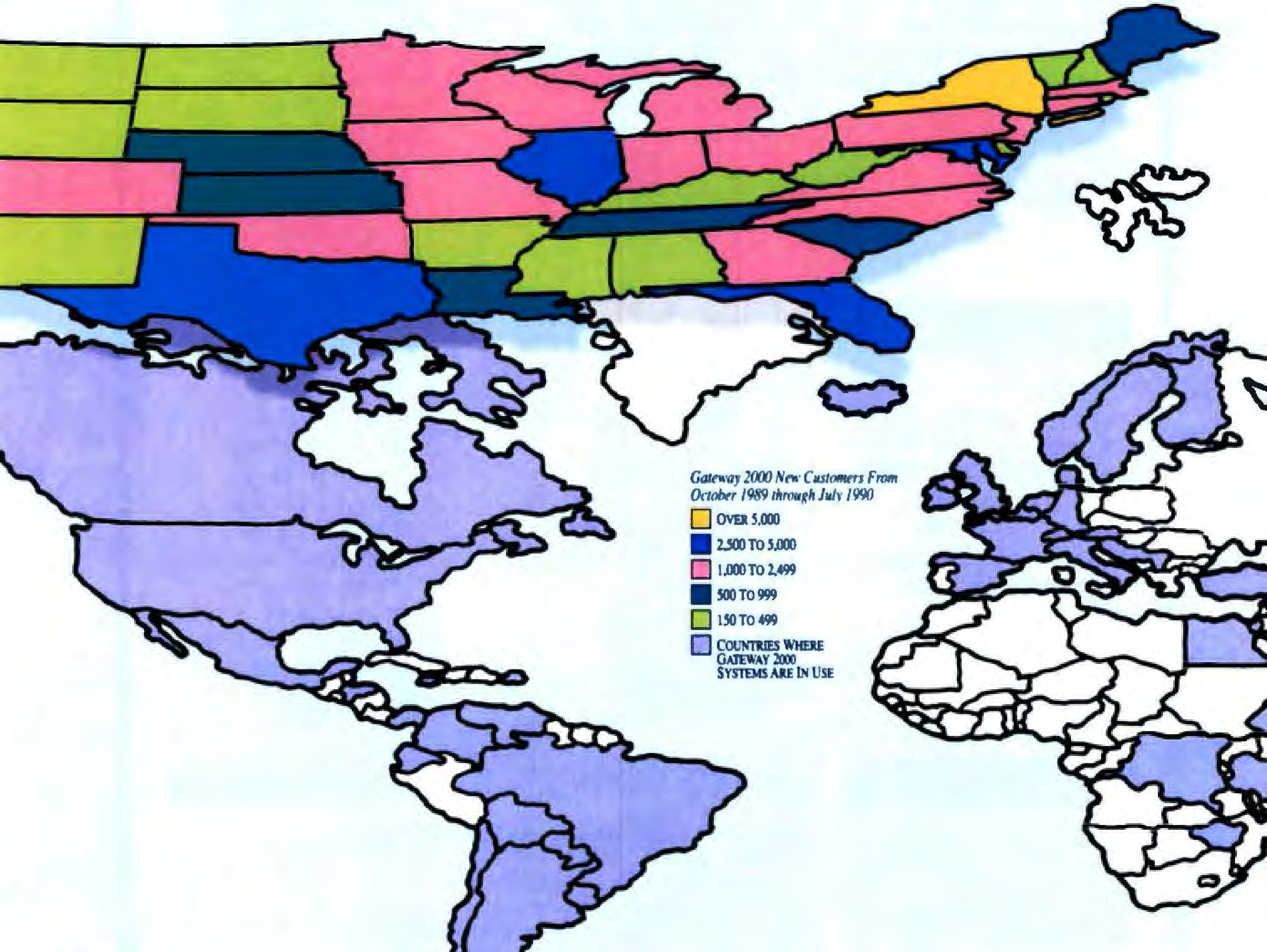

2000 computer because they're "equipped for the real world."

Little things like the way Gateway 2000 sales people develop excellent business relationships with their customers. Fred Gronemeyer tried his first Gateway because he was impressed by his sales person. Eighteen systems later, Fred is still impressed by his sales person.

And the biggest little thing of all is the feeling you get when you deal with the people at Gateway 2000. As Larry Mahan said, "they're honest-to-goodness nice folks."

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New software makes it easier to develop HyperCard-like applications on the PC

CROSSING OVER

I have done a fair amount of cross-platform development in my time, and it has never been very easy. I can recall trying to convert some complicated economic forecasting programs back in 1978. I brought these FORTRAN IV programs with me when I moved from Ohio State University to the University of Chicago. They were crucial for my historical research at the time, but I had written them using the FORTRAN IV compiler on an IBM 370 mainframe at OSU. Chicago's IBM mainframe ran a different version of FORTRAN, so I spent a couple of months converting my old source code to work on the new machine and then recompiling and linking. Not a fun process, I can tell you, even with a good debugger and line editor.

As much of a pain as that was, cross-platform development is more difficult. I need to develop instructional software that will run under the Mac OS, Windows 3.0, and the Unix X Window System, yet take full advantage of each system's inherent graphical user interface (GUI). So far, I haven't been able to find anything that successfully crosses all three operating-system boundaries nicely, but there is hope. Over the last couple of months, I have been working with a development system called Plus, which is published by Spinnaker Software. Plus runs on the Mac, OS/2 Presentation Manager (PM), and Windows 3.0 on the PC. Although the PC version should be shipping by the time you read this, this column is based on my work with beta software, which was done mostly without the benefit of printed Plus documentation for the IBM PC.

A Plus for Porting

Plus lets you port existing HyperCard or Plus stacks from the Mac to IBM PCs and compatibles running OS/2 PM 1.2 or Windows 3.0. Plus is essentially a superset of HyperCard with improved object-oriented programming (OOP) features, a much better editor, and real development utilities.

Plus has been around for a while, first sold by Format Software of Germany, then Olduvai Software of Miami, and now Spinnaker. It seems that Plus has really found a home at Spinnaker, since it has been revised to include the OS/2 PM and Windows 3.0 versions. Before Spinnaker took it over, Plus was strictly a Mac product. While the Mac version is shipping, the PC version is still beta (although it's due out by the time you read this), so keep that caveat in mind.

Plus is Spinnaker's idea of what HyperCard could be with the programming interface extended and improved and with a wish list of extensible features (e.g., color support, resizable and scrollable windows, resource editing and implementation, additional object types, and improved data typing) added. But Plus is still not true OOP, so don't expect to find niceties like polymorphism, true inheritance, or a class browser. Plus also locks you into the same card metaphor as HyperCard, which may be unsuitable for your work. For mine, though, where I use HyperCard daily for instructional examples, Plus is just the ticket for simple cross-platform development and multiple system work.

The real beauty of Plus is that it's nearly identical on the Mac and PC. The only real differences are those nuances dictated by the underlying GUI. This means that Mac programmers should be able to port Plus stacks over to the PC without much PC experience, while PC programmers knowledgeable about PM or Windows will find their commute equally straightforward.

According to the Script

Spinnaker built Plus's script editor into the system, as is the case with HyperCard's. In fact, Plus works much like

continued

ILLUSTRATION: DOUG PAULIN © 1990

HyperCard on steroids—its interface looks a lot like HyperCard's with some new menu items (e.g., Navigation, Object, Text, Font, and Graphic) at the top level, with a tool palette just below these menus. If you are familiar with HyperCard, Plus will seem like a version 3.0.

The big drawback to Plus, though, is that it doesn't build stand-alone applications in the true sense of the term. You'll need a copy of at least the Plus run-time system on your machine to run a Plus stack. Fortunately, you can include the Plus run-time system with your stacks free of charge.

I used Plus to port some student HyperCard stacks over to Windows 3.0, and I was pleased with the results. The work of one student in particular, Suzanne Gurland, typifies the kind of final project stacks that are turned in for my Computer Science 110-111 class (Computer Programming as a Liberal Art I-II). Her HyperCard stack helps her keep track of her duties as a summer camp counselor. The stack uses her own ideas, bits of scripts and objects from Activision's Reports stack, and external text files. With some tweaking, I used Plus to convert this to a Plus stack first on the Mac and then on a Toshiba T5200 running DOS 4.01 and Windows 3.0.

Most of Suzanne's scripts were attached to buttons, since most new HyperCard programmers tend to forget about using the card and background objects as script associators. For example, here's her script for an enhanced Find command:

```
on mouseUp
   push card
      ask "Who would you like
        to find?"
      put it into lookFor
   if lookFor is empty then
   pop card
   end if
   find lookFor --lets the
    --user proceed directly to
    --a desired card without
    --having to "flip through"
    --the stack
end mouseUp
```

This script and its button, like all those in her stack, are directly readable by Plus on the Mac and convertible to Plus under Windows 3.0. I used an AppleTalk PC board and Sitka to transfer files between my Mac IIfx and Toshiba T5200. The Plus Mac files are then directly readable by Plus on the PC.

Most students eventually learn to use the background for scripts whose functions need to be available at all object levels in the stack where that background is present. Plus's improved script editor and its multiple platform availability means that some of my students can now work on their Mac programming homework using their own PCs, running Windows 3.0 and Plus. Background scripts, like this user-defined on handler from Suzanne's Camp Stack, also get ported over to the PC without any modifications:

```
on returnInField
  put number of target into
         holder
   if holder=18 then
  exit returnInField --since
  --this is the last card into
  --which the user enters
  --information, there is
  --nowhere to send cursor
    end if
    if holder<19 then
       select after text of
         field (holder + 1)
  --automatically sends cursor
  --to next field when user
  --presses "enter"
    end if
    if holder=19 then
       select after text of
         field 2
  --this had to be added because
  --a new field was created late
  --in the process and affected
  --the logical ordering of the
  --fields
    end if
end returnInField
```

Although I expect Plus to work well for my initial purposes—to make it easier for students with PCs to take our HyperCard-based classes and to foster OOP/hypertext thinking on the PC as well as the Mac—the beta PC version lacks the same important development features as the Mac version. These missing features include a debugger, high-quality script editor, data exchange with other applications, and the lack of user-definable object properties. The other big trouble spot in the PC version is with XCMDs and XFCNs (external commands and functions).

XCMDs and XFCNs get written in other Mac languages, like Pascal or C, and are compiled and linked in with a Mac Plus stack to provide some code functionality that would be difficult or impossible in HyperCard or Plus. Unfortunately, when you port your Plus stack over to the PC, the XCMDs and XFCNs simply will not work—mainly because they were written to utilize certain Mac-specific features, such as color and sound. The porting process becomes pretty sticky at that point.

The first thing that you have to do is yank out the XCMDs and XFCNs from your stack using ResEdit on the Mac. Then you have to convert the modified stack to run in Plus and copy the modified stack over to the PC. But you're not done yet. Now you have to port over your original XCMD and XFCN source code to the PC, modify it to use PC-specific features, and then recompile it. Finally, you include it in the PC stack. This tiresome procedure was more difficult than it should have been because I was using a beta of PC Plus with almost no documentation, but it was still too complicated. This should be fixed before PC Plus is released. If it's not, the real utility of Plus as a Mac-to-Windows cross-platform development tool will be sorely limited.

Then There's the ToolBook

As I was finishing this column, I got a crack at another OOP-based hypertext system for Windows 3.0—Asymetrix's ToolBook. If you're looking for a more robust and truer OOP development environment for Windows 3.0 that still works as an amalgamation of OOP techniques and hypertext, you should consider ToolBook.

I've worked with ToolBook since it was released on May 21, and it definitely extends the hypertext metaphor (by emulating a book rather than a stack of cards) while retaining the building-block approach of HyperCard. A run-time version of ToolBook comes with every Windows 3.0 box, so if you build ToolBook applications, you can be sure that they'll have an audience. Currently, though, ToolBook does not run on the Mac, so it has no direct utility for cross-platform development.

Although ToolBook doesn't yet have a Mac-equivalent version, it is sufficiently like HyperCard and Plus to put some pressure on Spinnaker to improve its programming environment. In fact, I was so taken by ToolBook that I'm contemplating using it for some Mac-to-PC porting projects.

The reason is that ToolBook already looks a lot like HyperCard, except that it has replaced the card metaphor with that of a book. Stacks become books and cards become pages, while other HyperCard-like objects (e.g., fields, buttons, backgrounds, and foregrounds) are also available in ToolBook. Important differences abound, however, and the most

continued

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Inquiry 976.

ToolBook $395
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110 110th Ave. NE, Suite 717
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(206) 462-0501
Inquiry 977.

important is ToolBook's enhanced script editor and debugger. Both put Plus's currently weak efforts in these regards to shame. ToolBook also supports user-defined object properties and the Dynamic Data Exchange hot-links facility in Windows 3.0.

ToolBook scripts (the scripting language is called OpenScript and looks much like HyperTalk) can be clumsier than Plus's scripts. You also miss repeat structures, since you can't use repeat loops in your code; instead, you have to code a while control structure like this:

```
set ch to 1 --initializes the
 --ch local variable
while char ch of filename
          <> "."
   put char ch of filename
          after title --Title
 --is a local variable; put the
 --character that is in the ch
 --variable at the end of the
 --value that is in the first
 --variable
   increment ch
end while
```

I missed the loop structures like repeat, repeat until, and repeat while. Of course, a straight while structure functions nearly identically to a repeat, but sometimes touching base with commonly accepted syntax from other languages helps enfranchise more crossover programmers. ToolBook should have left in the repeat structures.

The ToolBook messaging system is a bit odd compared to Plus and HyperCard. Where all HyperCard objects generate messages for other objects when their handlers are correctly activated, the ToolBook messages are generated under more controlled circumstances. In some cases, this control can force you to explicitly send a message from object A to object B, since you can alter the natural message-passing through an object hierarchy. This can be confusing, especially if you expect the message to be passed automatically to the correct target object.

Say you want to send a message from one handler in an object's script to trigger the execution of another handler in the same script. You would write something like this:

```
to handle buttonUp
  move circle "RoundOne" to
        110,310
  send buttonDoubleClick
  --sends the buttonDoubleClick
  --message to the object whose
  --script contains this
  --handler
end buttonUp
```

Another handler in the same object's script would handle the buttonDoubleClick message. If not, only then would the buttonDoubleClick message travel up the hierarchy of ToolBook objects.

My impression of ToolBook is that it's needed for the Mac and that the PC Windows version needs all those Mac ToolBook applications that would eventually spring up, especially among dyed-in-the-wool HyperCard/Plus developers. ToolBook is not true OOP, but it's closer than Plus, and its adherence to the basic tenets of hypertext can't be faulted. And for professional developers, it includes decent basic development tools and utilities and the support of many third-party vendors with add-ons.

In the long run, I hope that Plus improves its environment and utility, while ToolBook makes it to the Mac. Once that happens, you'll have two good cross-platform OOP/hypertext development systems to work with. Both Plus and ToolBook are bound to enfranchise a whole new group of PC users who will be building their own custom software for the first time. It should feel like the kick in the pants Mac users got in 1987 when HyperCard was released. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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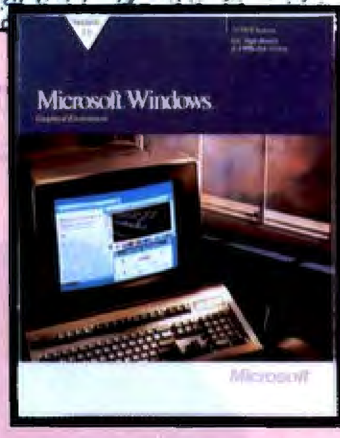

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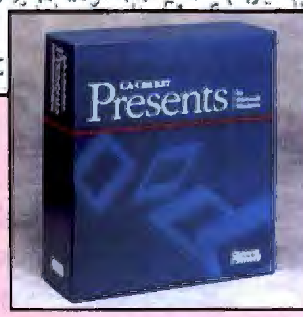

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Microsoft's answer to multitasking hasn't lived up to its claims, but there are other choices

THROUGH A WINDOW, DARKLY

For years now, we've been told that OS/2's Presentation Manager (PM) is the answer to the business user's requirements for productivity. In a fit not to be outdone by Apple with its Macintosh interface, IBM and Microsoft created this super windowing software package that is supposed to let us use a mouse to switch between applications as easily as we change channels on our TVs. The problem is, there aren't enough applications to make switching necessary.

Then, earlier this year, we were told that the new version of Windows would do the same thing for the DOS world. All of a sudden, we would be able to engage in real multitasking—running communications software in one window while using a word processor in another. Once again, the answer to the business user's need for productivity was at hand with Microsoft's graphical user interface. Of course, the fact that Quarterdeck had been doing this for years with Desqview (albeit without the GUI) was ignored.

Now, business users find themselves with two choices, each of which the heavy hitters say is the right GUI. One, OS/2, is supported by the heaviest hitter of them all, IBM. The other, Windows 3.0, is supported by Microsoft, which also wrote OS/2. OS/2 treats all your computer's memory as a big contiguous space in which to run programs. Windows 3.0 lets you load several DOS programs, each into its own 640K-byte segment. OS/2 also lets you have a DOS segment, but you can have only one, and not everything runs in it.

An Embarrassment of Riches?

Confronted with such choices, many business users might simply decide to ignore the whole thing and keep using plain old MS-DOS just as they always have. But can you afford to ignore either one of these? Can you afford to ignore both of them? Does either of Microsoft's GUIs have a place in your business?

To be useful in a business setting, a software package must do something to enhance the value of an employee. The employee must become more productive, more accurate, or more capable than before; otherwise, the software is just a waste of money. In addition, the software must not require resources that outstrip the value to be gained. If you have to spend $10,000 on computer hardware and software to realize a productivity gain of $5000 over the economic life of the computer, you have just thrown away the money you invested.

Accordingly, Windows and PM must do something worthwhile if they are to play a role in business, and, in addition, users should be able to justify them economically. I looked at Windows 3.0 and PM in a variety of environments to see if either of them makes sense. While I was at it, I checked out Desqview 386.

To make sure that I looked at machines similar to what most businesses use, I tried Windows 3.0 and PM on an old 8-MHz, 286-based Zenith Z-248. I also sized up more modern equipment—a Zenith 386/33, a Cheetah 386/25, and a Gateway 2000 386/25. I did not test Windows 3.0 on an 8088-based machine, even though it will allegedly run on one, because of reports that the operation is so slow as to be ludicrous.

PM and Windows 3.0 seem to be very similar at first glance. (For more information on the user interfaces, see "PC GUIs Go Head to Head" on page 82.) There are some significant differences in the software, however, and they can have a major effect on whether or not the packages will be useful to you and your business.

Is OS/2 the Answer?

OS/2's most important difference is that it's not MS-DOS. This statement may sound silly, but remember that most of

continued

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ITEMS DISCUSSED

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Inquiry 1221.

OS/2 1.2
(with Presentation Manager)
Standard Edition $340
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Windows 3.0 .... $149
Microsoft Corp.
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Inquiry 1222.

the software currently in use requires MS-DOS. While OS/2 does provide for a single MS-DOS session (some people call this the DOS "box"), that may not be what you are looking for.

There are some programs that don't run in the DOS session that OS/2 provides, including the standard DOS shell for Novell NetWare. This means you may not be able to use networked applications with OS/2 unless they recognize the OS/2 NetWare requester. In addition, some applications and utilities, including Procomm Plus, seem to run in fits and starts in the DOS session.

Also, to run at all, OS/2 requires a computer to have significant resources. You need several free megabytes on the hard disk and about 4 MB in system memory. Finally, you need an IBM Proprinter, since OS/2 doesn't recognize other printers. Neither VGA Video nor a mouse is required, but you should use both if you actually plan to make the GUI productive. If you plan to use OS/2's multitasking capabilities, you will need more memory than 4 MB.

Virtually all the software available for OS/2 is available for DOS. In addition, OS/2 seems to be the target of choice for applications being ported from the mainframe world to microcomputers. For example, in "Moving Down to Micros" (September BYTE), I wrote about SPSS for OS/2. This massive package requires OS/2 and uses PM as its interface for building user queries. If you plan to use software like this, you'll need OS/2.

Looking Through Windows

Windows 3.0, on the other hand, is a creature of the DOS world. It supports software designed for plain MS-DOS, as well as for earlier versions of Windows. It does, however, have some major shortcomings. For everything to work as advertised, an application must be written specifically for Windows 3.0. Non-Windows applications and Windows applications written for earlier versions may not work as expected when run from Windows 3.0 unless you run them in what's called "real mode"—the bottom 640K bytes. The extra memory does you no good whatsoever.

While Windows 3.0-specific applications apparently aren't difficult to write, right now they aren't ubiquitous. It is likely, though, that they will become available more quickly than applications for OS/2. In the meantime, you have to be careful of software that doesn't like Windows. Novell's workstation shell, for example, will run on a workstation that's using Windows, but you must either use it in real mode or get a special version of the workstation software. You also can't use Novell's IBM 3270 gateway with Windows on the workstation, or the gateway will crash.

On the other hand, applications for Windows seem to be easy to create. I asked a programmer to look at the Windows Software Development Kit, and he reports that it's a significant improvement over earlier versions. Thus, you can expect applications converted for use with Windows 3.0 to show up more quickly than those for OS/2, which is still very difficult to write for.

A Multiple Look

Unfortunately, neither PM nor Windows 3.0 seems to handle multitasking very effectively, at least not with current software. PM will do fine with OS/2 applications, but the chance of finding more than one application that you need at any given time is pretty slim.

Windows 3.0 will switch any DOS program into the background, but it may need to be in real mode to work with some applications. And once switched into the background, it seems to go into suspended animation. A DOS application operating in the background with PM also seems to run very slowly.

As a result, without applications written specifically for the environment in use, you don't really get a productivity gain. You do get context switching, but you can't download from an on-line database in one session while doing word processing in another. In other words, the hype for OS/2 and Windows 3.0 promised a lot, but they didn't really deliver much except a pretty interface. If you want multitasking, you'll have to look elsewhere.

Real Multitasking

The best solution to multitasking that I've used is Desqview from Quarterdeck Office Systems. While it's not a GUI, Desqview works with Novell NetWare and does windows, and its multitasking works quite well. It really does give you the productivity boost promised but not delivered by the others. Of course, this solution is neither brand-new nor heavily hyped, so it may appear to be low-tech to your power users. But Desqview does have the distinction of working where the others do not.

Eventually, perhaps by Fall Comdex, you will begin to see a number of applications that will work with Windows 3.0. Several manufacturers have announced versions of their packages for Windows 3.0, and as more computer manufacturers begin shipping Windows as part of their bundled software, you can expect more software manufacturers to follow suit. Meanwhile, though, your use of Windows 3.0 will be limited. You might as well wait until you really need it—either because an application you need requires Windows, or because it is included with a computer you just bought.

It's unlikely that you will ever see a great rush to PM. It seems to have missed its window of opportunity, and now it probably will find its niche supporting network servers and software packages that migrate from mainframes. The only real reason to buy OS/2 is because a specific application requires it. Otherwise, it's a waste of money.

The promise of a productivity increase based on multitasking remains unfulfilled, at least by Microsoft. Whether or not its GUI enhances your productivity is an open question. Meanwhile, right now you can get the next best thing by calling Quarterdeck. If you must decide between the Microsoft offerings, then the choice is clear. Unless a specific application drives you to OS/2, choose Windows 3.0. At least with Windows, the chances are good that you'll eventually be able to obtain some software. ■

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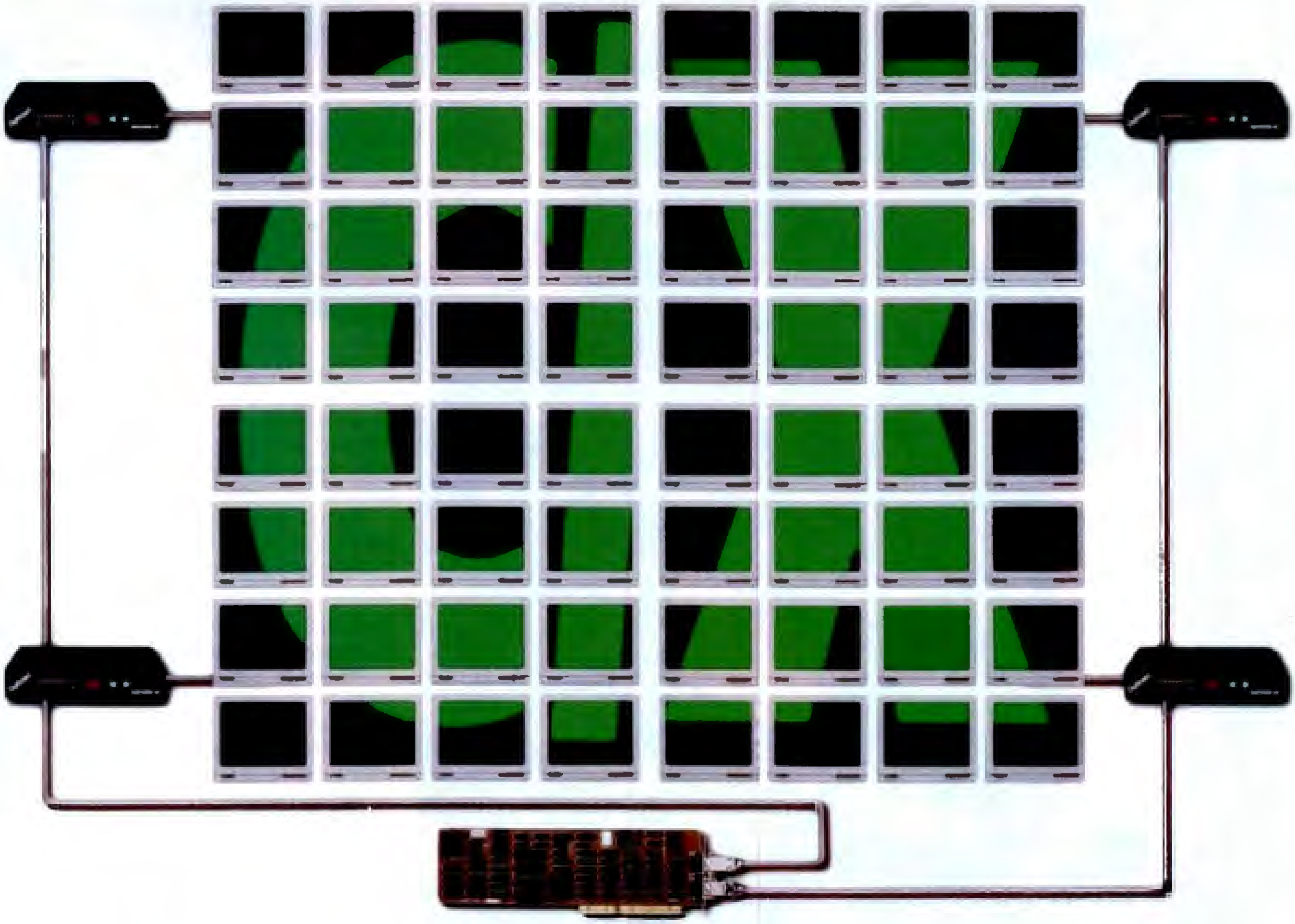
Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



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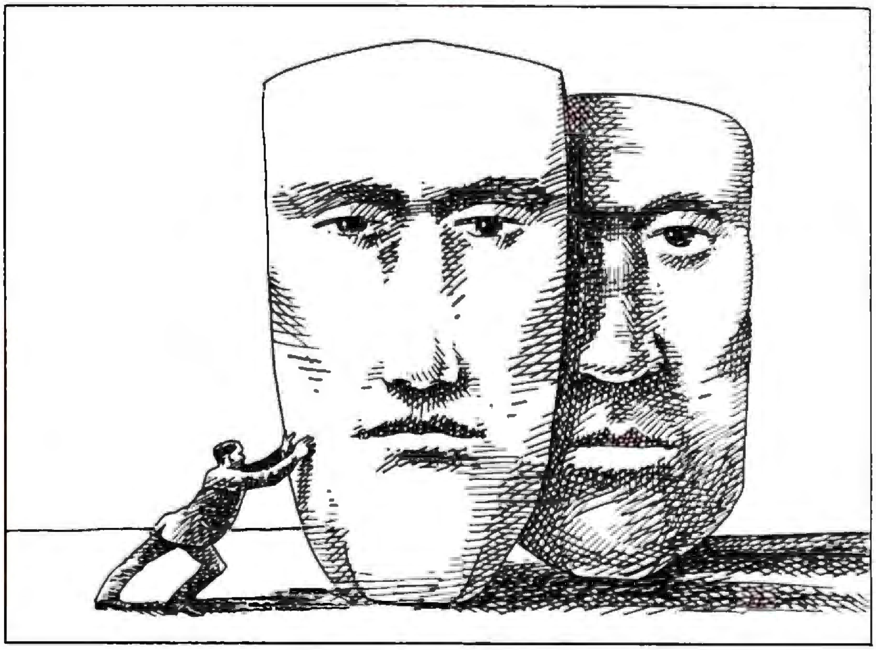
New Unix-specific machines from IBM indicate a new attitude toward Unix

IBM AND UNIX: PERFECT TOGETHER?



Everyone knows that AT&T wrote Unix. But that hasn't stopped IBM from developing products that have changed the face of the Unix industry and will continue to do so for some time. You could even say that IBM has been responsible for several of the more important de facto standards in Unix—and until recently, the products that have set these standards weren't even Unix products!

Look at the venerable IBM AT. Based on the Intel 286 CPU, the AT started to create interest in a modest way when firms such as Microport and The Santa Cruz Operation (SCO) ported Unix and Xenix for it. When multiport serial boards appeared on the market, the AT thus became a moderately priced, standardized base for multiuser applications.

In many ways, this was the true beginning of the low-end Unix market. Before the AT, low-priced Unix machines had been mostly 68000-based computers, with widely differing and incompatible architectures. The AT was a known entity with well-defined characteristics, and it had gotten into many developers' hands. So it was logical that it was a popular destination for DOS developers wishing to port their programs to Xenix and Unix: They already had the hardware, and so did their customers.

This is also how Xenix became so popular, since it was one of the first "serious" versions of Unix intended for small computers that had some of the extensions needed for business. SCO aggressively marketed Xenix to developers through direct sales and channels such as Tandy, which made its own series of Xenix-compatible computers (some of which were also based on Intel CPUs).

Chips Ahoy

The introduction of the Intel 386 CPU probably did more for this segment of the Unix market than any move AT&T ever made. The 386 was an instant success, but not quite the way IBM had planned. While IBM's sole 386 machine belonged to its new line of Micro Channel architecture machines, everyone else started dropping 386 chips into reworked AT motherboards. Suddenly, the most-wanted personal computer in the IBM world was something that IBM didn't make (and still doesn't): a 386-based version of the AT.

In addition, although many DOS-based PC users looked at their 386 machines as an expensive status symbol (which was true in some cases where people weren't doing serious graphics and CAD work), Unix users knew just what to do with all that power. It was desperately needed for the multiuser applications that had been stretching the 286-based AT computers to their limit. 386 PCs running Unix could now become a major force in the market.

There were technical, not just market-driven, reasons for this. The 386 is a much more powerful processor, is faster internally than the 286 while being upwardly compatible with it, and can run at clock speeds of up to 33 MHz. It has a fully separate supervisor mode, so a 386 Unix kernel can be run completely protected from the vagaries of user programs. Perhaps most important, the "virtual 8086" mode of the 386 CPU enabled software companies such as Locus Computing and Interactive Systems (together with Phoenix Technologies) to write emulators for MS-DOS that allow an entire DOS system to be run as a task under 386 Unix. This support of an IBM standard allowed more DOS users to see the potentials of Unix.

For the first time, Unix users could have a powerful processor at a reasonable price, on a totally standard hardware platform that was compatible with MS-DOS. Add to this the standard Unix ports available from AT&T, Interactive Systems, Intel, SCO, and others, and it's

continued

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obvious why the 386 has redefined the lower end of the Unix market. Of course, the i486 is an even more powerful platform for Unix, although the ramifications of the battle between the Extended Industry Standard Architecture and Micro Channel architecture buses are too complex to be discussed here. Again, it was IBM's lead in the business arena that helped this standard come about (in comparison, Motorola 680x0-based computers are generally no longer in the high-volume low-end market).

Software Solutions

But there's more. For every user who has moved to Unix from DOS, there are still probably 80 who haven't. Even so, DOS users are using Unix, albeit often transparently or as a back-end server. The programs that make this possible are things like PC XSight from Locus, PC-Connect from VisionWare, and PC-Interconnect from Motorola.

All these programs allow DOS users to access both Unix and DOS programs more or less (depending on the product) transparently. The Unix programs are expected to reside and run on a different machine, generally connected to the PC via Ethernet. The DOS side may look like an ordinary DOS screen, or like an X Window System terminal, or even like Microsoft Windows. The better programs even allow cutting and pasting between DOS and Unix programs. The result is that you can keep your IBM PC running DOS, while getting the benefit of the departmental or companywide Unix machine (see "DOS and Unix: On Speaking Terms," June BYTE).

DOS users are using Unix, albeit often transparently or as a back-end server.

IBM and Workstations

IBM has not been ignoring the mushrooming workstation market, either. IBM took early steps a few years ago with its RT computer, which was supposed to become a hot entry in the scientific market due to its use of RISC technology and Unix. In an attempt to ensure software availability, IBM went out of its way to make RT machines available at extremely good prices to software developers and porting houses. Although IBM was the originator of RISC technology in the first place, the scientific community didn't seem to find the RT very interesting. The original RT was underpowered compared to its competition, and the version of Unix that finally came out of IBM was simply nonstandard enough to cause problems.

All those software developers did play an important role, however. Once the initial cachet of working with IBM wore off, developers needed a way of recovering some of the costs involved in buying their RTs and porting their software. By selling both the IBM hardware and software to the business market, they were able to accomplish this, while introducing many executives to the idea of workstations in general.

continued

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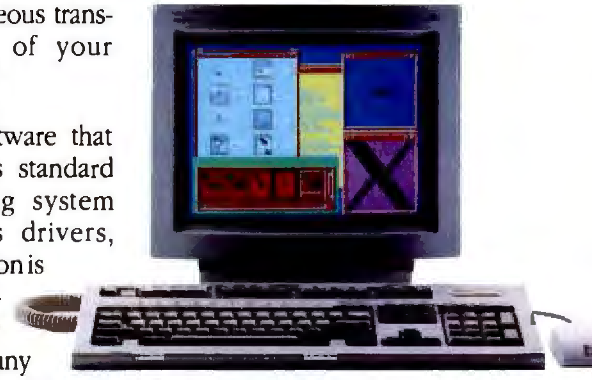

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It seems that some businesspeople weren't ready to deal with upstart companies like Sun Microsystems and concepts like workstations and networks, but of course, they would *always* buy hardware with the IBM name on it. So the IBM RT workstations found a niche in business, which became a bit larger when the RT was redesigned to make it even faster. Even so, the market share of the RT was microscopic compared to the rest of the workstation market.

The New IBM RISC Line

IBM's recent announcement of the powerful RS/6000 line of RISC workstations and servers (see "Sizzling RISC Systems from IBM," April BYTE) overshadowed what is probably more important: IBM's major new commitment to Unix. After talking to several top IBM executives, I am convinced that IBM is now absolutely serious about Unix and considers it as much a part of its strategy as AT&T does. The RS/6000 line, in particular, will play a large role at IBM for the forseeable future. And IBM will be supporting the RS/6000s the way you might expect it to take care of its mainframe customers, including 24-hour hot-line support.

Whatever the competition may think about the speed of the RS/6000, one thing is certain: These machines have a great deal of power. Even if you were to assume that IBM's own benchmark figures are greatly exaggerated, the slowest machine in the RS/6000 line would still be one of the fastest computers in its class. And since this entry-level workstation, the Powerstation 320, costs less than $13,000 (including AIX, 8 megabytes of RAM, a 120-MB hard disk drive, and a 19-inch monochrome display), you can expect that IBM will be tough competition for traditional workstation manufacturers. IBM itself thinks it will be a leading player in the workstation market by 1992.

The software delivered with the RS/6000 line sets a few standards, too. AIX 3 is a Posix-compliant, security-minded, and significantly enhanced version of Unix (although rumor has it that programmers may have to work around a few nonstandard features). AIX 3 will eventually be the standard Unix available for the IBM PS/2s and 370 mainframes, as well.

Along with the standard C compiler and development package, AIX users on the RS/6000 receive OSF/Motif and X under the name AIXwindows. The NextStep development system will also be available, meaning that developers will have two state-of-the-art development environments to work with. Naturally, both IBM and NeXT are hoping that NextStep becomes a standard the way X is and Motif is rapidly becoming. And IBM took care to ensure that many high-end applications were available for the RS/6000 line of machines at the time of its announcement.

IBM has not only played an important part in setting standards that have affected everyone in the Unix industry but is also creating new products that will themselves set the standards to come. It will be an exciting future. ■

David Fiedler is executive producer of Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

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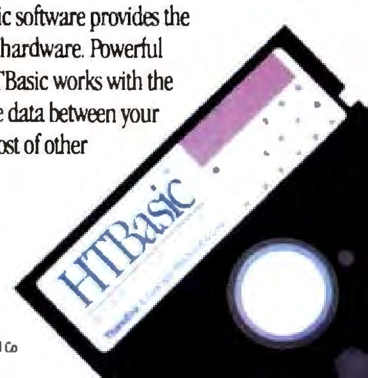

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Can Netware and LAN Manager learn to get along?

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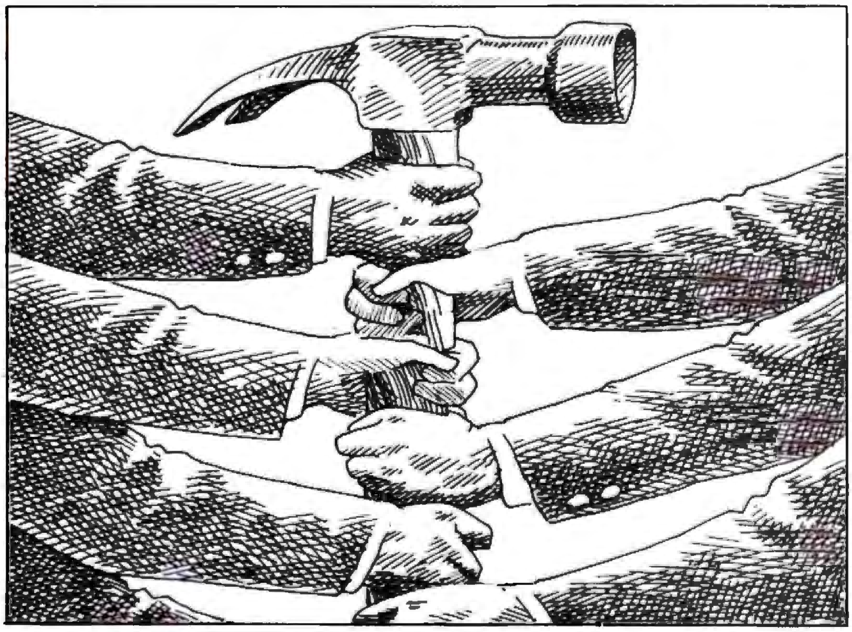

Any carpenter can tell you which tool is the right one for a given task. The same thing is true of LAN administrators selecting a LAN operating system; in both cases, you choose the one that best meets your requirements.

But it's not that simple. That strategy works when you choose your first LAN operating system, but what about the next time? Do you go with the LAN operating system you bought earlier, or do you choose the one that's right for your second job? They aren't always the same.

If you stick with a single LAN operating system, making your LANs work together is fairly simple; most vendors do a decent job of ensuring that their own products integrate reasonably. Choose two different LAN operating systems, however, and it's a whole different story.

We're faced with that situation in our lab, where NetWare and LAN Manager servers sit on the same Ethernet wire. And we are not alone. LAN Manager (as offered by such vendors as IBM, 3Com, and Microsoft) and NetWare are the two biggest PC LAN operating systems. More and more large organizations are in the awkward position of trying to let their network users work with both NetWare and LAN Manager servers.

What You Want

What's so frustrating about that situation is that the ideal answer is obvious: You want all your client PCs to be able to work with both types of servers simultaneously. Each client PC should be able to take advantage of the file, printing, and other services of both the LAN Manager and NetWare servers. Even more frustrating is that this solution is technically possible—but not likely. To see both how this solution could work and why it's not likely to happen, let's look closer at a single server function: file services.

NetWare and LAN Manager client PCs have the same three basic types of file-service software: a device driver, a protocol stack, and a redirector. The device driver lets the higher-level software talk to the network adapter card, such as the Ethernet cards we use in our lab. The redirector intercepts server file requests and makes them happen. Between the device driver and the redirector sits a protocol stack that sets up and manages communication sessions with the server.

Thus, to let a single client PC use both NetWare and LAN Manager servers, we need one device driver, one protocol stack, and two redirectors—one for the NetWare requests and one for the LAN Manager requests. Put another way, all we need is for Microsoft and Novell to agree to use the same device drivers and protocol stack, and we're in business.

Not a chance. At least, not yet. Both vendors have their own device driver standards and their own protocol stacks. Both are even working on their own standards for those parts. Novell's Open Link Interface defines a standard interface between device drivers and the protocol stack. The Microsoft/3Com LAN Manager equivalent is the Network Driver Interface Specification.

Unfortunately, the two standards are different. Worse, they're likely to remain that way. It's like the old joke: How many psychiatrists does it take to change a light bulb? Only one, but first the bulb must want to change. Microsoft and Novell don't want to use the same protocol stacks, so they won't.

What You Need

Because Microsoft and Novell won't change, we can't get the ideal solution that we want. We might, however, be able to get what we need.

For example, if we can't have a single standard software set, how about a way to run two sets at once? All we need is two device drivers, two protocol stacks, and two redirectors—and the redirectors

continued

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have to be smart enough to pass on any requests not destined for them.

We saw such a product at the Fall 1989 Comdex. Schneider & Koch & Co., a West German company, showed a single PC using the file services of a NetWare and a 3+Open server simultaneously. The second thing we did upon seeing this product (the first was to verify that it was working) was to run CHKDSK on the demo client. About 300K bytes of the PC's precious 640K bytes was gone, consumed by the protocol stacks. It's bad enough squeezing many applications into the memory left over after NetWare or LAN Manager loads; now double the memory loss—not a pretty sight on a standard 640K-byte DOS PC.

Still, there's hope for this approach. 3Com has announced (and should have shipped by now) 3+Open Connection for NetWare. This product, in conjunction with 3Com's Demand Protocol Architecture, lets a single PC run multiple protocol stacks with a single device driver and network board. 3Com's NetBIOS stays in memory constantly, while you load NetWare's SPX/IPX protocol stack in and out of memory as you require. The swapping is manual, so you must issue explicit commands to use a NetWare server. Furthermore, when you connect to a NetWare server, you pay the substantial memory overhead of having both the NetBIOS and SPX/IPX protocol stacks in memory at once. Consequently, while this product is a useful way to work with NetWare servers occasionally, its memory overhead is still too high for constant use of both servers.

Racal InterLan's LMN Server supports two protocol stacks.

Another possibility is to work in a PC environment, such as OS/2 or Windows 3.0, where 640K bytes is no longer a limit. OS/2 doesn't help the vast majority of DOS users, but Windows 3.0 might.

Unfortunately, Microsoft didn't think about this problem when it designed Windows 3.0. You can load two protocol stacks, but only if you do so before Windows starts. Once Windows is running, it knows how to mount network disks—but only for a single network. With just a little work from Microsoft, however, Windows could "learn" to work with more than one protocol stack at a time. Microsoft, are you listening?

Let the Server Do It

Another option is to stop making the clients do all the work and shift the burden to the server: Make the server support both protocol stacks. Racal InterLan's LMN Server does just that. LMN Server runs on a LAN Manager server, where it intercepts NetWare-format requests destined for that server and translates them into requests that LAN Manager can understand. NetWare clients then can treat that LAN Manager server just as they would any NetWare server.

Of course, LMN Server is only half of the answer; it doesn't help LAN Manager clients get to NetWare servers. For that, we'd need a Value Added Process

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(for NetWare 286) or a NetWare Loadable Module (for NetWare 386). Given those components, however, we'd have a reasonable way for the two worlds to coexist—and the added benefit of affecting only the servers, not all the clients.

Applications, Anyone?

All the solutions we've discussed so far are for general file services. In many cases, a general answer isn't crucial; all that's necessary is some way to make specific applications work on both LANs. (If those applications work with whole files, however, then direct file access is still critical, and we're back where we started.)

Client/server applications are natural starting points for this approach. In fact, one of the first applications that led to an interesting LAN Manager/NetWare link was the Microsoft/Sybase SQL Server. SQL Server is a database server that runs on an OS/2 workstation. It receives client requests via Microsoft's Named Pipes (a Microsoft standard interface between applications and the network protocol stack). The SQL Server client software on a DOS or OS/2 PC hands request messages to the client Named Pipes software, which in turn hands it down to that system's network protocol stack. When the requests arrive on the server, they flow back up through the server's network protocol stack, to the Named Pipes software on the server, and then to the actual SQL Server database software.

Note the use of the Named Pipes standard interface on both the client and the server; Novell did, and the result was its NetWare Requester for OS/2 software. That software gives OS/2 server packages a Named Pipes interface to NetWare's protocol stacks—so NetWare clients can talk to those applications. It's not an answer to all the problems we've presented, but it is, at least, a potentially good way to let LAN Manager and NetWare clients use some of the same client/server applications.

The Bigger Picture

We've intentionally cheated a bit so far by restricting the playing field to NetWare and LAN Manager. The same problems also exist for those who use two or more other LAN operating systems. We have, for example, omitted Banyan's Vines. Banyan is clearly aware of the need to work with other LAN operating systems, and the company is working with Microsoft to find ways to let Vines and LAN Manager work together. Other vendors are hashing out their own deals.

While all those deals are cooking, those of us who want to have client PCs using two or more LAN operating systems at the same time are out of luck. We'd love to see the major vendors standardize the client software and leave their innovations to the server side, but we doubt that it will happen. In the absence of such standards, let's hope that some of the approaches we covered above mature enough to become common and reliable ways to make different LAN operating systems coexist. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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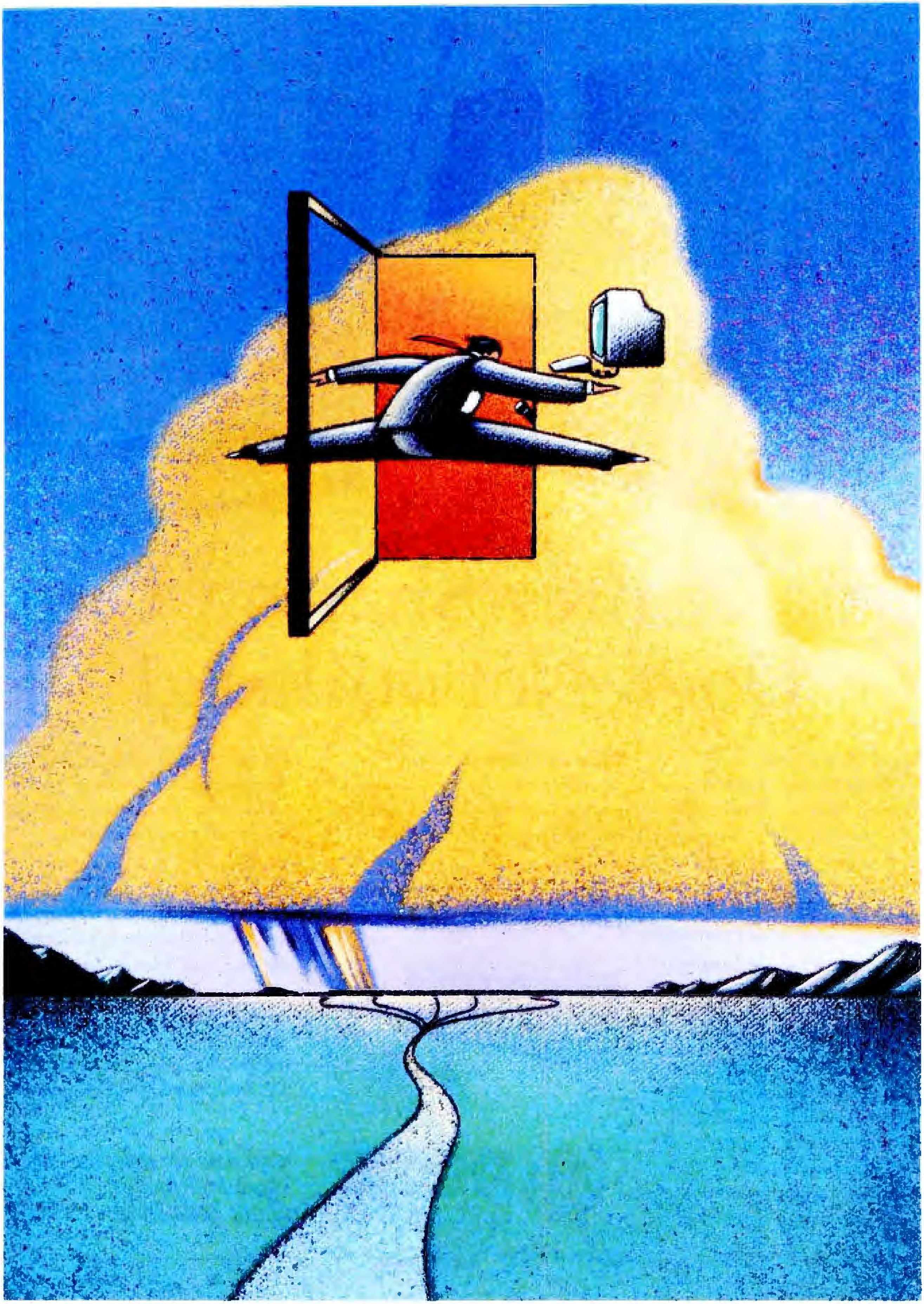

IBM IN THE NINETIES

A look at what lies ahead for Big Blue in the coming decade

Nick Baran

Nowadays, when you hear talk of IBM, it's no longer just the company that's being referred to, but an entire industry. Personal computer owners who say they have an "IBM" may very well be referring to a PC clone from Korea or Taiwan. Virtually every new technology in the microcomputer industry finds its way into IBM-compatible machines.

The Personal Computer Coup

As IBM enters the 1990s, the company faces a drastically different set of challenges than it faced a decade ago. When IBM introduced the PC in 1981, the personal computer was sort of a special project for IBM—an experiment. In spite of its unexpectedly enormous success, the PC in those early years accounted for only about 5 percent of IBM's gross revenues. Today, "the personal systems business," as IBM's James Cannavino calls it, accounts for about 16 percent of IBM's revenues, about 10 billion dollars' worth in 1989, according to figures given by Cannavino at a speech in New York last April.

Nevertheless, IBM enjoyed a much more comfortable situation in the early 1980s. Its main business consisted of mainframes and minicomputers, which yielded large profit margins and guaranteed additional future income in the form of maintenance contracts and leased software. Little did IBM know that its PC experiment would unleash a revolution in computing that would forever change IBM's standing in the marketplace—from a position of dominance to that of having to keep up with relentless competition and technical innovation.

IBM's dependence on its personal systems business will undoubtedly continue to grow as desktop computers based on Intel's 386 and i486 processors replace older minicomputer systems like the IBM System/38 as database and file servers for networks of personal computers. In addition, IBM has aggressively entered the Unix workstation market with its RISC-based System/6000 line of machines, which must also be classified as personal systems. Note that IBM now refers to "personal systems" rather than "personal computers," emphasizing the concept of a complete office system rather than a stand-alone computer for individual users.

In fact, personal computing on an individual basis is no longer the driving force behind the personal computer industry. The driving forces now are workgroups and organizations that share information and resources on a network. Initially, the personal computer was popular because it let you work independently on your own computer, away from the controls of system administrators, endless print queues, and the unpredictable performance fluctuations of mainframe or minicomputer systems. Now, the trend is back to organizational computing. But instead of centralized minicomputer and mainframe hosts, we now have distributed computing; each node on the network has its own processor, as well as access to the other processors and peripherals on the network.

Another trend has been toward computers with graphical user interfaces, which require graphics-based displays rather than character-based or alphanumeric displays. GUIs, along with the organizational computing model, have forced personal computer designers to make changes in the basic design of small computers.

New Hardware for Networks and Graphics

The trends toward GUIs and "workgroup" computing have led PC designers to adapt the basic model of a single processor—with a single, buffered I/O bus—to the more demanding requirements of multitasking, networking, and high-speed graphics. Recently, several vendors, including IBM, Hewlett-Packard, and Compaq, have introduced powerful extensions to the basic IBM PC architecture to provide the additional horsepower required by the networked and graphical environment.

For example, IBM introduced a new version of its Micro Channel architecture that supports data transfer rates of up to 40 megabytes per second, about twice as fast as the maximum performance of the original Micro Channel architecture bus. Compaq included dual-processor capability in its Systempro to

continued

provide the additional horsepower required of a high-performance network server. Hewlett-Packard provided a high-speed graphics bus (40 to 60 MBps) in its Vectra 486 computer to accommodate the demands of high-performance CAD and graphics-intensive tasks. And NetFrame introduced an Intel-based network server that provides multiple I/O channels, each with its own microprocessor.

The demand for high-speed buses and multiple processors has not gone unnoticed by chip-set manufacturers, either. A new company called S3, founded by engineers and marketers from several established Silicon Valley companies, has introduced a modular chip-set architecture that includes a high-speed bus called the Advanced Chip Interconnect. Using the concept of modular and scalable building blocks, the ACI architecture lets you design anything from a standard 386 or 486 PC with a single CPU and bus, to multiprocessing systems with multiple CPUs and buses. You simply add chip modules and address lines to the ACI. The ACI supports cache coherency, distributed interrupts, and interprocess communications, allowing PC manufacturers great design flexibility. Depending on the bandwidth of the address lines to the ACI bus (16, 32, or 64 bytes) and the clock speed of the host system (25 or 33 MHz), data transfer rates ranging from 60 to 120 MBps can be achieved.

While S3's approach may not appeal to manufacturers like IBM or Hewlett-Packard, which can fabricate their own chips and circuits, many of the so-called clone manufacturers will be able to compete at the high-performance end using off-the-shelf components based on the ACI architecture. And you can expect other chip-set vendors, such as Chips & Technologies and Headland Technology, to provide similar solutions at the system-board level for high-performance network and graphics computing.

A Better Way: Data Compression

High-speed buses and multiple processors are powerful but very expensive solutions to the problem of manipulating the enormous amounts of data that graphics applications require. Another approach, which is ultimately much more elegant and economical, is to use data compression to reduce the size of those data files representing graphics images. Such a technique is the objective of the Joint Photographic Experts Group (JPEG) standard compression algorithm, which is supported by IBM, Digital Equipment, and NEC.

A new company called C-Cube Microsystems has implemented the JPEG algorithm in an application-specific IC that can perform data compression at ratios of up to 60 to 1 in real time. The basic compression technique involves discarding data in the graphics image that describes frequencies that are not visible to the human eye. Thus, with compression ratios of 10 to 1 for screen images and 25 to 1 for print images, the difference in visual quality is hardly noticeable, although much of the high-frequency content of the image has been discarded by the compression algorithm. The key here is that the data is discarded, not restored at the other end of the transmission path. For example, a full-color 8½- by 11-inch image at 300 dots per inch requires 25 MB of storage. The ability to cut these storage requirements by as much as a factor of 25 means faster transmission rates and much smaller memory, storage, and bus bandwidth requirements, and it will eventually make 24-bit color available on low-end PCs.

You can expect to see data compression processors like the C-Cube start to appear as add-in boards or even directly on the system board in the personal computers of the 1990s.

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Some Folks Are Going Wireless

Another important trend that the IBM world will see in the 1990s is wireless LANs, in which PCs on the network are linked by radio waves rather than by hard-wired coaxial or twisted-pair cable. A leader in this area is a small start-up company called Agilis, which makes hand-held workstations as well as wireless network components for Ethernet-based networks.

The Agilis wireless network is based on spread-spectrum technology, which allows signals in a narrow frequency band to be spread and transmitted over a broad range of frequencies with a lower energy content (e.g., a collection of weak signals), thus minimizing noise and interference with other radio devices. The signal is then collapsed back to its original narrow frequency band at the receiving end of the transmission. Agilis uses a technique for spreading and collapsing the data signals called *direct sequencing*, which involves a sequencing algorithm that is set at both the transmitting and receiving ends to selectively pick up the desired signals. The Agilis system works at distances of up to 100 meters indoors and up to 1 km outdoors.

While the Agilis system in its present form is geared primarily toward "mobile networking" and exchanging data or E-mail in warehouses and retail facilities, manufacturing facilities, and service centers, and on trade- or convention-show floors, to name a few applications, the technology will also begin to appear in wireless office LANs. Obviously, wireless networks offer the major benefit of eliminating the installation of cabling throughout an office building, often a cumbersome and expensive task. The biggest limitation is the current maximum transmission rate of 236,000 bps (hard-wired Ethernet transfers data at 10 megabits per second). Advances in radio transmission technology should allow higher transmission rates in the near future, according to engineers at Agilis.

Going After Unix

So far, IBM's forays into the Unix workstation market have had limited success. The IBM RT was overpriced and had serious performance limitations as well as limited support from third-party software vendors. But IBM's new System/6000 workstation line is a different story. The System/6000 is based on a second generation of IBM's RISC architecture, which includes separate fixed-point, floating-point, and instruction/branch units that can operate in parallel. The System/6000 offers stunning performance (27 million integer instructions per second and 7.4 million floating-point operations per second) for a price that is competitive with those of workstation offerings from Sun and Hewlett-Packard. When IBM introduced the System/6000, over 70 software vendors showed products (primarily engineering and scientific applications) running on IBM's latest version of AIX, its own version of Unix.

In spite of the impressive performance of the System/6000, IBM faces intense competition in the Unix market, particularly on the software side. In an attempt to cover all bases, IBM is supporting the OSF/Motif GUI from the Open Software Foundation (a consortium of Unix vendors, including Hewlett-Packard, IBM, DEC, and several others), as well as the NextStep interface developed by NeXT and licensed to IBM. NextStep will probably be available on the System/6000 before Motif, since it is already a commercial product, whereas Motif is still under development and is not expected to be ready until sometime in 1991. Meanwhile, the Open Look GUI from Sun and AT&T is starting to appear in third-party applications for Sun workstations, giving Sun a head start in the Unix GUI battle.

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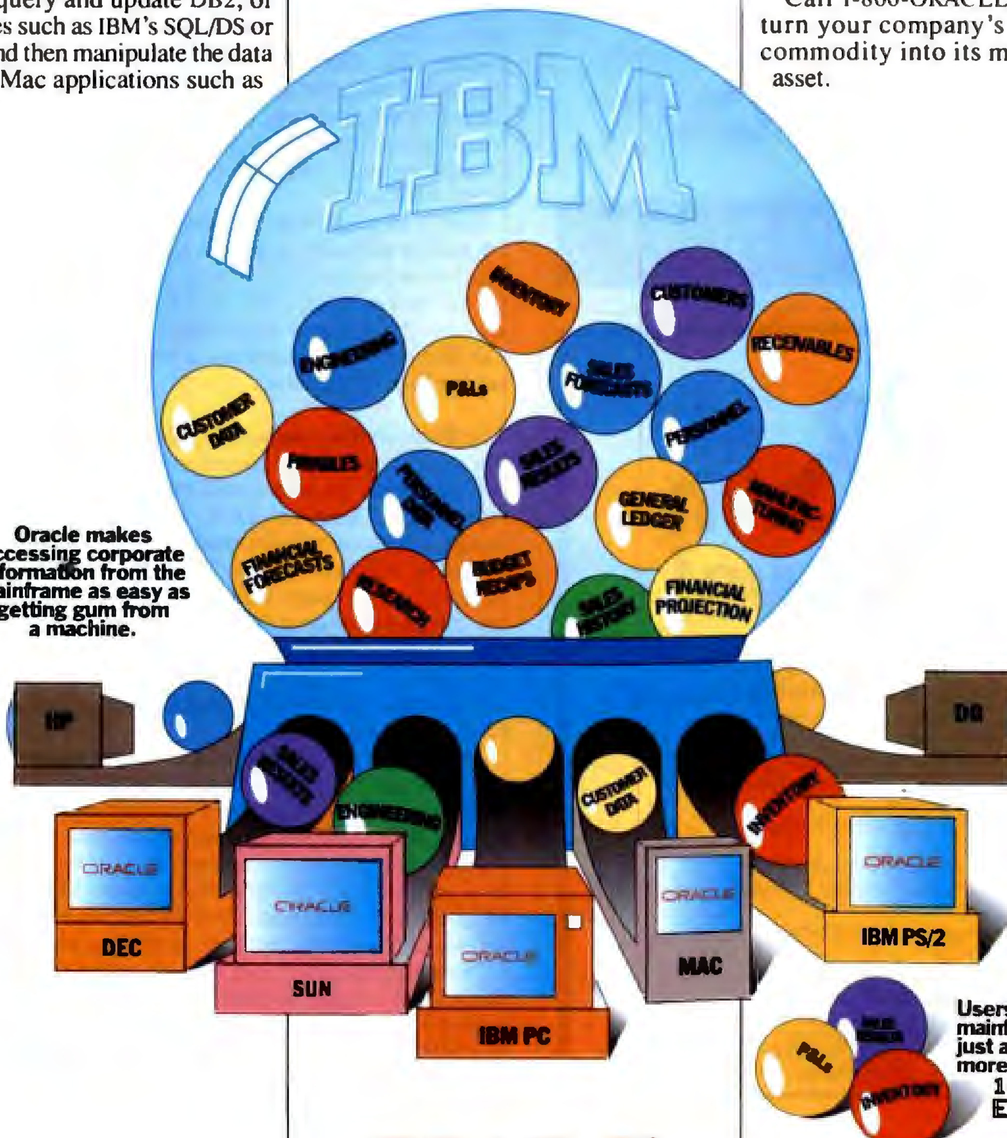

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But with the System/6000, IBM has made a strong statement that it's in the Unix market for the long haul. Undoubtedly, IBM will be a formidable competitor in the Unix arena in this decade.

IBM Has Seen the Future, and It's SCSI

SCSI has become the standard interface in Unix workstations and Macintosh computers for connecting to peripherals such as disk and tape drives, CD-ROM drives, and scanners. Until a few months ago, however, IBM did not support SCSI on its PC and PS/2 machines. Now, IBM has announced new versions of its PS/2 Models 70 and 80 that include SCSI adapters. And SCSI is the standard interface on the System/6000 workstations, which feature a blazingly fast 320-MB hard disk drive with 12.5-millisecond access time.

While IBM won't publicly admit it, it appears that SCSI will become the new standard on IBM hardware, marking the gradual demise of the ESDI and ST506 disk interfaces that IBM has used in its high-performance and low-end PCs, respectively, as well as the Centronics parallel port used for PC-compatible printers. But IBM obviously sees the writing on the wall. In this age of connectivity and office environments with multiple platforms and operating systems, SCSI is the de facto standard for peripheral interfaces. SCSI also offers the major advantage of allowing daisy chaining of as many as seven devices off a single SCSI port.

IBM's adoption of SCSI is good news for the rest of the industry and for end users as well. Vendors of Unix workstation and Macintosh peripherals will now have another substantial market for their products, thus increasing competition and presumably forcing prices to come down, particularly on optical and CD-ROM drives, which remain overpriced in the current market due to small demand.

The Belated Marriage of OS/2 and Windows

Microsoft's and IBM's crusade to make OS/2 the dominant operating system for Intel-based machines has so far been a dismal failure. Most MS-DOS users would rather fight than switch, and those who are ready to make a change find Unix an attractive alternative to OS/2. From a developer's standpoint, Unix is easier to work with, offering a full 32-bit paged memory model rather than the 16-bit segmented memory model of OS/2. And from an end user's standpoint, Unix is beginning to develop a strong library of applications, particularly on Sun workstations and Intel-based machines running on The Santa Cruz Operation's Xenix.

But OS/2's 16-bit limitations will go away this year when Microsoft introduces OS/2 2.0, which is a full 32-bit implementation with paged memory. In addition, OS/2 2.0 offers numerous other improvements in file and disk management functions, as well as greatly improved support for MS-DOS running as a subtask (see "Programming 32-bit OS/2" on page 97). Most analysts agree that 2.0 is the version of OS/2 that Microsoft should have come out with in the first place.

Nevertheless, OS/2 may end up taking a backseat to Windows 3.0, Microsoft's latest release of its MS-DOS-based windows product. Although the new version requires a minimum of 1 MB of memory, it is an excellent compromise between the high memory and performance overhead of OS/2 and the lack of a GUI in MS-DOS. In fact, Microsoft appears headed toward a merging of OS/2 and Windows. Microsoft executive Steve Ballmer recently referred to OS/2 as "Windows Plus." To strengthen the ties between Windows and OS/2, Microsoft has introduced a Software Migration Kit that will make porting

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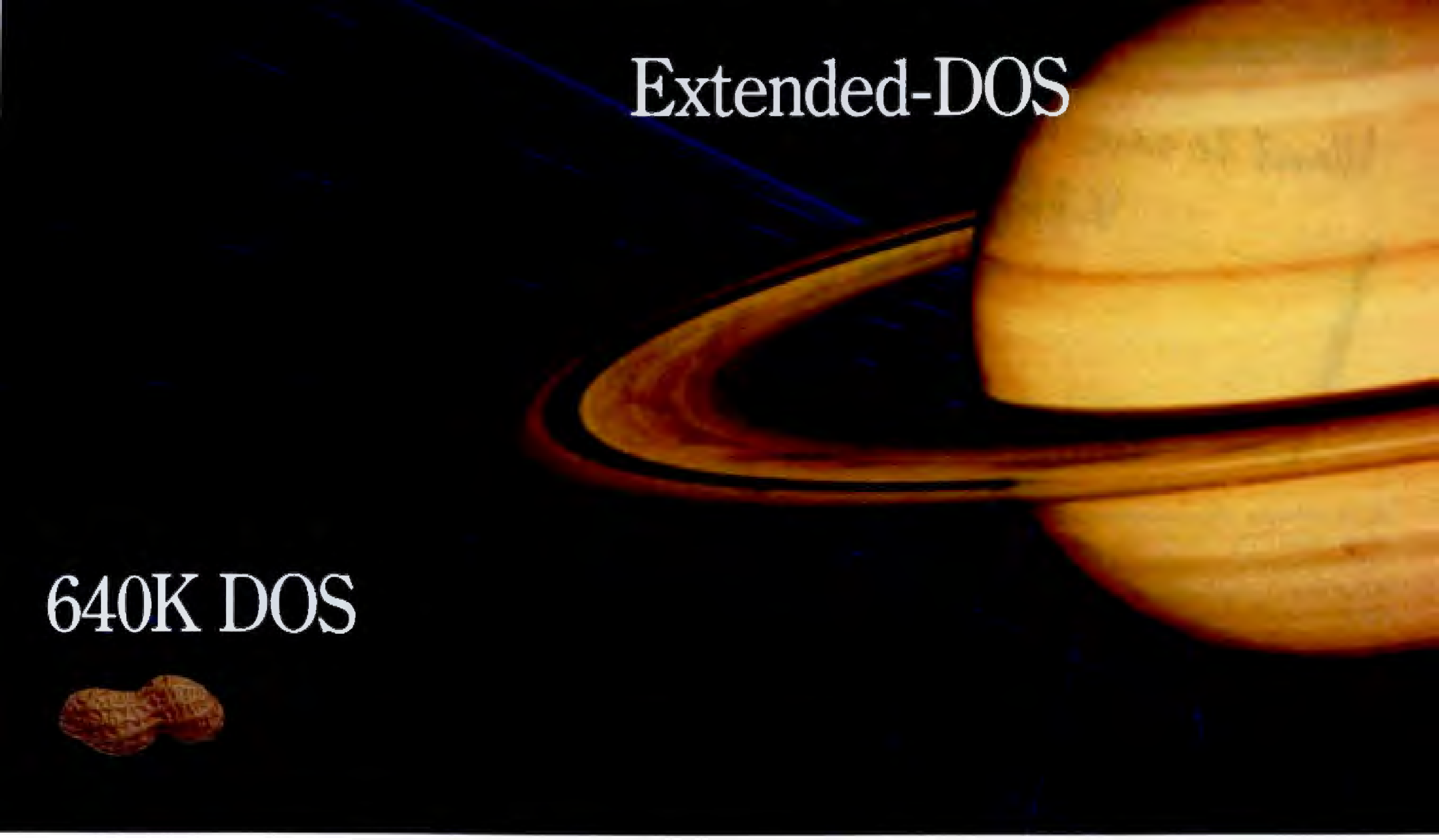

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Windows applications to OS/2 a straightforward procedure for software developers. Microsoft has also announced its intentions to provide binary compatibility between Windows and a future release of OS/2, allowing Windows applications to run under Presentation Manager with no modification.

In the long run, OS/2 will run on network servers with the PC nodes all running Microsoft Windows. Corporate users will get the benefits of OS/2, while individuals will get essentially the same interface but with less power in Microsoft Windows. There are also moves afoot to provide protected-mode operation of MS-DOS with a product called DOS Protected Mode Interface. Who knows—OS/2 may be obsolete before it ever gets a chance to prove itself.

Then There's That Other Three-Letter Word: SQL

Structured Query Language has been talked about in the press for the last two years, but very few products actually implemented the SQL interface to networked database servers. However, 1990 looks like the year when the hype is turning into reality. First of all, some of the vendors who promoted their SQL products two years ago but had nothing to deliver are finally introducing SQL interfaces this year. These companies include Lotus with its DataLens product; Borland with a SQL interface for Paradox; Software Publishing, which has quietly been working on an OS/2-based SQL interface for a couple of years; and, of course, Microsoft SQL Server, which is actually commercially available. Look for Gupta's SQL Windows to be a big success with Windows 3.0 running on networks with OS/2 servers.

But more important, SQL products are becoming a reality because connectivity to database servers is becoming a reality. Network operating systems like Novell's NetWare and Microsoft's LAN Manager are making big inroads into corporate America. With the proliferation of networks will come a proliferation of relational database servers. Of course, IBM is also heavily promoting its Extended Edition database server for OS/2 and connectivity to its mainframe and minicomputer systems running DB2. You can expect many more organizations to adopt SQL-based interfaces for their corporate databases.

The High Road and the Low Road

Not everything in the 1990s will involve networks, high-speed graphics, paged memory, and other high-end applications. There will also be major changes in the low end of the market—the 286 and 8088 markets. You can expect to see ever-more-compact laptops featuring minimal power consumption and higher-resolution displays. While chip-set manufacturers are focused on developing workstation capabilities with high-speed bus and multiprocessor architectures, there is also a continuing trend toward greater and greater chip integration, with more and more functions being placed on a single chip. Soon there will be complete 286 computers on a couple of chips. These integration levels will make possible the power consumption and size and weight improvements that you can expect in laptop computers.

In addition, IBM has recently proclaimed its intention to launch another attack on the laptop and home computer markets. You can expect to see a new line of 286-based machines from IBM, running Microsoft Windows and using SCSI drives. Also look for a good-quality laptop from IBM. And don't forget to start saving up for that notebook computer with handwriting recognition. It's all coming down the pike. ■

Nick Baran is a consulting editor for BYTE. He can be reached on BIX as "nickbaran."

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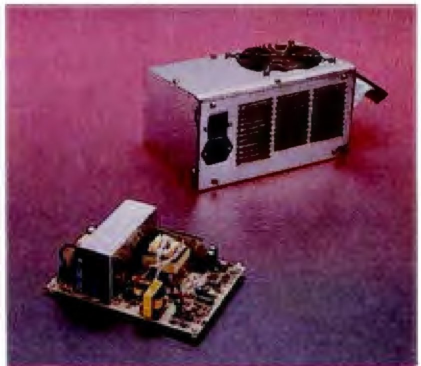

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Circle 54 on Reader Service Card

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BENCHMARKS AT A GLANCE: 1990

BYTE's performance rankings of popular IBM PC compatibles, Unix systems, and Macs

Compiled by Stanford Diehl

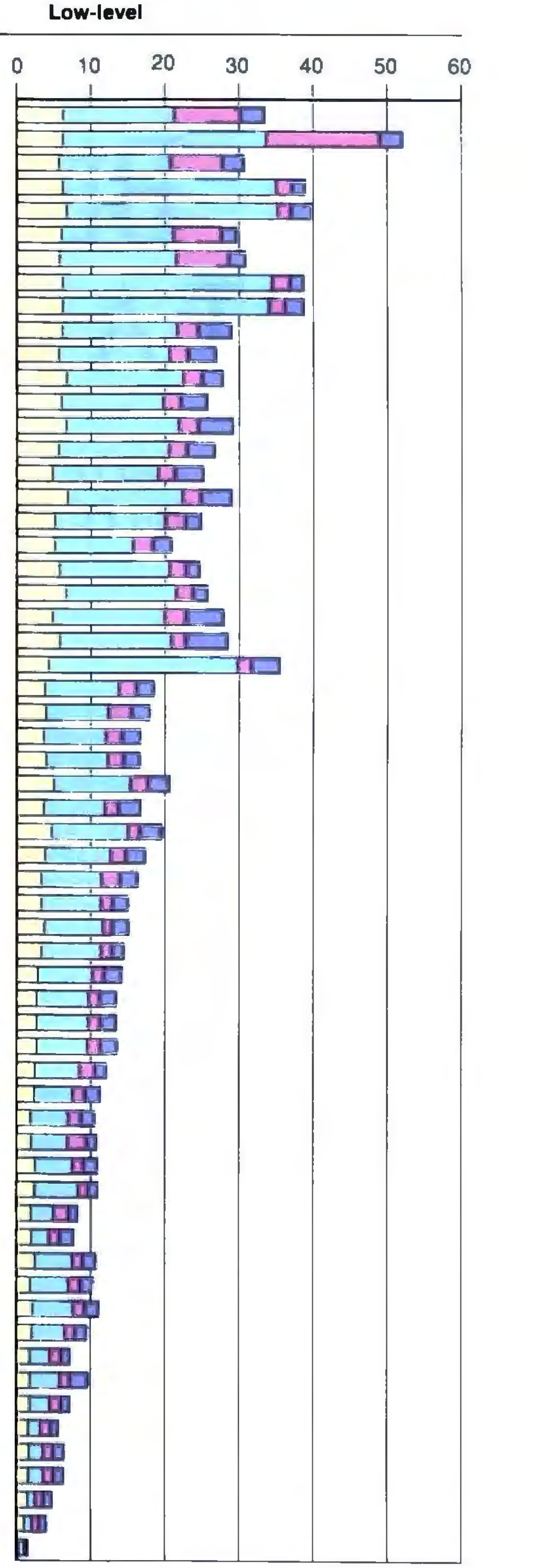
We've just about run out of adjectives to describe the steady supply of new machines arriving at the BYTE Lab for benchmarking: smoking, screaming, blazing, barn-burning. . . . Each time we think "they can't get much faster than *this*," a new system proves us wrong. Speeds for 386-based systems steadily rose from 20 to 25 to 33 MHz, and then when the processor speed topped out, we started receiving high-performance file servers stocked with megabytes of hard disk caching. Now the i486 has arrived, setting a new performance standard. Intel's latest processor, already available in 25- and 33-MHz flavors, will soon reach 50 MHz and beyond. One day soon, we expect a sonic boom to blast from one of these boxes.

continued

BYTE DOS BENCHMARK INDEXES (VERSION 1.0) WITH MATH COPROCESSOR

Table 1: *The SIA 386/33 file server, packed with an optional (and expensive) 4.5-megabyte hard disk cache, tops the final listing of BYTE's version 1.0 benchmarks. All systems were tested with a math coprocessor installed. All indexes are based on an 8-MHz IBM PC AT. Longer bars indicate better performance.*

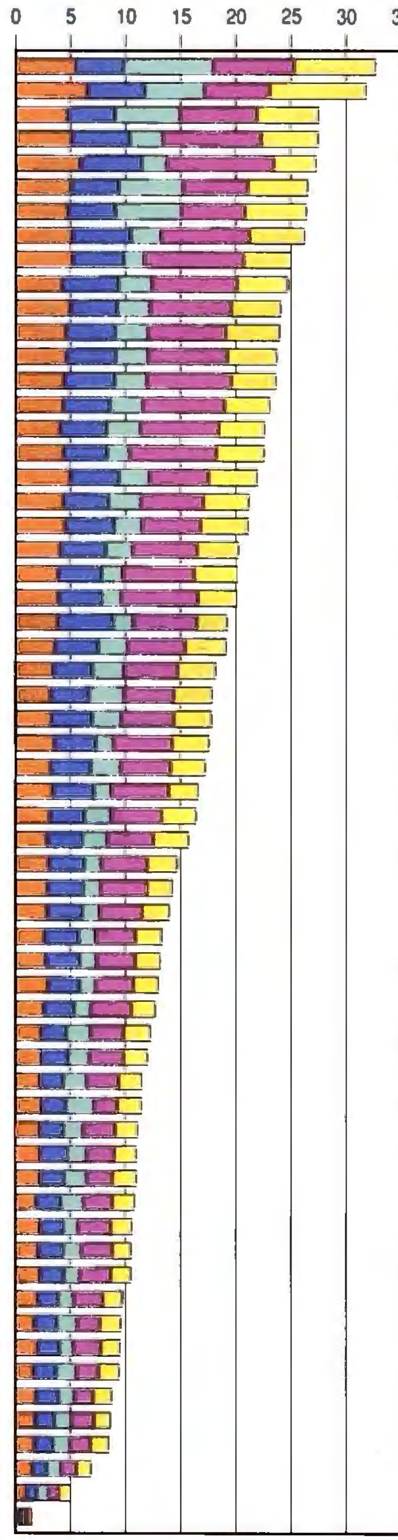
Computer	Month appeared	CPU	FPU	Disk	Video
SIA 386/33[1]	IBM Spcl. 89	6.27	14.97	8.99	3.27
Mylex 486/EISA[2,3]		6.21	27.44	15.44	2.98
Micro Express ME 386/33[1]	IBM Spcl. 89	5.66	15.06	7.02	2.97
Dyna Micro AIR486-C	July 90	6.21	28.79	2.19	1.75
AST Premium 486/25	June 90	6.75	28.46	1.78	2.77
National Micro Systems Flash 386/33[1]	IBM Spcl. 89	6.06	15.07	6.48	2.01
FiveStar Model 33/D (386/33)[1]	IBM Spcl. 89	5.74	15.75	7.14	2.22
Dolch-P.A.C. 486-25	May 90	6.20	28.20	2.48	1.81
Spear Super 486/25U	July 90	6.20	27.78	2.21	2.56
Compaq Deskpro 386/33	IBM Spcl. 89	6.09	15.50	2.90	4.53
Dyna Cache 386/33	IBM Spcl. 89	5.67	14.86	2.56	3.85
ALR FlexCache 33/386	IBM Spcl. 89	6.74	15.66	2.60	2.83
Blackship 386/33	IBM Spcl. 89	6.03	13.71	2.37	3.61
Compaq Systempro	Mar. 90 FI	6.63	15.21	2.65	4.70
Fortron NetSet 333 (386/33)	Jan. 90	5.65	14.85	2.45	3.76
AST Premium 386/33	IBM Spcl. 89	4.80	14.21	2.32	3.89
Everex Step 386/33	IBM Spcl. 89	6.84	15.48	2.45	4.26
PC Link 386/33	IBM Spcl. 89	5.10	14.87	2.83	2.11
ALR FlexCache 25386	Nov. 88	5.07	10.55	2.74	2.57
Tangent 333 (38633)	IBM Spcl. 89	5.73	14.83	2.28	1.79
Acer 1100/33	Dec. 89	6.60	14.84	2.29	2.01
Zenith Z-386/33	IBM Spcl. 89	4.79	15.10	2.96	5.05
Matrix MDP 386/33	IBM Spcl. 89	5.75	15.07	1.93	5.73
ALR PowerFlex i486	June 90	4.25	25.47	1.88	3.87
AST Premium 386/25[2]		3.78	9.92	2.49	2.34
Dell System 310 (386/20)	Oct. 88	3.91	8.38	3.21	2.45
Compaq Deskpro 38620	Feb. 88	3.61	8.34	2.23	2.54
Toshiba T5200/100 (386/20)	Aug. 89	3.96	8.27	2.22	2.16
ALR MicroFlex 7000 (386/25)	Sept. 89	4.99	10.29	2.41	2.97
Compaq 386/20e[2]		3.62	8.19	1.89	3.03
IBM PS/2 Model 70-A21 (386/25)	July 89	4.71	10.23	1.64	2.96
Dolch-P.A.C. 386-25	Aug. 89	3.84	8.77	2.12	2.64
Micro Express Regal II (386/20)	Aug. 89	3.30	8.08	2.51	2.50
FiveStar Model 320 (386/20)	June 89	3.31	7.99	1.66	2.11
Tandy 5000 MC (386/20)	Feb. 89	3.71	7.91	1.25	2.26
Tandon 386 (386/20)	June 89	3.30	8.02	1.49	1.71
Compaq Portable 386 (386/20)	Aug. 89	2.82	7.34	1.60	2.46
IBM PS/2 Model 80-111 (386/20)[2]		2.68	6.97	1.53	2.31
IBM PS/2 Model P70 386 (386/20)	Aug. 89	2.66	6.98	1.62	2.16
IBM PS/2 Model 70-121 (386/20)	Jan. 89	2.66	6.84	1.74	2.34
NEC ProSpeed 386 (386/16)	Aug. 89	2.41	6.00	2.15	1.59
AST Premium 386SX	June 90	2.36	5.17	1.70	2.06
Compaq 386s (386SX/16)	Nov. 88	1.86	5.03	1.78	1.87
ADC Powerlite 386 SX	Dec. 89	1.92	4.88	2.64	1.37
PC Brand 386/SX-16	Mar. 90	2.44	5.04	1.50	1.92
Toshiba T5100 (386/16)	Aug. 89	2.38	5.90	1.34	1.32
Swan 386SX (386SX/16)	Nov. 89	1.90	3.06	2.07	1.23
Zenith TurbosPort 386 (386/12)	Aug. 89	1.96	2.36	1.48	1.91
Gateway 386SX	Mar. 90	2.43	5.07	1.37	1.81
ALR PowerFlex 386SX	June 90	1.80	5.14	1.63	1.79
IBM PS/2 Model 70-E61 (386/16)	Jan. 89	2.11	5.50	1.55	1.93
Mitac 2386 (386/16)	Oct. 89	2.04	4.41	1.38	1.57
GridCase 1530 (386/12.5)	Aug. 89	1.76	2.69	1.55	1.24
IBM PS/2 Model 55 SX	Oct. 89	1.78	4.02	1.36	2.42
GridCase 1535 EXP (386/12.5)	Aug. 89	1.76	2.68	1.55	1.20
Wedge Turbo 286 (286/24)	Nov. 89	1.58	1.60	1.40	1.07
ALR PowerFlex 286	June 90	1.66	1.88	1.38	1.51
Compaq LTE/286	Dec. 89 FI	1.59	1.99	1.39	1.40
AST Bravo/286 (286/8)	Sept. 89	1.48	1.03	1.12	1.18
IBM PC AT (286/8)[2]		1.00	1.00	1.00	1.00
IBM PC XT (8086/4.7)[2]		0.22	0.71	0.32	0.25



[1] Optional hardware disk cache installed
[2] Systems listed for reference only
[3] Not a commercial system; technology demonstration unit
FI — First Impression, not a full review

BYTE DOS BENCHMARK INDEXES (VERSION 1.0) WITH MATH COPROCESSOR

Computer	WP	SS	DB	Sci./Eng.	Cmplr.	
	Applications					
SIA 386/33[1]	5.49	4.32	8.09	7.42	7.32	32.64
Mylex 486/EISA[2,3]	6.53	5.25	5.30	6.04	8.68	31.80
Micro Express ME 386/33[1]	4.76	4.32	5.83	7.12	5.55	27.58
Dyna Micro AIR486-C	5.14	5.30	2.92	9.07	5.11	27.54
AST Premium 486/25	5.93	5.58	2.21	9.81	3.83	27.36
National Micro Systems Flash 386/33[1]	5.08	4.35	5.77	6.00	5.37	26.58
FiveStar Model 33/D (386/33)[1]	4.82	4.31	5.91	5.90	5.53	26.47
Dolch-P.A.C. 486-25	5.18	5.35	2.68	8.15	4.94	26.31
Spear Super 486/25U	5.22	4.67	1.75	9.18	4.25	25.06
Compaq Deskpro 386/33	4.28	5.01	3.00	7.86	4.46	24.61
Dyna Cache 386/33	5.02	4.27	2.91	7.51	4.42	24.13
ALR FlexCache 33/386	4.61	4.50	2.88	7.18	4.86	24.02
Blackship 386/33	4.69	4.45	2.89	7.30	4.44	23.77
Compaq Systempro	4.45	4.59	2.85	7.80	4.00	23.69
Fortron NetSet 333 (386/33)	4.37	4.27	2.88	7.57	4.04	23.13
AST Premium 386/33	4.11	4.22	3.01	7.23	4.11	22.69
Everex Step 386/33	4.43	3.93	1.96	8.05	4.25	22.62
PC Link 386/33	5.03	4.43	2.68	5.51	4.36	22.01
ALR FlexCache 25386	4.41	4.13	2.83	5.80	4.08	21.24
Tangent 333 (38633)	4.57	4.45	2.45	5.43	4.27	21.17
Acer 1100/33	4.10	4.16	2.33	6.03	3.69	20.32
Zenith Z-386/33	3.91	3.97	1.87	6.59	3.85	20.19
Matrix MDP 386/33	3.95	3.90	1.74	7.09	3.43	20.11
ALR PowerFlex i486	3.90	4.97	1.81	5.89	2.69	19.26
AST Premium 386/25[2]	3.62	3.93	2.60	5.36	3.68	19.20
Dell System 310 (386/20)	3.45	3.56	2.84	4.98	3.41	18.24
Compaq Deskpro 38620	3.20	3.51	3.09	4.67	3.45	17.93
Toshiba T5200/100 (386/20)	3.34	3.66	2.57	4.89	3.40	17.86
ALR MicroFlex 7000 (386/25)	3.54	3.82	1.50	5.45	3.30	17.61
Compaq 386/20e[2]	3.26	3.64	2.62	4.68	3.07	17.26
IBM PS/2 Model 70-A21 (386/25)	3.42	3.75	1.52	5.33	2.62	16.64
Dolch-P.A.C. 386-25	3.16	3.14	2.37	4.67	3.11	16.45
Micro Express Regal II (386/20)	2.93	3.18	2.22	4.29	3.14	15.76
FiveStar Model 320 (386/20)	3.07	3.21	1.49	4.31	2.59	14.67
Tandy 5000 MC (386/20)	2.97	3.23	1.50	4.35	2.23	14.27
Tandon 386 (386/20)	2.91	3.19	1.52	3.97	2.41	14.01
Compaq Portable 386 (386/20)	2.68	3.11	1.49	3.73	2.32	13.33
IBM PS/2 Model 80-111 (386/20)[2]	2.81	3.07	1.45	3.63	2.21	13.16
IBM PS/2 Model P70 386 (386/20)	2.99	2.88	1.35	3.58	2.22	13.02
IBM PS/2 Model 70-121 (386/20)	2.63	2.74	1.46	3.75	2.15	12.72
NEC ProSpeed 386 (386/16)	2.34	2.33	2.14	3.11	2.37	12.29
AST Premium 386SX	2.36	2.47	1.85	3.21	2.14	12.03
Compaq 386s (386SX/16)	2.24	2.15	2.06	3.01	2.05	11.51
ADC Powerlite 386 SX	2.38	2.25	2.48	2.24	2.13	11.47
PC Brand 386/SX-16	2.21	2.17	1.77	3.00	2.01	11.16
Toshiba T5100 (386/16)	2.25	2.48	1.69	2.64	1.97	11.04
Swan 386SX (386SX/16)	2.25	2.23	2.01	2.38	2.14	11.02
Zenith TurbosPort 386 (386/12)	1.93	2.22	2.00	2.73	1.97	10.84
Gateway 386SX	2.24	2.11	1.32	3.06	1.89	10.62
ALR PowerFlex 386SX	2.09	2.27	1.60	2.93	1.65	10.55
IBM PS/2 Model 70-E61 (386/16)	2.28	2.18	1.35	2.94	1.78	10.52
Mitac 2386 (386/16)	2.08	1.82	1.36	2.76	1.67	9.70
GridCase 1530 (386/12.5)	1.78	2.01	1.81	2.17	1.82	9.58
IBM PS/2 Model 55 SX	2.07	1.97	1.21	2.61	1.67	9.53
GridCase 1535 EXP (386/12.5)	1.69	2.04	1.78	2.13	1.80	9.44
Wedge Turbo 286 (286/24)	1.92	2.02	1.40	1.82	1.62	8.78
ALR PowerFlex 286	1.83	1.73	1.52	2.14	1.43	8.65
Compaq LTE/286	1.77	1.66	1.52	1.93	1.61	8.50
AST Bravo/286 (286/8)	1.57	1.30	1.22	1.53	1.27	6.89
IBM PC AT (286/8)[2]	1.00	1.00	1.00	1.00	1.00	5.00
IBM PC XT (8086/4.7)[2]	0.33	0.28	0.22	0.35	0.29	1.47

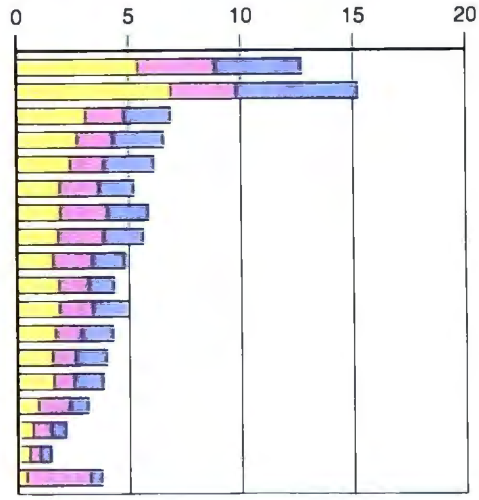


[1] Optional hardware disk cache installed.
[2] Systems listed for reference only.
[3] Not a commercial system; technology demonstration unit.

BYTE BENCHMARK INDEXES (VERSION 1.0) WITHOUT MATH COPROCESSOR

Table 2: *Zenith's EISA offering posted the best version 1.0 indexes for those systems tested without a math coprocessor installed. All indexes are based on an 8-MHz IBM PC AT. Longer bars indicate better performance.*

Computer	Month appeared	Low-level CPU	Low-level Disk	Low-level Video
Zenith Z-386/33E	July 90	5.41	3.46	3.85
Everex/SDI FileMaster II	July 90	6.88	2.92	5.42
Acma 386/20[1]		3.07	1.73	2.08
Northgate 386/20[1]		2.68	1.60	2.27
Bitwise 386/20[1]		2.38	1.51	2.23
Tandon LT/386	May 90	1.90	1.76	1.56
Zenith SupersPort SX	May 90	1.93	2.12	1.81
Dell 316LT	May 90	1.82	2.05	1.77
Compaq SLT/286 (286/12)	Mar. 89	1.59	1.77	1.43
NCR 386SX (386SX/16)[1]		1.87	1.34	1.11
Toshiba T3100SX	May 90	1.88	1.50	1.63
Ogivar 286 Laptop (286/12.5)	Mar. 89	1.70	1.19	1.38
Zenith SupersPort 286 (286/12)	Feb. 89	1.55	1.06	1.38
Mitsubishi MP-286L (286/12)	Feb. 89	1.62	0.92	1.29
NEC UltraLite (V30/9.83)	Aug. 89	0.93	1.42	0.80
Sharp PC-4641	Jan. 90	0.68	0.83	0.65
GridCase 140 XT	Jan. 90	0.53	0.49	0.47
Zenith MinisPort	Aug. 89 FI	0.40	2.86	0.49

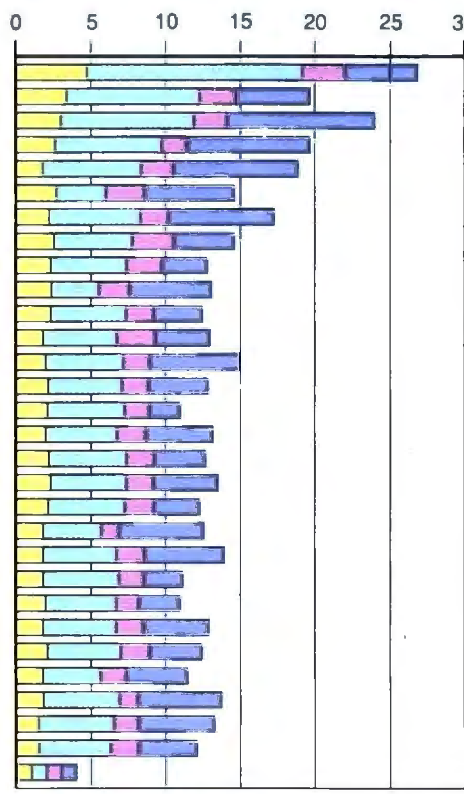


[1] Systems listed for reference only.
FI — First Impression, not a full review.
N/A = Not applicable

BYTE BENCHMARK INDEXES (VERSION 2.0) WITH MATH COPROCESSOR

Table 3: *Version 2 of the BYTE benchmarks tests four low-level components and seven application categories. All indexes are based on an 8-MHz IBM PC AT. All systems were tested with a math coprocessor installed (or with an integrated FPU). Longer bars indicate better performance.*

Computer	Month appeared	Low-level CPU	Low-level FPU	Low-level Disk	Low-level Video
Club 386/33[1]		4.71	14.42	2.91	4.83
Dell System 325[1]		3.37	8.91	2.44	4.94
Compaq Deskpro 386/25e	Aug. 90	2.97	8.91	2.22	9.90
Compaq 386/20[1]		2.58	7.15	1.72	8.21
Compaq 386/20 SX[1]		1.76	6.59	2.17	8.34
Micro Express ME 386SX	Aug. 90	2.67	3.30	2.61	6.04
Dell System 320LX	Aug. 90	2.19	6.11	1.86	7.10
Everex Step 386is	Aug. 90	2.52	5.22	2.82	4.06
AT&T 6386/SX	Aug. 90	2.30	5.06	2.41	3.02
Zeos 386/SX	Aug. 90	2.35	3.15	2.06	5.52
Tatung TCS-8800	Aug. 90	2.29	5.05	1.84	3.27
Hewlett-Packard Vectra QS/16S	Aug. 90	1.77	4.94	2.58	3.67
Acer 1100/SX	Aug. 90	1.97	5.18	1.77	6.01
Epson Equity 386SX	Aug. 90	2.13	4.92	1.82	3.98
Club American 316/SX	Aug. 90	2.08	5.15	1.68	2.06
NEC PowerMate SX Plus	Aug. 90	1.97	4.76	1.93	4.52
CPI Goupil Golf	Aug. 90	2.18	5.18	1.86	3.46
Acma 386 SX	Aug. 90	2.29	5.06	1.81	4.33
Arche Rival SX	Aug. 90	2.12	5.12	1.96	3.07
CSR 386/SX-16	Aug. 90	1.78	3.89	1.20	5.69
DTK Peer\1660	Aug. 90	1.78	4.91	1.89	5.34
Samsung SD700	Aug. 90	1.80	5.05	1.69	2.61
Tandy 4016SX	Aug. 90	1.95	4.73	1.51	2.77
Wang PC350/16S	Aug. 90	1.77	4.91	1.82	4.40
Dell 316SX	Aug. 90	2.10	4.88	1.95	3.50
Ultra-Comp Ultra 386SX Appeal	Aug. 90	1.78	3.85	1.73	4.12
Hyundai Super-386s	Aug. 90	1.81	5.08	1.24	5.61
Zenith Z-386SX	Aug. 90	1.49	5.02	1.67	5.09
CompuAdd 316S	Aug. 90	1.51	4.78	1.90	3.92
IBM PC AT[1]		1.00	1.00	1.00	1.00

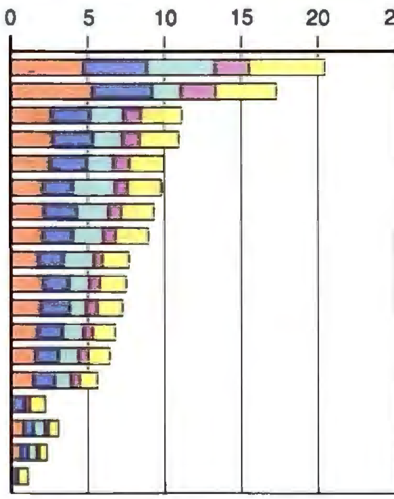


[1] Listed for reference only

BYTE BENCHMARK INDEXES (VERSION 1.0) WITHOUT MATH COPROCESSOR

Applications

Computer	WP	SS	DB	Sci./Eng.	Cmplr.	
Zenith Z-386/33E	4.73	4.17	4.38	2.23	4.91	20.42
Everex/SDI FileMaster II	5.32	3.93	1.80	2.28	3.96	17.29
Acma 386/20[1]	2.64	2.55	2.14	1.15	2.67	11.14
Northgate 386/20[1]	2.73	2.65	1.87	1.16	2.54	10.95
Bitwise 386/20[1]	2.53	2.46	1.68	1.08	2.24	9.99
Tandon LT/386	2.10	1.96	2.72	0.84	2.17	9.79
Zenith SupersPort SX	2.17	2.14	2.05	0.83	2.13	9.32
Dell 316LT	2.09	1.97	1.94	0.83	2.13	8.95
Compaq SLT/286 (286/12)	1.77	1.67	1.95	0.61	1.69	7.70
NCR 386SX (386SX/16)[1]	2.11	1.70	1.28	0.72	1.71	7.52
Toshiba T3100SX	1.94	1.91	1.02	0.78	1.62	7.28
Ogivar 286 Laptop (286/12.5)	1.75	1.63	1.34	0.62	1.45	6.79
Zenith SupersPort 286 (286/12)	1.59	1.53	1.28	0.64	1.40	6.43
Mitsubishi MP-286L (286/12)	1.45	1.41	1.05	0.59	1.13	5.64
NEC UltraLite (V30/9.83)	N/A	0.90	N/A	0.35	0.99	N/A
Sharp PC-4641	0.82	0.67	0.72	0.24	0.64	3.10
GridCase 140 XT	0.61	0.51	0.55	0.18	0.49	2.34
Zenith MinisPort	N/A	0.47	N/A	N/A	0.63	N/A

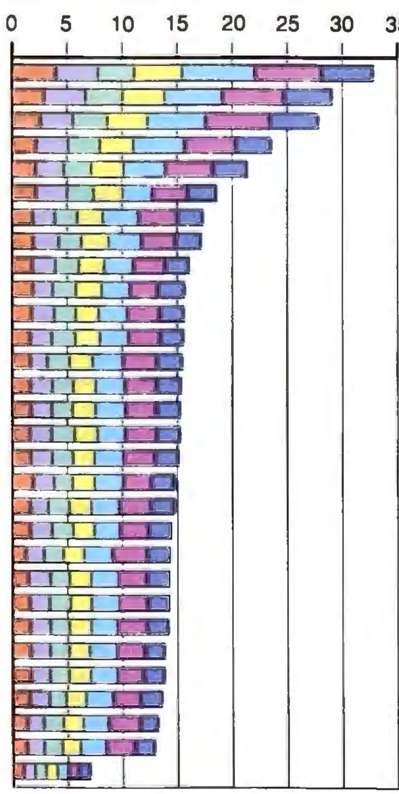


[1] Systems listed for reference only
N/A=Not applicable

BYTE BENCHMARK INDEXES (VERSION 2.0) WITH MATH COPROCESSOR

Applications

Computer	WP	DTP	DB	Cmplr.	CAD	Sci./Eng.	SS	
Club 386/33[1]	4.02	3.79	3.29	4.34	6.61	6.07	4.70	32.82
Dell System 325[1]	2.92	3.76	3.37	3.81	5.23	5.63	4.37	29.09
Compaq Deskpro 386/25e	2.60	2.94	3.14	3.63	5.26	5.84	4.44	27.85
Compaq 386/20[1]	2.20	2.92	2.87	3.03	4.63	4.67	3.24	23.56
Compaq 386/20 SX[1]	2.14	2.57	2.59	2.92	3.78	4.35	3.10	21.45
Micro Express ME 386SX	2.17	2.84	2.41	2.61	2.71	3.20	2.61	18.55
Dell System 320LX	1.90	1.99	2.05	2.30	3.23	3.53	2.36	17.35
Everex Step 386is	1.95	2.31	2.06	2.44	2.96	3.10	2.35	17.16
AT&T 6386/SX	1.85	2.08	2.15	2.28	2.63	2.92	2.15	16.05
Zeos 386/SX	1.90	1.81	2.11	2.31	2.58	2.53	2.45	15.69
Tatung TCS-8800	1.79	2.05	1.95	2.06	2.60	2.94	2.24	15.63
Hewlett-Packard Vectra QS/16S	1.65	1.95	2.15	2.21	2.61	2.89	2.12	15.58
Acer 1100/SX	1.68	1.54	2.02	2.06	2.74	3.12	2.31	15.47
Epson Equity 386SX	1.67	2.00	1.89	2.02	2.64	2.89	2.24	15.34
Club American 316/SX	1.72	1.89	1.88	2.05	2.73	2.86	2.14	15.29
NEC PowerMate SX Plus	1.61	1.98	2.09	2.06	2.51	2.87	2.15	15.28
CPI Goupil Golf	1.70	1.94	1.90	1.93	2.66	2.85	2.16	15.14
Acma 386 SX	1.93	1.87	1.69	1.99	2.58	2.57	2.05	14.67
Arche Rival SX	1.64	1.64	1.90	1.98	2.54	2.91	2.05	14.67
CSR 386/SX-16	1.63	1.99	1.91	1.91	2.36	2.54	2.11	14.45
DTK Peer\ 1660	1.24	1.61	1.78	1.87	2.57	3.18	2.06	14.31
Samsung SD700	1.49	1.96	1.74	1.94	2.45	2.64	2.03	14.25
Tandy 4016SX	1.59	1.79	1.89	1.89	2.48	2.67	1.95	14.25
Wang PC350/16S	1.62	1.84	1.71	1.97	2.37	2.75	1.92	14.17
Dell 316SX	1.66	1.76	1.73	1.83	2.42	2.66	1.78	13.86
Ultra-Comp Ultra 386SX Appeal	1.65	1.74	1.73	1.96	2.38	2.44	1.94	13.84
Hyundai Super-386s	1.55	1.79	1.54	1.75	2.47	2.55	1.92	13.56
Zenith Z-386SX	1.34	1.48	1.78	1.77	2.33	2.90	1.60	13.20
CompuAdd 316S	1.30	1.55	1.65	1.62	2.35	2.62	1.80	12.89
IBM PC AT[1]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	7.00

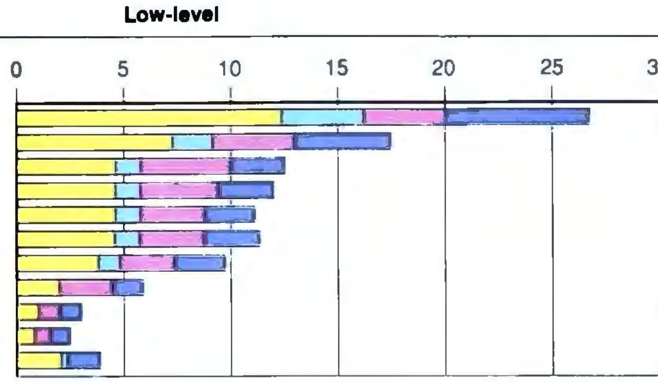


[1] Listed for reference only.

BYTE BENCHMARK INDEXES—MACINTOSH FAMILY

Table 4: *The Mac IIfx dominates the field of Macintosh systems. The FPU index is based on the Mac II. All other indexes are based on the Mac SE. Longer bars indicate better performance.*

Computer	Month appeared	CPU	FPU[1]	Disk	Video
Mac IIfx	Sept. 90	12.36	3.83	3.82	6.73
Mac IIci	Oct. 89 FI	7.27	1.87	3.83	4.49
Dynamac	Sept. 90	4.62	1.16	4.20	2.53
Mac IIcx	Sept. 89	4.61	1.15	3.65	2.58
Mac SE/30	June 89	4.61	1.16	3.01	2.33
Mac IIx	Dec. 88	4.57	1.16	3.02	2.59
Mac II	Oct. 87	3.81	1.00	2.56	2.35
Mac Portable	Oct. 89 FI	1.96	N/A	2.51	1.43
Mac SE	Aug. 87	1.00	N/A	1.00	1.00
Mac Plus	Nov. 86	0.81	N/A	0.75	0.91
Outbound[2]	Sept. 90	2.07	0.29	N/A	1.52



[1] The FPU index is based on the Mac II. All other indexes are based on the Mac SE.
[2] The Outbound could not run the Scientific/Engineering suite of tests; therefore, it did not post a cumulative application index.
N/A = Not applicable.

BYTE BENCHMARK INDEXES—UNIX FAMILY

Table 5: *Most of the workstations the BYTE Lab tested outperformed the baseline Everex Step 386/33 running Xenix 2.3.1.*

	C Compiler	DC Arithmetic	Tower of Hanoi	System Loading (8 concurrent tasks)	Dhrystone 2	Floating Point
Silicon Graphics Personal Iris Turbo	0.95	3.00	1.87	1.50	0.97	5.90
Opus 8140-PM	0.83	2.52	2.00	1.38	3.64	3.11
DECstation 3100	0.58	1.31	1.33	1.33	1.67	4.91
Opus 8110-PM	0.62	2.10	1.51	1.08	2.98	2.48
Everex Step 386/33	1.00	1.00	1.00	1.00	1.00	1.00
NeXT Computer	0.37	0.97	0.34	0.52	0.43	0.92

Note: Indexes show relative performance. For all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1. Longer bars indicate better performance.

To meet the challenge of the hardware vendors, the BYTE Lab introduced a new generation of system benchmarks in the August BYTE. Exercising the latest versions of PC software, the new benchmarks test four low-level components (CPU, FPU, disk, and video) as well as seven application categories (word processing, desktop publishing, database management, code compilation, CAD, scientific/engineering, and spreadsheets). The changes are significant enough that the new benchmark indexes should not be compared to the old indexes. With that in mind, this update offers a final listing of the old benchmark indexes (see tables 1 and 2) as well as a glimpse ahead at the new indexes (see table 3).

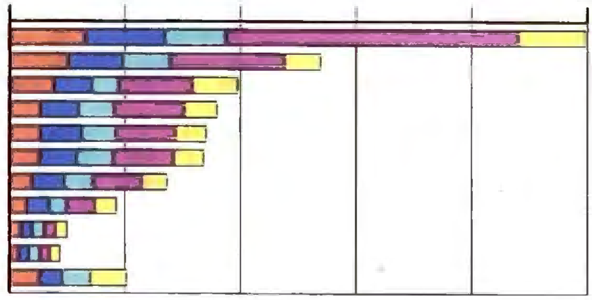
Our low-level suite tests a machine at the component level. If you are looking for a machine with a fast disk drive or strong video performance, the low-level indexes will give you a means of comparison. On the other hand, if you have specific applications in mind, consult the application indexes. They will give you a good idea of how a system will perform when running a broad range of application categories. If your work load involves heavy database use, word processing chores, or CAD applications, you should compare machines using the specific index corresponding to your specialized needs.

The BYTE benchmark indexes are relative. The PC indexes, old and new, are referenced to an 8-MHz IBM AT with an 80287 math coprocessor. The baseline AT registers a 1.00 on

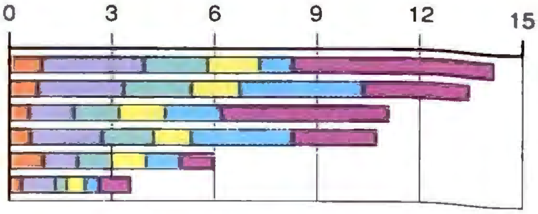
Silicon Graphics Personal Iris Turbo

BYTE BENCHMARK INDEXES—MACINTOSH FAMILY

Computer	WP	SS	DB	Sci./Eng.	Cmplr.	Applications
Mac IIfx	6.54	6.88	5.31	25.34	5.72	49.79
Mac IIci	5.12	4.67	4.08	9.97	3.07	26.91
Dynamac	3.87	3.25	2.33	6.43	3.84	19.71
Mac IIcx	2.72	3.25	3.07	6.13	2.79	17.97
Mac SE/30	2.68	3.53	2.99	5.23	2.60	17.04
Mac IIx	2.60	3.20	3.15	5.32	2.53	16.81
Mac II	2.00	2.72	2.53	4.24	2.16	13.66
Mac Portable	1.53	1.88	1.51	2.49	1.85	9.26
Mac SE	1.00	1.00	1.00	1.00	1.00	5.00
Mac Plus	0.80	0.88	0.93	0.91	0.84	4.36
Outbound[1]	2.61	1 94	2.48	N/A	3.12	N/A



[1] The Outbound could not run the Scientific/Engineering suite of tests; therefore, it did not post a cumulative application index
N/A=Not applicable




Mac IIfx

all tests. The cumulative application index represents an overall score based on the seven application categories, so the AT posts a 7.00.

We tried to test the machines as configured by the vendor, with some exceptions. We disabled any software caching and, for the new benchmarks, installed extended-memory drivers. Machines tested without a coprocessor are listed separately. Every system tested with the new benchmarks has a coprocessor installed (or, as is the case with the i486, includes an integrated FPU).

We discouraged vendors from sending us systems with optional caching disk drive controllers installed, as that inflated the disk I/O and cumulative application indexes. Those machines that have been benchmarked with caching controllers are marked in table 1 with a footnote.

The 40-MHz Mac IIfx leads the march of Mac boxes (see table 4). The 68000 processor inside the Mac SE, the Mac Plus, and the Mac Portable doesn't support an integrated math coprocessor, so those machines could not generate an FPU index. For the same reason, the Mac FPU indexes are referenced to the Mac II, while all other indexes are based on the Mac SE. The Mac indexes should not be compared to the PC indexes.

New for this benchmark roundup are the Unix indexes. Table 5 provides a broad means of comparison among several Unix boxes and Intel-based PCs running SCO Xenix.

Comparing speed indexes is fun, and it can be valuable when deciding among the varieties of CPUs and clock speeds. But speed should not be the sole criterion by which you judge a PC. Construction quality, customer support, compatibility, and price are just as important—perhaps more so, if your application does not require a great deal of performance from the hardware. In the tables, we've referenced the BYTE issue in which the review of each system appeared. If you're using this listing to shop for a PC, please read the full review for the whole picture.

So now we're ready for the latest stream of speed demons. We have the two things we needed most: new benchmarks and a bigger thesaurus. ■

Stanford Diehl is a BYTE Lab testing editor/engineer. You can reach him on BIX as "sdiehl."

PC GUIs GO HEAD TO HEAD

A user's view of Windows 3.0 and OS/2 reveals inconsistency within the consistency

Stan Miastkowski

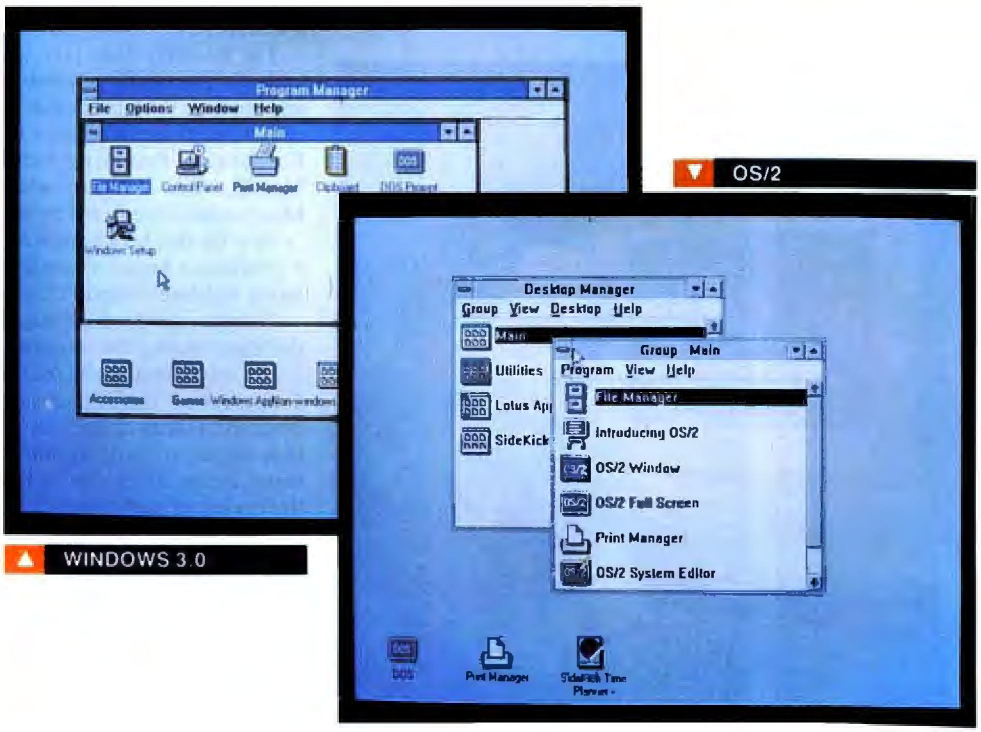
Over the past several months, tens of thousands (perhaps hundreds of thousands) of words have been written about the relative technical merits of Microsoft Windows 3.0 versus the current version (1.2) of OS/2. That's the problem: The words have concentrated on the *technical* merits, largely ignoring what's ultimately one of the most important factors in the equation: how you *use* them. While the technical intricacies of the two packages have a crucial role in the ultimate acceptance of both packages, and which environment (or both) developers opt for, the ultimate test of both Windows 3.0 and OS/2 are how they play in Peoria, or—more important—

continued

BASIC OPENING SCREENS

The basic opening screens of both Windows 3.0 and OS/2 look very different at first glance, but they share Common User Access traits, including three-dimensional buttons and pull-down menus. The screens shown here are what you see the first time you start the systems; you can customize them to fit your own preferences and work habits.

What Windows 3.0 calls the *Program Manager* and OS/2 calls the *Desktop Manager* are both essentially on-screen starting points. As you can see, Windows 3.0 has a more eye-catching look and feel and relies more on the visual metaphors of carefully designed and finely sculpted icons.



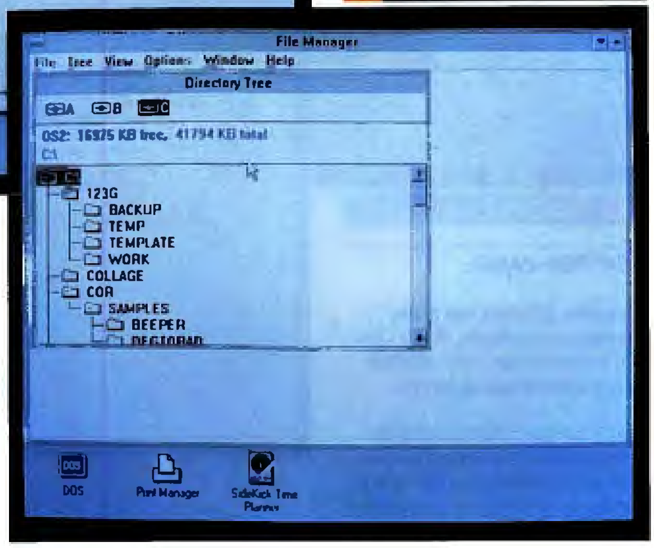
FILE MANAGERS

The File Managers of Windows 3.0 and OS/2 are nearly identical at first glance—with Windows again showing the more finely detailed icons. On start-up, Windows 3.0 shows only the top-level subdirectories, while OS/2 displays all directories and subdirectories. (As with other options, every time you start the File Manager, you can easily customize what it shows.)

Note that OS/2 is missing a *Disk* pull-down menu in its File Manager. In the Windows 3.0 file manager, this menu contains the necessary copy and formatting commands for floppy disks. Of course, these are available in OS/2, but they're hidden in the Utilities Group. OS/2 also contains a Fixed Disk utility that lets you create and modify hard disk partitions. While useful, it can be dangerous in inexperienced hands (which is evidently why it's missing in Windows 3.0).

▲ WINDOWS 3.0

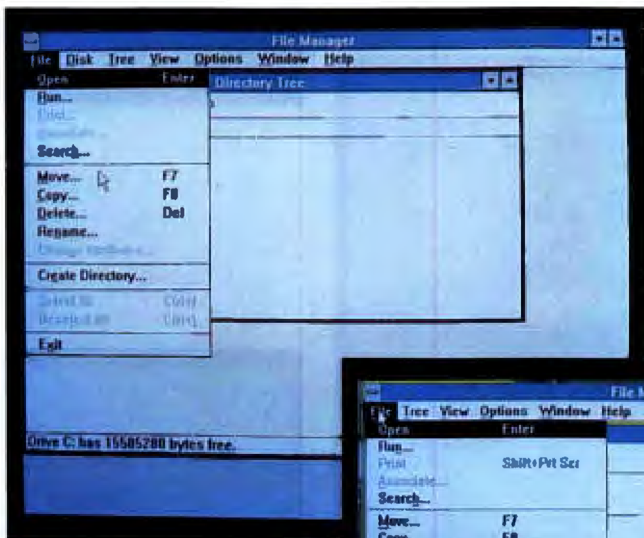
▼ OS/2



FILE MENUS

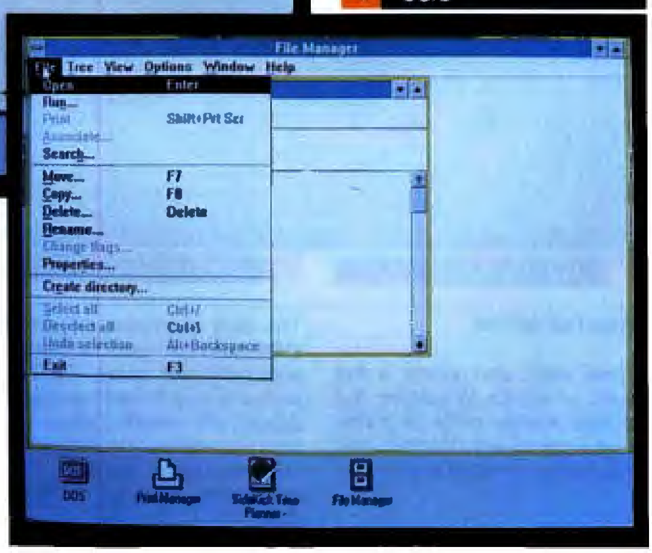
You'll spend a great deal of time in the main file pull-down menus of both Windows 3.0 and OS/2. The choices here are nearly identical, with a few notable exceptions. OS/2 contains a *Properties* option that lets you view extended information on your files (e.g., the icon, the subject, the date, and the time last changed). Also peculiar are the *Change Attributes* option in Windows 3.0 and the *Change flags* option in OS/2. Although they have different names, they do the same thing—they let you change the file type (e.g., hidden, system).

One thing that's still missing from both Windows 3.0 and OS/2 is the ubiquitous Trashcan that Macintosh users have grown to know and love. In both the Windows 3.0 and OS/2 environments, the Delete key does the job, although not as elegantly (if you can call a Trashcan elegant).



▲ WINDOWS 3.0

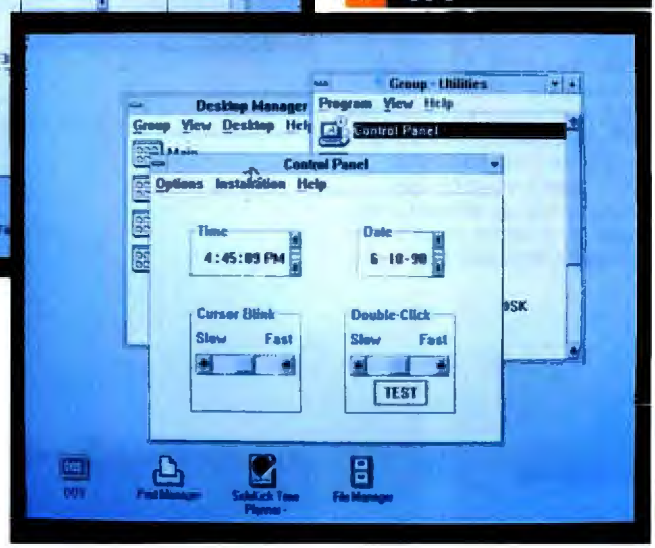
▼ OS/2



▲ WINDOWS 3.0

▼ OS/2

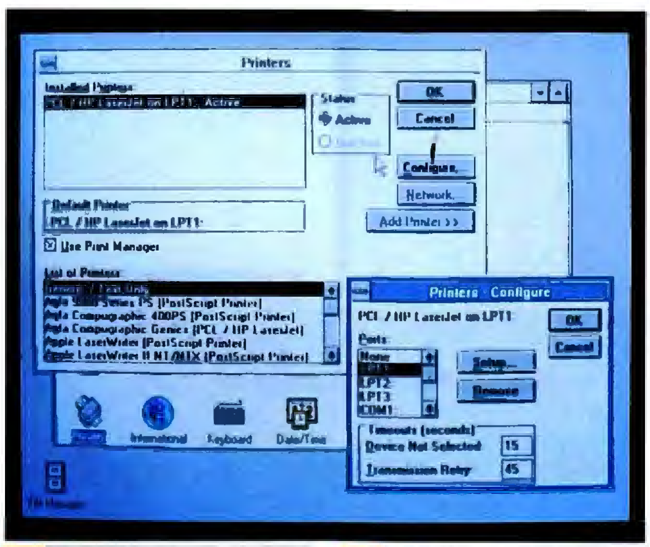
▼ OS/2

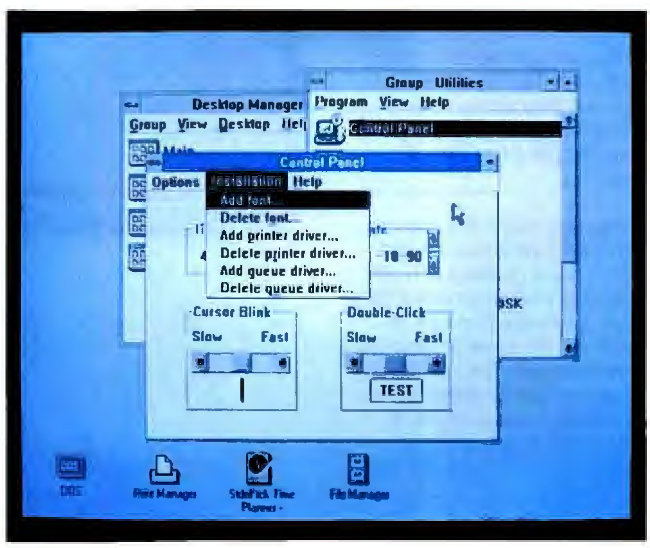


CONTROL PANEL

Windows 3.0 puts the many (necessary) options of the Control Panel in one child window using easy-to-grasp icons.

OS/2, on the other hand, puts a very limited selection on the first screen. All the options are available in OS/2, but, as shown in the second OS/2 screen, they're arranged in a pull-down menu that lacks icons.





▲ WINDOWS 3.0

▶ OS/2

PRINTER SETUP

Printer setup and options is one area in which Windows 3.0 shines. A wide range of printer drivers comes with Windows, and they're easy to install and set up.

The lack of printer drivers in OS/2 has been (and remains) a sore point with users. OS/2 includes a very limited number of drivers, and installing them is far from an intuitive task. It requires numerous steps, and the drivers themselves must be on floppy disks.

DESKTOP DESIGN

(a) In Windows 3.0, Microsoft has created nearly limitless options for customizing the look and feel of the desktop. Besides being able to choose basic colors for desktop elements, you can also fine-tune them through a virtually unlimited palette.

(b) Hidden farther down in the menus are options for "wallpaper" (the screen background) and even the patterns that show on the background of individual windows.

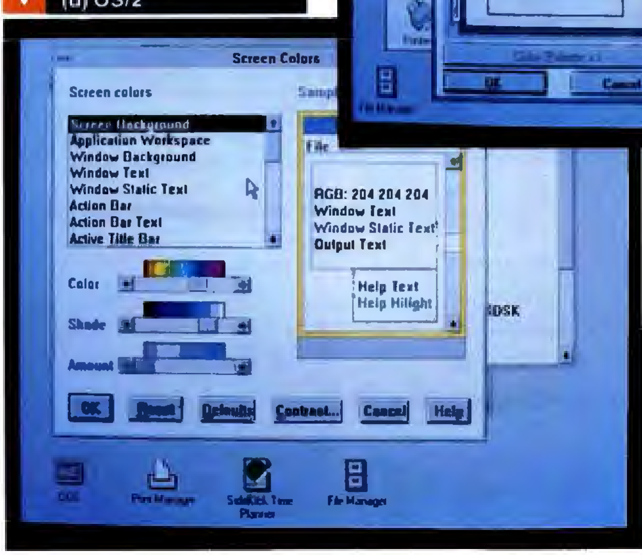
(c) Windows' concentration on bright windows and icons almost makes you feel like an interior decorator.

(d) OS/2 offers a severely limited choice of colors for individual screen elements, and no choice at all for screen background patterns. What you see is what you get.

(a) WINDOWS 3.0

(b) WINDOWS 3.0

(c) WINDOWS 3.0

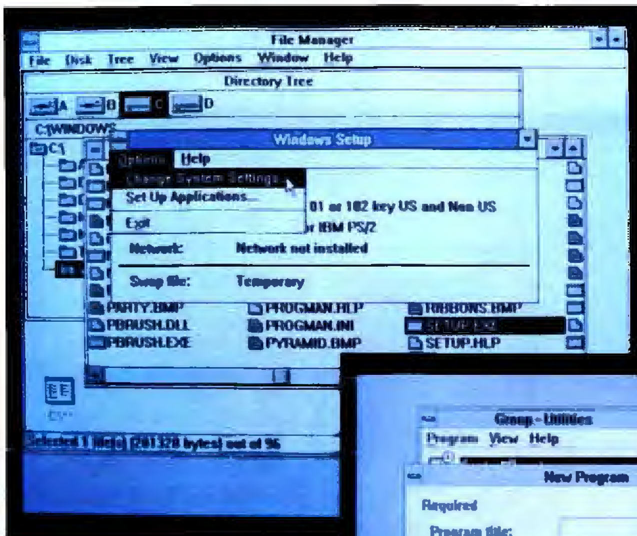


(d) OS/2

APPLICATION SCREENS

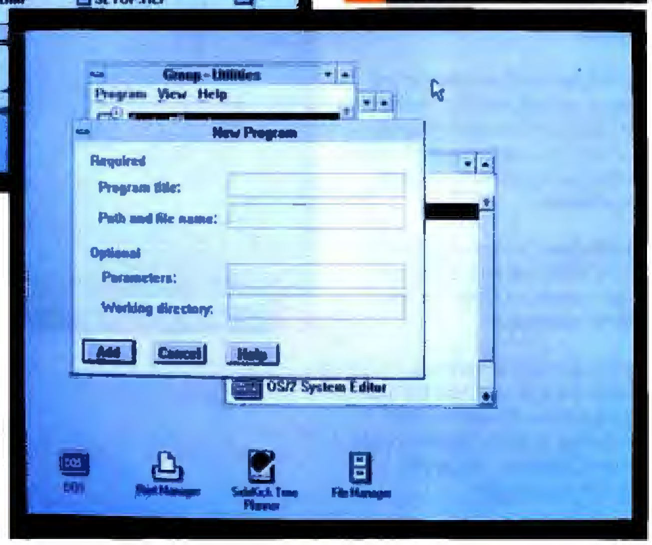
Because it's a DOS add-on instead of a full-fledged operating system, Windows 3.0 offers an easy way to modify system settings and to set up applications. It will also automatically search the disk for application files, create icons for both Windows and non-Windows applications, and place the icons in the correct groups.

There's no comparable screen shown for OS/2 because it doesn't have one. Making major changes in OS/2's setup requires reinstallation of the entire operating system. On the application side, OS/2 applications create their own applications and (usually) let you choose where to put them. The OS/2 screen shown is one of the screens necessary for installing a new program.



▲ WINDOWS 3.0

▼ OS/2

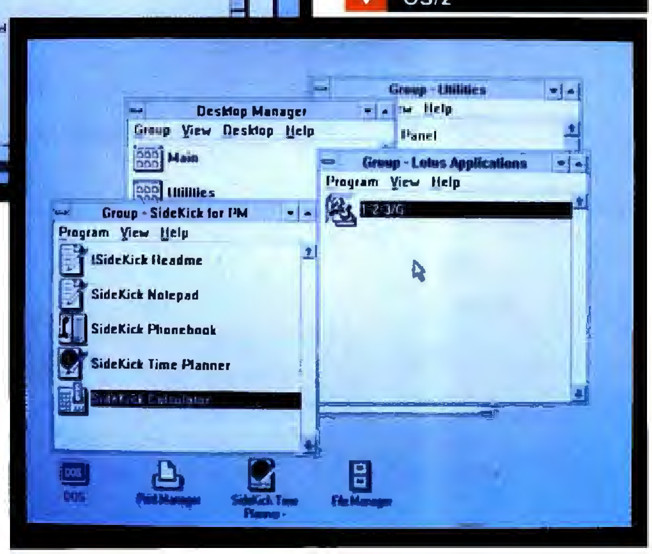


THE BASIC GUI

One of the biggest differences between Windows 3.0 and OS/2 is that Windows 3.0 makes much more extensive use of the graphical user interface and relies heavily on detailed icons.

▲ WINDOWS 3.0

▼ OS/2



with your screen, mouse, and keyboard.

Even though Windows 3.0 and OS/2 come essentially from the same parentage (i.e., the programming gnomes at Microsoft), there *are* some differences. Although at the most basic level, both are Common User Access–compliant—part of IBM's omnibus Systems Application Architecture specification, both packages represent an evolution, with Windows 3.0 the latest incarnation in the march toward the ultimate graphical user interface (GUI) design.

Fair Comparisons

One thing that people seldom mention in the "Great Windows 3.0 versus OS/2 Debate" is that in certain ways, comparing the two is like comparing apples and oranges. After all, Windows 3.0—at its heart—is simply a graphical DOS shell (albeit a *very* sophisticated one). OS/2, on the other hand, is much more a full-fledged multitasking, multithreading operating system. That crucial difference is the reason that you interact with Windows 3.0 and OS/2 differently.

What follows is a gallery of comparisons that show some of the key user interface differences (and consistencies) between Windows 3.0 and OS/2. Like a gallery owner setting up an art show, We've chosen the best—the highlights of what have become (for better or worse) the leading GUIs of the PC world. Not only do both environments have hundreds of screens and pull-down menus, they're also highly customizable to fit your own preferences and graphical prejudices.

Your ultimate choice of an operating environment depends on a wide range of factors, including your needs and the size of your wallet. But like choosing a car, when you have to live with a system from day to day, the ultimate question is: "How well does it drive?"

What of the future? OS/2 2.0 (for 386- and i486-based systems only) will probably have many of the graphical elements of Windows 3.0. OS/2 2.0 is due at the end of the year. Time will tell. ■

Stan Miastkowski is a BYTE senior editor. He can be reached on BIX as "stanm."

STRANGER IN A STRANGE LAND

It's easier than you might imagine to share information among the Macintosh and other personal computers

Tom Thompson

Just a few years ago, it was an uphill battle to get an Apple Macintosh computer through a corporation's doors. Now, they can be found peppering desktops in offices everywhere. No, they haven't taken over: Many tasks are better handled by PCs. But the Mac *earned* its spot on a desk, simply because its superior graphics capabilities produced professional artwork (e.g., charts, figures, and logos) better and faster than your garden-variety PC.

But as the Mac uniquely solves some business problems, it also adds some complications. You might, for example, want a Mac program to draw a chart that uses numbers computed on a Compaq Deskpro. Ideally, this should not be a problem. Practically, however, the disparate file formats that exist between PCs and Macs—and even among programs on the same computer—can make achieving this ideal a major headache. Suddenly, the Mac appears like a stranger, speaking in an unknown tongue.

But information sharing between PCs and Macs is not impossible. How the Mac handles data isn't that much different from how a PC handles it, although it may seem that way when you hear Mac folks talking about a file's *data fork* and *resource fork*. If you understand how the Mac handles data, you can convert a file's contents into something that any machine can use. Furthermore, a number of vendors (e.g., Microsoft, Aldus, and WordPerfect) have written programs that operate on both Macs and PCs while using the same file format.

I'll start by showing how to exchange files between Macs and PCs. I'll gloss over networking solutions, since implementing these is an article in itself. I'll discuss ways to make use of the file's information, whether you're using it on a Mac or sending it to a PC. Along the way, I'll provide hints on potential problems, even if you're using a vendor solution like Microsoft Word.

Dealing with Disks

Trying to move a file from a PC floppy disk onto a Mac floppy disk used to be a major chore, even though both machines use the same 3½-inch floppy disks. That's because each computer uses a different data-encoding method to record information.

The PC uses MFM for its floppy disks, while the Mac uses group-code recording (GCR). The end result is that neither computer reads the other's disks. In a large office, a network (e.g., Novell NetWare or Dayna Communication's DaynaNET) that links both computers bypasses this problem, but for a small office there used to be no easy solution.

The need for data exchange

continued

ILLUSTRATION: DON BAKER © 1990

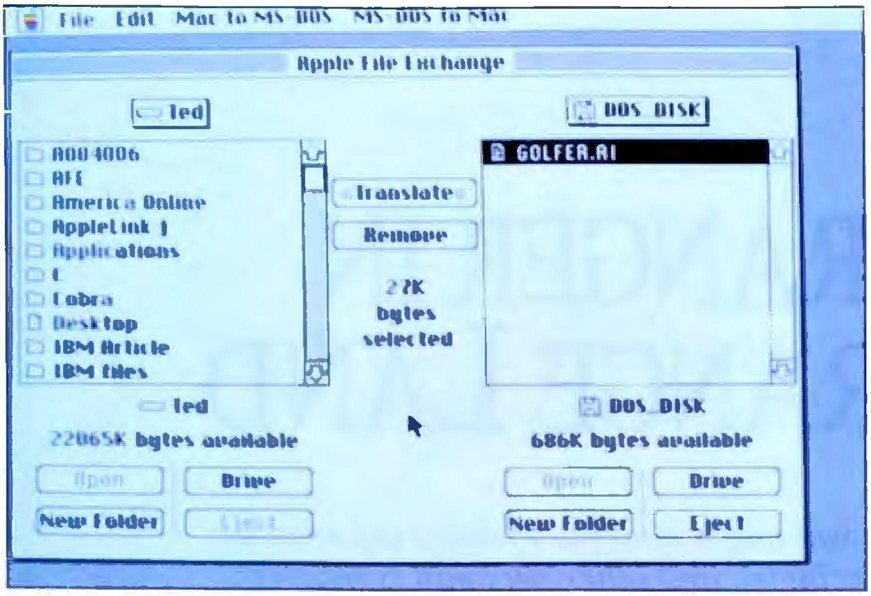


Photo 1: *The Apple File Exchange program copying a file from an MS-DOS disk.*

was so acute that vendors devised solutions that do not require a network. MatchMaker from Micro Solutions Computer Products is an Industry Standard Architecture (ISA) board for the PC that connects to an external Mac floppy disk drive. Using special DOS commands, you can examine Mac floppy disks and copy files.

Apple addressed the problem with its FDHD drive, dubbed the SuperDrive, which was first introduced on the Mac IIx. A SuperDrive can format, read, and write to double-sided or high-density 3½-inch 1.44-megabyte floppy disks, using either MFM or GCR encoding. With the exception of the Mac Plus, every Mac from the Portable to the IIfx is shipped with a SuperDrive. (The 68020-based Mac II, which had only a double-sided floppy disk drive, has been discontinued. Since September 1989, the Mac SE has been equipped with a SuperDrive instead of the double-sided floppy disk drive.)

By itself, the SuperDrive isn't enough to deal with an MS-DOS or OS/2 disk: The Mac Finder won't recognize the foreign file format and will ask to format the floppy disk for you. Instead, you must launch the Apple File Exchange (AFE) program, which assumes control of the SuperDrive and lets you copy files to or from a PC floppy disk (see photo 1).

AFE has a modular structure that lets you add extra procedures called *filters*, which translate the file as you copy it. Third-party vendors offer filters that perform conversions between a variety of PC and Mac file formats.

For example, DataViz offers MacLink Plus/Translators, a package that features an extensive library of filters that can translate, say, an MS-DOS WordPerfect file into a Mac Microsoft Word file while retaining the document's typefaces and styles. Even if your PCs and Macs are networked, you can use the DataViz translators with AFE to convert database, spreadsheet, and word processing files. DataViz also provides a standalone program to operate its filters if the AFE program isn't available.

The Serial Solution

OK, so maybe you've got a vintage Mac that doesn't have a SuperDrive, or your PC uses a 5¼-inch floppy disk drive. And still no network. What then? The answer is simple: Use the computers' serial ports. By connecting the serial ports of both machines with the appropriate cable, you can use terminal programs to transfer files.

Moving files this way can be frustrating, since there are many little details to get right before the transfer works. Telecommunications experience is a plus, because the file transfers are identical to downloading and uploading files to a BBS or on-line systems like BIX or GEnie. The difference is that the source machine is the PC rather than a mainframe.

The most crucial component in this operation is having the right cable. If the computers can't send signals to one another, they won't be sending files, either. You'll need a ***null modem*** cable whose connectors match the serial ports on both computers. The cable's name is couched in data communications jargon, but what it means is that the cable's transmit and receive data lines are switched between the two connectors. Or, put another way, the cable arranges the signals so that each computer's serial transmitter is sending to the other computer's serial receiver—precisely what's required for the two machines to exchange data.

The best ready-made null modem cable was the original ImageWriter printer cable. It was properly wired, and the male DB-25 serial connector for the printer made it ideal for hooking into most PCs' 25-pin serial ports. If you cannot find one of these cables (plus an adapter cable to convert the original Mac's DB-9 serial connector to the current mini-DIN-8 connector), you could try a computer store that specializes in custom cables.

While on the subject of adapters, if you have an AT-class machine, you've probably got a DB-9 serial port, which requires a 25-pin-to-9-pin adapter plug to complete the connection. For those who want to roll their own, the schematic in figure 1 shows the connections you need to make.

With the cable in place, you start the terminal programs on both computers. Both programs must be configured for the appropriate serial port, and settings like baud rate, number of bits, and stop bits must match exactly. A good starting point is full duplex, 19,200 bps, 8 bits, and no parity. If everything is set right, you should be able to type text on the Mac's keyboard and see the same text on the PC's screen. If this doesn't happen, the machines aren't communicating, so double-check everything. Once all problems are fixed, you're ready to transfer files.

Since many of the files you'll be moving contain binary data (e.g., formatting information), you need to use a protocol transfer (i.e., XMODEM, YMODEM, ZMODEM, or Kermit) to do the job—not ASCII capture. Using one of these protocols, select the file to send from the PC. Then have the Mac receive the file, using the same protocol.

An important point: On Mac terminal programs, disable the MacBinary conversion feature (if it has it), which either strips or adds a header of Mac-specific information to the file. MacBinary is required for serial file transfer from one Mac to another, but the unintentional modification to a PC file can make its contents unusable. (For more information, see the text box "The Fork in the File" on page 92.)

As a general rule, XMODEM, YMO-

MAKING MAC-PC CONNECTIONS

Macintosh signal	Mini DIN-8pin	RS-232C pin
Output handshake	1	No connection
Input handshake	2	20 for ImageWriter, not connected for PC
Transmit data (TxD-)	3	3
Ground	4	7
Receive date (RxD-)	5	2
Transmit data (TxD+)	6	No connection
No connection	7	No connection
Receive data (RxD+), ground for RS-232C emulation	8	7

Figure 1: *The schematic for a null modem cable to connect the serial ports of a Macintosh and an IBM PC. You can order an ImageWriter II extension cable and cut it in half to obtain the male DIN-8 connector. The DB-25 connector is available from most electronics stores.*

DEM, and ZMODEM transfers usually want the sending machine ready to go before the receiving machine starts. There might be a delay as the computers synchronize the transfer, but the file should then be transmitted rapidly. It might take you several attempts to get the hang of this, but once you do, you'll be able to move files easily from one system to another.

If all this sounds daunting, a variety of packages on the market can assist you with serial transfers. Both DataViz and Traveling Software offer packages (MacLink Plus/PC and LapLink Mac III, respectively) that include both software and a special serial cable.

Same Data, Different Machine

Now that you've got that PC file on a Mac (or vice versa), it's time to make use of it. You'll have little difficulty if you use a program like PageMaker, which runs on both machines. For other programs, some preparation might be necessary. I used a Compaq Deskpro 386/20 running Windows 2.11 to generate PC files that I transferred to either a Mac II or Mac IIfx to evaluate just how difficult it is to use data generated on a different platform. As long you work within the limits of both machines, sharing information can be surprisingly easy.

I just mentioned PageMaker, and for good reason. Its interface is consistent on both computers, and there has never been a problem with exchanging its files. While there are other page-layout programs, PageMaker's reliable performance across diverse machines is an asset. It runs faster on an equivalent PC than on a Mac II, which means that for some page-layout work you're better off using PageMaker on a PC.

Be certain to use the same version of PageMaker on both computers: The file format differs slightly from version to version. That is, you can exchange files between a Mac and a PC if they're both running PageMaker 3.0. But if you're using PageMaker 1.0 on a PC and PageMaker 3.0 on a Mac, a file exchange won't work. You'll have to upgrade the PC version of PageMaker to ensure file compatibility.

If you're using PageMaker on the Mac to incorporate different PC files (e.g., scanned images or PostScript figures), you'll have to modify the file's type so that PageMaker recognizes the file's data format. See the text box "A Matter of Type" on page 92 for details.

The PC version of Autodesk's AutoCAD (release 10c2) had no difficulty reading Mac AutoCAD files, nor did the Mac version (release 10c5) with PC files. WingZ for OS/2 and Windows 3.0 shares the same files with the Mac version. The same is true for Microsoft Excel: Its files are completely interchangeable between Excel 2.1 (PC) and Excel 2.2 (Mac). No file conversions were necessary, and the transfers were painless.

However, Microsoft complicated the situation with its word processors. First, there are two PC versions: Word 5.0, for a command-line interface (CLI) environment, and Word for Windows 1.0, for a graphical user interface (GUI) environment. On the Mac, there's Word 4.0. The different version numbers aren't so bad. However, if you misstep with the file format when saving the document, you wind up with a file that can't be used elsewhere.

The Word 5.0 file can be opened directly by Word 4.0 on the Mac. But if you're using Word for Windows 1.0 for its WYSIWYG display, be sure to save the file *not* in its default format (Normal), but as Word for DOS. On the Mac, you should configure Word 4.0 for Full Menus. When you save the file, click on the File Format button in the Standard File dialog box. Select the MS-DOS—not Normal—format and then save the file. Both Word 5.0 and Word for Windows 1.0 will read this Mac file and restore the formatting.

It sounds more complicated than it actually is, but as long as you remember to save the files in MS-DOS Word format, you will have no problems exchanging files. WordPerfect's word processors (5.1 for the PC and 1.0.4 for the Mac) have a similar gotcha: Save both as WordPerfect 5.0 documents.

Adobe Illustrator also has its share of quirks when it comes to file exchange. Illustrator 1.9.3 on the Mac readily accepts files from its PC cousin, Illustrator 1.0. However, when you save an Illustrator file for export to the PC, you first need to save it as a version 1.1 file (there is a version format problem similar to PageMaker's). Also, don't save the file with a preview (i.e., a bit-mapped image used to help place the graphic in a page-layout program).

Be aware of some differences between the two programs. On a Mac, you can add color to your artwork and view it (see photo 2) and have access to a blend tool (for blending colors).

On the PC, you can add color to the artwork, but your results will be guesswork, since you can preview the artwork only in shades of gray (see photo 3). And there is no blend tool. Also, you lose some information in a Mac Illustrator file when you convert it to transport to the PC.

A lock function, which is used to prevent the selection of overlapping objects,

continued

The Fork in the File

A Macintosh file is basically a collection of bytes on a disk—the same as a PC file. However, the Mac OS makes some significant distinctions when it deals with those bytes.

A Mac file is composed of two parts, called *forks*. A file's *data* fork is used to store a program's data, such as text from a word processor or numbers from a spreadsheet. The program is free to write anything it chooses into a file's data fork.

A file's *resource* fork contains special objects that are called—appropriately enough—resources. Much of what the Mac is and how it runs is accomplished through these resources. They store the operating-system code and its patches and a program's executable code. Other resources describe the appearance of a program's windows, the dialog boxes, menu contents, and possible alert sounds. The resource fork is accessed by a collection of Mac Toolbox routines termed the Resource Manager. The formats of certain resources (e.g., the window and sound resources) are precisely defined. It's possible to create custom resources for special purposes by using the Resource Manager.

A Mac file can have both a data fork and a resource fork, or only one. Document files, created by programs, have only a data fork, while Mac programs have only a resource fork. There are exceptions, of course. Some programs store user information (e.g., the owner's name and registration number) in their data fork, while a document's resource fork might hold special information (e.g., the color palette for an 8-bit color image).

The important thing to remember is that a resource fork typically contains Mac-specific information that's of no value to a PC. When you prepare to send files to a PC, take a moment to find out where this information is stored. CE Software's DiskTop is an excellent file-utility desk accessory that you can configure to show the size of a file's forks. If there's little or no information in the data fork, check to see that you saved the document in the proper format.

What Is MacBinary, Anyway?

By now, you might be wondering how a Mac handles a file download. Out of that stream of bytes marching into the serial port, how can it tell which bytes go to a file's data fork, and which to the resource fork? Mac terminal programs use a *MacBinary standard* that supplies this crucial information.

When a Mac file is uploaded to a BBS or an on-line system, the terminal program supplies a 128-byte header inside the first packet that is transmitted. This header provides the actual filename (an MS-DOS or Unix system can't deal with lengthy Mac filenames, including embedded blanks), Finder attributes (i.e., the file's creator and type, plus bits describing certain file characteristics), and the size of the file's two forks.

When a Mac terminal program downloads the file, it strips this header off, while using the information in it to reconstruct the file. The terminal program does this by copying the stated number of bytes into the data fork and then into the resource fork, setting the file's type and creator, and finally renaming the file.

When sending files to a PC, it's important to disable this feature in Mac terminal programs. Otherwise, a MacBinary header gets tacked onto the front of the file. Its presence will confound a PC program trying to read the data.

A Matter of Type

On PCs and the NeXT Computer, a file's contents are described by the filename's extension (e.g., .TXT is a file containing ASCII text, .AI is an Illustrator file, and .DOC is a Word file).

On the Mac, the file system saves extra information describing the file's creator (i.e., what Mac program made the file) and its type (or contents). When you double-click on a data-file icon on the Mac, the Mac OS uses the creator information to determine what program to start. The program uses the file type information to deal with the file's data.

These maneuvers by the Mac OS spare you from figuring out what program to use and how the programs deal with the file. However, when you transport files from a PC, you can throw a wrench in the works. That's because a Mac terminal program typically assumes a default creator (MacWrite) and type (TEXT) when receiving foreign data.

When receiving files from a PC, give the Mac file a descriptive name (AutoCAD file) or an extension (.DWG). This will help you keep track of the file until you need it. Next, start the desired program and try opening the file. If you can open it, immediately save it into another file so that the program writes the appropriate creator and type information along with the data.

Some programs look only for files of a specific type. If your file is of the wrong type, its name won't appear in the program's Standard File dialog box. To get the program to recognize the file, you'll have to modify its type information. A number of utilities let you modify the file's type and creator. The DiskTop desk accessory does this, and you don't have to exit the program to fix the file.

Some useful file types to know are TEXT (the file contains ASCII text), TIFF (the file has a TIFF image), EPSF (it's a PostScript file), and EPSP (it's an Encapsulated PostScript file).

is absent in the PC version of the program. Mac documents with locked objects lose this characteristic if the file is sent to the PC and back. Illustrator is a graphics-intensive program that brings out the best in a Mac: It performs faster and better on a 16-MHz 68020-based Mac II than on a 20-MHz 386-based Compaq.

Tailoring the Data to Fit

What happens if you're not using Excel or you're using a word processor other than Word on the Mac? With some care, you can still swap information. Some data formats serve as a common ground for data exchange. Be aware that you might have to tinker with files to make the data palatable to certain programs. What follows are some useful data formats, along with some guidelines to help you.

ASCII text is still the most reliable means of moving bulk text across different machines. No, there is no fancy

continued

Photo 2: *Adobe Illustrator 1.9.3 on a Mac II in the preview mode. (File courtesy of Adobe Systems)*

Photo 3: *The PostScript file from photo 2 on a Compaq Deskpro 386/20 running Adobe Illustrator 1.0 in the preview mode. Note the absence of the measure and blend tools.*

ITEMS DISCUSSED

Adobe Photoshop
Illustrator
Adobe Systems, Inc.
1585 Charleston Rd.
P.O. Box 7900
Mountain View, CA 94039
(800) 922-3623
(415) 961-4400
Inquiry 1146.

AutoCAD
Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(800) 445-5415
Inquiry 1147.

ColorLab 100
Computer Presentations, Inc.
1117 Cypress St.
Cincinnati, OH 45206
(513) 281-3222
Inquiry 1148.

DaynaNET
Dayna Communications
50 South Main St., Fifth Floor
Salt Lake City, UT 84144
(801) 531-0600
Inquiry 1149.

DiskTop
CE Software, Inc.
1854 Fuller Rd.
P.O. Box 65580
West Des Moines, IA 50265
(800) 523-7638
Inquiry 1150.

FDHD (SuperDrive)
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(800) 282-2732
(408) 996-1010
Inquiry 1151.

JX-100
Sharp Electronics Corp.
Systems Division
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9500
Inquiry 1152.

LapLink Mac III
Traveling Software, Inc.
18702 North Creek Pkwy.
Bothell, WA 98011
(800) 343-8080
(206) 483-8088
Inquiry 1153.

MacLink Plus/PC
MacLink Plus/Translators
DataViz, Inc.
35 Corporate Dr.
Trumbull, CT 06611
(203) 268-0030
Inquiry 1154.

MatchMaker
Micro Solutions Computer Products
132 West Lincoln Hwy.
DeKalb, IL 60115
(815) 756-3411
Inquiry 1155.

NetWare
NetWare for Macintosh
Novell, Inc.
122 East 1700 South
Provo, UT 84606
(801) 379-5900
Inquiry 1156.

PageMaker
Aldus Corp.
411 First Ave. S, Suite 200
Seattle, WA 98104
(206) 622-5500
Inquiry 1157.

Spectrum/24 Series III
SuperMac Technology
485 Potrero Ave.
Sunnyvale, CA 94086
(408) 245-2202
Inquiry 1158.

Word
Word for Windows
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
Inquiry 1159.

WordPerfect
WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057
(800) 321-4566
(801) 225-5000
Inquiry 1160.

Photo 4: *An image scan on a Sharp JX-100 scanner using ColorLab 100 scanning software on a Compaq Deskpro 386/20.*

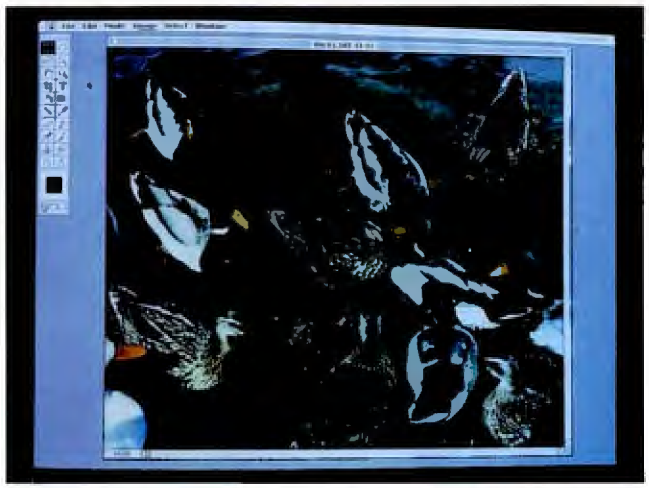


Photo 5: *The image in photo 4 was saved as a 24-bit TIFF file and transported to a Mac II. The image is being viewed with Adobe Photoshop using a 24-bit color SuperMac video board.*

formatting information, but quite often text transfers are done so that the receiving computer can merge the text into one document. You then add the typefaces, style, and graphics to this combined document. Where and with what program you finish the document doesn't matter: It could be PageMaker on either machine, Quark XPress on the Mac, or Ventura Publisher on the PC.

Also, tab-delimited text (i.e., ASCII numbers separated by tab characters) is useful for shipping tables of numbers. For example, those Compaq numbers mentioned at the start of this article can be saved as a tab-delimited table, which you send to a Mac. Cricket Graph can read tabular data in this format and produce a graph of the information in a matter of minutes.

When moving files from the PC, remember that its ASCII text files normally end with a carriage return/linefeed pair. On the Mac, text files end with just carriage returns. So remember to strip or add the linefeeds as you move raw text from one machine to the other.

PostScript is a fairly reliable means of exchanging graphics. Here at BYTE, we have moved graphics between Unix systems, PCs, and Macs using PostScript. Since PostScript commands are text-based, you can use ASCII file capture to move files around in a pinch.

However, Illustrator gets downright cranky when you try to get it to read PostScript files not made in Illustrator. The same goes for Encapsulated PostScript files: Some programs will read them; others won't. Since there's no reliable way to determine beforehand what files cause problems, you'll just have to experiment until you hit on a working combination of programs and settings. Or, stick with Illustrator exclusively.

TIFF was originally developed by Aldus to transport bit-mapped images across different computers. The specification is now in the public domain and is maintained by a number of vendors. It's also a reliable exchange medium. I've scanned images on a PC using a Sharp JX-100 scanner (see photo 4) and Computer Presentations ColorLab 100 software. I had ColorLab 100 save the images as 24-bit TIFF files and then transmitted the files to the Mac. On a Mac II equipped with a SuperMac Technology 24-bit color video board, the results—created on a PC—can be spectacular (see photo 5).

The biggest problem with TIFF files is how well vendors implement the specification. Some programs handle only 1- or 8-bit TIFF files, so that a 4-bit TIFF file (from a NeXT Computer) or a 24-bit TIFF file (from either a Mac or a PC) causes them to crash and burn.

Other potential problem areas in the specification are data compression and how the image is stored. In the latter case, the Motorola processor organizes its data in the reverse from how an Intel processor handles data storage. This potential problem is dealt with by information in the TIFF file that describes its data organization. A decent TIFF reader can read this information and reorganize the data as it accesses the file. Some programs don't. As is the case with PostScript, you'll have to experiment with various programs to see what works.

Finally, check to see what formats your target program can accept. Data compatibility might be just a matter of looking in the manual. For example, many Mac spreadsheet programs can read PC files saved in the SYLK format. Word and Word for Windows can save Rich Text Format files that describe the document's typeface and style information as text commands. These RTF files can be read by WriteNow or MacWrite II on the Mac, via filters.

Medium of Exchange

As you have seen, the Mac no longer works in isolation from its PC and workstation counterparts. Programs are available that let office workers use the same set of keystrokes and mouse actions to do the job, no matter what type of microcomputer they're using. Furthermore, copying files back and forth is no longer a nightmare. Instead, it's a convenient way to move the information from one user to the next. Even if you don't use WordPerfect, Illustrator, PageMaker, or the like, exchanging data is now more a science than an art.

Macs and PCs give today's office the best of both worlds. PCs can be used to their best advantage, and so can Macs. The ability to easily exchange information between the two creates a synergism resulting in work that's better than anything done by a single type of computer. Because information is easily shared nowadays, the Mac isn't a stranger in the office. Rather, it is an important ally in dealing with the Information Age. ■

Tom Thompson is a BYTE senior editor at large with a B.S.E.E. degree from Memphis State University. He can be reached on BIX as "tom_thompson."

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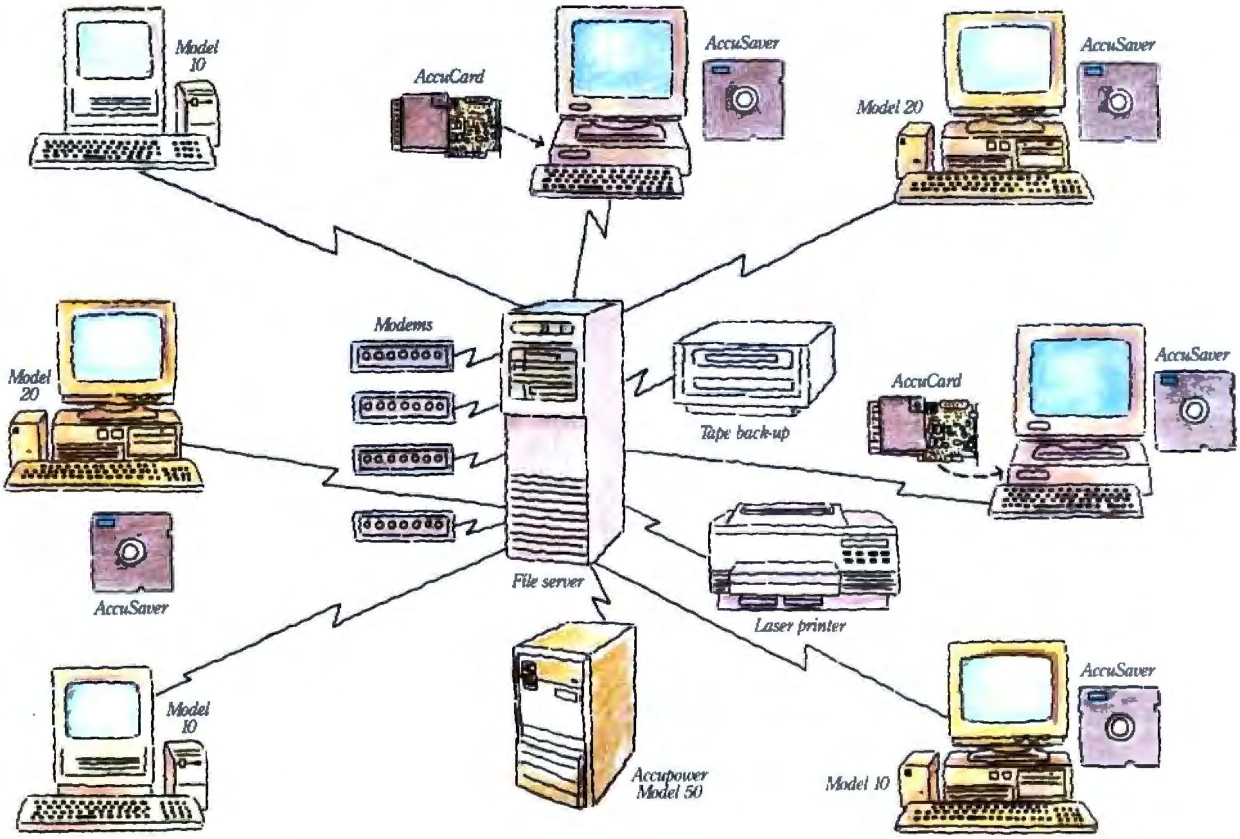

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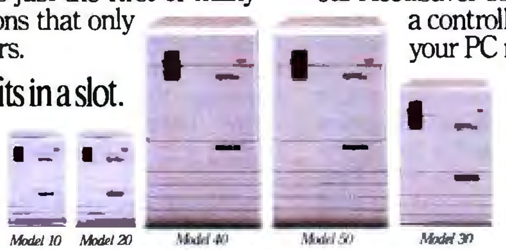

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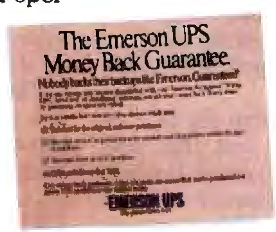

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PROGRAMMING 32-BIT OS/2

Working with the OS/2 2.0 SDK

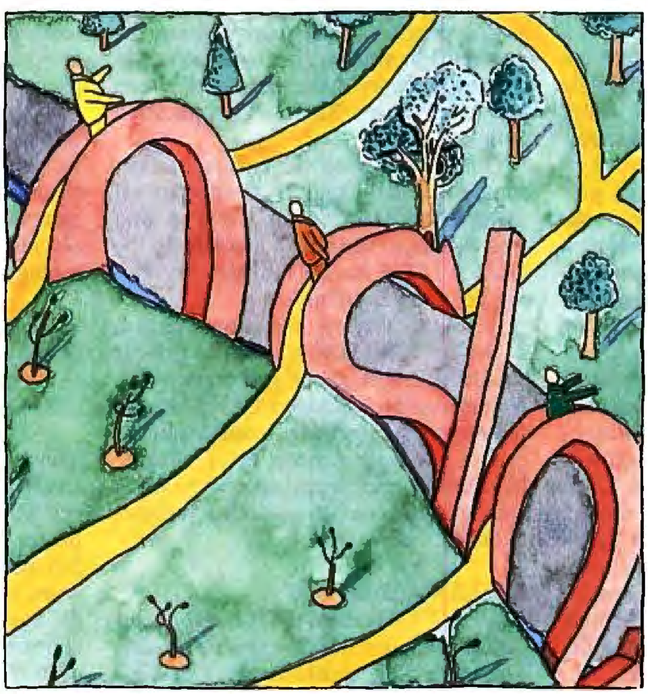
Martin Heller

As the next generation of operating system for personal computers, OS/2 2.0 has generated more than its share of media attention. What I'd like to do here is to strip away the hype and speculation and get down to the bare facts. I am working with the OS/2 2.0 Software Development Kit (SDK). This is a $2600 product that allows developers to use early versions of the operating system and development tools to prepare their applications.

Just the Facts, Ma'am
OS/2 2.0, a multitasking, single-user operating system for PCs, is based on the Intel 386 and i486 CPUs. It builds on the technologies found in earlier versions of OS/2 and in Windows/386. OS/2 2.0 offers many features:

- linear or "flat" 32-bit memory model
- paged virtual memory
- full use of the 386 instruction set
- support for existing DOS and OS/2 1.2 16-bit applications
- multiple virtual DOS machines (MVDMs)
- High Performance File System (HPFS)
- extended file attributes
- long filenames
- greatly expanded system limits
- support for Windows applications through the SMK

C Programming Models
OS/2 2.0 supports multiple programming models. Applications written for the Presentation Manager and built with the 32-bit tools have full access to the PM's user interface and graphical programming services. These applications will run only under OS/2 2.0 (although you can build 16-bit versions from the same sources to run under OS/2 1.2).



Character-mode applications don't need to use the PM to get the advantages of the flat 32-bit memory model. These programs are written using the C runtime library facilities and built with the 32-bit tools; they can also use the OS/2 2.0 application programming interface. Character-mode 32-bit applications (e.g., 32-bit PM applications) will run only under OS/2 2.0. Again, you can build 16-bit applications from the same source code—but if you use OS/2 2.0 APIs, you will need to make some adjustments so that they will be compatible with the OS/2 1.2 APIs.

The 32-bit model paves the way for a lot of Unix programs that haven't yet been ported to OS/2. That's mainly because Unix code assumes that pointers can look anywhere in memory, whereas OS/2 1.x programs target an architecture made up of many small, protected segments. OS/2 2.0 eliminates

continued

Listing 1: *OS/2 1.x supports memory objects larger than 64K bytes, but not very efficiently.*

```
SEL sel1, sel2;
PCH pabObject1, pabObject2;
USHORT offselector;
/* Method 1 - allocate two selectors */
DosAllocSeg ((USHORT) 0, &sel1, SEG_NONSHARED);
DosAllocSeg ((USHORT) 4096, &sel2, SEG_NONSHARED);
pabObject1 = MAKEP(sel1, 0);
pabOjbect2 = MAKEP(sel2, 0);
/* Code must use pabOjbect2 for memory references
above 64K bytes */
/* Method 2 - use DosAllocHuge */
DosGetHugeShift (&usShiftCount);
offselector = 2 << usShiftCount;
DosAllocHuge ((USHORT) 1, (USHORT) 4096,
              &sel1, (USHORT) 2, SEG_NONSHARED);
pabObject1 = MAKEP(sel1, 0);
pabObject2 = MAKEP(sel1 + offselector, 0);
/*
Code can use pabObject1 and pabObject2 as above, or take
advantage of the arrangement of the huge selectors by using
pointers of the type:
pch = MAKEP (sel1 + offset >> 16, offset / 16)
*/
```

that architectural mismatch.

In addition to the new 32-bit character-mode and 32-bit PM application models, OS/2 2.0 supports all OS/2 1.2, DOS, and (with a conversion) Windows models. Complicated? Yes. But for the user, the result is an operating system that runs existing applications with confidence.

Developers now need to choose their models carefully, balancing portability, performance, and development effort. One strategy might be to write a 16-bit PM application but include conditional 386 code that will run if the 386 instructions are available. This approach gains transparent portability between OS/2 1.2 and OS/2 2.0, but it doesn't take advantage of flat memory.

Another strategy is to write a PM application with conditional source code for 16- and 32-bit versions. The result here would be two separate executable images generated from a single set of sources. You can then choose the program file that is appropriate for your computer when installing the application. This approach takes maximum advantage of the new features of OS/2 2.0, but the developer will have to maintain complicated conditional code.

One "gotcha": If you have existing OS/2 programs written to the character-mode 16-bit API using OS/2 video, mouse, or keyboard functions, you will have difficulty converting them to 32-bit applications. The 16-bit video, mouse, and keyboard functions have no 32-bit analogs; you can either maintain these 16-bit applications as they are, rewrite the unsupported API calls as C function calls to convert to 32-bit character mode, or rewrite heavily to convert to PM.

Status of the SDK

The first release of the OS/2 2.0 SDK had a few problems. To begin with, the installation procedure took over the whole machine rather than coexisting with older versions of OS/2. The system was not totally stable. It provided only the debugging kernels, and these were slow, occupied a lot of memory, and monopolized a serial port. The on-line documentation was incomplete; the printed documentation consisted of a manual for the MEP editor and an eight-page letter. A few rather important things were broken; for example, the system would refuse to install if you had a numeric coprocessor in your computer. There were only three sample programs: one to demonstrate the new semaphore APIs, one to demonstrate the new memory management APIs, and one to serve as a 32-bit PM application template.

On the other hand, the system, toolkit, samples, and virtual DOS support all worked moderately well. Anyone who was willing to dedicate a machine to the OS/2 2.0 SDK was able to start developing 32-bit applications.

As of this writing, the second release of the OS/2 2.0 SDK is about to ship. It should fix most of the problems of the first release and include a LAN Manager redirector, substantial printed documentation, complete help files, better MVDMs, and a floppy disk boot option (so that it can coexist with other versions of OS/2).

OS/2 2.0's 32-bit API

The OS/2 2.0 kernel API is largely compatible with the OS/2 1.2 kernel API. The biggest difference is that OS/2 2.0 allocates memory by object, not by segment. This happens because the 2.0 memory manager uses demand-paged virtual memory rather than segment compaction and swapping. Another important change has to do with semaphores: The 32-bit semaphore functions are completely incompatible with the 16-bit versions. There are minor changes in some of the tasking functions, queues, and anonymous pipes.

Paged memory in OS/2 2.0 is similar to that in Phar Lap's 386|VMM DOS extender, Berkeley Unix, and VAX/VMS. The application asks for memory as needed, and the system manages the mapping of 4K-byte pages of memory to and from disk. The fixed size of memory pages simplifies allocation (compared to the allocation for the variable size of segments) but requires hardware support for "page faults"—that is, the attempt to read or write a page that is not currently in memory. The 386 chip supports paged virtual memory; the 286 chip does not.

OS/2 2.0 is unusual in the way that it differentiates between allocation and commitment of memory, and in the use of guard pages. The new `DosAllocMem` function in OS/2 2.0 replaces calls to both `DosAllocSeg` and `DosAllocHuge` and allows control of memory commitment—independent of memory allocation. The new `DosSetMem` function can selectively commit memory and change the access type of committed pages of memory. There are four access types: read, write, execute, and guard page. The guard page access type causes an exception to be raised in a process that attempts to access the memory. An exception handler could respond to the guard page signal by committing more pages.

Under OS/2 1.2, you could allocate a large memory area by using multiple selectors or by using `DosAllocHuge` (see listing 1); either way, using multiple segments is inefficient. Under 2.0, you simply allocate a single memory object by typing the following:

```
PCH pabObject;
DosAllocMem (&pabObject, (ULONG)
  69632, PAG_COMMIT | PAG_READ |
  PAG_WRITE);
```

This gain in simplicity comes at a cost. In OS/2 1.x, you can find common memory allocation errors by relying on the protection mechanisms—but in OS/2 2.0, protection violations are raised only when the program addresses an invalid 4K-byte page. You may want to keep a copy of OS/2 1.2 for debugging purposes even after you have switched to OS/2 2.0

for your day-to-day development.

Note that in the example of DosAllocMem I used the PAG_COMMIT flag to commit all the memory allocated. To allocate sparse memory, you would leave out the PAG_COMMIT flag and change the access of selected pieces of the allocated object with DosSetMem. You can decommit memory in the same manner. For example, you may want to allocate and fill a large memory buffer for print spooling and then decommit pages once you have printed the contents.

Another effect of the change from segment-based memory management to object-based memory management is the need to modify device drivers. In practice, you must revise base device drivers (e.g., disk drivers) to use 32-bit DevHlps (operating system services made available to drivers), but mouse drivers from OS/2 1.2 should work properly. Screen drivers from version 1.2 will most likely work under version 2.0, but they won't support EGA or VGA graphics in virtual DOS machines until you update them. It should not take long for you to update screen drivers for OS/2 2.0. Printer drivers from OS/2 1.2 may or may not work in version 2.0, depending on how they do their memory management.

Semaphores

Semaphores are system "flags" used to coordinate multiple tasks. There were several problems with the design of semaphores in OS/2 1.x. Many of the problems in OS/2 1.x occurred because a single type of semaphore was being used for multiple purposes. The 32-bit semaphore functions in OS/2 2.0 use a different design that should solve these problems, although the 16-bit semaphore functions are unchanged for compatibility. In addition to the new semaphore APIs, the total number of system semaphores was increased greatly, to 64 shared plus 64 private per process. OS/2 2.0 has three separate types of system semaphores: mutual exclusion (mutex), event, and multiple wait.

Mutex semaphores are designed to be used by several threads within a process, or by several processes, to protect access to a critical region. A typical use would be to prevent more than one thread at a time from updating a file on disk. Only one thread at a time can own a mutex semaphore. The OS/2 kernel blocks threads that are waiting for an owned mutex semaphore and queues multiple requests for a single semaphore. This grants ownership on a first-come, first-served basis.

Mutex semaphores are designed to protect access to a critical region.

Event semaphores have two states: reset and posted. They provide a signaling mechanism among threads or among several processes. You might typically use them to manage shared memory: Process 1 writes into the shared region and then uses a signal semaphore so that processes 2 and 3 can proceed to access the shared data. A little thought will convince you that what is fail-safe behavior for an event semaphore is unsafe for a mutex semaphore, and vice versa.

Multiple-wait semaphores are designed to allow a thread to wait on several mutex or event semaphores at once (although all the semaphores in the multiple wait must be of the same type). A typical use would be a thread that requires access to several shared regions of memory at once. By using a multiple-wait semaphore, the thread can block until the system has gathered ownership of all the regions. The thread can then proceed to process the data, while being assured that the critical resource is protected from all other threads.

The multiple-wait mechanism is important because it avoids deadlock situations. Suppose, for instance, that a multiprocess transaction-processing system needs simultaneous access to both the debit and credit ledgers. Transaction A may gain access to the debit ledger, while transaction B gains access to the credit ledger. Neither transaction will be able to complete, and neither will yield. However, if you use multiple-wait semaphores, and the transactions block until both ledgers are available, each transaction can proceed in turn.

Threads and Processes

The OS/2 2.0 DosCreateThread is more convenient than its 1.2 counterpart. To begin with, you can now pass a single doubleword argument to the thread—which can be the address of an argument list. You can start the thread in either the active or the suspended state. Best of all, the system automatically allocates stack for the thread.

The automatic stack allocation is not initially committed beyond the first 4K-byte page, so the application can ask for a large stack without a performance penalty. When the stack grows down to the guard page, the system will automatically create more stack space by committing the guard page and moving it down.

A few other minor problems have been cleared up. A new error code to DosKillProcess, "Process is Zombie," reflects the situation of a process that is dead but hasn't been reaped by its parent. And a new function, DosWaitThread, allows one thread to wait for another to die.

Queues and Anonymous Pipes

The 32-bit queues in OS/2 2.0 look very similar to 16-bit queues—at least on the functional level. However, the system resources that they create are not the same. 32-bit queues are completely incompatible with 16-bit queues. You cannot read or write 32-bit queues with 16-bit functions, nor 16-bit queues with 32-bit functions. In practice, this is not likely to be a severe restriction, since you could write a 32-bit "bridge" task that could connect a given 32-bit queue to a 16-bit queue.

The OS/2 1.2 function DosMakePipe is called DosCreatePipe in version 2.0. These two functions do the same thing. The 64K-byte restriction on the advisory size is removed in the 32-bit version; this can be a benefit if you really need to create a large pipe (e.g., if you want to pipe a fast stream of real-time data into a process to analyze and save the data). In this case, you wouldn't want the real-time process to block just because a pipe filled up, because that would mean losing data.

MVDMs

One of the major enhancements in OS/2 2.0 is support for MVDMs. An MVDM tries to make a user's transition from DOS to OS/2 relatively painless: It supports major DOS applications, protects the system from the cavalier way DOS programs sometimes act, and provides performance that is as good as or better than that of DOS.

DOS programs typically assume that they are all alone in your computer and can use whatever resources they can find. For instance, a DOS program will typically look at the ROM data area to determine the computer's configuration and then stuff bytes directly into video memory to write on the screen. DOS programs don't have to worry about refreshing their displays on demand—they

continued

assume that nothing can overwrite their displays.

The screen is not the only system resource that OS/2 programs need to share. They also need to share the mouse, keyboard, CPU, and peripherals such as printers and floppy disk drives. The keyboard polling issue can be serious; however, the MVDM code detects keyboard idle loops (on interrupt 28) and reduces the idle application's CPU time by a user-adjustable amount. Applications can help by explicitly yielding the CPU during their idle loop; this is done by an INT 2F with 1680H loaded into the AX register. (The same "yield" mechanism can help applications that are running under Windows 3.0.)

The "sharing" problem was partially solved in OS/2 1.2—but only for a single DOS box running in real mode in the actual lower 640K bytes of RAM. Under OS/2 1.2, a DOS application would have access to perhaps 510K bytes of RAM, and no EMS or Extended Memory Specification (XMS) memory. With OS/2 2.0, each MVDM—running in the 386 chip's virtual 8086 (V86) mode—has over 600K bytes of RAM available to it, as well as XMS and EMS memory. Even memory-hungry CAD and database programs that couldn't start in the OS/2 1.2 DOS box run well in the MVDM.

Is the MVDM a Better DOS Than DOS?

There is a friendly rivalry between the DOS and OS/2 groups at Microsoft—and one of the taunts that's tossed over the schoolyard fence is that OS/2's MVDM is a better DOS than DOS. In terms of the amount of RAM available to an application, MVDM can actually be better than DOS. In terms of performance, it may not be as good.

You really can't expect a computer that is running multiple DOS and OS/2 sessions to run any individual session as quickly as it could if that session was by itself in the machine. There is a certain amount of overhead from the virtual device drivers, some more from the OS/2 kernel, and more yet from the time-slicing that is done to support multiple sessions.

Yet, in special circumstances, a few DOS applications will run better under MVDM than under DOS. If DOS applications are constrained by memory under DOS and tend to be disk-bound, the increased memory available with MVDM and the increased disk speed that HPFS supplies can actually allow them to run better under OS/2 2.0.

On the other hand, the keyboard and mouse response in an MVDM is not as smooth as under DOS. You can run VGA arcade games in an MVDM, but the mouse may be jerky and the screen might show occasional hash. (But you didn't want OS/2 for shoot-em-ups, did you?)

There is a friendly rivalry between the DOS and OS/2 groups at Microsoft.

How They Do It

The 386 chip's V86 mode traps sensitive instructions and I/O attempts. Using a lookup table called the I/O permission map, the CPU can tell if the current task is allowed to use a given peripheral directly or whether the I/O attempt needs to be passed to a virtual device driver. The CPU redirects some instructions to software that maps, or "virtualizes," them. These include instructions to turn interrupts on and off, to push and pop the state flags, and to use and respond to software interrupts.

Under OS/2 1.x, the space in the DOS box was limited because the DOS kernel and all device drivers had to go into real memory. In V86 environments under DOS (e.g., Desqview), both DOS and the environment take up space. This leaves even less room for applications. In OS/2 2.0's MVDM architecture, there is no need to use real mode at all—the OS/2 kernel, file system, and device drivers all run in protected mode. As many as 16 MVDMs can run as if they each had 640K bytes of low memory, 32 MB of EMS memory, and XMS memory. Of course, much of this "memory" may turn out to be disk space—but OS/2 2.0 handles the overcommitment by using its demand-paging mechanism.

MVDMs can run in text windows on the PM screen, in the background as an icon, or on a full screen. They have full access to HPFS files (except for long filenames) and have cut-and-paste facilities: You can copy screen text and graphics from a DOS application to the PM clipboard and then paste text into the DOS program. The MVDM emulates DOS 4.0; it supports serial communications at up to 9600 bps without losing characters.

The High Performance File System

HPFS was introduced in OS/2 1.2 and OS/2 Lan Manager. OS/2 2.0 continues to support HPFS but uses 32-bit assembly code for its implementation, as opposed to the 16-bit C code that OS/2 1.2 uses.

HPFS is considerably more robust than the file allocation table (FAT) system that DOS (and OS/2) use. HPFS implements long mixed-case filenames with embedded blanks and multiple "." characters, extended file attributes, and several features to increase file access speed, reduce disk fragmentation, and ensure that files are not lost.

Long filenames can make it much easier for users to identify file contents. Likewise, extended attributes can make it easier for programs to identify their data files.

HPFS gains performance by using sophisticated disk data structures, multiple levels of caching, asynchronous read-ahead and write-behind, and strategic file allocation algorithms.

HPFS Implementation Details

When HPFS allocates a file, the data immediately follows the file control structure. This cuts down on unnecessary head motion. Data space is pre-allocated to reduce the amount of updating needed when writing the file. HPFS allocates simultaneously open files apart from each other on the disk, reducing the probability of their data areas interleaving. HPFS deals with the disk in sectors (generally 512 bytes) as opposed to the clusters (generally 2048 bytes or four sectors) that the FAT file system uses. Allocating sectors reduces wasted space on the disk—a significant problem when there are many small files.

HPFS organizes the disk using a B+ tree approach. This approach guarantees that a file will be found in three seeks to the disk. The root of the tree is the *super block*, which points to the *spare block* and the root FNODE. All the directories and files on a disk partition depend on the root FNODE. Directory FNODEs are the branches of the tree; file FNODEs are the leaves. Directory FNODEs can point to other directory FNODEs or to file FNODEs; file FNODEs point to the file allocation information.

The B+ trees are inherently efficient structures. On any given level of tree, either all entries have down pointers or none do; this simplifies the algorithms for searching. Tree traversal to any given file takes on the order of the log of the total number of files. For 13-character

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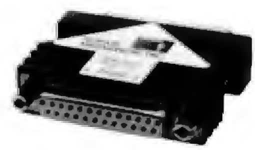

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filenames, a single-level tree can handle 45 entries, a two-level tree just under 2000 entries, and a three-level tree almost 80,000 entries.

HPFS uses three separate cache areas: one for disk sectors, one for directories, and one for paths. The disk sector cache, whose size is controlled by the `-C:xx` option to the IFS command in CONFIG.SYS, allocates up to 1000 blocks of 2K bytes each; it uses a least-recently-used algorithm. The directory cache block holds directory entries; this speeds file accesses within a directory. Path caching employs a "directory lookaside" algorithm to speed up multidirectory searching.

HPFS disk access is faster than FAT access in almost all cases. It may take a little more time to open a file, and the improvement on random reads may be insignificant. But file creation and deletion are much faster under HPFS. Sequential reads and both sequential and random writes are anywhere from 20 percent to 30 percent faster.

When the HPFS system starts, it automatically checks each HPFS partition for integrity, repairs the tree, and recovers lost files if necessary. The repair process is aided by signatures on disk data structures, duplication of filenames in the FNODEs, and "hot fixing" of the tree. HPFS doesn't support the Norton Utilities—but it doesn't really need it.

The TrueType Saga

Desktop publishers have been asking for high-quality scalable printer and screen fonts for DOS, Windows, and OS/2. The current technology in Windows requires bit-mapped screen fonts—a less-than-ideal situation. What is really needed is a unified imaging method—or rasterizer—that works fast enough to be used on-screen and well enough to be used on high-quality laser printers.

The two major candidate technologies for this role are Adobe's Type Manager and Apple's TrueType. While IBM has licensed ATM, Microsoft has licensed TrueType—leading to market confusion. Nevertheless, TrueType is scheduled to ship in Windows 3.1, OS/2 2.0, and Macintosh System 7.0. TrueImage, an embedded printer implementation of TrueType, is also in the works. However, it is not clear which printer manufacturers (besides Apple) will actually ship TrueImage printers.

Adobe designed its fonts with Bézier curves and "hints" for drawing small point sizes without losing the character of the outlines. TrueType fonts have quadratic B-splines. The practical difference between the two types of curves is that Bézier outlines require fewer points for definition but more CPU time for rasterizing; B-spline outlines need more points for definition—making the outline files bigger—but rasterize more quickly. Apple benchmarks imply that TrueType may have a speed advantage of a factor of 2 over Adobe's technology, but at a cost of a 25 percent enlargement in the font outline files.

Desktop publishers have been asking for high-quality scalable printer and screen fonts.

Part of why TrueType appeals to implementers is that it is a full type description language. A TrueType font file contains the TrueType code to draw each letter in the font. To display the letter *A*, the rasterizer interprets the TrueType code for the letter *A*.

But what about the installed base? TrueType will coexist with Hewlett-Packard, Bitstream, and Adobe fonts; with most current word processing software; and with existing printers. Most of the major DOS word processors will license it; Windows and OS/2 will include it; and all the major digital-type foundries have announced support for it. A TrueType font cartridge will be available for HP LaserJet printers, and you'll be able to download TrueType to existing PostScript printers.

On the other hand, TrueType may not really be necessary now that the Microsoft-Apple alliance has forced Adobe into opening up the PostScript specifications. And while TrueType's speed and quality appear to be superior to Adobe's Type 1 PostScript and Type Manager technology, Adobe's fonts are good enough for all practical purposes.

The 32-bit Toolkit

Experienced PM developers will find that they can convert their PM applications to 32-bit PM with very little effort. Generally, applications that follow the guidelines for the use of integer types (e.g., USHORT rather than `int`) convert almost automatically. You can debug converted applications fairly mechanically—you run the application until it faults, fix the line in error, rebuild, and continue testing.

In OS/2 2.0, the familiar Compile and Link (CL), Macro Assembler (MASM), and related compilation tools have been replaced with CL386, MASM386, LINK386, and CV386; obviously, you don't want a name conflict between your 16-bit tools and your 32-bit tools. The compiler apparently branches from Microsoft C Compiler 5.2; the tools are intermediate between Microsoft C Compiler 5.1 and 6.0, with the required changes for 32-bit code.

However, RC, NMAKE, LIB, ICONEDIT, FONTEDIT, DLGBOX, IPFC, MEP, and H2INC have not been renamed. Some tools (e.g., LINK386) are backward compatible with OS/2 1.2; others (e.g., RC) aren't. RC, in particular, now exists in versions for OS/2 2.0, OS/2 1.2, Windows 3.0, and Windows 2.1; developers need to be careful to use the correct version for the target being built.

The System Migration Kit

Until recently, OS/2 has suffered badly from a lack of true PM applications. At the same time, Windows has attracted hundreds of applications. Microsoft's System Migration Kit (SMK)—like Micrografx's Mirrors—is intended to allow developers to port "clean" Windows applications to OS/2 PM.

By "clean," I mean code that runs correctly in protected mode. Most Windows developers have clean code simply to support Windows 3.0; it shouldn't be much of an effort to relink these applications to the SMK libraries. Voilà! A PM application.

The SMK won't take Windows applications to 32-bit code—Microsoft suggests using the SMK as a stopgap to help ship 16-bit PM applications while working on 32-bit PM versions. If you build applications with the SMK, they will run under OS/2 1.2 and OS/2 2.0.

But an even easier alternative will exist for OS/2 2.x users: Microsoft plans to release a binary-compatibility layer for OS/2 2.0 or 2.1 that will allow Windows executables to run under PM. This layer will not be available for OS/2 1.2. The dynamic link libraries for Windows binary compatibility will be another enhancement available only in OS/2 2.x.

Final Testimony

You could certainly fault Microsoft and IBM for setting the price of the SDK so high. $2600 is more than most small

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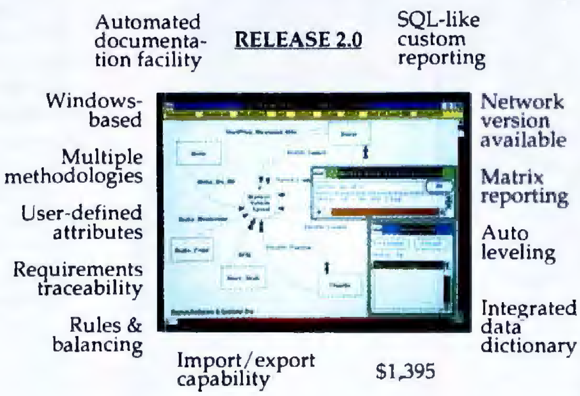

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developers can afford to pay for an early look at OS/2 2.0. On the other hand, it is understandable that Microsoft and IBM would want to limit the distribution of alpha-level code to a relatively small group of developers—for support reasons, as well as to minimize the impact of design changes during the development of the system.

Still, the OS/2 2.0 SDK seems to be coming along well. Compared to the OS/2 1.0 SDK and the Windows 1.0 SDK at similar points in their development, the OS/2 2.0 SDK has more of the projected features already implemented, and fewer ways to crash. Once OS/2 2.0 stabilizes a bit more, I'll try to find device drivers that will give it the same 1024- by 768-pixel screen resolution that I have in Windows and OS/2 1.2. Then I'll try to get drivers for my CD-ROM drive and printers.

Once I've got all that installed, the only reasons I would boot DOS would be to run extended-DOS programs with no OS/2 2.0 equivalent; to run Windows programs that haven't yet been converted to PM; and to do final compatibility tests of software that is targeted for DOS or Windows. The only reasons I would boot OS/2 1.2 would be to debug subtle memory-access problems and to do final compatibility tests of software targeted for 16-bit OS/2.

In short, I fully expect OS/2 2.0 to be my standard operating system by 1991, and I expect many other software developers to make the same choice. I also expect many Unix, CMS, VMS, and MVS developers to start thinking about OS/2 ports to their software once a moderately priced OS/2 2.0 toolkit is available.

It will be some time before most users replace DOS with OS/2, simply because of the huge installed base of 8088- and 286-based PCs. But I expect that the shipment of OS/2 2.0 late this year, and the perpetual trend toward faster computers with more storage for less money, will help that transition happen by the mid-1990s.

The bad news is that until the DOS-to-OS/2 transition is complete, PC software developers will have to deal with the complexities of developing for DOS, extended DOS, Windows, 16-bit OS/2, 32-bit OS/2, and Unix. The good news is that developers will be able to do over 90 percent of that work on an OS/2 2.x platform. ■

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MULTIMEDIA: DVI ARRIVES

The promise of DVI is becoming realized with commercial products by IBM, Intel, and third-party developers

Greg Loveria and Don Kinstler

The Mayans flourished for more than 1000 years on the Yucatan Peninsula in Mexico before their culture crumbled in the sixteenth century. Now, thanks to Digital Video Interactive (DVI) technology and New York City's Bank Street College, the Mayan civilization can return to life with a single keystroke.

Bank Street College's CD-ROM program, called the Palenque Museum DVI application, provides just one example of how DVI is being developed today: in this case, for surrogate travel. For example, if you select the Palenque application's Rain Forest Room icon, the exotic flora and fauna of the Yucatan Peninsula move across your VGA screen. If you click on an ant icon (appropriately located on a tree's leaf), you'll see a 30-second video and audio explanation of leaf-cutting ants at work.

Other sequences take you up the steps of a Mayan ruin. From there, you can look 360 degrees around, up, or down, just as if you were actually there.

While some computer veterans scoff at the publicity that currently surrounds multimedia, the melding of digital video and audio is producing concrete results for many areas (e.g., armchair travel, education, industrial training, and business presentations). According to Kathy Wilson, the Palenque project's director, a consumer version of the application will be available in the second quarter of next year.

Bank Street College is also working with the Metropolitan Museum of Art and the Chicago Art Institute to develop similar applications for the fine arts. The first implementations of these art databases will appear in interactive touch-screen kiosks for museum visitors.

The kiosks will use a combination of DVI technology, videodisk players, Targa boards, and hard disks. These applications may later be ported down to consumer DVI software releases on CD-ROM.

R&D Roots

While IBM, Intel, and others champion DVI, there are other technologies for melding digital sight and sound (see "The Four Multimedia Gospels," February BYTE). Proponents of other platforms, including those of the Amiga and the Macintosh, believe that those approaches may better exploit the multimedia market.

Nevertheless, DVI's roots are firmly established. They reach back to 1982 when RCA and General Electric engineers began their R&D efforts. Intel announced its commitment to the technology in 1987.

DVI technology is now owned by Intel and is under

continued

Photo 1: *With Bank Street College's Palenque Museum DVI application, surrogate travelers can climb Mayan ruins and view a 360-degree panorama as the compressed digital image is unwrapped in real time.*

the control of its Princeton Operation Division. Commercial DVI products are a blend of Intel/IBM add-in boards, software, system products, and third-party software.

The first of IBM's commercial DVI products include two ActionMedia 750 boards for Micro Channel architecture machines. The $1995 "delivery" board displays DVI-compressed video and audio data files from CD-ROMs, optical disks, or standard hard disk drives. A $2150 "capture" board enables users to produce digitized audio and video. Both products were announced last February and began shipping last spring. Intel distributes the ActionMedia board for Industry Standard Architecture (ISA)-bus computers.

After their joint-venture announcement early last year, Intel and IBM's first priority was to scale down the unwieldy seven-board DVI developer's platform to a two-board end-user version, aimed at training, point-of-sale, and desktop computer applications.

DVI merges TV and computer technologies that enable VGA-equipped computers to display full-motion video signals. The American TV format, NTSC, transmits and displays video signals on our TVs at 30 frames per second. Frames move in rapid succession at a 512-pixel (horizontal) by 482-pixel (vertical) resolution. Each frame of NTSC video can display as many as 16 million colors. By comparison, the standard VGA output from a PS/2-class machine can display only 16 colors at 640- by 480-pixel resolution, or 256 colors in 320- by 200-pixel mode.

To produce portions of the Palenque application, a photographic slide of actual ruins was shot with a 13-inch fisheye lens, producing a distorted circular image. The slide was then input to the computer with a color scanner and converted to a DVI-encoded graphic. The resulting single frame of DVI is unwrapped mathematically in real time as the user looks around the panorama (see photo 1).

A single color frame of NTSC video requires from 500K bytes to 2 megabytes as a computer data image file. One second's worth of full-motion video data (30 NTSC frames) can be as large as 60 MB. Intel's i750 video processing chip set, a primary component of the Intel and IBM boards, digitally compresses and expands full-motion video and audio files (sometimes called data streams) in real time. This ability to compress, store, and expand video signals in real time, with full-motion playback, contributes to the commercial promise of DVI.

Two main chips make up the i750 chip set: the 82750PA Pixel Processor (running at 12.5 million instructions per second) and the 82750DA Output Display Processor. The ODP chip can display digital video at varying resolutions of from 256 by 200 pixels to 1024 by 512 pixels, in 8-, 9-, or 16-bit colors. (At press time, the vendors were developing 24-bit color.) The technology can display full motion, digital-image output with a multitude of special effects (e.g., shrink, mirror, and wrap) because the i750 chip set's microcode can be reprogrammed at full operation speeds.

Blending Digital and Analog

Working in conjunction with an existing 640- by 480-pixel by 16-color VGA display adapter, the ActionMedia 750 boards blend 16-million-color digital video with the VGA analog output. Intel's ISA delivery board connects to the VGA card via the VGA feature bus. IBM's PS/2 version mixes digital video through the Micro Channel bus to the VGA circuitry on the PS/2 motherboard. You can then merge the digital video output within a DVI application using the analog VGA output for generating graphical overlays (e.g., icons or text) on or in the DVI video window. Since all the video generated is digital, you can move, shrink, stretch, and position the DVI window anywhere on the VGA screen.

The delivery board requires that you input video data in the DVI encoded format from an existing software file originating from a hard disk drive, a CD-ROM, or other optical storage device. This provides finite frame-accurate display control over each frame of the compressed video and audio data. DVI application programs let you search and display video pictures in the same way that you would manipulate a database. Like DOS, DVI can converse with a computer like a hardware/software operating system, but in the digital video dialect of DVI.

According to Intel, the motion-video file compression and decompression ratio is almost 160 to 1. That is, a compressed 4.5K-byte, single-motion frame of video/audio information can be expanded for viewing on the fly, back to its

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original file size of 720K bytes. This allows a typical CD-ROM disk to store 72 minutes of DVI-compressed motion video and stereo audio information. (The same CD-ROM disk could store only 28 seconds' worth of uncompressed data.) However, CD-ROM access speeds are slower than hard disk data-retrieval speeds (approximately 1 second versus 20 milliseconds, respectively). DVI's 4.5K-byte compressed frame files can be streamed off the CD-ROM fast enough for real-time decompression and display.

Saving Changes

In addition to motion video, the DVI format can compress big collections of still images (e.g., photographs or artwork). Resolution and antialiasing (often referred to as the *jaggies*) for still images is more critical than for motion video. Therefore, DVI compression ratios are generally only 25 to 1 for stills (versus the 160 to 1 possible for moving pictures).

This noticeable difference in compression ratios is due to the way DVI stores full-motion images. In several successive frames of motion video, very little of the picture may change from one frame to the next. Since storing all this redundant information over and over serves no purpose, the DVI system only stores the *changes* in each successive frame to keep the video file size to a minimum. For example, the DVI system would update a dancer twirling onstage but would not update the motionless stage background. The DVI system is smart enough to know when the scene has changed too radically for this method to work (e.g., panning the camera) and will store another "reference frame" from which successive mini-frames can again be interpolated.

Another phenomenon that helps to reduce motion-video file size is the human eye's inability to focus accurately on a moving object's edges (versus the focusing ease and closer scrutiny of viewing a still image). Because of this, antialiasing requirements can be lower for motion video than for still frames. Combined with the motion compensation technique—and other algorithms like it—these algorithms allow the huge compression ratios possible under DVI.

At present, DVI motion video has around 200 lines of resolution, which is less than VCR quality. Users who require higher DVI quality can use Production Level Video (PLV), which is VCR quality. For PLV quality, you must send your audio/video master tape to Intel's DVI/PLV production service, where a powerful mainframe compression system generates DVI files. The PLV service creates CD-ROM masters used for duplicating application disks for mass distribution. The average cost for PLV service is about $250 per running minute of final videotape. Both the PLV and Real Time Video (RTV) lose some focus, and colors tend to smear somewhat during playback.

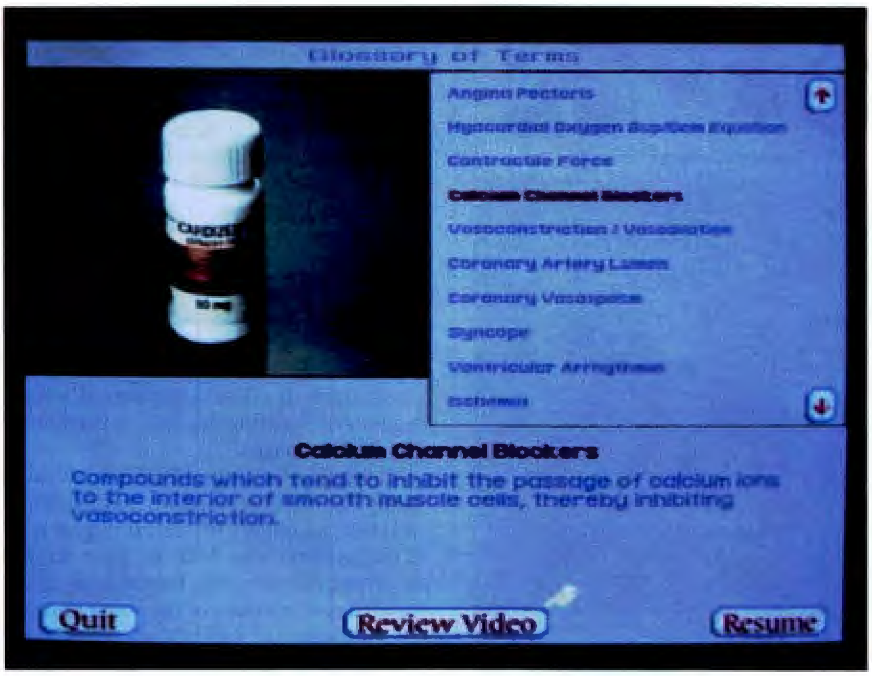

Photo 2: *Anderson Consulting's DVI-based medical application trains medical workers about the effects of prescription drugs on the heart. If a technician encounters an unfamiliar medical term, a click on an icon displays information about the subject.*

As high-definition TV looms on the horizon, Intel's goal is to have RTV meet near-TV standards and PLV to meet TV-quality levels (512 scan lines) or even HDTV quality by 1992. HDTV offers resolutions of 1050 lines (consumer grade) or 1125 lines (broadcast production equipment). Since DVI is digital, you can theoretically scale it to almost any resolution factor. Some observers believe that HDTV screens may well be lurking behind present-day VGA monitors, with technologies like DVI evolving to leapfrog HDTV's line resolutions.

Standards committees, such as the Moving Pictures Expert Group, coordinate and implement video standards. One MPEG member mentioned that the group is targeting video compression/decompression quality levels to exceed the current resolution of motion picture film—around 4000 lines. Instead of receiving two to three large reels of 35mm motion picture film, movie theaters would be able to receive the latest box office hit from Hollywood on a DVI encoded CD-ROM.

As communities meld existing telephone networks to fiber-optic links, cable companies will broadcast compressed video data. Instead of visiting the local video store, you'll download your choice of movie titles over the fiber-optic network.

Commercial and Educational DVI Applications

In addition to the Palenque tour, many other commercial and educational DVI applications are out. Applied Optical Media Corp.'s truck-driving safety simulation consists of an enclosed truck cab kiosk with a brake pedal, steering wheel, accelerator, and dashboard controls. Students face various DVI-based driving sequences similar to what they might see from the cab of an 18-wheeler, including full-motion video running in rearview side mirrors. AOMC is scheduled to ship about 27 of the simulations by 1991. Interestingly, the DVI boards in last year's simulations cost $9500, while the DVI technology going into the 1990 units costs just $2500. This is a price reduction of more than two-thirds in 12 months.

AOMC's Photobase and MediaSource disks are databases containing over 2000 DVI format images on CD-ROM. These

continued

optical disks provide multimedia resource material for DVI developers. Photobase's 512- by 480-pixel resolution images are categorized by photo-term topics, by photo ID numbers, or by a hypertext search feature called Lateral Browse. Both Photobase and MediaSource incorporate file format image conversions to paint packages (e.g., Lumena from Time Art) and are accessed from pull-down menus. The MediaSource disk includes digitized sound effects and background music for use in constructing actual TV-style program presentations. The Uniphoto Picture Agency of Washington, D.C., distributes Photobase images.

Orleans, also from AOMC, is a visual database that manipulates high-quality still images in DVI format. It targets real estate brokers who wish to show homes to prospective buyers. Buyers may click on different portions of the home to show explicit views of individual rooms or of the surrounding landscape.

Business Applications

Bethlehem Steel's DVI training application shows machine operators the complex workings of a steel mill. A graphical layout, which details the complete steel manufacturing procedure, shows machine icons at their positions in the manufacturing process. Selecting a specific machine icon displays a still of the machine, overlaid by a small motion video window of an instructor, who details the correct operation procedure for that machine. Selecting a button or hand-lever icon on the machine opens another motion video window that shows the specific machine action for the icon that was selected. This DVI application quickly educates new operators not only on specific machines but also on exactly how each machine fits into the overall manufacturing process.

Anderson Consulting of Dallas develops and implements specialized DVI applications for medicine, geography, and manufacturing. Its Process Analysis Workbench application creates working DVI applications similar to Bethlehem Steel's training application. Its DVI medical applications include a video study on Cardizem, a prescription drug, and its effects on the heart. You can select the Coronary Blood Flow option and watch a motion video on the topic or test your knowledge by answering multiple choice questions. If a medical term or phrase, such as "calcium channel blockers," sounds unfamiliar, you can click on an icon to get further information on the subject (see photo 2).

Authoring programs allow creation of simple DVI slide presentations to almost full-blown TV productions. Authology:Multimedia, from CEIT Systems, is a DVI program development tool that uses a mouse and standard windowing interface with pull-down menus. Developers create menus and graphical icons that future users will select for branching through the finished DVI application. After a user selects more information on a specific topic, motion video or graphical still images are displayed within rescalable windows.

Authoring packages let the DVI developer become a desktop TV producer. Just as the producer of a TV show decides which sequences of videotape will be displayed at certain times in the show, a DVI developer also decides where motion video and graphical stills will fade in or be cued at certain edit points in the script. Stereo digital audio for narrative or background music to accompany appropriate portions of the program can also be edited. Unlike a TV show viewer, however, the DVI end user has complete control over the finished production and can browse at will through specific topics of interest. (At last you can sidestep the commercials!)

Authology is expensive. At $4500 it is targeted toward developers who want to market and create commercial DVI applications. For playback of applications, CEIT Systems offers its Authology: MultiMedia Presenter, a $300 run-time software package for end-user systems. As the prices of the DVI boards themselves come down (Intel sources expect $1000 boards by 1991, $500 boards by 1992), you can expect DVI authoring system software prices to decrease, too, bringing them into the consumer mass market.

As entry-level prices of DVI products decrease, new applications may emerge. Computer users might generate their own DVI-TV productions and distribute them via BBSes, circumventing traditional distribution methods. New and exciting TV fare will be as close as dialing out with your modem and downloading the latest shareware video releases. The real question to ponder is, "What will the reruns look like in the year 2015?" ■

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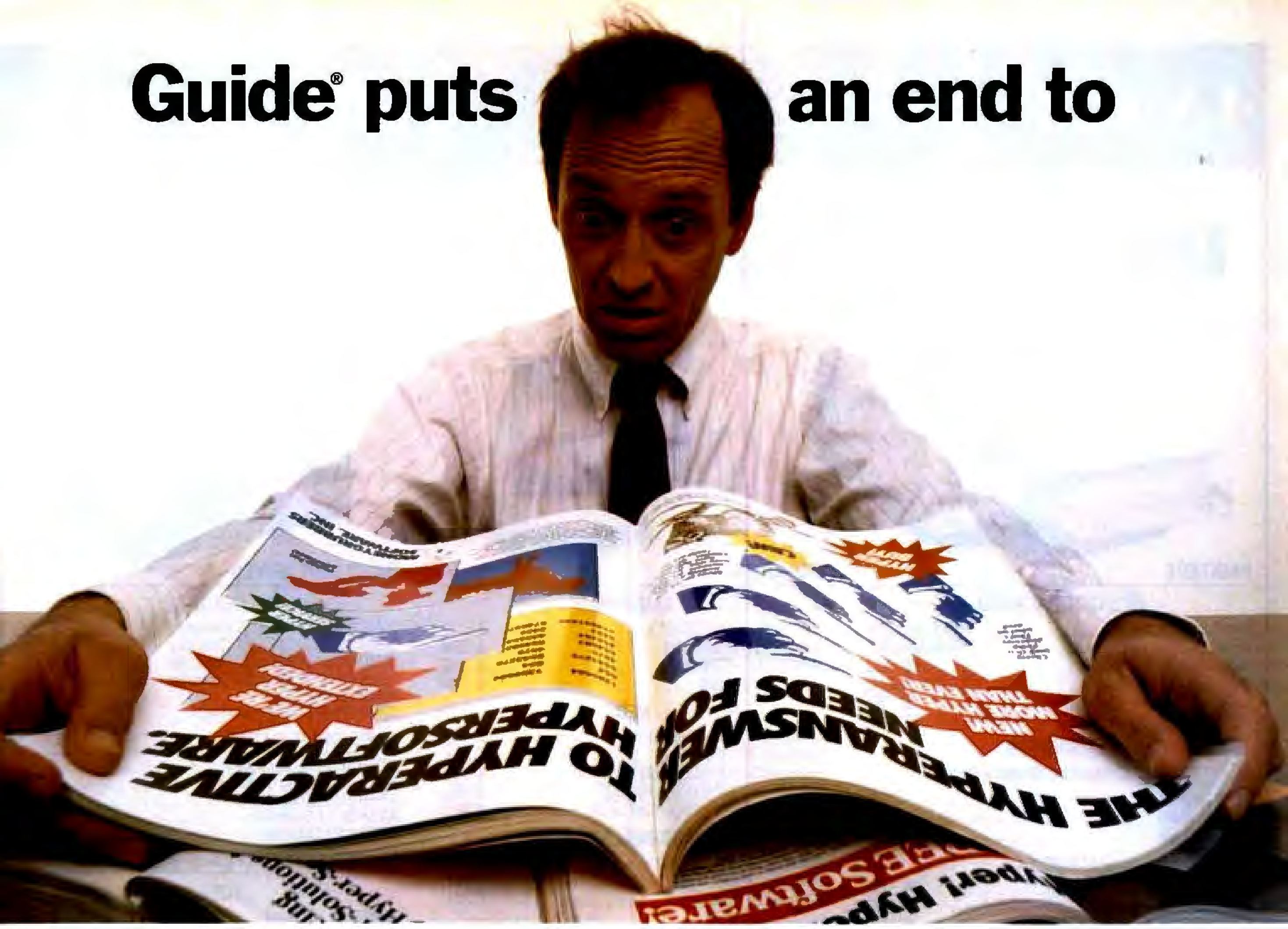

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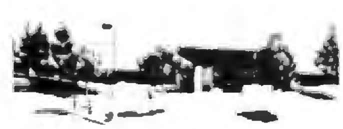

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DPMI: The DOS Protected Mode Interface

A new standard provides binary compatibility for protected-mode applications

L. Brett Glass

In the April installment of Under the Hood, I described the way DOS extenders surmount the limitations of DOS by allowing programs to run in protected mode. I limited my discussion to situations where an extended DOS application could safely take complete control of the machine—that is, I assumed that no multitasking or protected-mode environment was running. This, of course, is not the case in many real-life situations. When you fire up Desqview, OS/2, or Windows (in standard or extended 386 mode), you don't want to lose the ability to run extended applications. By the same token, you don't want to give an extended application the ability to destroy other applications' data structures, stop applications from multitasking, or crash the whole system.

The Virtual Control Program Interface was developed by Quarterdeck Office Systems (developer of Desqview), Phar Lap, and other vendors of multitaskers and DOS extenders (see "Stretching DOS to the Limit," *IBM Special Edition*, Fall 1989). VCPI is a set of conventions that allow extended DOS applications to run in the presence of multitasking environments and memory managers (such as QEMM) that put the 386 into virtual 8086 mode. It works well for its intended purpose; however, VCPI does not prevent the extended application from exhibiting destructive behavior.

An application that uses VCPI runs at ring 0, the most privileged level of the Intel protection scheme. It has access to all of the machine's resources and can take over at will, potentially causing data in other sessions to be lost. Microsoft correctly noted that extended-DOS applications should really run in ring 3—the least privileged level—if they are to coexist with other programs and work with multitasking environments. It's also appropriate for extended-DOS applications to *ask* for the use of system resources rather than simply commandeer them. The authors of "DOS boxes" for Unix concurred. On Unix systems, which can serve many users, it's especially important that the kernel retain full control over the machine's resources. Thus, the DOS Protected Mode Interface was born.

Some DOS-extender vendors grumbled when Microsoft told them about DPMI. They feared, with some justification, that Microsoft might use it to stifle environments that could compete with Windows or OS/2. However, a series of DPMI summit meetings—attended by Borland, Eclipse, IGC, Intel, Locus, Microsoft, Phar Lap, Phoenix, Quarterdeck, and Rational—produced a published standard to which all members agreed. This was

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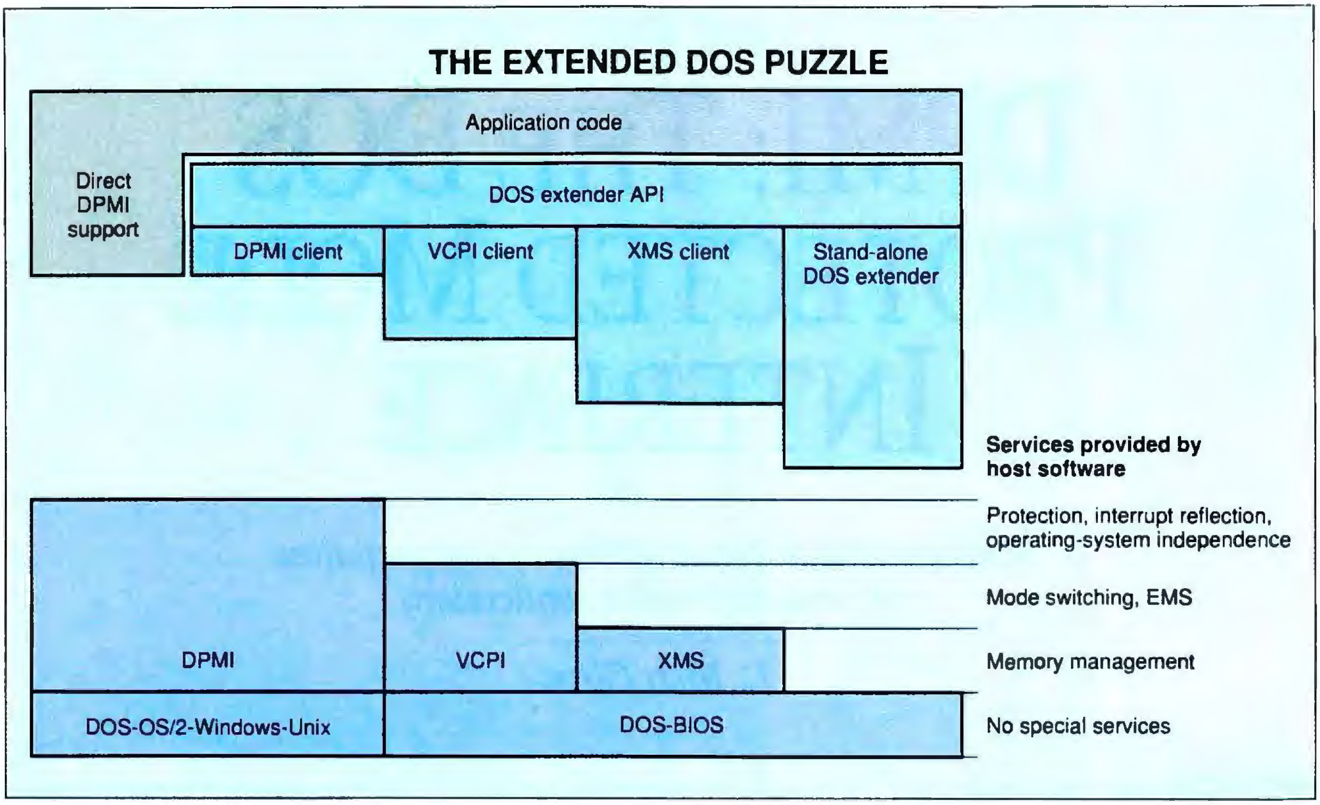

Many combinations and configurations of software run extended DOS applications. Here are all the services provided by the host environment, atop which runs the application.

DPMI 0.9, and it first became available to the general public in May 1990.

The Specs

DPMI 0.9 specifies a set of calls that an extended-DOS application program can make to set itself up, enter protected mode, and—once there—manage memory and interrupts. Microsoft's original version of the standard went further; it defined the subset of real-mode DOS and BIOS calls that would be available to an extended-DOS program running in protected mode. In other words, it was a complete specification for a DOS extender. As I mentioned in my earlier column, each DOS-extender vendor supports its own unique repertoire of DOS and BIOS functions. Some of them, for instance, save code space by not implementing the antiquated DOS calls involving file control blocks (FCBs), a relic of CP/M. Others limit the sizes of memory blocks that programs can use as parameters to DOS calls. And all offer unique memory and interrupt management services.

Because conforming to Microsoft's specification might have "broken" the code now in use by each vendor's customers, the committee members opted to remove all information regarding supported DOS and BIOS calls from the specification. Thus, DPMI 0.9 does not mention which (if any) DOS and BIOS functions are available to the extended application; the use of those functions is, at least for now, the province of the individual DOS extender's manual. Still, since Windows 3.0 and future versions of OS/2 are expected to support the functions Microsoft originally documented, DOS-extender makers may choose to gravitate toward that set—and more specifics may appear in DPMI 1.0.

The Protected-Mode Puzzle

The environment seen by an extended-DOS application may be very different each time it's run. If the program is running under POD (plain old DOS), or a pseudoPOD (such as DR-DOS), the DOS extender must provide all mode-switching and memory management services. If an Extended Memory Specification driver is present, it's best to let XMS manage extended RAM, but the DOS extender will still have to switch the CPU in and out of protected mode.

If a 386 extended-memory manager with VCPI, such as QEMM or 386Max, is loaded, VCPI will handle switches between protected mode and virtual 8086 mode (the mode in which DOS and BIOS calls are processed). However, the DOS extender must still take responsibility for fielding each DOS or BIOS call, asking VCPI to do a mode switch and reissuing the call in virtual 8086 mode.

If DPMI is present, it can handle the job of "reflecting" software interrupts to real mode on behalf of the DOS extender. In fact, in some cases, DPMI may decide it's faster not to perform a mode switch at all. For example, if a DOS extender asks DPMI to make a real-mode DOS call to open a file, and the underlying environment is OS/2, DPMI might route the request directly to OS/2's file system, which runs in protected mode. However, DPMI does provide low-level, or "raw," mode-switch functions for DOS extenders that wish to handle nearly everything on their own.

The figure puts all these scenarios in perspective. The bottom piece of the puzzle represents services provided by the host environment—from unenhanced DOS (which provides the fewest services) to a host with DPMI (which provides the most). The top piece shows the application program, which will, in most cases, have a DOS extender bound to it. Note that the DOS extender must be adaptable; it must "fill in" any services the host doesn't supply.

continued

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The scenario on the far left is the one DOS-extender vendors may not want to contemplate. It is also the scenario that applications vendors, who don't want to pay royalties to the DOS-extender suppliers, are eyeing carefully. It's possible today to write applications that, because they interface with DPMI directly, don't need DOS extenders to run. Two things are required to make this approach practical for the average developer: DPMI drivers for all the major host operating systems, and development tools that help build the applications. Both of these requirements may be met very soon.

Windows already has DPMI built in, as will OS/2. DOS boxes on Unix machines, multitaskers such as Desqview and VM/386, and multitasking DOS replacements such as PC-MOS will follow. Third-party DPMI drivers for plain old DOS are a logical product offering. Finally, it's not inconceivable that Microsoft will put DPMI into future versions of MS-DOS (Digital Research may get it into DR-DOS first). And as for development tools: No announcements have been made at this writing; however, there are four language vendors on the committee that's charting the future direction of DPMI, and lots of other companies that may want to get in on the action.

Hello, Protected-Mode World!

How does a DPMI client application start running? DPMI takes a straightforward (and downward-compatible) approach to this problem: The program begins execution in real mode and switches to protected mode once it has made sure that DPMI is present. Unfortunately, since the DPMI standard does not specify a file format, every DPMI application must carry with it a loader that performs fix-ups on the protected-mode portion of the code. (See "Gateways to Protected Mode," April BYTE.)

To detect the presence of DPMI, the application executes an INT 2Fh (the multiplex interrupt) with the value 1687h in the AX register. If DPMI is present, the AX register is cleared and system information is returned in the other registers. A flag in BX indicates whether 32-bit programs are supported; a code in CL gives the processor type (286, 386, or i486). DX contains the DPMI version number, and SI contains the amount of DOS memory, in paragraphs, that the application should allocate for DPMI's private use. Finally, the register pair ES:DI contains the address of a procedure to call to enter protected mode.

After allocating any required DOS RAM, the application calls the procedure at ES:DI. Hopefully, when the call returns, the program finds itself in protected mode. It's possible for the mode switch to fail, so the code immediately after the call must be executable in either mode. All the DPMI function calls, most of which the program can access via INT 31h, are available immediately after a successful switch to protected mode.

DPMI Services

The DPMI services fall into 14 distinct groups, some of which—at least for the moment—contain only one function:

The *program termination* function ends the program. This is the only INT 21h function that is officially defined by DPMI. The program executes the software interrupt with 4Ch in AH, just as it would in DOS, but it must be in protected mode at the time.

The *mode detection* function tells the program if it is running in protected mode under DPMI. If either of these conditions is not met, the caller receives a negative answer. Because this function has to work in either protected or real mode, programs access it through the DOS multiplex interrupt (2Fh).

The *LDT managment services* let the program allocate, deallocate, and manipulate LDT (local descriptor table) descriptors. (For security reasons, the program cannot gain access to the global descriptor table.) It's possible to allocate several descriptors for a "huge array" at one time. When this is done, the descriptors appear evenly spaced in the LDT so that the arithmetic the program will need to perform on the descriptors is less cumbersome than it might have been.

The *DOS memory management services* shepherd precious real-mode memory. Blocks of memory in this area may be necessary when your program is making calls to software that runs in real mode and cannot reach beyond the 1-megabyte limit (NetBIOS is an example of such software).

The *interrupt services* let a program field interrupts and exceptions generated in both real and protected mode.

The *translation services* let protected-mode programs make calls to real-mode software, and vice versa. When a protected-mode program calls a real-mode procedure or software interrupt, the translation services can set up a stack that's reachable by the real-mode stack pointer and load appropriate values into all the registers. Another function of the translation services lets a real-mode program call a protected-mode program, necessary in cases such as network and

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mouse drivers that run in real mode but must use interrupt completion routines to signal an event to code running in protected mode. Yet another function provides the address of a routine that does a "raw" mode switch (for compatibility with the code of DOS-extender vendors).

The *memory management services* allocate linear (as opposed to virtual or physical) address space.

The *page locking services*, which work on systems with virtual memory, allow the application to lock pages into memory. Locked pages cannot be swapped out as the system attempts to grant a memory request. The *demand paging performance tuning services* do the opposite; they let the application mark a page as a good candidate for swapping, or tell the memory management software that the contents of a page need not be saved (i.e., discarded rather than swapped).

The *physical address mapping* function maps a range of physical addresses to linear addresses by creating entries in the 386 or i486 page table. This is useful when software needs to access memory-mapped peripherals.

The *virtual interrupt state services* let a task ignore interrupts it has "hooked." In a protected-mode operating system, individual tasks cannot execute the CLI instruction and really turn off interrupts; it might hang the entire system. Therefore, DPMI, like many protected-mode operating systems, provides these functions, which let a task ignore hardware interrupts during a critical section of code.

The *get vendor-specific API entry point* function allows vendors of DOS extenders and implementors of DPMI to add their own extensions. This function does what amounts to a dictionary lookup: Your program can call it with a null-terminated string containing the name of the extended function. On return, your program receives an address it can call to access the extended function.

Finally, the *debug register support* functions allow an application to set and clear debugging watchpoints. Because the built-in debugging registers of the 386 and 486 can only be accessed from ring 0, and DPMI applications run at ring 3, these functions are necessary to let a program such as a debugger manipulate the debug registers.

Putting It All Together

Using DPMI's array of services, it's simple to build an extended-DOS application. The hardest part will most likely be creating a protected-mode loader; hopefully, these will be available from tool vendors by the time you read this. Since the specification doesn't give many hints on how to fit everything together, you may wish to bone up on protected-mode programming techniques and DOS-extender principles before getting started.

DPMI shows great promise as a standard for extended-DOS applications—and not just because it affords better protection from system crashes. DPMI realizes an ideal not yet achieved in any other environment: binary compatibility across dozens of vastly different operating systems. If you're concerned about paying again for all your software as you move to the operating systems of the future, DPMI applications might be the soundest investment you can make. ■

L. Brett Glass is a freelance programmer, author, and hardware designer residing in Palo Alto, California. He can be reached on BIX as "glass."

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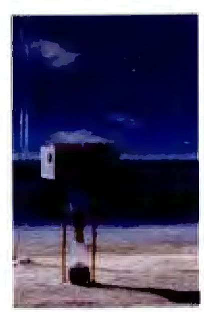

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OPTICAL STORAGE PRIMER

What you need to know to take advantage of the most significant advance in computer storage since the floppy disk

David A. Harvey

Once considered little more than a fringe technology, optical storage devices for personal computers have hit the mainstream with a vengeance. They enable you to store—at a minimum—hundreds of megabytes of data. In fact, devices that store over a gigabyte are not uncommon, and even terabyte storage is available through disk-changing systems (the so-called "jukebox" systems). The question is: What do you do with all this storage space?

When the only storage devices available for your PC were single-sided 5¼-inch floppy disk drives, you used disk storage for programs and discrete data files. Optical technology enables you to view data storage in a new light. In conjunction with your computer, it offers far more than a dumping ground for data.

Data into Information

Computer storage lets you sort, search, and manipulate information in ways that were never before possible. For example, in just minutes, a business executive can sort—and group by region—the total sales for his or her company for a decade; a doctor can retrieve a concise and diagramed summary of a particular ailment and information about treatment; and a programmer can trace every instance of a particular variable in an enormous program.

The ability to instantly recall large amounts of data in a multitude of formats lets you look at that data from many different perspectives. This lets you better use that information—to find solutions that may have eluded you, or to see patterns that may have been previously hidden.

Visible Benefits

Along with the benefits of storing information come a series of nightmares. Traditional magnetic storage devices (in which an electromagnetic head flies just microns above the surface of the medium) are susceptible to errors, head crashes, and corruption of data. Indexing and keeping track of files and backups on a gigabyte-plus system can become a major headache. When the hard disk is full, it's full—and there isn't much else to do but buy bigger, faster drives.

Optical technologies offer the beginnings of a solution to all these problems:

- They are interchangeable: When the disk is full, you can just slap in a new one.
- The media are generally far more stable—either (as in the case of WORM [write once, read many times] and CD-ROM) there isn't any magnetization involved, or, as in the case of magneto-optical drives, the drive employs a

continued

medium that (at standard temperatures) is resistant to change.

• You can put documentation on CD-ROMs and keep it on-line—this makes finding solutions or troubleshooting code a nearly instantaneous activity.

Inner Workings

Optical storage devices use a source of coherent light—usually a semiconductor laser—to read and write data. There are three big advantages to using a laser: size, safety, and portability. Because you can focus a laser onto an area that is approximately 1 micron in size—a far smaller area for encoding a bit of data than conventional magnetic drives—you can fit more data into the same area than you could if you were using magnetic storage.

Optical media are also far more stable than metal-oxide disks. They aren't affected by light, normal temperatures, or electromagnetic fields, and the read/write head never gets as close to the medium as it does in conventional disk drives. Because optical disks are interchangeable, you can remove them and take them off-site far more easily than hard disk drives.

Some manufacturers of magneto-optical and WORM drives use proprietary file systems. Some of these vendors build an almost-universal system within their system. As long as all your components are from one manufacturer, you can use the cartridges under just about any operating system with no special modifications. Given the right software, most operating systems can read almost all CD-ROM databases on the market today.

While it provides many advantages, the technology still has growing pains. Optical storage comes in three basic flavors: CD-ROM, WORM, and erasable. The differences in the technologies determine the applications that are best suited for each.

WORM at Work

WORM drives offer you a permanent and virtually incorruptible storage medium. They are ideal for applications that require a lot of data security. Not only is your data safe from disaster, but because the medium is removable, you can safely lock it away from prying eyes.

Most vendors use their own proprietary file format for their WORM subsystems. Thus, a WORM disk created on one manufacturer's drive will likely not be readable by a drive from another vendor. In other words, the WORM medium is not universal. On the other hand, the proprietary nature of the file systems means that you can probably use the same manufacturer's drive and medium under multiple operating systems.

Of all optical technologies, WORM drives will probably come to occupy the most specialized niches. Although a WORM drive is ideal for backup purposes, it isn't terribly cost-effective unless you have large amounts of data and need file-tracking features. Most WORM drives can keep an audit trail of different versions of a file.

Optical media are also far more stable than metal-oxide disks. They aren't affected by light, normal temperatures, or electromagnetic fields.

If you need to keep a record of every version of a file and need to be able to easily access and compare those versions, WORM technology is for you. If you measure the size of your backups in gigabytes—particularly if you want to access those backups randomly—you'll also want a WORM drive.

WORM Guts

WORM media consist of either a polycarbonate or hardened glass substrate and a recording layer made of a highly reflective substance—either a dye-polymer or a tellurium alloy. The recording layer is covered by clear plastic to protect the recording medium.

WORM systems use a laser beam to record data sequentially. A write beam burns a hole—usually called a pit—in the recording medium. This produces either a change in the reflectivity or a change in the phase of a lower-powered read beam. The result depends on the composition of the recording layer. Photosensors pick up the reflection of the read beam. Special electronics translate the information in the beam into binary information.

Most WORM drives use SCSI and proprietary device drivers. While some vendors use the DOS file system, others use a TSR interrupt 21 hexadecimal interceptor, which mediates between DOS and the device driver. The interrupt-handler software usually does not support all normal DOS file operations, and you have to invoke the TSR to access the WORM. The advantage of the interrupt-handling strategy is that it maximizes the version-tracking abilities of the WORM; this can result in better performance.

Using a proprietary file structure also means greater portability of data. For example, if you had a WORM drive that used a straight DOS file structure, you couldn't hook it up to a Mac or Unix box to get at your data. With a proprietary file structure—assuming the vendor supports those other operating systems—all you'd need would be the device and file system drivers.

WORMs are not a universal solution. With access times of 90 milliseconds and more, and data transfer rates in the 600,000-bps range, they are too slow to use as a replacement for a hard disk drive. And if you run a program from a WORM drive, you'll need to direct any temporary files that the program creates to a conventional hard disk drive. If you need permanent data storage and extensive file tracking, a WORM drive is indispensable.

Write and Rewrite

The fastest moving optical technology is erasable or rewritable technology, which is best represented by magneto-optical drives. Magneto-optical technology is fast approaching the point where its access and transfer times will be equivalent to those of current conventional magnetic media (the performance of magnetic media technology, of course, also continues to evolve). Magneto-optical drives offer huge storage potential on a medium that is far more stable than the one that is used in hard disk drives. In many situations it has the potential to displace magnetic media.

Conventional mass storage media are extremely susceptible to magnetic fluxes and mechanical disruption. Because the recording material in magneto-optical disks is encased in plastic, there is little chance of encountering the type of head crash you often see with conventional media. Because it is rewritable, you can use magneto-optical drives as you would conventional hard disk drives.

Hot Point

The magneto-optical medium makes use of a recording material that, at room

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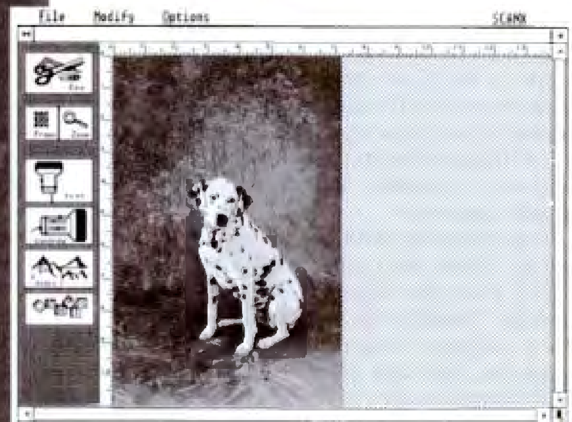

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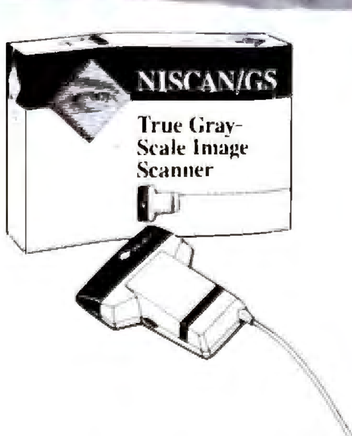

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temperature, is resistant to changes in magnetization. The measure of this resistance is called coercivity. The coercivity of the material used in magneto-optical drives can be altered only at a high temperature—the so-called *Curie point.* At high temperatures—around 150°C—the coercivity of the recording material becomes 0, and the material can be magnetized.

This is where the laser comes in. The heat of the laser brings the recording material to the Curie point. Then, a bias magnet reverses the magnetic field of the heated area (which represents 1 bit). Because the laser beam is approximately 1 micron in diameter, it does not affect nearby data areas.

One problem with magneto-optical drives is that you can't change a bit directly from one magnetic orientation to another. Initially, the medium has a uniform magnetic orientation. Once the magnetic field has been changed, you can't simply write new data to it like a conventional hard disk drive. Thus, magneto-optical drives need to make an erase pass prior to every write. The first (erase) pass shifts the magnetization of a bit back to its original state. The second (write) pass actually encodes the data.

You use a low-power laser beam to read the data on a magneto-optical disk. The polarization of the read beam as it reflects off an area of the recording medium changes, depending on the magnetization of that area.

This polarization difference is known as the *Kerr effect.* The read beam is bounced off the disk, directed through a polarized beam splitter, and picked up by one of two detectors. One detector finds areas of positive polarization; the other detects negative polarization. These areas correspond to the on and off bits of the disk.

Magneto-optical disks consist of a polycarbonate substrate with pressed guide grooves and address pits. The guide grooves operate like the grooves on a record album–they keep the magneto-optical drive's laser where it belongs. Address pits are basically the same as the pits used to encode data on WORM and CD-ROM drives. They are laid down at the beginning of each sector. The magneto-optical layer is made up of several layers, including the magnetic alloy. It is sputter-plated onto the substrate and covered with a plastic coating.

DOS Considerations

Almost all magneto-optical drives are completely transparent in terms of operating system. You don't need to load a device driver or any TSR software to be able to use the drive. You simply partition it with FDISK and format it.

Without a driver, however, the drive will be treated as a fixed hard disk. In order to use an optical drive as a removable medium, you'll need to load a device driver that lets DOS treat the drive as an enormous floppy disk. Even with the driver loaded, though, the volume will be completely DOS-compatible. This is fine if you are using the device in a DOS or networked environment. However, if you need portability between operating systems, see a vendor who offers a proprietary file structure and supports all the platforms you'll be working with.

Magneto-Optical Gets Small

One of the more exciting developments on the horizon is the 3½-inch rewritable

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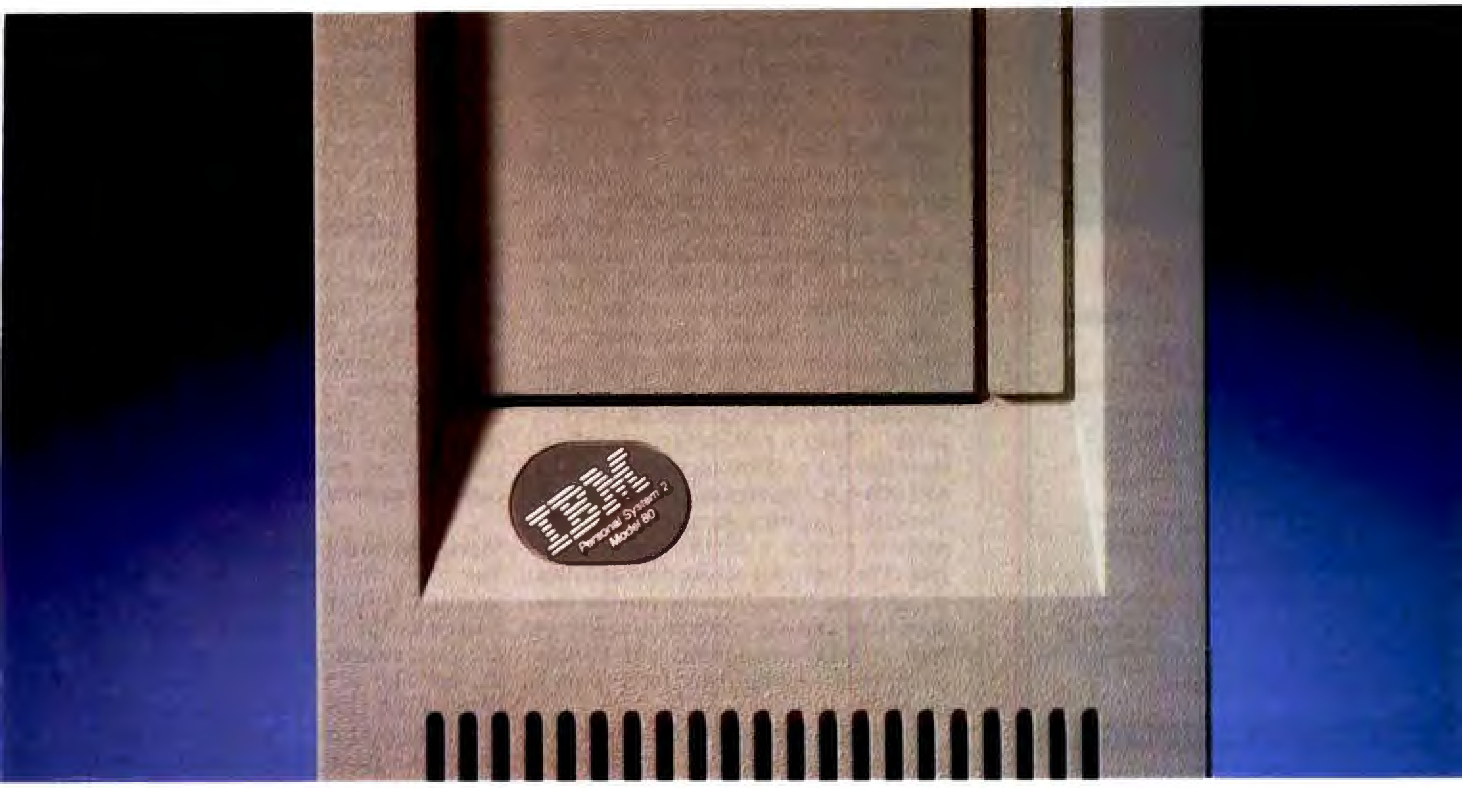

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drive. When the International Standards Organization wrote the standard for 5¼-inch drives, there were already a number of drives on the market. Consequently, the standard was written loosely in an effort to encompass all these drives. To avoid this problem with 3½-inch media, manufacturers are waiting until the ISO standard is complete before moving forward with their 3½-inch drives—this will help to ensure that all manufacturers' drives are interchangeable.

According to Sharp's Greg Peel, the 3½-inch magneto-optical drive will use a single-sided 128-MB medium. Sharp, Sony, and other manufacturers are developing 3½-inch drives. Sharp expects to introduce some models early next year. The 3½-inch drive may provide significant performance enhancements. For example, Sharp's preliminary specifications call for a 45-ms access time and a 640,000-bps data transfer rate. By using the SCSI-2 interface standard, Sharp expects to provide a 2-MB burst transfer rate. The improved access time and data transfer rate come from the smaller medium size and the medium's ability to spin at 3000 revolutions per minute (compared to 2400 rpm for 5¼-inch models).

Rewritable optical disk drives are fast approaching a price and performance level that will make them a viable alternative to hard disk drives. Although the overall costs for a magneto-optical drive are high—in the $5000 range—the cost per megabyte of storage is lower than that for hard disk drives (once you factor in the comparative costs of buying a whole new drive versus picking up a new cartridge).

Speed is the critical factor. Until the drive can erase and record data in one pass, and until the optical head is made smaller and faster, optical disk drives aren't going to be able to compete with hard disk drives. Panasonic has announced a read/write optical disk drive that uses phase-change technology to feature one-pass writes. Whether the medium is durable enough for continuous use remains to be seen.

CD-ROM

Unlike rewritable and WORM media, CD-ROM is a publishing tool. Although it's possible to produce a CD-ROM disk in-house, the time and expense that it requires makes this a cost-effective solution only if you need many copies of the same data, and if that data is unlikely to change over time. Even then, unless the data has special indexing requirements, you would probably be better off hanging a WORM drive off a network.

The best way to envision CD-ROM is as an alternative way of accessing information that's traditionally printed on paper. The advantage to CD-ROM is that you can instantly—or almost instantly—access information from the comfort of your desk. You don't have to leaf through the large volumes of information on your bookshelf or at a library.

In the real world, CD-ROM is being used for everything from medical diagnoses to troubleshooting telecommunications switches. A pathologist can use CMC's Cancer Abstracts to take a prepared slide, compare it to an image on the CD-ROM, and make a diagnosis. Many manufacturers are putting their documentation on CD-ROM. Boeing, DEC, Mac Trucks, and Compaq (to name a few) already offer their documentation on compact disk—and other companies are following suit.

Strengths and Limitations

Too often, the charges that are levied against CD-ROM fail to take into account what the technology is designed to do. Sure, compared to even the lowest of the low end in hard disk drives, CD-ROM is dog-slow. But compared to the time it would take to perform the same tasks with paper media—well, you're talking "warp drive" here. And yes, there is no killer application for CD-ROM, but then again, the form and shape of a book hasn't exactly been revolutionized in the last 500-odd years. You need to view CD-ROM technology through a different pair of glasses.

As CD-ROM technology improves, the speed differences between it and traditional media will begin to evaporate. For now, you need to realize the unique advantages of CD-ROM to make the fullest use of this technology. Before CD-ROM can really blossom, display technology needs to improve. Until a screen can duplicate the clarity and resolution of the printed page, reading large amounts of text on a monitor is not going to be comfortable or practical. Even so, CD-ROM will be used increasingly as a reference tool. I can easily envision using a dual-monitor setup—one dedicated to CD-ROM, and the other a standard computer display.

Making It Go

Left to its own devices, DOS cannot recognize the file structure of a CD-ROM. (DOS versions 3.3 and lower are also unable to deal with the size of the CD-ROM volume, which can be up to 660 MB.) To

continued

get a CD-ROM to run under DOS, you need a hardware-specific device driver and the Microsoft CD-ROM extensions. The extensions are installable file system drivers that utilize the network interrupt 2F hexadecimal.

A CD-ROM volume name looks like a network volume. Therefore, when DOS gets a file I/O request, it generates the network interrupt. The extensions then look at the volume name; if it really is a CD-ROM device, the extensions pass control to the device driver. To support the extensions and the device driver, you'll need at least 34K bytes of memory (the extensions use 23K bytes).

Fortunately, you can load both the extensions and the driver into high memory; this saves RAM in that precious lower 640K bytes. I had no problems loading the extensions into high memory with Quarterdeck's QEMM or loading them into individual Desqview windows. As a result, I can have two CD-ROM disks on-line at all times. You can also save RAM by telling the extensions to load part of themselves into expanded memory.

Version 2.2 of the extensions should be out by the time you read this. Microsoft says that it has been working closely with its licensees for this upgrade; the extensions will provide fixes for problems encountered in multitasking environments and for unclear error messages. Another enhancement will let you load 12K bytes more of the extensions into memory.

Although the extensions seem to work seamlessly with DOS and I had no major problems getting them to handle more than one drive at a time, the extensions are really only a fix—not a solution. Microsoft would not comment on what it plans for the forthcoming version of DOS (except to say that it's exploring various approaches). Hopefully, CD-ROM extensions will become a permanent part of DOS.

For OS/2, the problem of getting a CD-ROM to talk to the operating system is greatly simplified by OS/2's installable file system. Microsoft says it is currently working closely with device vendors who are helping to write installable file system drivers for OS/2. Sony and others have already announced IFS drivers—expect to see them later this year or early next year.

In the Marketplace

The CD-ROM player market is growing quickly, and prices are falling. Today, you can purchase a player for as little as $600. Players come in a range of shapes and sizes, from single-drive units (internal or external) to jukebox-style multidisk players to daisy-chained units that are housed in one enclosure.

Which route you take depends on your needs. If you're a home user, you could probably make do with a single unit—although if you plan on accessing more than one database at a time, you may want to get two or three. If you're in a business or government environment, you may want to get either a multidrive system or a jukebox-style unit.

The major manufacturers in the CD-ROM player market are Sony, Hitachi, NEC, and Philips. Most companies offer both a proprietary and a standard SCSI; most claim that their proprietary interface offers additional features not available through a standard SCSI.

The CD-ROM market needs to standardize its hardware. It looks like SCSI is going to take over in the long run, and

continued

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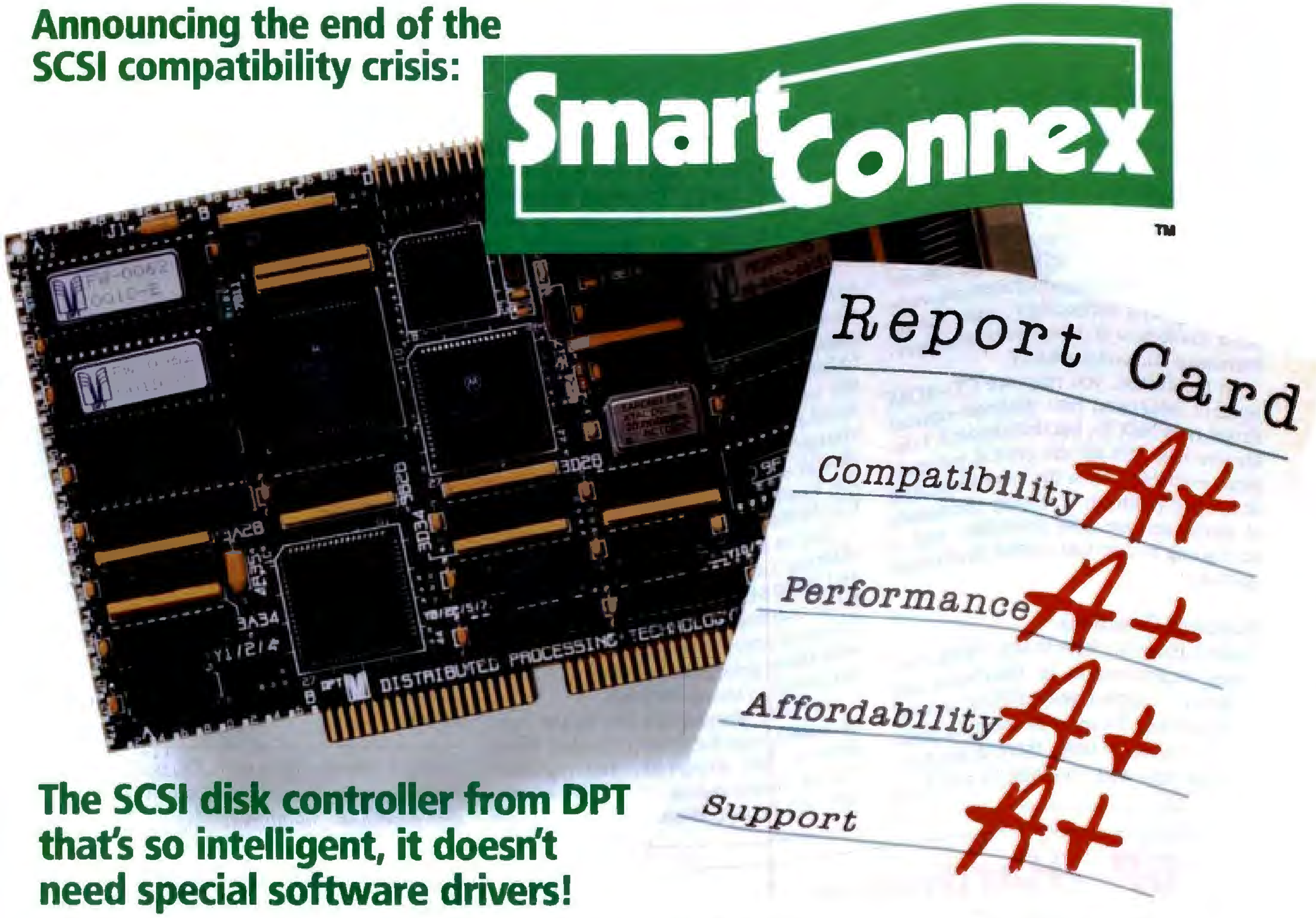

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this seems like a very good thing. You can interface a standard SCSI drive with both IBM and Macintosh platforms. The SCSI bus lets you daisy chain up to seven SCSI peripherals, including other vendor's CD-ROM drives, hard disk drives, magneto-optical drives, and WORMs. With the advent of SCSI-2 and the increased focus by manufacturers on standardizing this technology, you should see a whole host of drives with better performance and compatibility.

In the future, you may see CD-ROM readers integrated into magneto-optical drives (à la NeXT), but that shouldn't deter you now. Of all the optical technologies available, this is the most stable and developed platform. Literally thousands of databases are now available, and it isn't going to cost you a great deal to get started.

Standard Questions

Optical drives are here to stay. With continued improvements in interfaces and hardware, coupled with falling prices, there will be a lot more of them on desktops. At the same time, there is no question that you will continue to use hard disk drives. Hard disk drive technology has been around longer and is more developed. Although the cost per megabyte for optical drives is lower than for hard disk drives, the start-up costs are far greater.

With the introduction of SCSI-2, the next year will see a general move toward standard SCSIs. This will result in faster data transfer rates and make it far easier to have multiple optical units hanging off the same controller. This may result in standardized interface cards and interchangeable device drivers. This year should also bring many OS/2 installable file system drivers for both WORM and CD-ROM technologies.

You're also likely to see more vendors offering file structures for both erasable and WORM media; this will allow portability between operating systems. The 3½-inch rewritable magneto-optical disk will allow greater use of read/write optical drives in transportables.

Overall, standardization is the next necessary step for optical storage. When drivers, file structures, and hardware can be mixed and matched, optical storage will be as convenient as floppy disk and hard disk storage. In the long term, you're likely to see greater compatibility between the different optical technologies (e.g., drives that can create both write-once and read/write disks and can read ISO-9660 and High Sierra CD-ROM disks).

Optical Future

Whether the optical disk will ever fully replace conventional magnetic media is impossible to predict. I think that it's unlikely within the next five years. One thing's for sure: Optical technologies, led by CD-ROM, are going to find their way into a great many computers in the very near future. Already, Tandy and Headstart sell systems with CD-ROM drives as standard equipment, and IBM has introduced a CD-ROM drive for its PS/2 line.

Although the information age has been around for over a decade, it will be optical technologies that finally make it fly. ■

David A. Harvey (Houston, TX) is a freelance computer journalist. You can reach him on BIX as "daharvey."

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CONTINENTAL COMPUTING

Despite IBM's success there, Europe is a diversified marketplace for computer companies foreign and national

Colin Barker

If I had to pick out the most important month in the history of personal computing in Europe, the choice would be easy: January 1983. That month I attended two press events and saw products that have completely reshaped the European personal computer market and decimated the indigenous U.K. microcomputer industry.

The Beginnings

The first event was a "hands-on" demonstration of a new Apple computer. It was a secret meeting at Apple's European headquarters in Hemel Hempstead in England. After solemnly signing nondisclosure agreements, I sat down in front of a funny-looking computer called the Lisa and was amazed at what I saw. This was probably the easiest-to-use computer ever invented, shown in all its glory, albeit not in its final form—we had a year to wait for the Mac—and I left the demonstration convinced that I had seen the future of personal computing, and it was good.

Two weeks later, I pressed into a room with around 150 other U.K. computer journalists and waited with bated breath for the "big news" from IBM. It was the belated launch of the IBM PC in Europe, a full 18 months after its U.S. debut. What I saw was a basic, and not particularly well-designed, 8-bit computer dressed up in semi-16-bit clothes. It had a new operating system that looked a lot like CP/M, a keyboard that had important keys in the wrong places, a noisy fan, and slow and noisy disk drives. The monitor was poor: It was big and clunky, you couldn't tilt it, the poor phosphor quality hurt your eyes, and it had a weak character set. (For ergonomic reasons, it was not legal in Sweden and Germany.) The PC had nothing special to offer over existing systems. Compared to the stately elegance of the Lisa, it stank. But the price was a lot better.

At the time that these two systems were being launched, Europe had a thriving microcomputer industry. In fact, it had many different industries that all contributed to the "new technology" boom. The IBM PC and, to a lesser but still important extent, the Macintosh, changed all that. In the next four years, the U.S. computer industry would come to dominate the European microcomputer market. Why was this so?

Europe Is Different

"One of the biggest mistakes you can make when you launch a European subsidiary is to assume there is some kind of United States of Europe," says Don Taylor, an American with considerable experience establishing European subsidiaries for U.S. computer companies. He is

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right. The U.S. is a land of over 200 million people with widely varying ethnic backgrounds, united by a common language, a Constitution, and a belief in "American values." Europe is a land of over 300 million people of widely varying ethnic backgrounds, with no common language (there are at least 40 major European languages), no constitution, and very few common beliefs.

Three separate trade groupings give some areas of Europe a semblance of uniformity. The European Community (EC), formerly the nations of Europe, includes West Germany, France, Italy, the U.K., Ireland, Denmark, Belgium, The Netherlands, Luxembourg, Spain, Portugal, and Greece. The Eastern bloc is a rough grouping of Soviet satellites and includes East Germany, Hungary, Bulgaria, Poland, Romania, Czechoslovakia, and Russia (that part of Russia that lies to the west of the Ural Mountains is considered to be geographically and culturally part of Europe). The third grouping is the European Free Trade Area (EFTA). This is a loose association of the non-aligned states and includes Norway, Sweden, Finland, Austria, and Switzerland. Outside of these groupings are some independent countries (e.g., Yugoslavia and Albania) and a network of semi-independent or completely independent principalities, bailiwicks, and tax havens.

The biggest and most important economic unit is the EC. The idea for the EC was developed in 1952, and the Treaty of Rome established it in 1957. Its aim is "to lay the foundations for a closer union between the peoples of Europe on the basis of a common internal market, the gradual approximation of member states' economic policies, and a framework of common debate."

Within the EC there are no internal tariffs or trade barriers; any citizen of an EC country is free to visit, work, or live in any other EC country. There is a common sales tax (value-added tax, or VAT), and common rules govern agriculture, the sale and packaging of goods, taxes, pollution control, and human rights. But none of this means that there is a "United States of Europe."

By the end of 1992, there will be much closer trade ties between the EC countries; many barriers that exist today will come down. There is talk of introducing a common currency before the end of the century, and some would like to see a full political union follow that. But this all seems to be a long way off.

For now, Europe is a collection of separate countries and separate markets, each with its own characteristics. The microcomputer revolution is affecting each country differently. As far as PCs are concerned, there is a lot of common ground, but there are also some interesting discrepancies.

The Players

There are some strong computer companies within Europe, but few of them have made any impact in the U.S. One of the exceptions is Groupe Bull. This French company entered the computer industry by signing a deal with Honeywell to set up a jointly owned computer company, Cii Honeywell Bull, in France. While Honeywell Information Systems set up subsidiaries in the rest of Europe, CiiHB prospered, and eventually Bull took over Honeywell's systems interests. Bull is a major player in the systems market (with around $5.5 billion in revenues last year), and its purchase of Zenith Data Systems earlier this year has strengthened its presence in the PC market.

The Siemens group has dominated the German computer industry. This conglomerate is involved in many areas of manufacturing, from heavy engineering to computer systems to consumer goods. Siemens Information Systems' revenues were around $6 billion last year. Like Bull, the company has produced primarily mainframe and minicomputer systems. Earlier this year, Siemens took over Nixdorf, the second largest German computer company, with annual revenues of around $3 million. Nixdorf is a general systems supplier, but in recent years it has been most successful in supplying electronic point-of-sale terminals.

In the Netherlands, Philips (with annual revenues of around $3 billion) is the leading computing and electronics manufacturer. Based in Eindhoven, it is a leading company in home electronics and communications.

The U.K. is the home of International Computers Ltd., now owned by Standard Telephone and Cable. ICL traces its genealogy back to some of the first companies that built electronic computers. The going got tough in the 1980s, but the company is now stable. ICL has systematically bought technology from other countries. It uses Fujitsu processors in its mainframes, Sun's SPARC processors in its departmental servers, and a variety of suppliers for its low-end products. The joint STC/ICL group has annual revenues of around $2.5 billion.

Italy has Olivetti. This company was a late entrant to the computer market. It started with office products, but it is probably the most successful supplier of midrange systems and microcomputers in Europe. With annual revenues of around $5.5 billion, it is the second largest supplier in Europe (Siemens is first). It sells Unix minicomputer systems and a wide variety of PC compatibles. Digital Equipment relabels Olivetti PCs in the European market.

Who Is Number One?

Although these companies represent the top six indigenous technology companies in Europe, they are not the biggest. IBM Europe's revenue last year was more than 50 percent of the combined revenue of these six companies. There is no doubt, in Europe or the world, about who is number one.

If you talk to the average European IBM executive, you'll find that the IBM corporate culture is the same there as it is in the U.S. But European executives will point out that they do not work for a U.S. company. The *I* in IBM stands for "International," and the belief among European IBM employees is that their company is a truly international one that just happens to be based in the U.S. For example, if you go to the Hannover Faire in Germany, you will find that IBM GmbH carries all the appearance of a German data-processing company. And IBM (U.K.) Ltd. proudly boasts that it is the largest computer-industry employer in the U.K.

In the 18 months between the launch of the first IBM PC in the U.S. and its European debut, IBM did not waste any time. The initial success of the PC in the U.S. had caught the company by surprise, and it could sell as many of the machines as it could make. Many of the earliest models found their way to Europe, especially the U.K., as so-called "gray imports." IBM anticipated great success in Europe and set up a manufacturing facility in Greenock, Scotland. This facility builds virtually all the PCs and PS/2s sold in Europe today. IBM found the competition in Europe to be stiffer than it was in the U.S. Before the PC arrived in Europe, almost all the major hardware vendors in Europe and the U.S.—from Philips to DEC to ICL to Data General—had launched their own personal computers.

In addition, many suppliers had built up a loyal customer base for their own products. The Commodore Pet and the Apple II were successful in Europe, as were the Tandy TRS computers and the ACT Sirius (a 16-bit microcomputer that was also known as the Victor). While Pets and TRS-80s were considered to be home or hobbyist computers in the U.S., they were used by both small and large businesses in Europe.

But none of this stopped IBM. With a corporate steamroller approach, IBM launched a blanket marketing campaign and went after its traditional customer, the corporate data-processing manager. It took IBM longer to get the PC off the ground in Europe than it did in the U.S., but it succeeded.

The control that IBM holds over the market is not absolute, however, and there are some notable exceptions to it. And while the big names in the PC software, hardware, and networking business in the U.S.—Lotus, Ashton-Tate, Borland, AST, and Novell—are big in Europe as well, the market is *not* a reflection of that of the U.S. In Germany and Denmark, the Commodore Amiga is popular as a business system; the Germans like the Atari systems as well. If you thought that Digital Research's Concurrent DOS and GEM were "dead" packages, you'll be surprised to find that they sell well across Europe. Multiplan is the most popular spreadsheet in France, where they love the Macintosh. A PC database called DataEase outsells both dBASE III and IV in the U.K.

Timing and Attitude

Two major factors that help determine if a company will succeed in a particular country are timing and attitude: the timing of the move to Europe and its attitude toward Europe.

The classic—and mistaken—way for a U.S. company to approach the European market is to set up a subsidiary in the U.K. or Ireland, launch products there, and (if successful) try to extrapolate the reasons for that success across Europe.

This is an understandable course of action, since it gives the company a chance to try to understand the European mentality, market, and culture while dealing in a common language. The problem is that the U.K. is atypical of Europe. Of all the European PC software and hardware markets, the U.K.'s is the closest to the U.S.'s. A "top 10" of PCs, software, and hardware would be more like the U.S.'s top 10 than any other market's in Europe.

Some companies began early with Europe and learned quickly. One such company is Digital Research. It opened its European offices in the U.K. in the days when CP/M was virtually the only microcomputer operating system available on more than one type of machine. It licensed the system to many local hardware suppliers, first in the U.K. and then all over Europe. While Microsoft was sweeping the boards in the U.S. after the launch of the PC, Digital Research plugged away first with CP/M-86 and then with Concurrent DOS and GEM. Microsoft arrived in Europe, via the U.K., soon after the PC was launched in the U.S. Microsoft did well, but Digital Research had done enough work to ensure that it had a future in Europe.

On the hardware side, it is a similar story. IBM cut a swathe through the suppliers of microcomputers, and now the IBM PC standard dominates—with some exceptions.

Two major factors that help determine if a company will succeed in a particular country are timing and attitude.

Of Apricots and Acorns

Before the PC arrived, the U.K. boasted more than 20 domestic manufacturers of microcomputers, all different, with different operating systems and no standards. Most have long since vanished. One supplier that held out longer than most is Apricot. This company came out of a systems house called ACT. ACT first became involved with microcomputers when it won the rights to sell the Sirius microcomputer in the U.K. From there it was a short step for the company to set up its own manufacturing arm to make the Apricot computer.

This was an interesting system: It was one of the first to use 3½-inch floppy disks as standard, which meant that although it was based on the 8086 processor and could run MS-DOS, it was not IBM PC-compatible. A neat design with an excellent screen made it a system that disparaged the IBM PC. It was semiportable—in the same way that the early Macintoshes were—and packed more power than an IBM XT into a very small box.

Its success was helped by the fact that many data-processing managers (the biggest PC customers) were familiar with the ACT. It was like buying from IBM; the Apricot came from a company people thought they could trust. But, like everybody else, Apricot had to fall into line, and, in recent years, the only personal computer products coming out of the company have been been PC compatibles. This year, ACT sold the Apricot portion of its business to Mitsubishi.

Acorn is the only other major personal computer supplier to survive the last six years in the U.K. This company produced an 8-bit computer that, thanks to generous government support, became the standard for use in British schools. It was also successful as a home computer. As times got tough in the home-computer marketplace, Acorn diversified into Unix systems. The company produced the excellent Archimedes computer for the home/educational market and the R100 series of Unix workstations based on its own RISC technology. This was not enough, though, and Acorn is now owned by Olivetti.

Survivors

Look around Europe, and you'll see similar tales of manufacturers struggling to come to terms with IBM and either going out of business, finding a benefactor, or falling into line and producing PC compatibles. Olivetti has been the most conspicuously successful company.

With a solid background in office systems, Olivetti first moved into the PC market with the M24. This PC compatible was stylish, performed better than anything IBM offered (although tweaking the system gave it some compatibility problems), and was very well designed. It took up just over half the desk space that the IBM PC required, but it still had the same number of slots and a much better screen. In fact, Olivetti tried to repeat the success of Compaq by offering compatibles with added value and Italian élan. It was hugely successful in Europe; it was also Europe's last great shout in the PC market.

Over the last four years, the European market, like the U.S. market, has become a commodity market and is much more price-driven than before. Suppliers from Japan and Taiwan have moved in and have been very successful. But the European suppliers will not lie down; they still add variety and interest that you will not see anywhere else. Olivetti still produces the prettiest and most elegantly designed PCs. Victor of Sweden produces PCs with lots of power in a small box. Schneider of Germany produces PC compatibles that are to the PC industry

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what Volvos are to the car industry—not the prettiest devices in the world, but ones that you know will last.

Apricot invests a lot of money in R&D in its bid to stay one step ahead of the Japanese. Other companies, such as Tulip of Holland, Mission of the U.K., and Philips, are all trying to get an edge through technology or price and are adding variety to the market.

Then there is Amstrad. This home-electronics company is run by Alan Sugar, who decided five years ago he could produce a fully functioning business computer with monitor, drives, printer, and software for less than £500 (about $900). He was spectacularly successful. His completely non-IBM-compatible system sold by the millions. (He eventually moved to IBM compatibles as well, with slightly less success.) He is one European who realized very quickly that, like soap, cars, and bicycles, computers are commodities. If your expectations are big and your pockets are small, then Sugar is your man.

Sugar established that a target price-point in the U.K. for a complete computer system for home use was £500. This is a trend that other companies have followed. But that is at the lowest end of performance and cost; in concentrating on that end of the market, Sugar is a specialist and also an exception in Europe. His is one company that can enjoy some success by competing price-wise in the PC market with the Eastern suppliers.

The rest of the European PC manufacturers are looking elsewhere for growth and profit. The two key areas that they are concentrating on are high-end i486-based PC systems and the Unix or Open Systems market.

Analysts believe that the Unix market is growing more quicky in Europe than anywhere else in the world. Workstations are beginning to take business away from the PC in the general computing market. European suppliers are desperately hoping that this will continue, because Unix systems mean big file servers, complex networks and terminal connections, expensive software, and the opportunity to sell personal computer systems the way minicomputers used to be sold: with high margins and big profits. European companies find it difficult to compete with the rest of the world on price and quality. The European suppliers hope that the tastes of PC users will continue to change. ■

Colin Barker is a BYTE senior news editor in London. He can be contacted on BIX as "colin.b."

CREATING VIRTUAL PCs ON THE 386

They said it could be done but never told how; here is how!

Matt Trask

With the introduction of the Intel 386 microprocessor, it became possible to create virtual machines with a desktop personal computer. Although there has been a long tradition of VMs in larger computer systems, such as the Wang VS series and the IBM 360 with CP/CMS, this is the first time this kind of capability has been available to the small-computer user. OS/2 2.0, Alloy's 386/MultiWare, Microsoft Windows/386, and the Borland Turbo Debugger all use this new operating mode.

Even if you are not trying to create the next great hypervisor for MS-DOS, the emulation techniques discussed here will show you how to use the 386's virtual 8086 (V86) mode to virtualize an IBM PC compatible in your favorite 386 operating system.

Although the Intel literature makes the statement that "the 80386 can switch rapidly between its protected mode and V86 mode, giving it the ability to multiprogram 8086 programs," there is very little information available for the programmer on how to implement such a system. I will draw on my experiences with Phoenix's VP/ix and Control/386 projects, as well as the Stellar "MS-DOS in an X Window" project, to describe the various methods used in creating a virtual PC (VPC).

A Historical Perspective

For the purpose of this discussion, I'll define a VM as any combination of hardware and/or software that creates an environment in which a piece of software can be fooled into believing that some hardware feature or operating-system capability exists when it really doesn't. A good example of this is the familiar RAM disk programs that are used on many PCs. This combination of RAM and software creates the illusion of a very fast disk drive that an application program cannot distinguish from the real thing.

VMs have traditionally been offered as a way of maintaining backward compatibility with an existing software base when a computer manufacturer introduces newer, incompatible hardware or operating systems. In this way, vendors can offer newer technologies while leaving their customers with that warm fuzzy feeling as they continue to use all that expensive software and data they accumulated with older systems. IBM's System 370 with VM/370 is a good example of this, because it can actually run OS/370 batch jobs faster in individual VMs than if the jobs are all multitasked under OS/370.

Although VMs may seem to be the sole province of large computer systems, the PC community also has a long

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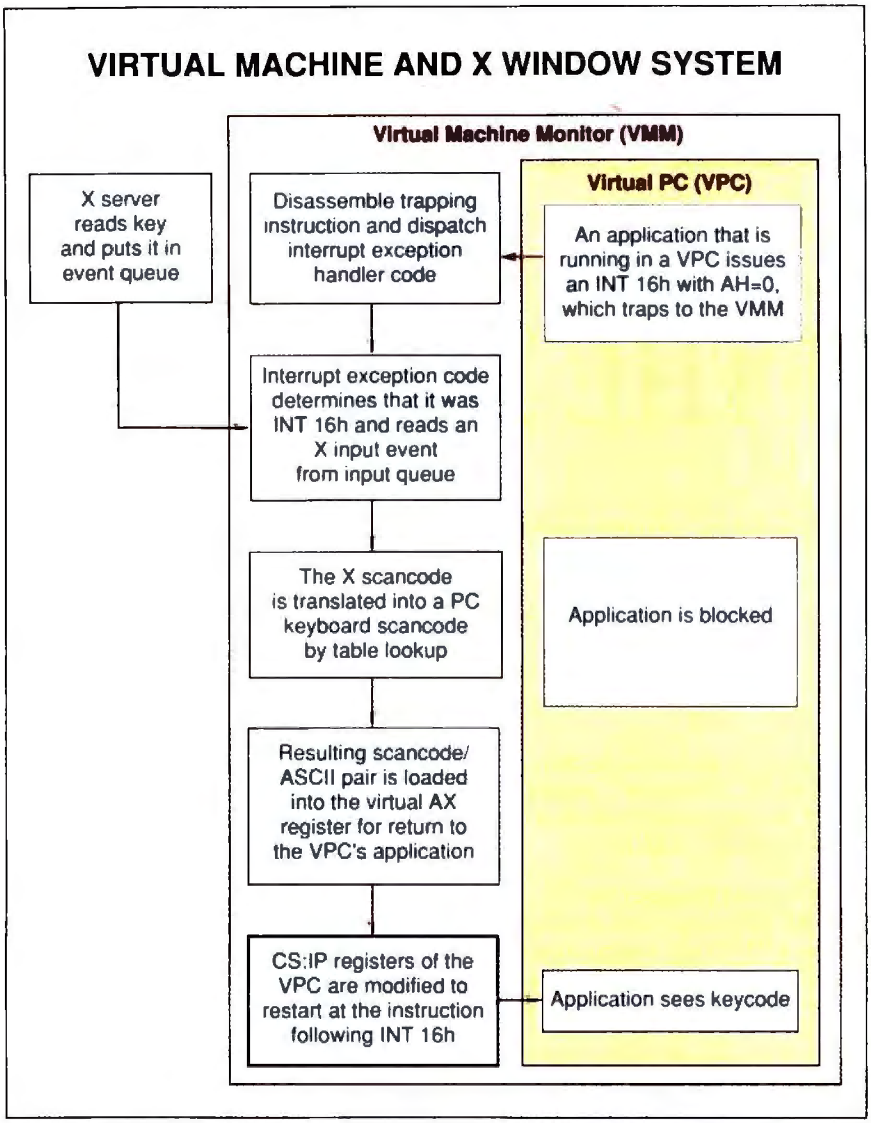

A virtual machine using an X window for its user environment. The X client is running separately on the host. The X server is wherever the user may be.

tradition of such necromancy. Products such as MultiLink from The Software Link and DoubleDOS by SoftLogic Solutions allow more than one DOS application to run concurrently on a PC by providing each program with the illusion of its own PC operating environment, albeit with limited memory for each program. Another example is the hardware coprocessors created by Phoenix Technologies for Unix workstation companies like Sun and Apollo—these allow DOS applications to run in systems that do not have Intel-family CPUs or PC-compatible expansion buses.

One VM system that failed in the PC marketplace is the NEC V20 microprocessor. Although this CPU is capable of executing the 8080 instruction set and this ability can be used to virtualize the CP/M 2.2 operating system, it was never a smashing success. I attribute this to the lack of a widespread, large investment in CP/M applications software. Computers with 8088 processors were capable of running most of the same applications as CP/M (e.g., WordStar, dBASE II, and Crosstalk) under a very similar operating environment, MS-DOS. With no 64K-byte limit, there was no incentive to develop virtual CP/M systems.

The 386 arrived at a time when large corporations had tremendous investments in DOS software, such as Lotus 1-2-3 and Microsoft Word, none of which can execute directly in the 386's native protect mode or be easily ported to run in such an environment. This large software base will ensure the success of VM products that are based on the 386.

It is important to note that although the V86 capability of the 386 can be used to emulate operating systems such as MS-DOS, greater success comes from emulating the PC itself, because its large base of installed software is heavily dependent on the vagaries of PC hardware.

Current Products That Use 386 VMs

Before digging into the hows and whys of emulation, here's a look at some of the products that use the V86 mode of the 386 and where they fit in. I'll divide these products into three groups: hypervisors, applications, and control programs.

A *hypervisor* is a multitasking environment that allows concurrent execution of more than one VM. Each VM may be running a copy of DOS or some other PC operating environment, such as CP/M-86. Windows/386, Alloy's 386/MultiWare, and Intelligent Graphics' VM/386 are good examples of hypervisors because they all use V86 mode to run multiple copies of MS-DOS, each with real-mode DOS applications. I'll also put The Software Link's PC-MOS under this category, although there is a fine line beyond which it would have to be called an operating system instead of a hypervisor because it also provides a native execution environment for new software development.

VP/ix from Phoenix Technologies/Interactive Systems and Merge 386 from Locus Computing are both examples of what I'll call *applications*. Rather than providing the multitasking environment of a hypervisor, they provide the ability to execute DOS in VMs while running as an application under various 386 Unix operating systems. They get their multitasking ability as a result of the environment that they run in. The Sun386i workstation demonstrates this "DOS under Unix" technology—older Sun systems require the addition of emulation hardware in order to run DOS, but the 386i comes with DOS built in because of the V86 capability of its 386 CPU.

The last group of 386 VM products is the *control* programs. These use the new capabilities of the 386 to enhance the use of the system but do not attempt to be operating systems in their own right. Compaq's CEMM program allows DOS to run in V86 mode while using the CPU's page-translation hardware to emulate the operation of an AboveBoard. Qualitas's 386Max provides similar functionality for 386-based machines. Phoenix Technologies provides Control/386 to OEMs for more specialized uses, such as backfilling DOS memory to 640K bytes in machines that are capable of adding only 512K bytes below the 1-megabyte boundary. Debuggers such as Nu-Mega Technologies' Soft-Ice/386 and the Borland Turbo Debugger are among the more interesting applications that can be found in the control-program genre. These products operate on real-mode DOS applications and run them in 640K-byte VMs. By keeping their own code outside of the DOS address space and using the CPU's hardware debug registers, they can provide functionality similar to that of much more expensive in-circuit emulators.

My own Stellar MS-DOS project falls into the control-program category. Its primary function is to run a 386-based service processor built into the Stellar Model GS1000 Graphic Supercomputer. In this capacity, it boots the big CPU and handles low-speed I/O devices, such as mouse, keyboard, and serial lines, on behalf of the GS1000's native Stellix operating system. Because this places little demand on the 386 CPU, all extra cycles are used to run MS-DOS in a VM that displays its output through the Stellix X Window System display manager as if it were a native Stellix application.

Address Translation

The 8086 and 8088 CPUs generate linear memory addresses from two components—a segment and an offset. The segment address is shifted left by 4 bits, and the offset is added to the result, giving a 20-bit linear address. A 286 or 386 in real mode generates addresses in the same fashion.

The segment component is renamed to selector when running in protected mode. Instead of being a value that can be used directly to compute an address, a selector is an index into a table of segment descriptors. Each descriptor contains information about the location, size, and protection attributes of an area of memory. When a selector is loaded into one of the segment registers, its associated descriptor is used to calculate linear memory addresses instead of the older shift-and-add method.

When the 386 CPU is run in virtual 8086 mode, address translation is done as if it were an 8086 CPU. This means that all virtual PC address space must begin at an offset address of zero. Protection in a multitasking system must be provided by the memory management unit because segment descriptors are not used.

How to Virtualize

Emulation is the technique of gaining control of the CPU from a program that is executing and passing the program's execution to some sort of a monitor or supervisor program. This monitor then determines what the original program was trying to do, causes the desired result, and restarts the original program at the place at which it would have normally arrived if it was not in an emulated environment. This taking of control is referred to as *trapping* and usually requires hardware support. On the 386, trapping generally takes the form of a general protection (GP) interrupt. An example of software-based trapping would be a virtual disk device driver that is chained onto the Int 13h vector so that it gets control every time a disk request is made.

The 386's V86 mode provides many trapping mechanisms you can use to support emulation of PC-compatible hardware. It is possible for a VM monitor (VMM) to set up trapping on accesses to I/O ports, interrupts, operations that affect the interrupt flag (IF), and attempts to execute privileged operating-system instructions, such as those that enter and leave protected mode.

The figure describes the flow of control in a keyboard emulation. PC-based application programs typically get keystrokes by using Int 16h to read them from a ring buffer. The data objects in the ring buffer are a combination of an ASCII value and the scancode of the key that was pressed. In the Stellar MS-DOS implementation, all keystrokes are received from an X window and must be translated into a form that is useful to PC applications. If a trap is taken every time an Int 16h is issued, the VMM can read an X keyboard event, translate it into an ASCII/scancode pair, load this value into the AX register, and resume execution at the instruction following the Int 16h.

Other examples of emulation are the so-called limulators—products that provide the same functionality as an Intel AboveBoard by trapping all use of Int 67h and using the 386's page-translation hardware to remap extended memory in the same way that the AboveBoard's hardware remaps extended memory.

Why Virtualize?

By supporting VMs, an operating system can execute other operating systems as if they were applications, or perhaps just execute applications that would normally run under some other operating system. An example of the latter would be a version of Unix that has been extended to directly execute OS/2 binary programs.

One primary reason for virtualizing an operating environment is to provide the illusion of hardware support for peripheral devices that do not really exist. Often the host system will have peripheral devices such as floppy disk drive controllers or video controllers that are not compatible with the NEC 765 and Motorola 6845 used in the PC; in this case, the emulation software can translate I/O requests into a format that is meaningful to the native devices. An equally important reason for virtualizing an operating environment is to provide for the sharing of devices like serial lines and floppy disk drives in multitasking environments.

Although it is possible to create an environment that directly virtualizes MS-DOS by trapping at Int 21h and virtualizing the individual DOS calls, I believe that a more thorough and compatible job can be done by emulating the hardware of the PC itself. In the past, operating systems like Concurrent DOS (also known as Concurrent CP/M) provided less-than-complete emulations via the use of filter programs and case-by-case exception handling to run only the most popular applications software.

386 Support for VMs

The 386 has many advanced features that support the creation of VPCs. These include multitasking, virtual memory, memory protection, and I/O protection. The 386 multitasking model provides for hardware-based task switches in which the registers associated with an outgoing task are dumped by the CPU into an area of memory called a task state segment, and the registers for the incoming task are restored from its TSS. V86 mode is a special kind of task—when bit 17 of the EFLAGS register is set, address translation for the associated task is done as it would be on an 8088 (see the text box "Address Translation" above). There are also changes to the way that I/O protection is handled that make it easier to do device emulations.

continued

Virtual memory is the ability to remap memory resources as needed to locations other than the physical addresses associated with them. You can use this to create the illusion of greater system memory than actually exists because some of a process's memory can be stored on disk when it is not needed. In addition to 286-compatible segment-based address translation, the 386 is capable of doing page-based address translation. With its built-in memory management unit (MMU), the 386 can map any 4K-byte page of physical memory to any virtual address within the CPU's 4-gigabyte linear address space. Virtual memory is particularly important when emulating a PC because all VPC memory maps must originate at logical address 0:0.

Memory protection is a fundamental requirement of a multitasking system; if a task could arbitrarily alter another task's memory, the system could crash at any time. The 386 provides two types of memory protection: descriptor-based and page-based. Descriptor-based protection is the technique used by OS/2 1.x to protect an application's memory segments. This method is not appropriate for a V86-mode task because segment descriptors are not used. Page-based protection uses the MMU to create a unique address space on a per-task basis by changing the memory map on each task switch. You can obtain additional protection on a per-page basis by defining supervisor (kernel) and user (V86 task) page attributes. Later I will show how page-based memory protection can be exploited to emulate a memory-mapped video system.

The 386 CPU provides for I/O protection to trap any or all accesses to I/O port addresses. The 386 version of the I/O privilege level (IOPL) mechanism is an extension of the 286 that includes a selective trapping mechanism. The 386 uses an I/O permission bit map for each V86 task with a bit corresponding to each byte-wide port. By setting and clearing these bits, a VMM can take traps on devices that need to be emulated or shared while allowing direct access to selected hardware by VM application programs.

Listing 1: *The UART defined as a state machine with a C structure.*

```
struct uart {
  u_char iob; /* Tx/Rx buffer */
  u_char dll; /* divisor latch LSB */
  u_char dlm; /* divisor latch MSB */
  u_char ier; /* interrupt enable register */
  u_char iir; /* interrupt ID register */
  u_char lcr; /* line control register */
  u_char mcr; /* modem control register */
  u_char lsr; /* line status register */
  u_char msr; /* modem status register */
  u_char scr; /* scratch register */
};
```

Listing 2: *Flow of control during reflected interrupt and IRET trap.*

```
/*
* REFLECT() - cycle a VPC interrupt service routine.
*/
reflect(regs, intnum)
regs_v86_err_t * regs;
u_char intnum;
{
  u_short * mem_ptr;
  u_short flags;

/* calculate flags image from virtual flags */
  flags = regs->FLAGS;
  if (*VIRTUAL_FLAGS & IF) { /* is virtual IF set? */
    flags |= IF; /* yes, set it here */
  }

/* "PUSH" FLAGS, CS, and IP registers */
  mem_ptr = (u_short*)((regs->SS << 4) + regs->SP);
  *--mem_ptr = flags;
  *--mem_ptr = regs->CS;
  *--mem_ptr = regs->IP + 2; /* fixup for restart */
  regs->SP -= 6; /* fixup SP */

/* calculate new CS and IP from interrupt number */
  mem_ptr = (u_short*) (intnum * 4);
  regs->IP = *mem_ptr++;
  regs->CS = *mem_ptr;

}

/*
 * IRET_HANDLER() - VPC trapped on an IRET instruction.
 */

iret_handler(regs)
regs_v86_err_t * regs;
{
  u_short * stk_ptr;

 /*
  * "POP" CS, IP, and FLAGS registers, force IOPL to zero
  * and clear the interrupt flag in case v86 code modified
  * the flags image on the stack
  */
    stk_ptr = (u_short*)((regs->SS << 4) + regs->SP);
    regs->IP = *stk_ptr++;
    regs->CS = *stk_ptr++;
    *VIRTUAL_FLAGS = *stk_ptr;* save virtual IF */
    regs->FLAGS = *stk_ptr & 0x0dff; /* IOPL=0, CLI */

 /* fixup stack after 3 "POPs" */
  regs->SP += 6;

}
```

Emulation Techniques

Once the VMM has gained control of the VM due to a general-protection trap, there are many different techniques that you can use to perform an emulation. For the purpose of discussion I'll assume that the GP trap handler is entered by a task switch so that the VM's TSS will contain a snapshot of the VPC's registers. By using the stored CS and IP values from the TSS, the VMM can build a pointer to the instruction that caused the trap; by disassembling the instruction, it can determine what type of emulation is appropriate. After the required result is obtained, the VMM "fixes up" the TSS so that when the VPC task restarts, it begins execution at the first instruction after the one that was trapped.

I/O trapping is the most straightforward method of emulating PC peripheral devices. This emulation is simplified by the register-based interfaces to VLSI

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peripheral devices such as the interrupt controller, floppy disk drive controller, universal asynchronous receivers/transmitters, and video controller. The 8250 UART is a good example of a device that is easy to emulate directly. I start by defining a state machine as a standard C structure (see listing 1).

Whenever an application outputs to the COM1 address range of 3f8h through 3ffh, the VMM fills in this structure with the data byte that is being written. An input trap at one of these ports will return the value that is stored in the structure. A VMM armed with this information can do emulation in a few different ways. One way is to translate 8250 UART I/O to commands that are meaningful to some other UART—like an 8251 or 8530—that is available in the system.

If the VMM is hosted by an operating system such as Unix, the emulation code would use control outputs that set the data transfer rate, raise DTR, and so on to do `ioctl()` calls to the standard Unix serial device driver. In this case, the VMM stores the status returned by the driver in the structure's status registers until an input trap is taken. The VMM makes the translation between the inputs and outputs at the virtual Tx/Rx buffer port, and the reads and writes of a file descriptor associated with the Unix serial driver.

Interrupt Reflection

Interrupt reflection is a technique whereby the VMM takes a trap on an INT*nn* instruction but does not immediately attempt to do any emulation. Instead, it fixes up the V86 task's TSS to the interrupt state. The VMM uses the SS:SP registers to build a pointer to where the CS, IP, and FLAGS registers would be written with the three PUSHes used to save them. SP is modified as if these three PUSHes had been done, and the register values are written at the address pointed to by SP. Next, the VMM gets the interrupt handler's address from the table in low memory and writes it as CS:IP in the TSS. When the VPC is restarted, it executes the interrupt service routine that the vector table pointed to. The IRET instruction at the end of the ISR is trapped. The VPC reverses the situation by retrieving CS, IP, and FLAGS from the place where it synthetically PUSHed them. The SP register is restored to its original values.

Listing 2 shows code fragments from the Stellar MS-DOS VMM code that reflect interrupts and handle the IRET instruction used to return from a reflection. This technique is most useful with BIOS interrupts where it is desirable to wait for the BIOS port accesses and use the I/O trap as the entry point into emulation code.

In my task-switching GP trap model, reflection is not very useful as a way to handle real hardware interrupts because of the latency of 538 clock ticks associated with doing a task switch on every external interrupt. Even if this were not a problem, a multitasking system that is running more than one VPC might have the task with the proper interrupt handler idle or swapped out at the time the interrupt occurs. This means that the kernel must be able to participate in interrupt handling on behalf of the VM. Device drivers with intimate knowledge of the interrupting hardware can field the actual interrupt and save the data or other interrupt event information in a queue for later delivery to the VPC's ISR. A signal is then sent to the VMM indicating that an interrupt reflection is required for the VPC to process the interrupt as if it were an asynchronous event.

Memory Translation

Memory translation and protection can also be used for device emulation. Memory pages that have been mapped to the video regeneration buffer addresses of B000h and B800h can be marked as read-only, which causes a page-fault trap whenever an application attempts to write directly to video memory. The page-fault handler can then dispatch to video emulation code, which determines what the application was trying to do and causes the same effect on the computer's display.

In the Stellar MS-DOS project, I used a hardware assist in video emulation—there is a block of shared memory that is used for interprocess communication between the 386 kernel and Stellix. This memory is doubly mapped so that it can be accessed either as ordinary RAM or as first-in/first-out RAM. When pages are mapped from the FIFO address range into video buffer locations, all writes by PC applications to this RAM have their addresses encached in the associated FIFO. The video emulation code that is running under Stellix can retrieve these addresses and use them as indexes into the shared memory array to obtain video updates rather than using the less efficient method of comparing the whole video buffer with a local copy. You can also use memory translation to solve the infamous A20 wrap problem by aliasing the first 64K bytes of memory to the 1-MB boundary.

How to Emulate a PC

Now that I've illustrated some emulation techniques, I'll create a working definition of what it takes to virtualize a PC-compatible system. Remember that you are emulating the hardware of a PC rather than just the MS-DOS operating system, so every standard PC peripheral device must be accounted for. Of the subsystems that I'm about to describe, most are best emulated by I/O trapping when the BIOS or an application attempts to directly access the device.

The keyboard is both simple and complex to emulate. In its simplest form, you can emulate the keyboard by trapping Int 16h, reading data from the keyboard or device driver, and returning this input data to the VPC in the TSS register image. The complexity occurs when you consider the other functions of the keyboard controller and the real devices that you can use to emulate the keyboard. The 8042 keyboard controller chip is also responsible for software CPU resets and gating the A20 line to cause megabyte wraps on AT-type systems. A PC keyboard generates scancodes that identify which key you've pressed and whether it was a downstroke or an upstroke (i.e., make or break codes). If you are using an ordinary ASCII terminal (e.g., a VT100) as the VPC's console, some translation must be done from ASCII to scancode, and break codes must be synthesized. Stellar MS-DOS uses X as the source for input, so the translation is pretty easy; X input events include a scancode equivalent and press/release information, so it is just a matter of doing a table lookup to find the corresponding PC-compatible scancode.

Console emulation must provide a PC-compatible display, such as MDA, CGA, or Hercules, in addition to being a source of keyboard input. You can use serial terminals as VPC consoles by emulating PC video attributes (e.g., inverse video, underlining, and flashing) with whatever capabilities exist in the terminal. You can simplify this task by using terminals like the Wyse 60 and the Kimtron, which have PC-compatible display attributes and can be programmed to generate scancodes.

Video emulation is usually a combination of memory-based protection (as mentioned above) and I/O trapping on ports associated with the 6845 CRT controller. Lotus 1-2-3 is one of the main reasons for this combination—it uses BIOS and direct video memory accesses for most of its work, but goes directly to the 6845 when entering a graphics display mode. Because of this, an interrupt trap on the video BIOS alone would be inadequate to emulate all 1-2-3 output. The consensus among many 386 VM developers is that EGA graphics emulation is too difficult to perform in software. The complex architecture, combined with many write-only control registers, would consume too much compute power in return for a very-low-performance emulation. VGA, on the other hand, may provide new opportunities, because a simple hardware assist can intercept the video data at the auxiliary video connector after the VGA has done all the hard work but while the output data is still in a digital form.

Emulating Disks and Drives

Floppy disk emulation is a challenge because of the secretive nature of the copy-protection industry. You can emulate normal disk operations, such as sector reads or writes, by trapping Int 13h and reading from or writing to a 360K-byte file containing the image of a disk. This facilitates device sharing by allowing each user to have his or her own floppy disk image.

When dealing with copy-protected applications, it is usually easiest to disable trapping in the VPC I/O permission bit map so that direct access to the floppy disk drive controller chip is possible. Of course, this will work only if an NEC 765 or compatible FDC chip exists in the system at addresses 3f0h through 3f7h. The real floppy disk drive can be shared among multiple VPC users when you implement a trap on the first access algorithm; this releases I/O trapping when a VPC first attempts use, and reenables trapping when the application has completed its use of the floppy disk drive.

Hard disk drive emulation is similar to floppy disk drive emulation with one notable exception—it would not be desirable to keep a 30-MB emulation file hanging around waiting to be filled just because a type-3 drive is being emulated. The VP/ix emulation uses a minimal-size file that is extended as needed when files are written to it. This is most useful for booting MS-DOS and for programs that can install their copy protection on a hard disk.

A better way to emulate large mass storage devices is a file redirector that translates requests (e.g., open, close, read, write, and find first) into requests for the native file system on the host operating system. Stellar MS-DOS uses this method because it has the additional benefit of allowing DOS and Stellix files to be shared transparently from either environment.

Clocks and Interrupts

The battery-backed real-time clock chip (also known as the CMOS) must also be emulated, because it provides information to the VM about memory size and device configuration. It would be inappropriate to allow direct access to the real CMOS (if any), because it is used to boot the host operating system and must be protected from capricious changes. A 64-byte data file containing the image of a CMOS can be maintained for each VPC, allowing all users to have their own configuration and concept of time and date.

One interesting fact about the MS-DOS operating system is that it does not need a real clock in order to function correctly.

Many PC applications make direct accesses to the 8254 counter/timer chip in order to generate unusal sounds, measure real-time events, or provide a periodic timer tick interrupt at a higher rate than the PC-standard 18.2 Hz. A state-machine timer emulation needs to receive periodic signals from the host operating system to keep track of the passage of time. An interesting fact about the MS-DOS operating system is that it does not need a real clock in order to function correctly. One way to take advantage of this and improve VPC performance might be to give just one or two timer signals per second to the VMM and adjust the tick count in the VPC's low memory every 15 seconds or so to the correct value. This would allow time to pass for file-system time stamps and applications, such as the Brief editor, that have on-screen clock displays.

An emulation of the 8259 programmable interrupt controller (PIC) chip plays a role in many of the other emulations. Before acting on a queued interrupt signal for a timer tick or an incoming serial line character, the VMM must examine the state of the PIC emulation to determine whether this interrupt level is enabled and not masked. Similarly, the state of the virtual IF in the VPC's FLAGS register must be checked to ensure that an application has not issued the CLI instruction to disable external interrupts.

Other Devices

Sound emulation can be a particular challenge because of the diverse uses placed on this seemingly unimportant subsystem. You can emulate the standard beep tone that is generated by the ASCII BEL character (^G) on just about anything, even on a serial terminal console device, but you can emulate the more complex sounds that are used with game programs only if there is adequate hardware support.

You can support serial communications using the example I gave earlier for emulation techniques. One copy of the UART structure would be required for each emulated port. This is a place where the VMM must use interrupt queuing and signals, because incoming data and UART status might be lost if the VPC task is not running when the real hardware interrupt occurs.

Sharing a printer is not a problem that most PC applications are concerned with, since each PC usually has its own. But in a multiuser system or a system in which a 386-based VPC is hosted under an operating system like Unix, printer control is managed by a spooler program rather than directly. The VPC can trap BIOS outputs that use Int 17h. When the VPC receives the interrupt message, it can direct the outgoing characters to a disk file. When the print job is done, the VPC can then send the file to the print spooler. Spooling is a major problem in the PC environment because there is no real concept of job end or end of file when printing. There are three strategies that the VMM can use to detect this condition and submit a print job: time-out, program termination, and direct user interaction. A time-out would close the file and send it to the spooler after some duration since the last character output. The VMM would detect the termination of a program by a trap on Int 20h and the DOS Int 21h subfunctions 00h, 31h, and 4ch. Direct user interaction is the simplest and least elegant method—the user would have to run a short program or make a selection from a system menu with a mouse to start the printing job.

Mouse emulation is the one type of emulation where the least amount of slop can be tolerated—since the mouse is a high-performance component of many

continued

user interfaces, any noticeable delay between mouse movement and mouse cursor movement could affect its usefulness. This is a particular challenge in multiuser time-sharing systems such as VP/ix, where the DOS application is drawing the mouse cursor but the Unix serial driver is taking the mouse interrupts. If the DOS task is sleeping or swapped out when the mouse is moved, the jerky motion could be intolerable.

Network emulation can usually be accomplished by the file-system redirector (mentioned earlier in the discussion of hard disk drive emulation). This allows the VPC to take a free ride using whatever network services are provided for remote file systems in the host environment. If desired, you can emulate NetBIOS by trapping its entry point, or you can emulate individual network cards (like the 3Com 3C501 and the SMC ARCnet adapter) by I/O trapping.

The last remaining emulation is an EMS expanded memory manager that provides over 640K bytes of RAM to DOS applications. Although this emulation is not required for PC compatibility, the 386's MMU makes it easy because you can use page translation to map memory in much the same way that a real expanded memory manager does hardware-based memory mapping on an AboveBoard. You can emulate this device by trapping Int 67h and letting the VMM do the emulation, or by running a real expanded memory manager (like the one Intel provides) and trapping on the I/O port accesses when it tries to manipulate its AboveBoard-control registers.

Problems of Emulation: Civilizing MS-DOS

While all the above descriptions may make you think that the creation of a VPC is a fairly simple task, there are problems with emulation, performance, and system security that must be addressed. It is not possible to emulate a native 286 operating system, such as OS/2, on the 386. A number of the privileged system programming op codes (e.g., LMSW, ARPL, CLTS, and LLDT) that the 286 operating system would use cannot be emulated because the 386 kernel uses them. (For more insight into what would be required for 286 emulation, see "Emulating the 386" in the May/June 1988 issue of *Programmer's Journal*.)

Peformance is probably the single biggest issue in VPC creation. In the good old days, end users had lower expectations for their PCs—an emulation that ran as fast as a 4.77-MHz XT would have been considered acceptable. Nowadays,

Performance is probably the single biggest issue in VPC creation.

most typical users have been exposed to MS-DOS running on 20- to 33-MHz 386 AT clones. A VPC with anything less than 6-MHz AT performance would probably be considered unacceptable.

MS-DOS exhibits a behavior considered antisocial in larger multitasking systems such as OS/2 or Unix—it "busy-waits." What this means is that when there is no work to do, DOS soaks up all available CPU cycles by polling the keyboard and network (if any) in an idle loop. If it were allowed to do this when running as an application in a VP/ix system, all other programs running concurrently would be penalized. Another contributing factor to VPC inefficiency is the overhead associated with trapping to the VMM. Unlike a slow 8088, where saving every CPU cycle improves the performance of an application, the 386 shows a speedup only when major algorithmic changes are made. If you can minimize the number of task switches that must be made in order to do an emulation, the overall speed of the VPC improves.

VP/ix addresses the DOS busywait problem by detecting idle loops—DOS and applications will exhibit characteristic behaviors such as polling the keyboard without getting input when idling. This is used to lower the task's priority or even to put the task to sleep. Another improvement can be made by "short-circuiting" the entry into an emulation. For example, a trap on the Int 10h write-teletype function can do simple output faster than a reflected interrupt that must take multiple traps as the Int 10h BIOS accesses the 6845 video-controller registers. The address-caching FIFO described earlier for the Stellar video emulation is an example of how a simple hardware assist can improve emulation performance.

An improvement that is more difficult to implement is changing the trapping model from a task switch to a level switch. Instead of using a task gate for the GP interrupt handler, you can use a trap gate to cause a change in Current Privilege Level from application (level 3) to kernel (level 0). This is not as simple as a task switch, because the GP handler doesn't get a nice snapshot of the VPC in a TSS. It must do its own register preservation and work from the state that is saved on the stack in order to dispatch a proper emulation. But this complexity can save 317 clock ticks round-trip on each trap—a task-switch INT/IRET sequence takes 538 clock ticks, while a level-change INT/PUSHA/POPA/IRET takes only 221 clock ticks.

The other major performance booster is the use of IOPL=3. By definition, the CPL of a V86-mode task is always 3, so if IOPL is less than 3, instructions that modify the interrupt flag like `CLI/STI/PUSHF/POPF/INTnn/IRET` will cause GP traps so that the IF can be virtualized. If IOPL=3, these operations are no longer privileged, allowing the VPC application programs to have direct access to the CPU's IF, thus minimizing the number of traps that must be taken.

This leads right into another emulation problem: system security. What if a bug causes a DOS application to crash after it turns off external interrupts with a CLI? Any timer tick-based multitasking would cease to function, and it would be time to reach for the big red switch.

To determine the appropriateness of using IOPL=3, you must look at what the system is being used for. In a Unix system, where security and reliability are very important, it would not meet the needs of other system users if a VPC could bring down the house. But with Windows/386, a single-user system, it might be appropriate because performance is more important than security, and the user can't hurt anyone else with a bogus program.

For the Stellar MS-DOS implementation, I defined the shared memory interface between the 386 kernel and Stellix as the security point. If the 386 were to crash for some reason, it would not affect any Stellix applications that were running; thus, the 386 could be rebooted without anyone other than the MS-DOS user noticing. To this end, I have installed a hardware assist—a watchdog timer that issues a nonmaskable interrupt to the 386 if it is not reset periodically by the normal timer-tick ISR. This guarantees that the 386 kernel will be able to recover from the above scenario and terminate the offending DOS application with no further side effects.

The Future of VMs

OS/2's DOS compatibility box on 286 systems can be considered a VM by any

continued

of the definitions used here. It is a combination of software and hardware that lets most DOS applications believe that they are running under standard MS-DOS on a PC. OS/2 2.0 is a native 386 version with even greater performance and functionality. Its multiple DOS compatibility boxes are much simpler than the contortions that had to be used to make a single compatibility box work on the 286. Segment sizes for protected-mode applications are essentially unlimited, making more sophisticated applications possible—the VPCs for this system are implemented as applications just as VP/ix was implemented for Unix. Page-based virtual memory allows multiple VMs to run more efficiently than is possible with 286-style segment swapping.

Rumors of multiprocessor i486-based systems that run a "new technology" portable OS/2 are just starting to get around in the development community. The Motorola 88000 RISC CPU is rumored to have enough microcode space left on its die to implement and decode the full 386 instruction set. Clone chips like the Nexus F86 chip set will provide full 386 binary compatibility with much greater performance than can be had from a single-chip microprocessor.

Even if none of these rumors is borne out, the future is promising for soft coprocessor technologies, such as the ones that Insignia Solutions and Phoenix Technologies offer. These software-only VMs are similar to language translators in that they compile or interpret an 8086 instruction stream. Like the hardware-based VPCs that I have described here, they must also emulate I/O devices to be fully PC compatible. Future generations of CPUs, such as the i860 and MIPS R6000, both with horsepower in the 40- to 60-million-instruction-per-second range, will be able to run MS-DOS on these soft VPCs at least as fast as the current 8- to 10-MHz 286-based AT systems. But by then I'm sure we'll find nothing less than 20-MHz 386 DOS performance acceptable. ■

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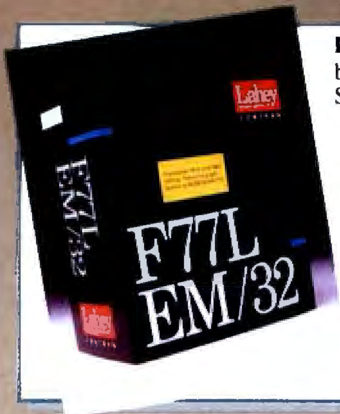

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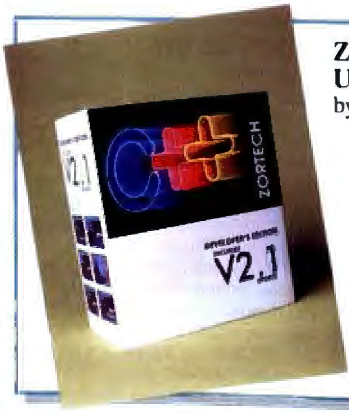

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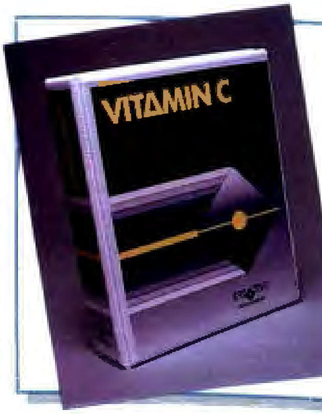

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NOTEBOOK PCs SET THE PORTABLE STANDARD

Today's state-of-the-art totable computers pack AT-class power into about 6 pounds

Paul Schmidt

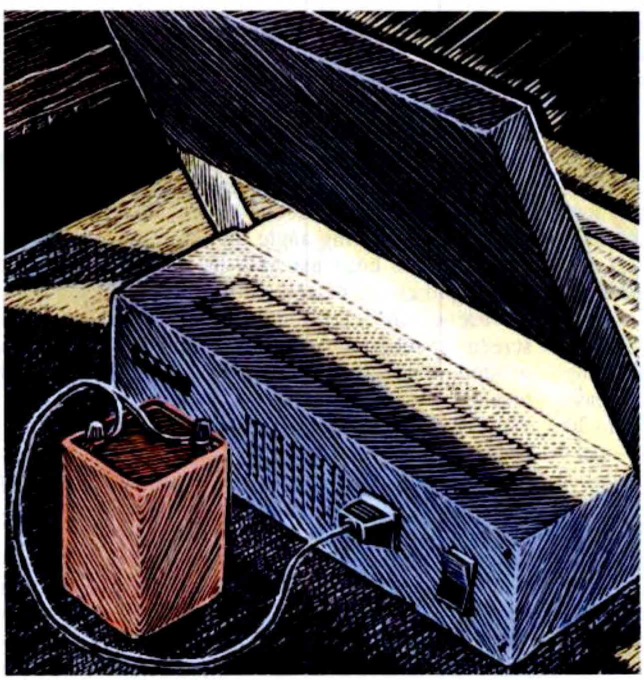
The portable computer market is an exciting, dynamic arena. It seems that every new model introduction advances the state of the art. Portables are receiving more development attention as sales increase; they are becoming a very important segment of the PC market. According to International Data Corp., about 9 percent of PC sales in 1987 were portables; by 1992 that market segment should jump to 15 percent.

But what defines the state of the art in portable technology? What sets a portable ahead of all the others in its price bracket? The factors that are most often evaluated are form factor (i.e., its physical design and dimensions), weight, screen quality, and battery life.

I will focus on a class of portables known as notebook PCs. These represent the fastest growing segment of the portable computing market. They range in size from about 8 by 11 by 1½ inches to 10 by 12 by 2 inches, and weigh 4½ to 8 pounds. Notebook PCs pack most of the utility of an AT-class desktop into the smallest possible package. Although seemingly a narrow niche, notebook PCs offer a lot of variety in terms of power (9-MHz 8088 to 12.5-MHz 286 CPUs), features, and price ($1800 to $5000). The photo shows some popular notebook models.

Other classes of portable PCs include hand-helds, laptops, and luggables. No "official" classifications of portable PCs exist; I use these terms for the benefit of this article. Hand-held PCs are battery-powered, weigh about 1 pound, and can fit in a coat pocket. The best examples of this genre are the Poqet PC and the Atari Portfolio.

Laptops are either battery- or AC-powered. They weigh between 8 and 17 pounds, almost always use more powerful 386SX or DX CPUs, and measure up to 15 by 16 by 4 inches. The Compaq SLT and the Toshiba T5100 are popular laptops.



Luggables are sometimes referred to as "lunchbox" PCs because of their shape, but not all luggables have that form factor. All luggables are AC-powered and provide the greatest performance in terms of CPU (386 or i486), mass storage, RAM, and video. The heaviest units (some of which have color LCDs) weigh up to 27 pounds—more than some desktop PCs. The Dolch-P.A.C. 486-25 and the IBM Model P70 are examples of luggables.

Notebook Limitations

The screen and keyboard are the limiting variables in the design of notebook PCs. The current state of the art in keyboards is an 84-key design, with a numeric keypad embedded in the alphanumeric

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keys (external keypads are common options). Control, Shift, Alt, and similar keys are standard size and in their familiar locations. Keys that you use infrequently (e.g., Print Screen and Scroll Lock) are sometimes smaller and in less familiar locations. A standard keyboard requires 11 inches; however, some vendors "squeeze" this to achieve a smaller form factor.

The amount of key travel needed to provide good feel dictates the thickness of the keyboard. Around 0.15 inch—the same as a standard AT-style desktop keyboard—is best. Half that thickness is acceptable if strong tactile feedback is present; otherwise, you might feel like you are banging your fingers on a hard surface when you type. Nearly all notebook makers use membrane-type, rather than mechanical, keyboards to minimize thickness. A membrane keyboard uses a rubber grommet with carbon contacts under the key caps. Pressing a key causes the contact to complete a circuit with a polyester sheet that is embedded with conductive material.

Display Technology

Readability limits the display size. The display must provide adequate visual resolution to someone who views it at a typical operating distance. Preferably, it should have a 1-to-1 aspect ratio (i.e., the display shows the true shape of the text and graphics, not a compressed version to compensate for a shortened screen). The current panels are around 11 inches diagonally and are 11 to 12 inches wide to accommodate the display circuitry. The overall thickness of the panel is between ¼ and ½ inch. VGA, with a resolution of 640 by 480 pixels, is rapidly becoming the standard display mode.

The display portion of the laptop can also be extremely power-hungry, nearly rivaling the electronics in its appetite. Some display panels draw extremely low current, but they are also the least pleasing to view. Because of this trade-off, the display design is one of the most difficult aspects of laptop engineering.

Various types of LCDs are by far the most prevalent panels used today. The only exception is the gas-plasma display; however, the power it consumes (20 to 30 watts) is greater than most battery-operated systems will tolerate, so it's usually relegated to AC-only laptops.

All LCD panels have similar construction. The liquid crystal material is sandwiched between two plates of glass, which are, in turn, sandwiched between two polarizing filters. Each glass plate carries transparent conductors made of indium tin oxide—one aligned vertically, the other horizontally. By passing current along one pair of intersecting horizontal and vertical electrodes, the liquid crystal material at the intersection becomes polarized and blocks the light at that point. The display electronics sequentially scans each pair of conductors, addressing all points of the display.

Because of the small size of the conductors, only a limited amount of current can be delivered at any given time. This limits the rate at which the liquid crystals become polarized and increases the time each pair of conductors must remain powered. As a result, the image appears to smear when text or graphics move rapidly across the screen.

It is also difficult to restrict the area of liquid crystal that becomes polarized. The pixels can become ill-defined around the intersection of the address lines, exacerbating the smearing. This becomes more acute as the resolution increases; adjacent pixels are closer together, and conductor size decreases, further limiting the polarizing current. Fortunately, this problem can be controlled somewhat by reverse-biasing adjacent electrodes.

The twisted-nematic display was most commonly used in machines built from 1984 to 1986. It was inexpensive and consumed relatively little power—usually under 1 W. This was normally a small text-only display and rarely displayed the full 25 rows by 80 columns we've come to expect. The twisted-nematic display is almost never used today, as this material has an extremely narrow viewing angle and a low contrast ratio that make it difficult to read in some situations, even when viewed straight on.

Supertwist LCDs are the current standard for low-end notebook PCs. They make a much more pleasing display than the twisted-nematic, with a significantly higher contrast ratio (about 4 to 1) and a much wider viewing angle, maintaining a reasonable contrast at a 50-degree viewing angle. (The contrast ratio is the difference in brightness between the screen's background and the characters printed on it; the viewing angle tells you how far to the left or right you can clearly view the screen.) Supertwist LCDs are also available with a range of graphics resolutions; some provide monochrome EGA capability.

While the quality of the supertwist display is higher, the materials and construction of the unit bring a disagreeable blue or yellow cast to the image. Unit costs are somewhat higher than those of twisted-nematic panels. Power consumption is also somewhat higher (slightly over 1 W), but supertwist LCDs do not require backlighting—although it is frequently used to enhance readability.

Dual supertwist is the standard display on today's midrange and high-end notebook PCs. It is constructed using two separate LCD panels. The active bottom panel uses the standard supertwist material, while the passive top panel uses a different liquid crystal material that compensates for the color distortion that the bottom layer creates. This produces a highly readable paper-white display, with contrast ratios of around 14 to 1. While the viewing angle is not markedly widened, the contrast at its lowest limit is still around 5 to 1, instead of the 2 to 1 that supertwist and twisted-nematic panels have. Generally, these supertwist displays are high-resolution VGA displays with 16 gray-scale levels. The first flat-panel color displays use this technology.

You can measure the drawbacks to this type of display in both dollars and battery life. Because the unit has two supertwist panels, material and assembly costs are higher than those of a standard supertwist display. Obviously, two panels draw more current than one, but the dual supertwist also requires brighter backlighting than the twisted-nematic and supertwist displays, thus incurring a power penalty of another 8 W. However, newer panel and backlight combinations have reduced power consumption, down to as little as 1.5 W.

A significant improvement on the dual supertwist display is the film double-twist display. Film double-twist uses a polarizing plastic film instead of the compensating LCD panel. This design cuts panel power consumption significantly and does not require high-power backlighting like the conventional dual supertwist display.

A few manufacturers are currently developing active-matrix LCD panels. This type of unit uses a switching transistor at each pixel location and provides power and ground planes across the entire surface. This allows a much higher polarizing current; the addressing conductors carry only the low-current switching signal.

Because the polarizing current is both higher and better controlled, the visual contrast ratio is extremely high—on the order of 100 to 1. Power consumption is on a par with the dual supertwist panels. The main drawback of the active-matrix display is a relatively low manufacturing yield; a million or so transistors must be placed evenly across 30 or 40 square

Three popular notebook PCs (from left to right): The Zenith MinisPort, the Compaq LTE, and the NEC UltraLite. The MinisPort and LTE weigh in at over 6 pounds each, while the UltraLite weighs only 4½ pounds.

inches of glass, and any single failure ruins the display.

Power Management

By carefully selecting a display, an engineer can design a computer that is pleasing to use yet operates for a reasonable period of time on battery power. But simply choosing the right low-power components is not enough for a state-of-the-art laptop. Today's machines also manage power on the fly by selectively turning off unneeded portions of the machine.

Because the LCD and its backlighting consume large amounts of power, these components have been targets for dynamic power management. The idea is to shut down the display and backlighting whenever you aren't using them. The most convenient way to do this is to let the computer control the power automatically.

Special logic circuits can monitor the CPU address lines and capture memory accesses to the screen. When custom hardware is not available, the BIOS or a TSR-like program can monitor the display interrupt service routine. Because many applications bypass the BIOS and write directly to the screen, the software also monitors the keyboard hardware interrupt routine. Regardless of the method used, if the monitor does not see any activity within a given time period, it turns off the display subsystem. Any subsequent keystroke or screen write restores power.

The latest hard disk drives have 2-inch platters, hold 20 megabytes of data (40 MB by the end of the year), and easily fit into a shirt pocket. The size of the drive is obviously important with small computers, but careful power management is crucial for battery operation.

Unlike displays, hard disk drives never operate on a constant basis; an application is loaded and a data file is read in, but after that, almost all processing takes place in memory. There may be some occasional disk activity, but the disk is not needed again until you want to update a file. If the drive is off when you don't need it, you can save a significant amount of power.

While you can monitor and control drive activity with software, several hard disk drives now have specialized power management electronics. These drives use programmable internal timers to decide when to drop back to a low-power state. When a drive switches into this mode, it removes power from portions of the drive electronics and, optionally, the spindle motor. When the CPU attempts to access the disk, it must be held off for a short time (at worst, only a few seconds) while the drive returns to an active state.

The PrairieTek hard disk drive is a good example. It has three operating modes: active, power save, and standby. In the power-save state, it powers down some electronic components. In standby, it turns off the spindle motor. The BIOS boot code programs the drive to automatically switch between states by setting timers in the drive to the desired values. After this initial programming, no further CPU intervention is required.

This can achieve considerable battery savings; when the drive is active, it draws from 1.2 to 3.5 W of power (the latter during platter spin-up). In the power-save state, the drive draws 0.9 W; in the standby state (motor stopped), it draws a mere 0.06 W. This power savings barely affects performance: It takes only 3 seconds to spin up the platter from standby to active, and only 100 milliseconds to get from power save to active.

With the increasing efficiency of hard disk drives and display panels, the power drain from the notebook's electronic components becomes an increasingly significant fraction of overall power consumption. One design goal to limit this consumption is to reduce the number of ICs required.

The most effective way to cut the chip count is to use a special set of IC chips that replace the functions formerly provided by numerous discrete logic components. Several manufacturers have various chip sets that have reduced costs in PC-compatible desktops. Other forms of integration, such as application-specific ICs, and surface-mount technologies also help reduce size and power requirements.

Because the amount of power that the computer's electronics consumes is proportional to the rate of logic switching, slowing the clock speed brings corresponding power savings. Virtually all chip sets provide programmable system-clock dividing circuits, allowing the CPU to slow itself down. The trick is to decide when to slow down the clock. If an application is simply waiting for keyboard input, then the CPU can slow down drastically (or even stop) with no discernible impact on performance. Unfortunately, current techniques cannot detect the difference between a genuinely idle condition and a complex spreadsheet recalculation; in the latter case, both the screen and the hard disk drive are inactive for a time even though the CPU is working furiously. Despite this deficiency, CPU speed management is a popular feature of notebook PCs.

Several new chip sets have been introduced recently (e.g., Genesis and 82340 from Intel, and LEAP from Chips & Technologies). In addition to saving on power and chip count, they monitor and control various system activities (e.g., video access) in hardware.

Suspend/resume features are also a type of power management. This utility preserves the state of the system and then

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shuts down the CPU, support electronics, and peripherals. Later, you can resume the session where it left off. You can invoke Suspend in several ways: by pressing a key or a special button, closing the computer's lid, or leaving the machine idle for an extended period. The system may also be suspended if the battery reaches a critically low level. Several methods can preserve the system state; one uses the main DRAM memory in a slow refresh mode. Other systems use low-power battery-backed CMOS RAM or write the information to disk.

Battery Technology

Since batteries are a significant fraction of a computer's weight, laptop designers are closely examining new battery technologies. The perfect battery would be small and lightweight and would supply endless power. In an effort to approach this ideal, manufacturers are refining existing battery chemistries, as well as combining new materials.

Lead/acid batteries (the same type found in your automobile) are found in a few portable PCs. You can easily measure their state of charge and recharge them. These batteries have a significant power-to-weight problem: They are too heavy for the amount of power they produce. The sulfuric acid-based electrolyte poses its own problems. Very few new portables feature these batteries (the Macintosh Portable is a notable exception).

The current standard laptop battery is the nickel cadmium. It is relatively lightweight, small, and available in a wide range of configurations. One of its greatest advantages is that its output voltage is nearly constant regardless of its state of charge. This makes the design of the laptop voltage regulators and associated electronics easier, but it also makes it difficult to determine the battery's state of charge. However, recent advances in power measurement techniques are eliminating this drawback.

Another problem with nickel-cadmium batteries is that they exhibit "memory" in their charge/discharge cycle. If you routinely recharge the battery after using it only a short while, it soon becomes incapable of delivering more than a portion of its normally available power. Several vendors have found ways around this, and since its other flaws are minor, the nickel-cadmium battery will remain in popular use for the next few years.

An emerging battery that is a cousin of nickel cadmium is nickel hydride. It promises to provide about twice the energy of a similar-size nickel-cadmium battery, and it will not have nickel cadmium's recharging problems. These batteries are still in the prototype stage, have not yet measured up to expectations, and will cost more than nickel cadmiums. Production quantities should be available next year.

Lithium batteries have been available for many years, but they have significant drawbacks. They are not rechargeable and are more expensive than nickel cadmiums. Also, all but the smallest sizes show a tendency to explode when shorted or overheated. Some new chemistries have alleviated this problem, but lithium batteries are still subject to hazardous-materials shipping restrictions.

The future of lithium batteries is looking up, however, as different chemistries have produced rechargeable designs. Their big advantages are that they are only one-third the size and one-quarter the weight of nickel cadmiums of similar capacity and that they will survive more charge/discharge cycles than other available chemistries. Unfortunately, the rechargeable lithiums are still explosive under the right conditions; if this problem is solved, they will be widely used.

A new kind of battery based on polymers is under development, and it could prove to be a notable success by the latter half of the decade. This battery is composed of either vanadium oxide or titanium sulphate attached to a polymer substrate. All component chemicals are solids, and because of their plastic base, they can be formed into nearly any shape. Polymer batteries should be extremely light and small; they may be as little as one-fifth the size of current batteries with the same power capacity. They will also have a much longer life span—it is claimed that they survive as many as 1500 charge/discharge cycles (versus 200 for nickel cadmium) and have a longer shelf life. Polymer batteries are still in the research stage and are unlikely to become commercially available for several years. However, they may become the new standard notebook power source for the late 1990s.

Getting Small in the Future

Because of recent technological advances, it is difficult pick a single notebook PC as today's standard. The market is still young, but it will stabilize quickly over the next few years. I expect that within the next five years, it will be as mature as the desktop-clone market is today.

Notebook PCs in 1995 will not be much smaller than today's models, due

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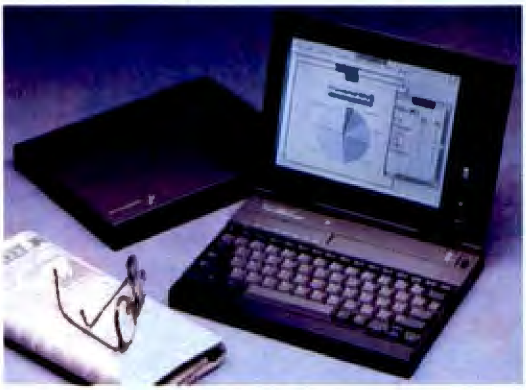

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to limitations in keyboard and display size—roughly 8 by 10 inches will be the standard flat dimension. However, these notebook PCs will be significantly thinner. Recent advances in displays (6- to 7-mm panel thickness) and hard disk drives (less than ¾ inch high) indicate a trend toward devices in a 1-inch-thick package.

The CPU will be a CMOS version of the 1994 standard CPU (which might be a 586SX). A single support chip will provide timers, DMA, serial ports, a disk drive controller, a video controller, and a memory controller. I expect that 8 MB will be the standard memory configuration, with 32 MB and 64 MB available as options.

You'll still be using floppy disk drives in 1995, but only as a distribution and transfer medium; both 3½- and 2-inch disks will be available, with capacities in excess of 20 MB. Magnetic hard disk drives with capacities of 300 MB and up will be standard; some high-end laptops and luggables will offer optical drives boasting capacities of nearly a gigabyte.

Recent industry standards for both hardware interface and software have been announced for battery-backed IC memory cards. These cards contain no moving parts to consume battery life, and they weigh considerably less than conventional mass storage devices. The Poqet PC and the NEC UltraLite are the best known examples of small computers that use this technology. The drawbacks to using this medium are high cost (up to $500 or more per megabyte) and a limited selection of commercial software. By 1995, as production quantities increase, prices will drop dramatically (perhaps to less than $50 per megabyte). This should become a popular software distribution medium, since most major hardware and software manufacturers in the small computer market seem committed to the standard.

The popular display will be VGA- or MVGA-compatible color active-matrix LCD; the quality will be identical to that of today's CRTs. Developers are introducing various prototype heads-up displays (e.g., Reflection Technology's Private Eye virtual monitor), but people who are not touch-typists may find them awkward to use. Keyboards will be essentially unchanged; they will become thinner while retaining a comfortable feel. Handwriting and voice-recognition algorithms are improving each year, but I don't expect that in 1995 they will be ready for the noisy, bumpy environment of trains and airplanes.

The 1995 portable PC will use either nickel hydride or variations of the lithium battery. The batteries will be in sizes that fit the 1-inch thin notebook case. Because of improved power management techniques, you will be able to run the average notebook PC for 12 to 24 hours before recharging the batteries. A suspended machine will be able to retain its state for many months.

In 1995, a notebook PC will appear similar to some of today's models—until you turn it on. Available processing power, display quality, and amount of mass storage will exceed those of all but the most advanced desktops today. The era of portable computing has been heralded for some time, and it will certainly be in full swing by the middle of this decade. ■

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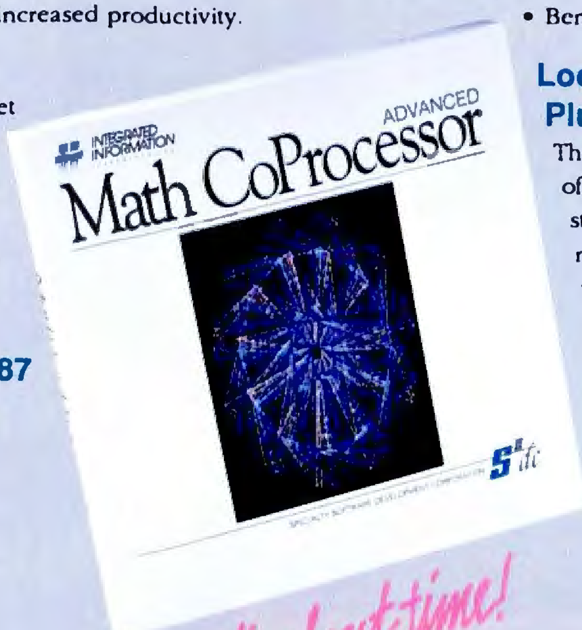

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LOOKING AT THE GRAPHICAL USER INTERFACE

Graphics capability is reaching a critical mass stage, with a number of high-quality choices

Bill Nicholls

Graphics, like the year of the LAN, will sneak up on us. In the next few years, most larger systems will use a graphical user interface. By then, the rationale for a GUI will be obvious, yet today the GUI is a hotly debated issue, and the outlook for its success is far from certain. To understand why I think this will change requires a look into the components of the GUI, especially the enabling graphics technology.

The question of graphics is broad, spanning a range of issues from the user who is the object of the graphics to the technology used to deliver the graphics. The various components are the display, the controller, the software environment, the application, and the user—two hardware, two software, and one jellyware.

Hardware has been the primary constraint on the broad availability of graphics, since the other components have been available for varying lengths of time and with varying degrees of capability. Recent developments in all the component areas have made the success of graphics, and of the GUI, almost inevitable.

Hardware

Starting with display technology, we can see two tracks: the traditional CRT and the newer flat-panel (FP) technology. The CRT represents a mature technology that is being pulled by consumer demand and pushed by its competition to lower prices and raise performance.

The once-expensive EGA display has been replaced by VGA-capable displays that cost less than a CGA display I got in 1984. Super VGA (800 by 600 pixels) displays are an incremental cost increase over VGA, and displays supporting 1024- by 768-pixel resolution are now under $1000 at mail-order prices. We can expect higher-resolution displays to follow VGA down the cost curve.

FP technology is currently on the warm-up track, replacing the CRT where the FP advantages in size, power, and ruggedness outweigh its cost and performance disadvantages. With the exception of units like IBM's large plasma display, FP displays do not replace the CRT. Rather, they supplement the CRT and are usually sold as an integral part of a portable system.

Because FP technology is just beginning to mature and CRTs are near the peak of their maturity, I expect the penetration of FP displays to begin to increase. FP technology will probably show up first in mass-market TV sets and will later displace CRT units in the computer environment.

Graphics display controllers are on the fast track. From the basic Hercules chip to the VGA "Tower of Babel"

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to fully programmable controllers, price decreases and performance increases are coming with astonishing frequency. With the dominance of Texas Instruments' TMS34010 chip, the acceptance of the Texas Instruments Graphics Architecture (TIGA) standard for software, the establishment of the Video Electronics Standards Association (VESA) Super VGA standard, and the agreement of an IBM 8514/A register standard, choices in terms of both cost and performance have never been better.

Standard VGA cards cost about $150, and Super VGA-capable cards are not much higher. VGA cards have become a commodity. The price difference between an 8-bit standard VGA card and a 16-bit Super VGA card mostly reflect the differences in production and marketing cost, with little added for hype.

Given the advantages of the VGA instruction set and its wide support, even monochrome displays should be driven by VGA. Super VGA cards are an easy choice if you do graphics, even if your current display can't show the card's full resolution. Among the several varieties of cards, the ones to buy have 16-bit bus interfaces and room for 512K bytes of memory for the display. These represent what I consider the low end for future graphics and GUI support.

The middle of the market, which as recently as a year ago was considered the high end, is in a real state of flux. The 1024- by 768-pixel resolution level can be reached by a few Super VGA cards and all the cards that are driven by either a TMS34010 chip or the IBM 8514/A controller. The Super VGA cards are pushed to the limit here and are limited in performance and colors compared to the others.

This many pixels (786,432) demands a graphics processor for good performance, especially if you are using 256 colors (8 bits per pixel). Either the IBM 8514/A or the TMS34010 can provide a performance boost, leaving more cycles for applications to use. In a GUI environment, I consider this assist necessary.

Similar to VGA cards, prices are being aggressively reduced for cards driven by the TMS34010. At Fall Comdex in 1989, the $1000 list price barrier was broken, and by the end of the show, vendors were talking about $795 cards. By the time you read this, I expect to see $595 (list price) cards driven by a TMS34010. IBM 8514/A cards lag behind TMS34010 cards because the chip set is not as mature. But this year's Fall Comdex should show the IBM 8514/A repeating the same experience/cost curve.

The graphics hardware is here today for almost any graphics application or GUI, but the transition to a GUI is not happening fast. The major factors slowing this transition are the limited number of applications available, the installed base of PC- and XT-class machines, and the choice of a GUI environment.

Software

The magic word for graphics success is *standards*. Why is this so important? Simply put, only companies the size of Lotus and Microsoft have the resources to support every possible system and display in graphics mode, and it is not easy even for them. But reduce the number of graphics environments to a reasonable number, and smaller software companies can support a large enough user base to make a profit. Since the great majority of software comes from smaller companies, this should lead to an explosion of GUI-compatible software.

We're not quite there. For IBM, with Windows, OS/2 Presentation Manager (PM) 2.0 with full 386 support, GEM and Desqview with an X.11 graphics window, Hewlett-Packard's NewWave enhancement to Windows, and other options, 286 and higher systems have a variety of GUI choices.

Atari has GEM, the Amiga has Intuition, and the Macintosh has its Toolbox and standards that create the Mac user interface (UI). Unix has X.11 from MIT, with Open Look and Motif GUIs and Open Desktop as a graphics organizing tool.

While this is probably too many GUIs, it is a step in the right direction. Windows has been around long enough to establish a broad base of software, and X.11 has taken the Unix world by storm. Those two GUIs, along with the Mac, will clearly be among the winners of the GUI competition. Desqview's user base is big enough (over 1 million), and its choice of an X.11 window on Unix servers is an interesting alternative.

GEM, PM, and NewWave are less obvious, but NewWave's features make it a good choice for integrated DOS/Unix networks. For Unix, Open Look and Motif will both succeed, and they may in time merge in capability.

Another straw in the wind is the recent appearance of two companies, Glockenspiel and Advanced Programming Institute, that offer multi-GUI systems, requiring only a recompile for different GUIs.

Applications are the final technical issue. Those requiring graphics (e.g., desktop publishing and CAD) have long been available, but until recently, DTP was the only one available in a GUI environment. Now, CAD and word processing join DTP under Windows and other GUI environments. Other applications will soon cover a user's major needs.

One of the major reasons for the slow development of GUI applications has been the major shift in program dynamics—away from the applications driving the user toward the user driving the applications. Most programs outside CAD and DTP have traditionally led the user, but this technique fails to provide the kind of flexibility needed for the future, and users are becoming more insistent about being in control of the application.

From a programming point of view, this user-driven perspective requires a dramatic change in program structure and is not easily retrofitted into an existing program. The need for new calls to the GUI for a wide variety of services also contributes to the conversion time. Once restructured, however, a program can be more easily ported to other GUIs. I expect the current slow start in GUI applications to become a rush as tools arrive and companies get past the first conversion.

Jellyware

Why use a GUI? Beyond having easier access to graphics applications, there are a number of less obvious benefits. Ease of use and reduced training are two of the most compelling.

To achieve these goals, the GUI imposes a set of restrictions on the methods for program and user interaction, with a suggested set of standards based on experience and UI research. Not only is this usually better designed than the ad hoc UI of current applications, it is consistent across the application spectrum. Learning a new application under a GUI benefits from the transference of previous learning because of UI consistency. Except for the initial learning curve for the GUI and the first application, this is a significant benefit. The Mac is the best example of this.

Another benefit of a GUI is the enhanced interapplication capabilities, such as Windows' Dynamic Data Exchange and NewWave's links. The provision of standard facilities for interapplication communications in the GUI and the support of those by the applications provide new capabilities for the user. We don't have to wait for the application designer to provide a specific function, nor do we need a special program. We can now link one tool to another, generating

continued

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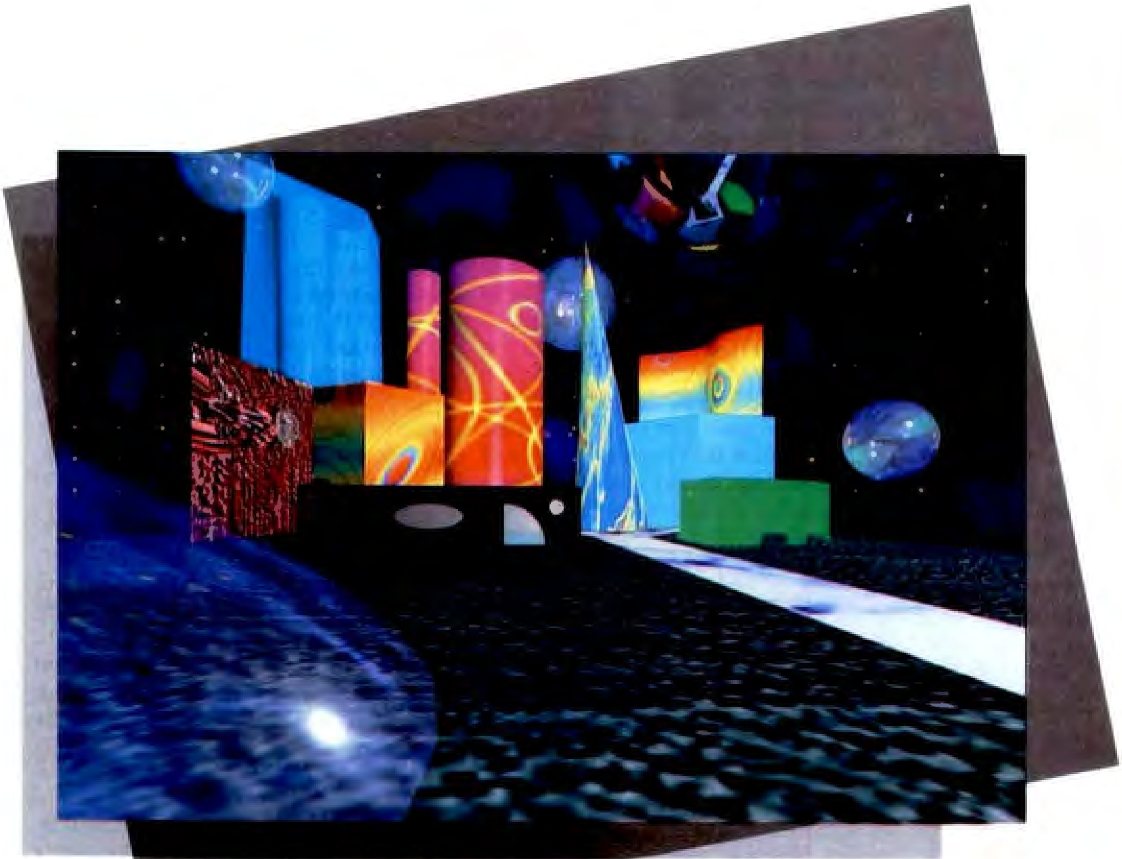

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something new, without special programming.

This new user programming has the same kind of potential that spreadsheet programming brought to numeric analysts. It enables problem solving by anybody who wants to learn the basics of linking two tools together. The major difference here is that the range and value of user-created solutions will be much greater than the range of spreadsheet applications. Instead of moving the three-year application backlog from the mainframe to the PC, we can empower the end users to provide their own solutions and (mostly) eliminate the backlog.

The Dilemma of Decision

Along with the opportunity of choice comes the dilemma of decision. The benefits of a GUI don't come free—there are hardware and software upgrades, and basic training is needed.

Choosing a GUI involves a complete reassessment of your system and your needs. Every item, from the hard disk drive to the display, will be affected by this change. More important, however, is that the way you work will also have to change to make best use of the GUI. I'll now look at what those changes will involve.

Hardware Upgrades

Consider first that a GUI is more compute-intensive. A screen display, multitasking, and bigger applications simply can't be supported well with less than a fast 286-based machine and plenty of memory. And while the screen display issue gets most of the attention, multitasking will become the key element in the GUI success. This is already heralded by the success of DOS multitasking. Once users experience not having to wait on anything, from a printer to a slow recalculation, there will be no going back. Real productivity gains will also come from users being able to respond to interruptions without losing track of what they were doing.

Starting with the base platform, we must face the final obsolescence of PC- and XT-class machines. With adequate peripherals and power, a $200 motherboard upgrade to a 12-MHz 286 system and $100–200 for additional memory is a minimal cost for enabling technology. A $300 CPU upgrade will get you a 16-MHz 286 processor with hardware EMS 4.0 built in. There is no longer any reason to handicap people with obsolete technology.

For more demanding needs, a 16- to 20-MHz 386- or 386SX-based system with 2 to 6 megabytes of memory, with room for more, should be adequate. For the power-hungry, people whose applications always run too slowly, a 25- or 33-MHz 386 with 8 MB should ease even their impatience. Along with all this will be the need for more hard disk drive capacity—more than you might expect. Consider 60 MB as a minimum, and 100–200 MB as more typical. Although these systems may seem large for the simple use of a word processor, the GUI benefits are good reasons for increasing capacity, and the hardware is no longer priced out of reach.

Getting the graphics in front of the user is next. A basic VGA and display gets you minimum resolution for graphics work. But if you are upgrading, you can get Super VGA capability for only a small increase in cost. Match the display against your processor capability—consider the sum of the processing power of the CPU and the display controller, measured against the combined processing/graphics load.

For example, a 25-MHz 386 machine will drive a Super VGA display to the limit of the controller's capability and still have quite a few cycles left for computation. A 12-MHz 286 will be slowed quite a bit by Super VGA, so use standard VGA, upgrade the processor, or off-load the graphics to a graphics processor on the controller board.

TMS34010 and IBM 8514/A cards offer an alternative to upgrading the whole system. You may choose to upgrade the controller to a graphics processor first, and wait on a processor upgrade. The higher your planned graphics resolution, the more processor power you need for equivalent performance. As a rule of thumb, an AT slower than 12 MHz should limit its display to 640 by 480 pixels. Processors that are 16 MHz and faster are needed for Super VGA (800 by 600 pixels), and by the time you reach 1024 by 768 pixels, a graphics processor is almost a necessity.

Software Upgrades

The environment you choose will depend in great part on the applications you are running and those you want to add. A DOS application user's simplest move is to Windows or, less easily, OS/2 (which requires more in platform resources but offers more capability). For many users, Windows is a logical choice because of lower platform requirements and a larger application base. OS/2 may be considered an evolutionary step beyond that.

Another option for DOS users with minimal resources is Desqview. This is multitasking without the graphics overhead, yet you can still run most graphics applications. Desqview offers its own set of interface calls, but the requirement for a standard UI is not there. Desqview is most functional on a 386, less so on a 286 with EMS 4.0 support, and least flexible without EMS. Each application still has its unique UI, which can be confusing.

Unix is in a different ballpark. First, the required resources start where OS/2 starts, but they grow larger in many cases. Second, the applications do not overlap the DOS environment very well, and running DOS emulation should be limited to a few necessary tasks. Third, Unix requires technical support not easily found in many businesses.

Why then would Unix be of any interest? For use with a powerful workstation with X.11 graphics or for special applications, Unix excels with large and complex tasks, particularly in networking. Networking (i.e, the sharing of files, devices, and peripherals—even CPU cycles) is part of the standard Unix software. For uses like a database server, Unix offers a broader and more powerful set of platforms. Currently, it is more likely that you would network into a Unix server than run a Unix workstation on your desk, but that may change as more powerful hardware and applications make Unix attractive.

Success of the GUI

Success ultimately will be determined by what best serves the user, as the user's needs are what justifies the cost of computer use. User needs drive the whole process, from applications to new display technology. As we evolve into networked environments that feature increased complexity and more powerful applications, there will be a greater need for the user to respond to ad hoc questions without custom programming.

Something must be done to prevent that complexity from requiring all computer users to be software gurus just so they can accomplish their workday tasks. That *something* is the "single system image" concept, where the complexities of the environment are hidden behind a user-oriented interface. That *something* is a GUI.

Current problems with cost/performance issues will be resolved quickly by improved implementations and faster, less expensive technology. New display and controller technology is an important part of making that happen. The other part of the picture is the user/software interface. User productivity

continued

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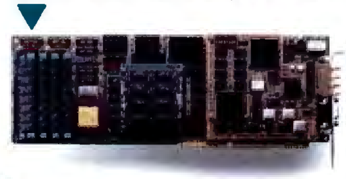

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will be enhanced by the GUI ease of use—the dynamic and user-built links and data access through networks that are transparent to the user.

In short, quicker learning and much greater functionality will drive the transition to a GUI. It will be aided by reducing the effort and complexity required to generate new solutions. Thus, as the computer penetrates further into business and home, the non-computer-literate population is the new audience. The GUI will broaden the base of people able to produce results from computers with these new tools. ■

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LAYING OUT THE FUTURE

Increased capabilities and color should give desktop publishing a rosy future

Matt and Mary Page

Our perspective on the future of desktop publishing is that of a small business, specifically an advertising agency. Our capital expenditures for computer equipment have to be carefully researched, as the difference between a good and a bad buying decision can ultimately mean the difference between staying in business as a profitable entity and struggling month to month. Discussing some current issues facing DTP is a good starting point for leading into what the future holds for DTP.

First, Some Background

Back in November 1987, we started Page After Page, a small, full-service advertising agency in Rutland, Vermont. Most of our business comes from small- to medium-size companies. DTP can be lucrative; we've doubled our sales each year and added two more people to our staff.

We help our clients plan their marketing and advertising strategies, as well as design, develop, and produce everything from print ads, brochures, newsletters, and corporate identity programs to radio and TV spots and books. Recently, designing and writing software documentation has become a major portion of our business. An important production tool in the daily operations is DTP, and it has surely added to our company's success.

Hardware/Software

We have grown up with and currently use IBM PC compatibles, as well as two Macs. Table 1 has a list of the equipment we're using. It's a mix of the new and the old—a mix that we think is typical of small DTP services.

But times are changing, and we'd like to keep current. As money and the business permit, we're planning strategic upgrades to enhance the performance of the software we have and to add new capabilities. Color figures heavily into the upgrade equation, as do beefier processors and higher display resolution. Table 2 shows our planned upgrades and our wish list.

Eek! A Mouse!

The transition from keyboard to mouse was the first hurdle to get over when we started with DTP. The nature of our business compelled us to investigate the Mac because of its command of the graphics environment.

With the type of work we do, keeping current in both environments is essential for serving our customers and keeping a competitive edge. The ability to exchange disks with our clients has been an important asset. And the fact that most businesses use IBM PCs or compatibles ensures that we will maintain and, hopefully, progress with DTP trends on both platforms.

continued

ILLUSTRATION: JAMES STEINBERG © 1990

CURRENT EQUIPMENT

Table 1: *Our current flock of hardware and software, typical of many DTP environments.*

COMPUTERS AND OTHER HARDWARE

IBM XT enhanced with 12-MHz 286 Sota mothercard, 1 MB of RAM, monochrome VGA, and 30-MB hard disk drive

ALR 386 running at 16 MHz with 2 MB of RAM, a 66-MB hard disk drive, and a Cornerstone SinglePage monitor

Mac II with 4 MB of RAM, a 65-MB hard disk drive, and a Cornerstone DualPage monochrome monitor

Mac SE/30 with 2 MB of RAM and a 40-MB hard disk drive

NEC 690 Silentwriter PostScript laser printer

20-MB removable Bernoulli drive, used for backups

Microtek International MSF-300C 2-bit scanner (1987 technology)

Orchid fax/modem

MAJOR SOFTWARE

Aldus PageMaker for Macs and PCs

Arts & Letters Graphics Editor 2.0

Microsoft Word for Windows

Microsoft Word for Macintosh

MultiMate Advantage II version 1.0 for the PC

EyeStar Plus scanning software for Microtek International scanner

Ventura Publisher 1.1 for the PC

Adobe Illustrator 88

DeskDraw and DeskPaint by Zedcor

Mind Your Own Business accounting software by Teleware

Reports by Activision for HyperCard (we created an invoicing system with HyperCard and Reports)

Microsoft Windows

TOPS AppleTalk network for all computers

PROSPECTIVE EQUIPMENT

Table 2: *Planned expansions and a few items that, while not critical, would be wonderful to have.*

High-resolution PostScript-output laser printer—possibly the LaserMax 1000

Abaton or Hewlett-Packard gray-scale scanner with ColorSet by Studiotronics (turns a gray-scale scanner into color) or Microtek International MSF-300Z scanner for color and gray scales

RasterOps 24-bit color board with 14-inch monitor (Sony or NEC)

Aldus PrePrint

SyQuest 44-MB removable cartridge drive

Network upgrade (we will need a faster network in the future, and it will probably be an Ethernet with a dedicated file server)

Additional PostScript fonts on an as-needed basis

9600-bps modem when a real standard emerges

KEEPING OUR FINGERS CROSSED

Polaroid Bravo Slide Maker

Radius Two-Page 24-bit color display with QuickDraw accelerator

Mac IIfx

QMS ColorScript printer

Linotronic L300 Imagesetter

PC World Issues

Many of our concerns in the PC environment revolve around memory issues—specifically, the memory limitations of the Windows/DOS world—and the nongraphical nature of DOS. For instance, we use Arts & Letters as our primary drawing and clip-art package for the PC. We like it, but it's painfully slow when working with a complex drawing, and it takes forever to print. In comparison, we use several drawing packages on the Mac, including Adobe Illustrator 88. For the most part, the functionality of A&L and Illustrator is comparable. But since the Mac's operating system was designed to be graphically based, Illustrator on the Mac prints much faster than A&L under Windows, and the Mac maintains a consistent interface between packages.

We've seen Windows 3.0, and we're pleased with the performance increase and the improved memory support. But now we must wait and be prepared to pay: Which software packages will be compatible with Windows 3.0, and at what cost?

The lack of graphics standards in the PC world poses other concerns, too; it's easy to be confused by all the different file formats. If you are not sure which package you will ultimately be placing a graphic into, or if you want to bring it into another graphics package first to change something—good luck! No two software packages seem to read or interpret these formats the same way.

Drawing on PostScript

It will be great if IBM's endorsement of PostScript means that we'll finally be able to see fonts correctly on-screen. But while screen appearance is important, the biggest issue with PostScript is lack of speed. Fortunately, this is being addressed by some printer vendors. Newer printers have faster processors and resolutions higher than 300 dots per inch.

We are currently considering the purchase of a high-resolution, plain-paper device. We've looked at the Varityper VP600, the NewGen Systems PS400, and the LaserMaster LaserMax 1000; the latter two are PostScript clones. NewGen's PS400 seems to have some incompatibilities, but so far the LaserMax looks pretty good. Presently, a high-resolution service bureau and traditional typesetting have enabled us to get the high print quality we need.

Desktop publishers have made a huge investment in PostScript—not only in equipment, but also in fonts. With this in mind, reinvestment in another standard

continued

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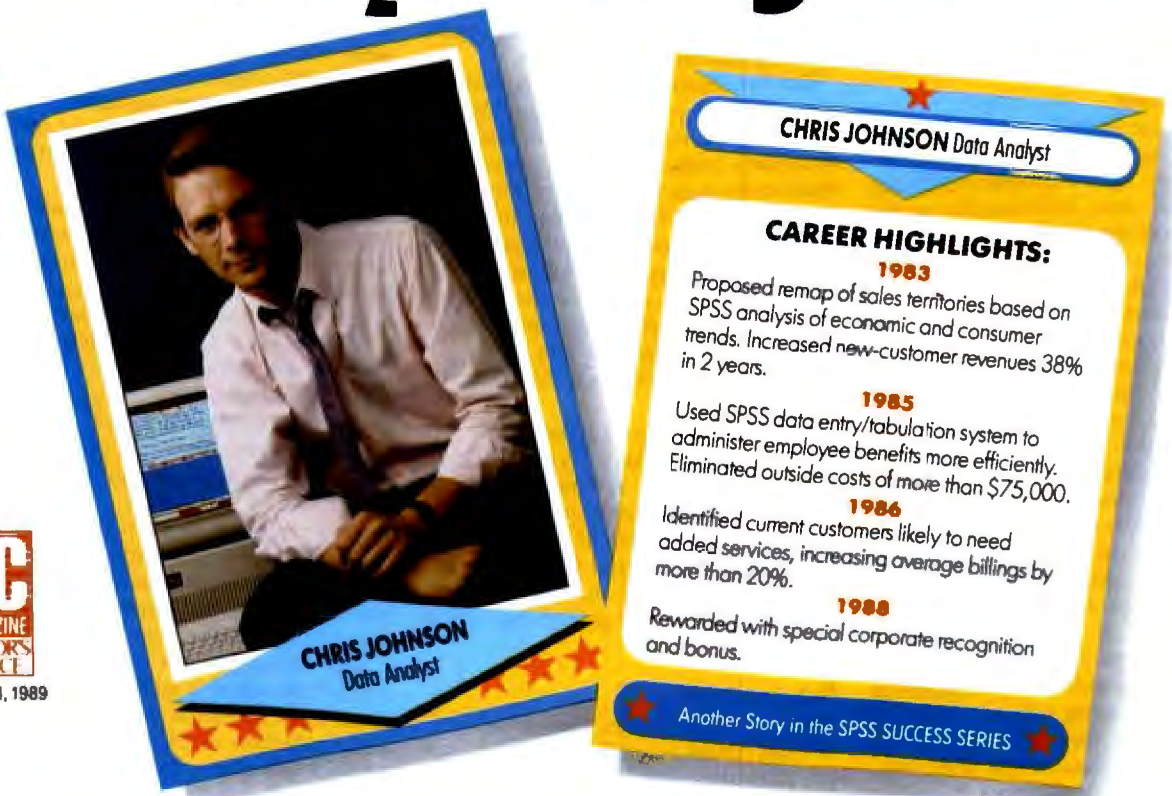

PC MAGAZINE EDITOR'S CHOICE
March 14, 1989

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seems out of the question unless someone develops a truly outstanding language and offers customers some sort of trade-in incentive.

Microsoft's new font technology is interesting. In our opinion, however, for it to gain market share quickly, it must be able to overcome the speed difficulties PostScript currently has, while keeping the ability to handle current PostScript-based applications and fonts. Again, we feel forced to take a "show me" stance. Will we have to update our software again with this new technology? And at what cost?

In Living Color

Color is a huge issue for us in advertising. The costs can be astronomical. Being able to see what a Pantone Matching System (PMS) color will look like on the screen is great for layouts and compositions; however, the next question from our client would be, "Can I have a copy to show so-and-so?" So we're not just talking about a color monitor and display board—we'd need a color printer, too. You can see where this is leading.

In any case, we have investigated color technology and think that the current costs are prohibitive. However, our future purchase plans include a 24-bit color board and a color monitor. Even without a printer, there still is value in being able to switch PMS colors on the screen and allow our clients to view the different versions.

We would use Aldus Separator and PrePrint for spot color only. Traditional methods of producing four-color separations are better for four-color photographs. Doing the same job with computer software is truly labor-intensive, and the output we have seen is substandard. For example, when you see a color scanner demonstrated, its output looks impressive on a computer screen, but the output printed on a PostScript printer looks nothing like it does on-screen. The color gradations have a linear, stepping effect. Besides, we would need to have a substantial amount of color work all the time to justify the costs of having a full-time color specialist, a color scanning device and software, and an adequate output device.

Back to the Drawing Board

There are other subissues as well. First, look at how you create a color layout. For us and many other graphic designers, it is simply uncomfortable to create layouts on a computer. The techniques of using a pen, paintbrush, marker, or airbrush cannot be duplicated to our satisfaction.

When artists draw, they look simultaneously at their hands, their tools, and what they are creating. Blending, shadowing, showing light on a subject from a certain angle, and showing reflections are all difficult techniques to duplicate electronically. Working on the computer is frustrating and, frankly, too slow. We can have a few layouts done manually in the time it takes to orchestrate one on the computer, so it usually does not make sense to use the computer for that particular process. And since designs are typically billed on an hourly rate, we would be doing our clients a disservice.

But have faith—we're sure that someone will develop a true designer's drawing board for microcomputers with the necessary tools: a larger, horizontal touchscreen with levels of pressure sensitivity, and styli that resemble markers, pens, and airbrushes. The analogy of paper on a drawing board is fundamental to designing and should be the basis of the design of an effective input device. Affordability would be key, too, for folks like us, or even for the freelance designer market.

It's when the layout is completed that DTP truly has value. Trying different typefaces—slanted, outlined, justified, or centered—and moving text and graphics around to get different effects are just a few of the time- (and money-) saving features. Previewing the output before committing it to the printer has saved many a disaster.

Dots per Inch

For many of the pieces that we produce, 300-dpi output is sufficient. Newspaper ads (they massacre everything anyway), newsletters, direct-mail letters, and so on all look just fine at 300 dpi. But for some of the more sophisticated multicolored collateral material and books, we send our files to an output service for 1800-dpi resolution.

There are desktop laser printers that do better than 300 dpi, but we weren't truly impressed until the LaserMax 1000 printer, with 1000 by 1000 dpi, became available for about $8000. Without a loupe, it's difficult to tell the difference between its output and that of a higher-resolution device (offering 1200 to 1800-plus dpi). Even 7-point type is readable and not fuzzy. Sure, it would be wonderful to have a Linotronic Imagesetter and be able to print out 1800-plus dpi in our shop. But at over $30,000 (plus the costs of paper, supplies, chemicals, and maintenance), it would be hard to justify the $22,000 differential for what we think is a minimal increase in quality.

Where Do We Go from Here?

In terms of page-layout packages, PageMaker 4.0 should answer many of the complaints that we have with PageMaker 3.0. Most of these complaints revolve around text editing. Because we need both IBM and Mac versions, we'll wait until we hear when the IBM version is to be released before we update.

The documentation work we've been involved in lately has confirmed the need for a true object-oriented DTP package with good text-editing capabilities. This would alleviate much repetitive work when editing copy related to one topic; it would also reduce errors. Also, in supplying documentation via electronic media, it would be beneficial to be able to find any or all references to a particular topic and browse through them.

Synergy, if not total integration, of DTP and multimedia already exists. As with any new technology, educating people about its benefits and capabilities takes time, so the process of market penetration is slow. Only a limited number of our customers would use this new form of communication. We give it a year or so before it truly catches on.

Staying technologically current makes sense only if you can afford to, or can't afford *not* to. As a small company, we try to keep down our expenses for new equipment and technology. But as computer enthusiasts, it's fun to investigate and to hope that if something is terrific, it will become affordable.

Our philosophy has been to embrace technology where it makes sense. We've stuck with traditional methods of design and production when moving up would be too expensive or labor-intensive. We use DTP, not because it lets us work faster, but to give us more control over how the final product looks and when it will be delivered. DTP's biggest failing is the initial learning curve. The time savings come only after many hours (or years) of learning and making mistakes.

Communication and professional presentation are essential to the success of any business, and that is what DTP is all about. As we see it, DTP can't help but increase its market share and mature and expand its focus. ■

Matt and Mary Page own and operate Page After Page, a small DTP company in Rutland, Vermont. Prior to starting their own company, Mary was the director of product management and Matt was the director of operations at MultiMate International, creator of the MultiMate word processor. They can be reached on BIX c/o "editors."

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COLOR FOR THE DESKTOP

New printer technologies offer color at a price

Rick Cook

The average color printer is about four times as complicated as a monochrome printer with the same resolution. Color brings with it a whole raft of difficulties that you don't have in designing a monochrome printer.

Because of the problems and added costs, color printers are not likely to sprout up on everyone's desk in the next few years. They are getting less expensive and more flexible, however, and new computers and new kinds of software are making them more attractive all the time. A color printer also increases the scope of a computer system, so some users are willing to pay extra for them. Thus, color printers for desktop systems represent a fast-growing segment of the printer market.

There are three major technologies used to build color printers for desktops: dot matrix, ink jet, and thermal wax. A fourth technology, dye sublimation, is beginning to show up in small computer applications, and several other methods, such as color laser and dye transfer, will probably appear during the next two or three years.

The Challenge of Color

The basic problem with color printers grows out of the way they print color. All existing color printers build up reflective colors by applying primary-color inks to the paper. In printing, those colors are cyan (blue-green), magenta, and yellow. All other colors can be blended from them. Since it is hard to get a good, solid black by mixing colors, almost all printers include black as a fourth color. This is called the CMYK system, K being the printers' designation for black.

The mechanical problems that this blending causes are obvious. The printer has to have four print heads or make four passes to lay down all the primary colors. To get the colors in the right place, the paper alignment with the print head, or *registration*, has to be tightly controlled. This is particularly true of page printers that use thermal wax or sublimation processes, in which the sheet of paper is run through the mechanism four times.

Beyond mechanical considerations, however, there is a whole other class of problems that grows out of the nature of color itself. For example, one-color printers are judged almost entirely on resolution. Resolution is important in color printers, too, but it doesn't tell the whole story. A sublimation printer at 160 dots per inch has a much better apparent resolution than a 300-dpi thermal wax printer, because a thermal wax printer produces visible dots and a sublimation printer doesn't.

On a one-color printer, black is black, pretty much. Gray scales are also pretty

continued

ILLUSTRATION: CATHARINE BENNETT © 1990

Photo 1: *The Hewlett-Packard PaintJet XL ink-jet printer.*

much the same from printer to printer. On color printers, things are not nearly that uniform. A medium yellow on one printer doesn't necessarily look anything like another printer's medium yellow, or like the medium yellow you saw on the screen.

Finally, ink and paper technology is much more important in color printing than in monochrome printing. Getting an ink that stands up to the rigors of the printing process, blends well with other colors, doesn't smear in paper handling, and is absorbed into the paper properly is not an easy job. In fact, most of the ink formulations used in conventional printing simply will not work. Besides, most printer inks are made with solvents you don't want in the air in your office.

As for paper, everything from absorbency to thermal characteristics plays a role. Papers differ in these characteristics, even among batches of the same kind of paper from different manufacturers. Ideally, users would like to be able to print on "plain paper"—which translates into "any paper I want." Some color printers, notably dot-matrix and ink-jet printers, come close to this ideal. Some, like sublimation and dye-transfer printers, cannot do this because they demand specially treated paper.

Dithering

Desktop printers can manage 300 dpi of resolution—but, because of the characteristics of color printing, 300 dpi isn't really 300 dpi. In fact, it can be more like 35 dpi. The problem is that colors must be mixed to get shades, and most desktop color printers on the market today have fixed dot sizes. In other words, they put down either no ink or a fixed amount of ink in a particular color. This is very different from ordinary color printing, where the photoengraving process produces a range of dot sizes.

With the primary colors and fixed-size dots, you can actually get only eight colors in a single dot: paper white, black, cyan, magenta, yellow, red, green, and blue. The last three are made by placing two dots of the appropriate complementary colors on top of each other. With most technologies, the other colors are produced by dithering.

Dithering originally meant introducing a small amount of random noise into a system to smooth out artifacts (system-induced features). This is analogous to what color printers do.

Color printers dither by combining dots into blocks and then varying the number of dots of each color within the blocks to get the right shade. In effect, each block becomes a superpixel whose color is determined by the number of dots of the primary colors laid down in the block. The most common sizes of blocks are 4 by 4, 5 by 5, 6 by 6, and 8 by 8 dots.

Dithering is effective, but it imposes a trade-off. The smaller the block size, the higher the resolution but the fewer shades you can have in that block. It also introduces a couple of problems of its own.

At first glance, you would think that dithering takes us back to the dark ages of desktop printers. A 4- by 4-dot dither pattern on a 300-dpi printer gives a resolution of 75 dithered blocks per inch. That implies that a 300-dpi color printer is no better than a coarse dot-matrix printer. In fact, this isn't as much of a problem as it seems.

Dithering reduces the effective resolution of the color image, but not as much as simple division suggests. Once you get about 6 inches away from the picture, your eye starts integrating the dots into areas of solid shade. Also, because each block contains several separately addressable pixels, antialiasing is built in. This eliminates the jaggies caused by low resolution. The result is a lack of apparent sharpness, rather than the effects normally associated with low resolution.

However, there are other problems with dithering besides low resolution. The pattern of colored dots within each block can produce unwanted effects. The most extreme are the moiré (watered silk) patterns you get with a large area of very regularly patterned dots. Another is the banding of an area that is supposed to be smoothly shaded. Other problems include lack of perceived sharpness over and above the lack of sharpness that comes from the superpixels in the first place, and muddy colors.

Many different dithering patterns can be used to print color from dots. Most color printers have several patterns available, and some, like Hewlett-Packard's PaintJet (see photo 1) and some Tektronix models, examine the image and automatically choose the most appropriate dithering pattern for it.

Dot-Matrix Printers

Far and away the most numerous color printers are the dot-matrix printers. Many dot-matrix printers from companies such as Epson and Citizen can produce color output simply by using a ribbon with the primary colors on it.

As almost anyone who has ever used a computer knows, a dot-matrix printer uses wire-like elements driven by individual solenoid hammers to press an inked ribbon against paper to produce an image. In almost all desktop models, the print head has between 9 and 24 wires and is mounted in a carriage that moves it across the paper.

Dot-matrix printers are the most popular color printers on today's desktop. They are simple, cheap, and reliable, and they do a good job on graphs and most other kinds of simple presentation material—the major part of the market for color desktop printers today.

The biggest problems with dot-matrix printers are resolution and color quality. Nominally, some dot-matrix printers go as high as 180- by 360-dpi resolution. In practice, the resolution tends to be somewhat lower because of perceptual factors and because of the size of the print-head wires.

Given multirow print heads, it is possible to lay down dots on 1/300-inch centers, but this isn't the same as having true 300-dpi printing. The other limiting factor is the diameter of the wires in the print head. Thinner print-head wires are more delicate and can't take the pounding of the solenoid hammer. Also, it gets harder to keep the wires from binding in the head as the mechanism heats up in use. For these reasons, the printing elements tend to be larger than the nominal resolution of the printer in high-resolution units. The printer may produce 300 dpi, but the dots overlap, and the image doesn't look as sharp as a true 300-dpi image.

Colors on a dot-matrix printer tend to be muddy. This is partly because of the inks used, and partly because the ribbon tends to become contaminated by other colors as it makes multiple passes across the paper.

The other problem is that, while dot-matrix printers can do color, they lack the specialized features built into other kinds of color printers. For example, dot-matrix printers usually do not have the processing power needed to support elaborate dithering algorithms. It is hard to avoid banding, moiré patterns, and other artifacts, especially in large areas of color. Photographic and other continuous-tone images suffer particularly.

Figure 1: *An image created on an HP PaintJet XL ink-jet printer. Resolution is 180 dpi, and the original shows a lack of sharpness in areas such as the feather edges. Hewlett-Packard and others are developing 300-dpi ink-jet printers.*

Ink-Jet Printers

An ink-jet printer can be thought of as a dot-matrix printer without the wires. Instead of using hammers to press wires through an inked ribbon, ink-jet printers spray drops of color onto the page. At low resolution, the result looks like dot-matrix printing. However, ink-jet printers are capable of higher resolution than dot-matrix printers. They also avoid some of the problems of dot-matrix color printers, at the expense of adding some problems of their own.

Some color ink-jet printers use solid ink (melted before spraying onto the paper); others use solvent-based ink. But most ink-jet desktop printers use water-based ink.

There are three main types of ink-jet printers, classified by the way they generate the droplets of ink. Some large ink-jet printers (but no desktop models) use a pressurized ink feed combined with fast-acting valves to produce ink drops. An electrostatic system steers the drops to the paper. Desktop ink-jet printers use either a piezoelectric crystal or a burst of heat from a resistor in the print head to generate ink drops. The heating print head ("thermal ink jet" in Hewlett-Packard parlance, and "Bubble-Jet" to Canon) can be made small. But the ink in a heating ink-jet printer has to be able to withstand the heat, and that further limits the ink choices.

Although some large, expensive ink-jet printers have resolutions as high as those of laser printers, the models on desktops are more comparable to dot-matrix printers. The limiting factor on ink-jet resolution is not the print head but the interaction of the ink and paper.

The thermal/Bubble-Jet ink-jet heads are fabricated using techniques for building ICs, and they can be made small enough to put 1000 ink-dot orifices side by side. Piezo mechanisms tend to be a little bigger, but there are methods (e.g., staggering the orifices) of making a 1000-dpi head with that technology, as well. The trouble comes when all those droplets of ink hit the paper. Unlike the ink in thermal printers, which is fluid only because it is heated, the ink in ink-jet printers is a liquid that soaks into the paper; adjacent dots can bleed together if they are close enough. Because of the characteristics of the printer, ink-jet ink has to flow freely. That is one of the reasons ink-jet printers work best on more absorbent papers.

Hewlett-Packard has been doing extensive research in the area of ink-jet-printer inks for several years. One result was the HP DeskJet, a 300-dpi one-color ink-jet printer that sells for less than $1000 and produces nearly laser-quality print. But the DeskJet also illustrates the problems of high-resolution ink-jet printing. The main complaint about it is that its ink is extremely water-soluble, even after it has dried. Anything printed on a DeskJet has to be kept dry or it becomes illegible. Hewlett-Packard had a lot of trouble finding an ink that would work at 300 dpi, and the DeskJet ink is the best the company could come up with. The problem is worse with color, because different colors can bleed together and change shade noticeably (see figure 1).

One way around this is to use special paper with controlled characteristics. Hewlett-Packard says it could have introduced a 300-dpi color ink-jet printer more than a year ago if it had been willing to take that approach. Instead, the company is concentrating its efforts on making a printer that will work with any common kind of paper. Although Hewlett-Packard isn't saying, observers are betting that it will be at least two years before the company can bring such a printer to market.

One possible method of getting better resolution and color from an ink-jet printer is to vary the dot size. This has the effect of mixing the colors right on the paper.

In multidot printing, the basic unit of ink is much smaller than one full dot's worth, and dots are built up with multiple

continued

Photo 2: *Some thermal wax printers, such as the QMS ColorScript 100, are PostScript compatible.*

units. The printer combines many tiny dots of the appropriate colors to produce a full-size dot of the finished color. This works especially well with ink-jet printers because the inks they use are very transparent and mix easily. Some very expensive ink-jet printers, such as ones from Iris, use this system. Its application on the desktop is more difficult.

For one thing, the orifices in the ink-jet head have to be much more precisely manufactured because they are smaller. That is hard to do in a printer inexpensive enough to sit on your desktop.

There is also the problem of mixing colors on the fly. The printer needs the processing power to figure out the best way to mix each drop of ink to get the proper color, and it has to make that calculation for each of the million or so dots on a page.

Furthermore, the process is limited by the quantization of the amounts of ink that can be applied. Compared to conventional printing, which can vary the amount of ink applied to a dot smoothly over a wide range, a multidrop printer would have a fixed, limited number of ink units per dot. This puts limits on color matching without going back to dithering and superpixels.

Thermal Wax Printers

If you want quality that goes beyond what an ink-jet or dot-matrix color printer can give, a thermal printer will probably be your choice. At $5000 to $15,000, they are expensive but not totally out of reach. Colors are bright and saturated, and most models have a resolution of 300 dpi.

A thermal printer has an array of individually heated wire-like print elements. Heating an element melts a dot of wax-like ink onto the paper. Because the elements don't have to move, as dot-matrix printing elements do, they can be thinner, allowing higher resolutions.

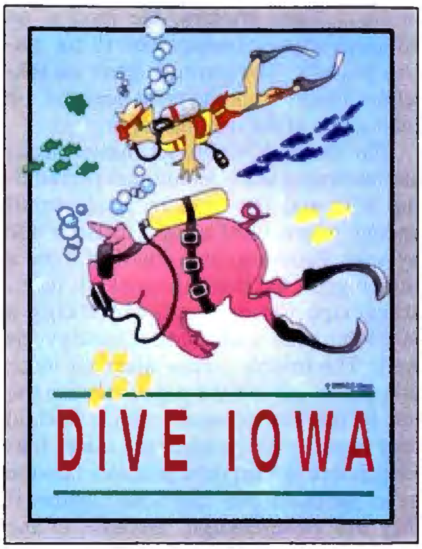


Figure 2: *Thermal wax prints, printed on a Tektronix Phaser PX thermal wax printer, show the printer's 300-dpi resolution and highly saturated colors. What is less obvious in this reproduction is the way the dithering of the dots reduces the effective resolution.*

One thermal wax printer, the $200 Okimate 20, uses a moving head and cartridge ribbon like a dot-matrix printer. However, its print quality is poor for a thermal wax printer. The professional models, such as the Tektronix Phaser PX (see figure 2) and the QMS ColorScript 100 (see photo 2), use a fixed sheet-wide print head and a sheet-wide ribbon.

One advantage of thermal wax printing is that it puts less demand on the inks than some other technologies do. Basically, the ink only has to melt at a given temperature and adhere to the paper. Because the ink requirements are less demanding, thermal wax printers tend to have more saturated primary colors than other common kinds of color printers. This translates into a wider range ("gamut" in printer talk) of available colors, although not as wide as with sublimation or some other advanced technologies.

Although thermal wax printers can print on plain paper, they produce their best results on special, smooth-surfaced papers. Thermal printing doesn't work well on textured surfaces, and even the way the paper responds to heat has an effect on how the image appears.

Like most other color printers, a thermal wax printer can't print a bleed page in which the color runs to the edge of the paper on all sides. At least one edge is covered by the gripping mechanism that moves the paper through the printer.

Unlike in ink-jet and dye-sublimation printing, the dots from a thermal printer don't spread on the paper at all. At its worst, this produces an effect similar to that of the rotogravure process used to print the Sunday comics: You get the same sort of red-speckled flesh tones you see in the comics (see figure 3).

Just don't expect cheap prints. With the exception of the remarkable little Okimate 20, the materials are expensive. Thermal-printer ribbons are typically more than $100 each, and each ribbon can be used only once. As a result, prints from a thermal printer cost between 25 cents and $1 apiece.

Color Laser Printers

Color laser printers exist, but they are expensive. They have remained in the $50,000 to $100,000 category, although there are now a few edging down into the $25,000 bracket.

The fundamental problem with a color laser printer is that the paper has to pass through the print engine four times to complete the image. Not only does this cause the usual problems in registration, but laser printers have some special problems as well.

One of them is the toner. A color laser printer has to lay toner over toner in order to produce mixed colors. The whole process is roughly equivalent to trying to paint over wet paint and keep the colors separate. It is also hard to avoid contaminating the toner and getting flecks of misplaced color on the image.

All these problems have solutions, but so far the solutions haven't come cheaply or in a small package. A small color laser printer is pricey and is about the size of a compact refrigerator. Thus, they are not popular as small system peripherals.

This is beginning to change. Traditionally, laser printer technology has been driven by copier technology. In the last several years we have begun to see cheaper, better-quality color copiers. As the technology shakes out, we can expect to see more color laser printers.

Other Technologies

Several other color printing technologies seem to be making their way toward

continued

Figure 3: *In spite of the 300-dpi resolution, the dot pattern of thermal wax printers looks coarse, because the colors are produced by dithering. In the original printout, produced on a QMS ColorScript 100 printer, this effect is most noticeable on the woman's skin and the water in the pool.*

ITEMS DISCUSSED

Hewlett-Packard PaintJet XL
Hewlett-Packard
Customer Information Center
19310 Pruneridge Ave.
Cupertino, CA 95014
(800) 752-0900
Inquiry 851.

QMS ColorScript 100
QMS
One Magnum Pass
Mobile, AL 36618
(800) 631-2692
Inquiry 852.

Tektronix Phaser PX
Tektronix
Graphics Printing and Imaging Division
P.O. Box 1000, MS 63-630
Wilsonville, OR 97070
(800) 835-6100
Inquiry 853.

desktops. So far, only dye sublimation is a competitor to thermal wax, ink jet, and dot matrix, but others have at least the potential to show up on desktops.

Sublimation printers are first cousins to thermal wax printers. They, too, use a thermal print head composed of an array of wires. But instead of turning liquid under the heat of the printing head, the inks in sublimation printer ribbons vaporize. The vapor crosses a small air gap to the specially treated paper, to which the color is fixed.

Superficially, a sublimation printer looks like a thermal wax printer. Indeed, one company, Mitsubishi, packages its thermal wax and sublimation printers in the same case. Paper handling and electronics tend to be very similar as well. But the print engines are very different.

The printing elements in a sublimation printer are heated to as much as 400°C (752°F), much higher than the elements of a thermal wax printer. Because of the high heat, and because the ribbon isn't actually in contact with the paper, the resolution tends to be lower than with thermal-transfer printers. Most desktop models are around 150 to 160 dpi.

But this means less than you might think. The most remarkable thing about a sublimation printer is that the image shows no dots. The inks blend on the paper to produce smooth, even tones with no need for dithering. A print looks like a color photograph.

It also costs like a color photograph. Sublimation printers cost about $12,000 and up. The ribbons and treated paper are also expensive—typically, prints cost $5 a copy.

Another printing technology is Mead Imaging's Cycolor process. It uses dyes in microcapsules similar to the ones used on carbonless forms. The "ribbon" is a special paper or film coated with microcapsules, each of which contains a dye and a compound that hardens the capsule when it is exposed to light of the proper color. The paper is then impregnated with an acid resin that develops the dye that comes in contact with it.

Exposing the sheet with the dye capsules to colored light hardens those capsules that aren't needed to produce the color. Then the color sheet and the receiving sheet are pressed together by pressure rollers. The unhardened capsules rupture, their contents mix with the resin on the paper, and the image forms.

Cycolor printing does a very good job of capturing fine gradations in color. It is expensive, however, and the color saturation isn't as good as in some other processes. The materials are also photosensitive, which means that they must be handled like lithographic film.

Finally, there are several color printing methods that use techniques much like color photography. They include photographs produced by color film recorders, Honeywell's dry-silver process, and several others. All of them use special media, and usually the media are light-sensitive. In most cases, the medium contains layers of dyes that are activated when light of the proper color strikes them. The processes differ in how the image is developed. The Honeywell process uses heat; some others use chemical solutions.

As a class, these processes are characterized by saturated colors and excellent handling of fine gradations in tone. They are generally expensive and, in some cases, cumbersome for desktop use.

Color for the Future

One thing you can always safely predict about computer equipment is that the price will drop. In the last three years, the price of the cheapest color thermal printers has fallen by about half.

But there are limits to how low prices can go. By its nature, a color printer has to be more precisely constructed than a monochrome printer of the same resolution. The mechanical components that are needed to move and position paper don't follow the same price curve as electronics, and, in general, the more mechanisms a device needs, the higher its price will remain.

On the electronics side, there is a lot more to a color printer than to a monochrome one. This is especially true of RAM. Like a laser printer, a thermal wax printer needs 1 megabyte of RAM to store a full-page image at 300 dpi in one color. That means 4 MB to store a color image, and, unlike a monochrome laser printer, a thermal wax printer can't economize by storing only part of a page at once. Because it makes multiple passes to print the image, it has to have all of the image in memory at the same time. Still, you can reasonably expect that over the next two years 300-dpi color printers will drop into the same price range as medium-price ($2000 to $3000) desktop laser printers.

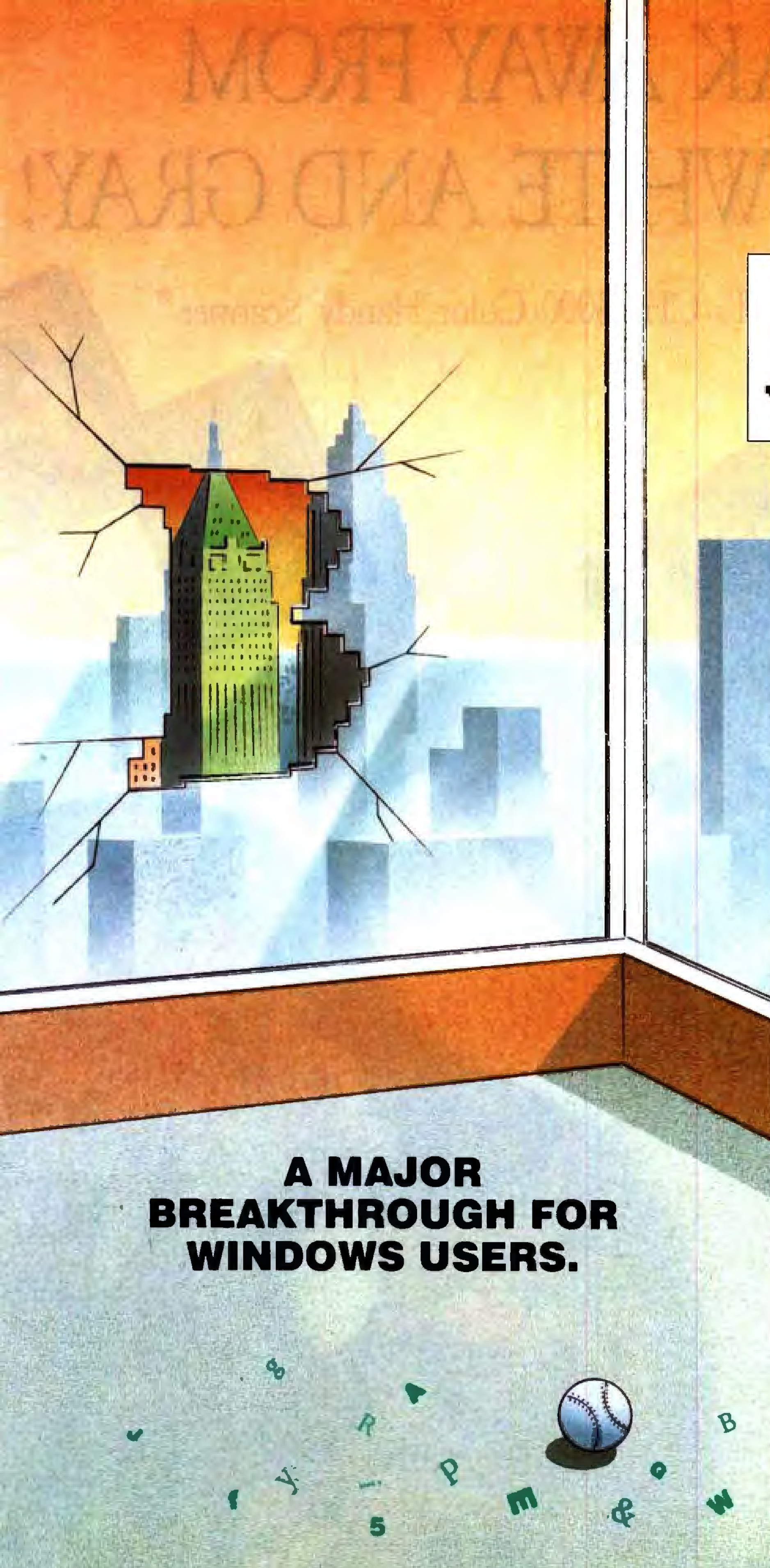
The first contenders for "low-cost" 300-dpi color printers will probably be ink-jet models. Late this year or early next year, 300-dpi color ink-jet printers will probably hit the market. The first ones will probably cost $5000 to $8000 and will require special paper. Follow-on models will drop in price and be capable of printing on most kinds of paper.

There is a definite trend toward plain-paper printers. This works in favor of technologies like ink jet and laser, and against thermal, sublimation, and some other forms of dye-transfer printers. But the trend shouldn't be over-emphasized. If someone comes out with a good sublimation printer that sells for $1000 less than a thermal or ink-jet printer of the same quality and that uses special paper, most users will probably learn to live with the paper issue.

Theoretically, a color laser printer has a lot of advantages, not least of which is a combination of high resolution and plain-paper printing for a fairly low cost per copy. In the next several years, color laser printer prices may drop to as low as $10,000. Something like an LCD shutter or LED-type printer might go lower yet.

No matter what technology is used, color printers aren't for everyone. But as they get better and cheaper, you'll undoubtedly find one for your desktop. ■

Rick Cook is a freelance writer specializing in computers and high-technology subjects. He can be reached on BIX as "rcook."



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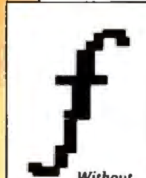

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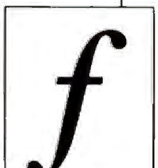

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THE MIGRATION OF THE X WINDOW SYSTEM

A standard windowing system may be in everyone's future

David Moore

Windowing systems used to be novel; now they are commonplace. Working with a windowing environment was once a treat; working without one is now a burden. But the windowing systems in use on personal computers today are all different, and it's hard to move an application program from one system to another. Developers can't afford to support all the windowing systems; neither can they afford to restrict their market to users of one system. Consequently, few applications take advantage of any of the existing windowing environments.

For window-based applications to become the norm, a standard windowing system is needed. This is particularly important in the personal computer world, where there are at least three incompatible windowing systems—GEM, Microsoft Windows, and OS/2 Presentation Manager (PM). Ideally, the standard should run on a variety of machines, rather than just on personal computers, so that familiar application products will rapidly support hardware advances (e.g., fast RISC-based machines).

Manufacturers of popular personal computers view the prospect of increased competition from alternative hardware platforms with trepidation. It's easy for them to see increased competition decreasing their market share. It is much more difficult for them to see their sales increasing overall because of an expansion in the size of the market. You cannot look to them for a standard windowing environment.

Fortunately, MIT has been working on the X Window System for many years. This system began as a windowing environment for Unix, but it is spreading to other platforms, including MS-DOS.

The Origins of X

When Unix first became widespread in the mid-1970s, users worked at teletypewriters and simple video terminals. On the earliest video terminals, text appeared at the bottom of the screen and scrolled up and off the screen as more text was written. These video terminals, commonly called "glass teletypes," were simply more convenient replacements for the terminals that printed on rolls of paper.

The modern video terminal responds to a variety of commands that control how and where text is displayed on the screen. This allows a modern Unix application to format screen output. There are numerous makers of terminals—many with incompatible command sets—but Unix can automatically handle these differences. An application programmer does not have to be familiar with every type of terminal in existence. Instead of writing to

continued

the terminal directly, the programmer talks to the terminal through a library of software routines.

While Unix can run several programs at once, it has no standard facility for organizing their output. Early windowing systems used the capabilities of intelligent text-based terminals to separate the output into windows. As terminals became more powerful, graphics terminals appeared.

Unfortunately, as with text-based terminals, each make of graphics terminal had its own set of commands, and different models of the same make had slightly different specifications, requiring slight differences in the code that drove them. Workers in the MIT Athena project were faced with having to individually program hundreds of different graphics terminals.

The X project was conceived to address this problem. X produced a windowing environment that was more sophisticated than the environment of text-based terminals. As the design of X progressed, so did the goals of the project. The result is a windowing system that is far more capable than any of the proprietary systems found on personal computers. The present version of X not only supports a windowing environment on a range of graphics terminals, it also supports distributed execution of applications. A graphics terminal does not have to be connected directly to the machine that runs a program; it can be anywhere on a network.

X can display output from several programs at once, and these programs can run simultaneously on different machines. X allows you to access any machine on a network as if it were directly connected to your terminal. The machines do not have to be the same type or run the same operating system. Everything in X is treated as a window, even drop-down menus and radio buttons.

How X Works

X defines two sorts of programs: servers and clients. An X server is the program that actually manipulates images on a terminal. Clients are user applications that use X facilities and X utility programs.

A client talks to a terminal's server rather than writing directly to the terminal. The server is customized to work with a particular type of graphics terminal. It can perform various primitive graphics operations and display text in a variety of fonts. Consequently, many of the messages from the client to the server are quite short, containing only a high-level command and some parameters, rather than the pixels required to draw an object. In addition to commands flowing from the clients to the server, keyboard and mouse actions (*events*) cause messages to flow from the server to clients. These events normally go to the application that owns the window in which the mouse is positioned. So, when running several applications at once, you input to an application by first moving the mouse pointer into one of the application's windows. If a special client called a *window manager* is running, it determines which window receives input and how the windows are stacked, and gives you the tools to move and resize them. Without a window manager, X can be manipulated only by the application and a handful of command-line utilities.

Selecting a window manager has little impact on client programs, but it can change the way windows look on the screen, and it affects the way you manipulate windows. For example, if you don't like having windows disappear under other windows, you can select a window manager that "tiles" windows, so that they never overlap. The Motif graphical user interface, for instance, has a window manager that gives all windows a distinctive "chiseled" border.

X provides several utility programs that run as X clients. The most commonly used of these is `xterm`, which makes a window look like either a DEC VT102 text terminal or a Tektronix graphics terminal. Under `xterm`, a user can run anything that will run on a conventional text-based terminal. The `xterm` utility captures all the output from the program and redirects it to X; it also captures all of the program's attempts to read from the keyboard and directs these requests to X.

You gain several advantages running under `xterm` rather than on a simple terminal: Multiple copies of `xterm` can run simultaneously, allowing many programs to run at once; `xterm` can use any of X's fonts, so you can tailor the style and size of the text to your liking; and you can scroll back through text that has disappeared from your screen.

A cut-and-paste facility allows you to move text between windows. You do not have to run an application to do a paste; you can cut a line out of a help file in one window and execute it as a system command in another. Other utility programs include such things as a bit-map editor, a scientific calculator, a manual browser, and programs that let you see how X is performing. In addition to the standard X utilities, a given implementation is likely to have several utilities that were contributed by X users.

Motif and Open Look

One of the original goals of X was to impose no style of interface on its users. The designers recognized that no one interface would be suitable for all applications and did not want to produce a windowing system that was good for only some applications.

Other windowing systems, such as those of the Mac and OS/2's PM, do much more than just manipulate windows. They define guidelines for how applications should interface with the user, and they provide libraries that support (and enforce) these interfaces. Under X, a layered graphical user interface (GUI) provides similar facilities.

An X GUI consists of a window manager that imposes consistent appearance and behavior characteristics on X top-level windows, and a software library that supports the creation of applications that adhere to the style guidelines of the GUI. The libraries support the various objects that you would expect in a windowing environment: menus, dialog boxes, selection lists, and radio buttons. There is also likely to be a resource compiler, so you can define the contents of your objects outside your compiled code. Two GUIs have gained wide support: Motif and Open Look. Motif is produced by The Open Software Foundation. Open Look is the result of the combined efforts of AT&T and Sun Microsystems. Motif has been adopted as part of a standard version of Unix in Europe, where computer companies see Unix as a bulwark against the inroads foreign computer manufacturers are making into their market.

The existence of two competing GUIs should not have a major impact on users. While it is possible to produce applications that critically depend on the window manager being used, this is poor practice. If applications are written correctly, it should be possible to run an Open Look application under Motif and a Motif application under Open Look. There may, however, be some problems for developers if a particular machine does not have an implementation of their chosen GUI.

Workstations and Terminals

For some time after the introduction of X, the only way to run it was on an expensive graphics workstation. A recent development is the availability of X terminals. These terminals are working computers in their own right, but dedicated to a single task: running an X server. The terminal must be attached—either through a network or through a serial cable—to one or more hosts on which the X clients will be run. The terminal itself cannot run client programs.

It would seem logical that any computer advanced enough to run an X server should be capable of managing other tasks as well. This thinking led to the birth of PC X server software.

A PC X server, in effect, turns your PC into an X terminal for as long as it runs. True to its "terminal" image, it is incapable of executing X clients. What's more, most PC X servers can't run other DOS programs while X is running; X must be suspended until the DOS program is finished.

Quarterdeck Office Systems, maker of the Desqview multitasking environment that runs under MS-DOS, is working on an implementation of X for Desqview. What's unusual about this project is its goal: to provide not only an X server that runs alongside DOS, but an environment under which X client programs can be written and executed on DOS systems. Quarterdeck intends to support both Motif and Open Look and will make developer's packages available for both of these environments, as well as for the basic X interface.

I was fortunate enough to see an early version of this software running on one of Quarterdeck's development machines. Despite the developer's warnings that this was still an early version, the software ran wonderfully.

When I sat down at the demonstration machine, four programs were running—each with its output displayed on a separate, Motif-style window. Only two of the programs were running on the PC; the other two were actually running on a networked Unix box in another room. Quarterdeck's implementation can also run applications on other networked MS-DOS machines running Quarterdeck's version of X. Only a seasoned X user would fail to be impressed by this level of functionality. For each application, Desqview maintains information on where the program is and which directory it is to run in. When running the X environment, you can specify a machine name in addition to a directory name. Once this is done, starting the application is completely transparent to the user.

Of course, as with standard Desqview, you can run all your existing MS-DOS applications in the new environment. You can also run all your existing Desqview-specific software. You can use any of the standard window managers with Quarterdeck's X system. In addition, a window manager that looks and behaves like the standard Desqview window manager has been implemented. This window manager is much smaller than the standard ones.

The X Window System promises to become the standard windowing environment.

Quarterdeck is attempting to make the process of transferring software from Unix to X under Desqview as easy as possible. To minimize the changes programmers have to make to their code, Quarterdeck is even implementing a number of Unix C calls that have no real equivalents in MS-DOS.

I am told that the Desqview environment will support virtual memory on both the 286 and 386 and will support programs written using the protected mode available on these processors. Application developers will not have to shoehorn large Unix applications into DOS's 640K-byte memory, although they may have to use a DOS extender to make that extra memory available. The entire environment, including Quarterdeck's window manager, will fit in less than a megabyte of memory, so it will be possible to use Desqview/X on a 2-MB machine. This compares well with OS/2 PM, but with memory costing around $100 per megabyte, memory use is only an issue if your machine lacks expansion capability. If you want to do serious multiprogramming, I recommend 4 MB.

Quarterdeck intends to release a runtime-only version of its X implementation, so developers will be able to sell to all MS-DOS users, not just those who use Desqview/X. This software makes it easier for Unix developers to move their software to MS-DOS. Without a compatible environment, this process is prohibitively expensive for most developers. Not only does it require considerable work to move the software to a foreign platform the first time, but much of the work must be repeated each time there is a new release.

The process will also work the other way: Developers of MS-DOS software will implement under X so that they can later move up to the Unix workstation market with little extra effort.

X—An Emerging Standard

X promises to become *the* standard windowing environment. It is the only windowing environment that is not tied to a single operating system, and its distribution is not subject to the commercial interests of any one supplier. Anyone who wants to port X to a new system can get the source code free from many locations; you can also buy it from MIT for the cost of duplication. Any machine that supports multitasking and interprocess communication and has a C compiler can support X. Although MIT retains the copyright on X software, it allows the software to be freely distributed, provided that MIT's copyright notices are maintained.

X is already the standard on Unix workstations. It is available under AIX on the PS/2s, Interactive Systems' 386/ix, and The Santa Cruz Operation's Unix System V/386. For larger systems, it can be run on VAXes, Crays, and Data General's MV series, among others. You can also expect to see third-party implementations on OS/2, and probably even on the Mac under System 7.0.

Should developers write to plain MS-DOS, or should they embrace a windowing system? MS-DOS has given good service for a number of years, but it must gradually become obsolete. For all but the largest software companies, making the wrong decision could be fatal. X provides a neat way to avoid this dilemma, and you can expect many developers to embrace it. If some of the larger MS-DOS developers also adopt X, its future as a standard will be ensured, and proprietary windowing systems will come under severe scrutiny. On the other hand, if the large companies do not support X, they could face difficulties as the distinction between personal computers and workstations becomes increasingly blurred.

In any case, the likelihood is that users will demand the ease of use and cross-platform compatibility that only X can deliver. No matter how apparently committed particular vendors are to some proprietary windowing interface, the drive for standards will eventually push them toward X. ■

David Moore is a programmer working on FORTRAN for Yarc Systems' (Agoura Hills, CA) AMD 29000 RISC-based computers. He can be reached on BIX as "damoore."

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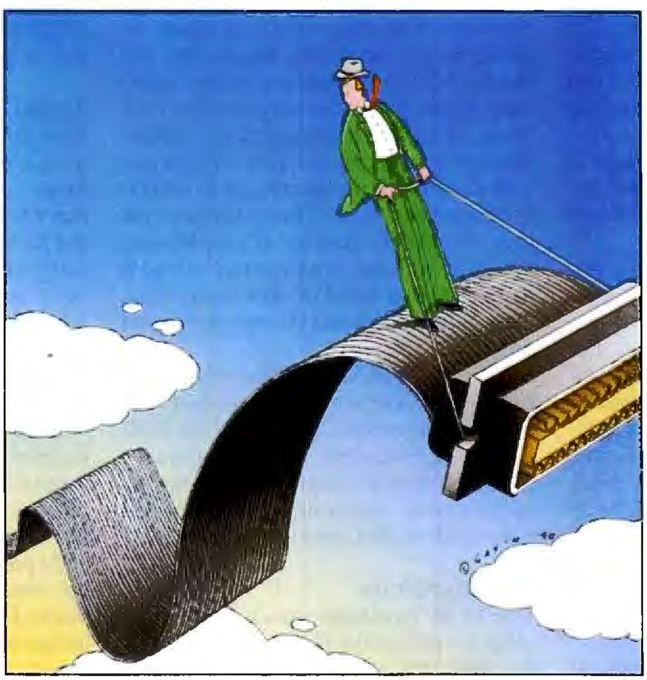
SCSI: THE I/O STANDARD EVOLVES

Now in its second revision, the SCSI standard is about to become the universal interface for microcomputer peripherals

Bruce Van Dyke

Over the years, microcomputers have grown to meet the demands of the information industry. New software allowed them to meet these demands. For example, microcomputers couldn't perform CAD jobs until someone wrote CAD software. This is partly because microcomputers' processing power has grown to meet the demands of certain jobs (e.g., file servers managing network cards and large hard disks).

Although the PC's processing power has grown, I/O throughput hasn't. Many file servers don't function at maximum performance because they are I/O bound (i.e., waiting for I/O to a peripheral device to complete). In addition, microcomputers continue to evolve into increasingly complex configurations; this further complicates the performance issue. Today's desktop PC frequently has one or more hard disk drives, a tape backup unit, a network card, a scanner, and a laser printer. Add to that the prospect of emerging storage technologies, such as CD-ROM and optical storage drives, and system complexity grows exponentially.



Trying to get all these devices to cooperate can be a user's nightmare. That's because each peripheral might have a different hardware interface or use a driver that can conflict with other drivers or software. System users must consider these diverse peripherals and help them work synergistically. This is where SCSI comes in. SCSI is a PC interface that boosts I/O performance, while eliminating the difficulties of attaching peripheral devices and reducing software problems.

Although SCSI might be somewhat new to PCs, its origins are much older. SCSI is based on the same architecture as the block-multiplex channel found in early IBM mainframe systems. This I/O bus could deal with several peripherals simultaneously.

In the early 1980s, ANSI started work on a microcomputer I/O bus standard based on the block-multiplex channel functions. This work evolved into a SCSI specification in 1984 and was approved as a standard in 1986 (ANSI X3. 131-1986). For further details on SCSI, see the two-part article "The SCSI Bus" in the February and March BYTE.

Certain microcomputer vendors adopted the SCSI bus some time ago. Apple first used an embedded SCSI bus on its Mac Plus in 1986; every Mac introduced since then has one. Commodore offered a SCSI adapter board for its Amiga 2000 in 1987 and made it an embedded bus on the Amiga 3000. Many workstation vendors also use the SCSI bus to connect to both

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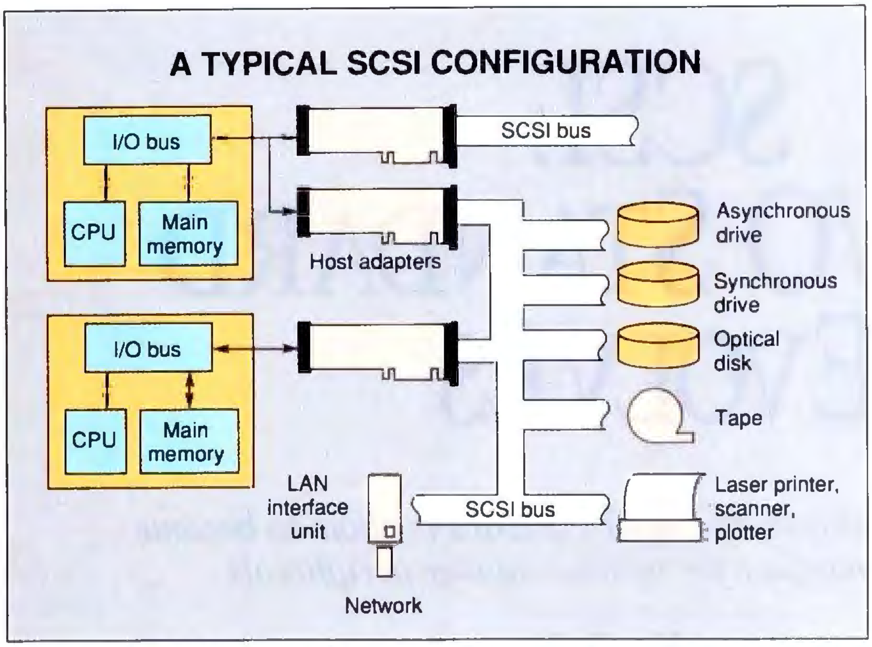

Figure 1: *The SCSI bus standard allows the bus to extend beyond the microcomputer chassis via a 50-pin cable. Its protocols allow connections to different I/O devices.*

internal hard disk drives and external peripherals. Interestingly, IBM (which normally set the standards in the microcomputer industry with its IBM PC and the Industry Standard Architecture bus) just adopted the SCSI bus as standard equipment in the PS/2 Model 80 and Model 60 SX last March.

The SCSI Advantage

Like Micro Channel, VME, and NuBus, SCSI is a true bus: It defines standard physical and electrical connections for devices. The fundamental—and distinguishing—difference between SCSI and the other buses is that SCSI facilitates the use of many diverse peripherals. Its communication protocols treat peripherals as logical devices that use a defined set of commands, which eliminates hardware incompatibilities.

The SCSI specification outlines several commands for many device types: hard disk (random access), tape (sequential access), printers, and others. The specification includes mandatory, optional, and vendor-unique commands. The SCSI bus treats a hard disk as a defined-capacity random-access device that responds to standard format, read, and write commands. The actual hardware might be a hard disk drive that uses an MFM, RLL, ESDI, or even a proprietary interface. A built-in SCSI controller translates the commands into interface-specific control signals.

Furthermore, SCSI lets the physical bus exceed the bounds of a typical microcomputer chassis. You can "stretch" the SCSI bus via a cable of up to 6 meters in length by using single-ended drivers, or via a cable of up to 25 meters in length by using differential drivers. This eliminates the problem of trying to pack every peripheral into the computer. It also allows you to connect large peripheral devices, such as scanners, that wouldn't fit anyway (see figure 1).

This combination of connectivity and economy of hardware delivers many capabilities to users with demanding I/O needs. SCSI's standard connectors allow easy connection to many peripherals, while its standard command set simplifies the system design. This lets the end user select SCSI peripherals from several different vendors with the assurance that they will be compatible. It's significant that SCSI's versatile nature has helped it to emerge as a standard on most companies' system-level and storage peripheral products.

To see how SCSI's role as a peripheral I/O bus standard evolved, you must first examine the various elements of the SCSI ANSI specification, which include a hardware specification, a signal-timing specification, and a device-independent command-set description.

SCSI Hardware

The SCSI hardware specification description details the physical characteristics: the cable, signal pin-outs, connector types, and so on. There are two commonly used types of SCSI connectors: a standard 50-pin ribbon cable header for connecting internal peripherals, and a Centronics-style 50-pin cable for connecting external devices. Apple chose instead to use an external 25-pin high-density connector using single-ended drivers for the Mac. (Recent Macs use the standard 50-pin ribbon SCSI connector for internal hard disk drives while still using the external 25-pin connector.) Both the Amiga and the NeXT Computer use Apple's external connector and signals; this lets them access devices and cables made for the Mac. To further complicate matters, when IBM announced its SCSI host adapters for the Micro Channel, it chose a 60-pin connector.

Although this seems like a failure of the SCSI hardware specification, these peripherals use the standard 50-pin SCSI connectors. Most of the time, you just connect the first SCSI peripheral to the host computer with an adapter cable and then use standard cabling to chain to the other SCSI peripherals.

As with any standard bus, the wires in a SCSI cable resemble transmission lines, which can generate undesirable effects, such as signal reflection and uneven loading of the line drivers. To reduce these effects, you must have termination resistors at the two physical endpoints of the SCSI cable. Termination resistors are usually located at the beginning of the SCSI bus (typically inside the computer) and on the last device attached to the cable (typically using a plug-in resistor pack). Improper termination of the SCSI bus results in erratic device operation or general bus failure.

Signal Transmission

The SCSI signal specification defines delays, minimum pulse widths, and hold times for the SCSI bus. However, you don't need to worry about these because the SCSI protocol chips manage the majority of the timing constraints. Some of these protocol chips include Adaptec's AIC-6250 (found on SCSI host adapters made by Adaptec and IBM) and NCR's 5380 and 5390 (used in the Mac and other computers).

SCSI uses an interlocked handshake to transfer information across the bus. The communication protocol is based on this request-acknowledge handshake. SCSI bus states are called *phases*. There are eight possible bus phases (see table 1); all but one use an asynchronous transfer mode. In the data phase, information can be handshaked in one of two modes: synchronous or asynchronous. Synchronous data transfers occur only after both the host and the target device agree to such a transfer. Data is transferred in parallel across the bus, 1 byte at a time, using eight data lines. The typical asynchronous transfer rate is about 2 megabytes per second; the synchronous transfer rate can reach a maximum of 5 MBps.

What's Your ID?

Every device on the SCSI bus requires a SCSI ID number. These IDs are generally configured with jumpers, although some external Mac peripherals have a thumbwheel for setting them. The SCSI ID serves two purposes: It uniquely defines each peripheral's device address, and it determines the device's priority on the bus during the arbitration phase. The arbitration phase determines which device will own the bus when two or more devices simultaneously request to use it. During arbitration, each data line represents a single device, so there can only be a maximum of eight devices on a SCSI bus. ID 7 has the highest priority, and ID 0 has the lowest. Logical unit numbers are secondary addresses associated with each SCSI ID. There can be up to eight LUNs for each target ID.

The *initiator* is the SCSI bus controller that selects the target device at which commands are directed. The *target* is the SCSI bus controller that receives commands from the initiator. The initiator is generally located in the host computer; the target is typically a peripheral device (e.g., a disk drive or tape drive). Once the initiator selects the target, the target is in complete control of the bus. The data transfer direction is always defined with respect to the initiator. See figure 2 for a typical sequence of SCSI bus phases during an I/O operation.

The SCSI bus allows multiple I/O operations to run concurrently between different devices on the bus. The disconnect and reconnect (D-R) capabilities defined in the standard allow this to happen. D-R lets a device relinquish control of the bus while it is conducting a lengthy operation (e.g., a seek on a disk drive or a tape rewind). This allows other devices to use the bus while that device is busy. When the SCSI bus is free and the device is ready to complete its command, it can reconnect to the bus. This combination of high throughput with multiple device support gives SCSI the potential for handling large applications that require lots of processing power.

IBM is using SCSI to maximize performance and peripheral connectivity in the Micro Channel architecture. Moreover, SCSI is expected to become the peripheral I/O interface for other architectures, such as EISA. Almost every major peripheral device manufacturer now offers SCSI products. Some devices (e.g., CD-ROM) rarely have other interfaces.

SCSI BUS PHASES

Table 1: *The various bus states (phases) defined in the SCSI standard. These phases are used to communicate with peripherals, control access to the bus, and transfer data.*

Phase	Purpose
BUS FREE	Bus is available.
ARBITRATION	Device obtains control of bus via arbitration.
SELECTION	Target device is selected by the initiator.
RESELECTION	Target device selects initiator and reconnects to the bus.
COMMAND*	Target device requests command information.
DATA*	Data is sent to or from target device.
STATUS*	The target device requests to send status data.
MESSAGE*	Messages are sent to or from the target device.

*These phases are termed the "information transfer phases."

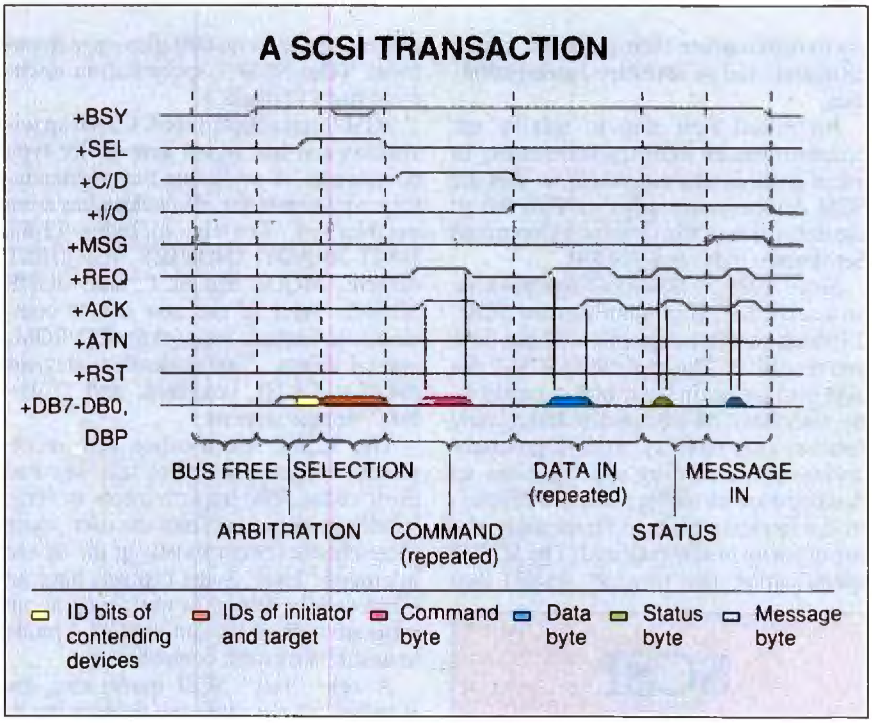

Figure 2: *SCSI bus timing. During a transaction, the signals and phases can occur in the sequence shown. The ARBITRATION phase, which was optional in the original SCSI standard, is now mandatory in the new SCSI-2 standard described in the text. The target may disconnect during a lengthy operation, freeing the bus for other devices. The device reconnects later by use of a RESELECTION phase (not shown).*

Enter SCSI-2

The first SCSI peripherals suffered from compatibility problems. These problems existed not because there was an inadequate standard or a faulty device design, but because there was too much flexibility in the specification. The original specification (SCSI-1) allowed so many variations in a SCSI controller implementation that the early SCSI peripherals weren't compatible. For example, the use of parity on the bus was an option: SCSI peripherals that used parity obviously wouldn't work with devices that didn't. Also, there were numerous permutations of the SCSI commands; this led individual device manufacturers to

continued

WHAT DOES THE SCSI-2 STANDARD ACCOMPLISH?

Table 2: *The new SCSI-2 standard adds features while remaining compatible with the existing SCSI standard.*

Refined physical specifications to promote plug-and-play:
- Better definition of who supplies terminator power (the initiator)
- Use of parity required on bus
- Arbitration required

Refined message specifications to promote device compatibility:
- Synchronous protocol better defined
- Number of mandatory commands expanded
- Sense codes for error recovery added

New features added:
- New devices and commands defined
- Fast synchronous protocol doubles transfer rate to 10 MBps
- Optional "B cable" expands SCSI bus from 8 to 16 or 32 bits, allowing a possible transfer rate of 40 MBps

try to differentiate their products, which ultimately led to software incompatibilities.

An initial first step to solving the problem was an industry-wide effort to adopt a minimum command set that all SCSI devices must support. This led to the definition of the Common Command Set (known today as CCS 4B).

Since 1986, ANSI has been working on a second SCSI standard, called SCSI-2 (which should be approved by the time you read this). The goal of the SCSI-2 design is to maintain backward compatibility with the SCSI-1 bus while adding new features (see table 2). SCSI-2 precisely defines some existing specifications so that there are no ambiguities in SCSI controller implementations; for example, the use of parity is now required. The SCSI-2 specification also provides insight into command use in its 600-plus-page document. (The SCSI-1 specification document had 212 pages.)

SCSI-2 has adopted the CCS 4B specification and has added new device type commands. A minimum set of mandatory commands for all devices has been established. The list includes TEST UNIT READY, INQUIRY, REQUEST SENSE, MODE SELECT, and MODE SENSE. Some of the new device command sets include support for CD-ROM, optical drives, communications devices (SCSI-to-LAN), scanners, and "jukebox" storage systems.

The SCSI-2 specification also incorporates standardized error recovery and error codes. The improvements in error handling are hidden from the user, since these changes occur mostly at the device microcode level. Some changes have an impact on the drivers as well, but you can program a device to run in SCSI-1 mode to ensure backward compatibility.

A new "fast" SCSI mode uses the standard 50-pin cable and doubles the 8-bit SCSI bus's maximum transfer rate to 10 MBps. It accomplishes this by cutting the synchronous transfer timings in half. There is also a "wide" SCSI option that uses a second 68-conductor cable (called the B cable). This cable contains an additional 24 data lines that allow 16-bit and 32-bit data transfers. (The other 8 bits are handled by the standard 50-pin A cable.) A negotiation process similar to synchronous negotiation in SCSI-1 enables both wide and fast SCSI. This allows SCSI devices with different data bus widths and data transfer rates to coexist on the same bus. Using both the fast and wide SCSI capabilities of SCSI-2, it's possible to achieve a 40-MBps transfer rate.

Generally, all SCSI-2 improvements are backward compatible with SCSI-1. Existing SCSI-1 devices that adhered closely to the standard should be able to share a bus with SCSI-2 devices, but they will reject extensions in the SCSI-2 protocols. The new device support and fast SCSI option are welcome additions to the standard. However, the two-cable wide SCSI implementation isn't expected to find wide acceptance in the PC market. That's because it costs more and requires more space to provide a second connector. And there's no room at all for a second connector on certain peripherals, such as 3½- and 5¼-inch internal hard disk drives.

Implementing the fast and wide capabilities of SCSI-2 will probably require silicon changes to today's SCSI protocol chips. It's expected that in the future, manufacturers will start by supporting 8-bit fast SCSI that uses the existing 50-pin cable. You should be careful in your purchase of SCSI-2 peripherals. It's possible that you could buy a SCSI-2 device (say, a hard disk drive using the fast SCSI capability) only to find that the adapter card in your PC doesn't support this option.

SCSI Specification

The SCSI specification is available for $25 from ANSI, 1430 Broadway, New York, NY 10018, (212) 642-4900.

The X3T9.2 committee working documents, Common Access Method (CAM) committee documents, and the most current draft of the SCSI-2 specification are available for downloading from the SCSI BBS at (316) 636-8700 (300, 1200, or 2400 bps; 24 hours).

A paper copy of the SCSI-2 draft specification is available for $60 from Global Engineering Documents, 2805 McGaw Ave., Irvine, CA 92714, (800) 854-7179 or (714) 261-1455.

SCSI Software

SCSI software compatibility has been an industry-wide problem. On the peripheral side of the bus, the SCSI-2 command set goes a long way toward solving communication problems. However, there are also problems on the initiator's side of the bus, especially for software drivers that use SCSI adapter cards in the host. All too often, the program that uses the SCSI peripheral (e.g., the scanning software for a SCSI scanner) won't work with a particular SCSI adapter, or it won't share the adapter with another peripheral's program (perhaps the backup program for the tape drive). The end result is that you usually fill up your computer's slots with a SCSI adapter card for each peripheral—hardly what the SCSI designers had in mind when the standard was made.

A Common Access Method committee met to implement a common SCSI interface across different machines. Adaptec has developed the Advanced SCSI Programming Interface software specification—now a working document of the CAM committee—that addresses this problem. ASPI defines a standard software interface to the SCSI bus; this interface is independent of the host bus adapter manufacturer's hardware implementation. It provides a protocol that allows multiple SCSI device drivers and programs to submit I/O requests to one adapter card, independent of the card manufacturer's implementation.

The ASPI architecture reduces the number of software drivers required to support a host adapter and its peripherals under various operating systems. ASPI's modular design lets you use only the drivers that go with your SCSI peripherals. As you add more devices, you add the corresponding interface modules. ASPI also facilitates the addition of new devices without disturbing the existing drivers or peripherals.

A more radical approach that is being considered is implementing the SCSI bus by using optical driver technology.

Microsoft has adopted a software architecture for OS/2 that is similar in approach to ASPI. Its layered device drive architecture, called LADDR, defines an application programming interface that is independent of the host adapter. This approach simplifies support for multiple host adapters and allows up to seven SCSI devices per adapter.

The Future: SCSI-3

As SCSI-2 nears completion, work is under way for a SCSI-3 standard. Although it is in its early stages, the proposed features for SCSI-3 include a 16-bit data path on a single 68-pin connector; more than eight SCSI IDs on a SCSI bus; longer cable lengths; bus fairness; more command sets (e.g., digital audio tape and file server); and a fiber-optic option as an alternative data transfer medium.

SCSI-3 will probably be the first to implement wide SCSI. SCSI-3 uses the SCSI-2 high-density 68-pin connector (the B cable) for the primary cable instead of the standard 50-pin A cable defined in SCSI-2. You can connect both the 68-pin and 50-pin devices to the same cable because there are nine new signals added to each side of the 50-pin connector. This connector will provide peripheral manufacturers with a smaller footprint while adding the flexibility to either implement 16-bit wide SCSI or remain in standard 8-bit mode.

Since SCSI-3 proposes a 16-bit data path on a 68-pin cable and a 32-bit data path with a second 68-pin cable, 32 devices or IDs can be supported on the bus. A proposed "fairness" scheme would periodically give the bus to devices with lower IDs that have not been able to win arbitration.

Placing 16 devices on a 6-meter, single-ended cable will be a difficult task, because most of the devices may be located in an external cabinet. The industry expects that improvements in terminator designs and driver technology will be required to facilitate this change and to support fast SCSI. Single-ended drivers may not be able to support fast SCSI (10 MBps) at the maximum 6-meter cable length. However, internal devices on a properly terminated short cable should work. Differential drivers should provide the signal quality necessary to drive a cable of more than 6 meters at fast transfer rates.

A more radical approach being considered is implementing the SCSI bus by using optical driver technology. This could stretch the SCSI cable well beyond its current length limits while still maintain high-speed data transfer. A fiber-optic implementation would use information packets for data transmission—a dramatic departure from the current architecture.

It might seem premature to consider what's beyond the SCSI-2 standard, especially since it will take time for SCSI-2 features to show up in today's peripherals. Nevertheless, this shows the success of the SCSI standard itself. Even IBM has adopted SCSI for its peripherals; that makes the SCSI bus more universal than either the Mico Channel or EISA. It promises not only to establish an I/O bus standard on microcomputers, but to make peripheral devices accessible to all computer users, no matter what platform or operating system they use.

Hardware standards provide definitions that allow different machines and technologies to connect and communicate, and SCSI seems to have succeeded in this area. However, as existing technologies become faster and new technologies evolve, then the standards must evolve as well. SCSI is evolving to meet these new demands. ■

Bruce Van Dyke is an applications engineer at Adaptec, Inc. (Milpitas, CA). He can be reached on BIX c/o "editors."

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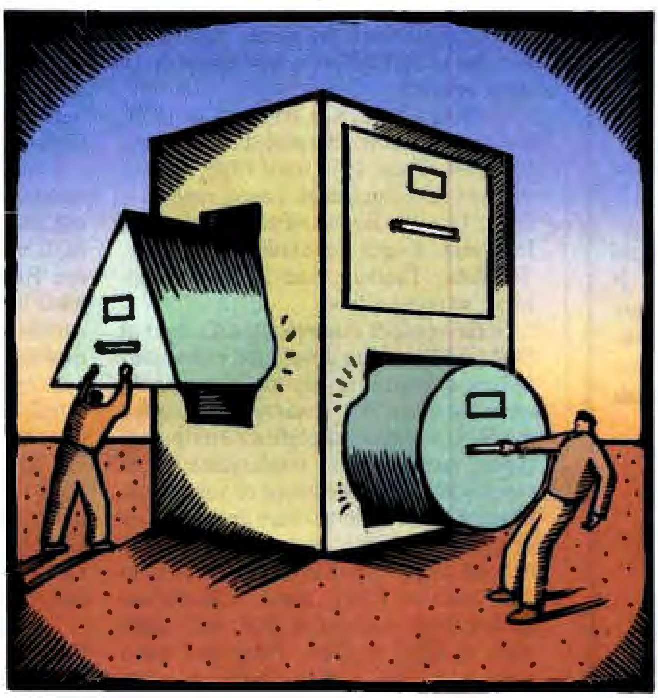
DATA TO THE DESKTOP: THE SQL ADVANTAGE

The plethora of SQL implementations limits data exchange

Robert J. Crutchfield

While the 1980s will be remembered as the era of the microcomputer revolution, the 1990s are shaping up as the age of the database explosion. The battle for the desktop has been won. Microcomputers are more powerful than ever, and the increased processing power is being used for applications traditionally reserved for minicomputers and mainframes, like database management. The desktop has become a window to access corporate information.



Broader Access

Indeed, we have undergone an information revolution. Users now have access to more information than ever. This is due to the changing computer environment—that is, moving from host-based to network-based systems. The decentralization or flattening out of the corporate structure, coupled with the desire to move information closer to the people, has greatly changed the data-processing shop. The data center has evolved from single-vendor computing to a decentralized multivendor environment.

During the 1980s, spreadsheet vendors like Lotus and VisiCalc turned a generation of middle managers into accountants and, at the same time, created one of the most widely used PC applications of the decade. In the 1990s, developers of advanced fourth-generation languages and computer-automated software engineering tools have the potential to turn today's users into programmers. Granted, there will always be a need for professional software developers. However, the applications backlog is forcing many users to develop applications using 4GLs. And many of these applications are used in conjunction with databases.

Over the last decade, database management has evolved from a mundane, "glass room" process into a process that offers companies a competitive advantage through applications like on-line transaction processing, decision support, and executive information systems. Structured Query Language (SQL) based relational databases, the client/server architecture, improved user interfaces, and distributed computing are all allowing users greater access to almost instantaneous information to make mission-critical business decisions.

The relational model of data was introduced by Dr. Edgar F. Codd in 1969. The IBM Research Labs developed SQL in 1974 to support the Codd model; it was designed to interrogate and process data in a relational database.

SQL is rapidly becoming the preeminent database structure because of its functionality and its flexibility. SQL-based relational data-

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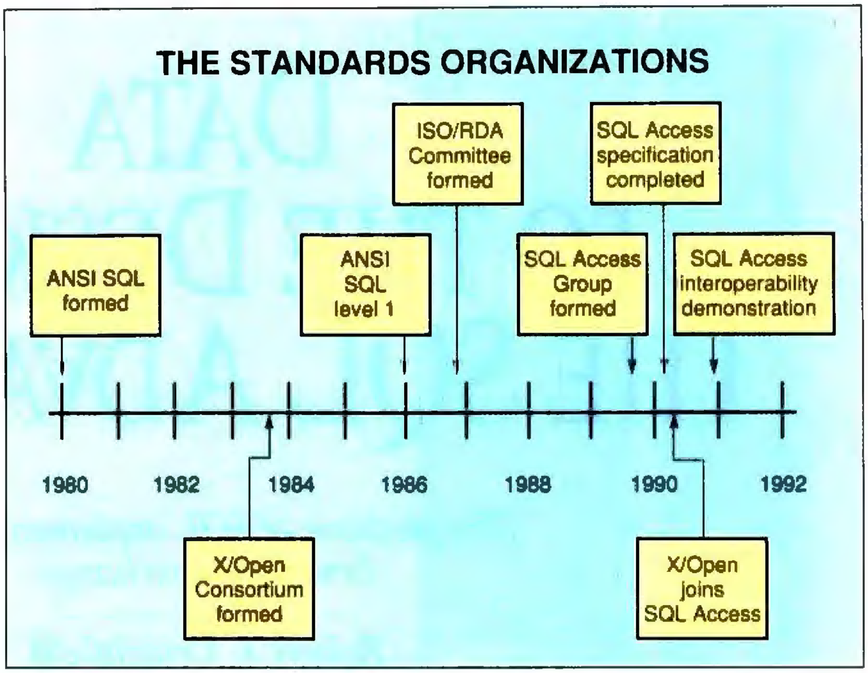

Figure 1: *The time line shows the development of SQL standards organizations.*

bases are arranged as tables, with pieces of information residing under columns or fields. SQL commands are used to search data by its field and database. SQL can also be used to write information into an existing table. With SQL, users can create, access, and update data within a database.

SQL-based relational database management systems gained in popularity and acceptance throughout the 1970s and into the 1980s. During that time, SQL was implemented in some form by a number of RDBMS developers and hardware vendors.

Although SQL was invented in 1974, it did not become a formal standard until late 1986. From 1974 until 1986, various vendors developed SQL-based systems—IBM, Oracle, Hewlett-Packard, Ingres, Informix, Gupta Technologies, Sybase, Teradata, Tandem, and Digital Equipment, to name a few.

Some vendors implemented a subset of SQL, while others developed extensions to it or altered it to suit their computing environments. For example, although the SQL standard specifies certain data types, most vendors implemented data types with some extensions or variations. Most of these systems were developed as single-node RDBMSes; some were enhanced to provide distributed access to their data or hosts. Some vendors extended their versions of SQL with gateways to DB2 or IMS. Even end users were using SQL and beginning to write their own RDBMSes. With the proliferation of SQL, ANSI, a quasi-governmental body made up of vendors and users who set standards, formed a SQL committee in 1980.

After six years of work, the ANSI committee released ANSI SQL level 1, its first attempt to develop a set of SQL standards (see figure 1). In 1987, the International Standards Organization, which is made up of national standards organizations like ANSI from throughout the world, formed the ISO/Remote Data Access Committee. The ISO/RDA Committee is defining a standard interface between a program (client) and a database (server) on different systems.

Since 1987, both the ANSI and ISO committees have been meeting and refining their standardization efforts. ANSI SQL level 2 should be published in 1991; the RDA work will not be completed until 1992. This means that the industry cannot achieve heterogeneous access to multiple databases until at least 1993.

Along with the national and international standards organizations, a number of vendor-driven associations are working on standards issues in the areas of SQL, Unix, networking, and open systems. These groups include the X/Open Consortium, Unix International, the Open Software Foundation/UniForum, and the SQL Access Group.

Most of these vendor-driven associations have been formed to react quickly to the dramatic changes occurring in the

Forging a Standard

Client/server computing is rapidly advancing information management. This architecture benefits users while creating challenges and opportunities for MISes, database administrators, hardware vendors, and software developers alike.

With many companies using multiple relational database management system products on multiple hardware platforms, it will be a major challenge to manage information that is scattered across an organization under different RDBMSes and various computing environments. And although advances in multivendor integration enable different systems to be networked together in a distributed computing environment, Structured Query Language (SQL) based RDBMSes and application tools from different vendors still do not have the ability to interoperate.

Recognizing this problem, a group of companies, including Ingres, Sun Microsystems, Digital Equipment, and Tandem Computers, began meeting informally to discuss how to achieve interoperability and portability of SQL-based RDBMSes. These vendors determined that while standards organizations like ANSI and the International Standards Organization (ISO) had made progress toward standardizing SQL, their work did not go far enough to solve the RDBMS interoperability problems in multivendor environments.

Out of these early meetings, the SQL Access Group was formed. The group's mission is to develop a technical specification that will allow one vendor's SQL application to access data in other vendors' SQL servers, thus enabling RDBMSes and application tools from different vendors to work together.

The SQL Access Group published its technical specification last March and plans to demonstrate a working prototype in early 1991, running on the hardware and software of the various member companies. The work is based on existing standards developed by ANSI and ISO, as well as guidelines published by the X/Open Consortium's Portability Guide.

The group's work is in response to the growing need for users to create applications that will operate with multiple RDBMSes, regardless of the platform the data resides on. The group is tackling two major technical barriers that currently prevent intervendor SQL access; eliminating them would allow users to operate more than one heterogeneous SQL RDBMS at a time.

First, each brand of SQL is different. While the ANSI committee sets standards, many areas of ANSI SQL (SQL 1, 1986) are left up to the user or vendor to define. The SQL Access Group is standardizing many of the implementer-defined items in the application programming interface, including:

- Association management statements (connect, set connect, and disconnect)
- Three-level object names
- Standardized system catalog name
- New catalog tables (SQL languages and server defaults)

Second, because of the different client communication protocol, one vendor's SQL client cannot connect to other vendors' SQL servers across the wire because of the different client/server protocol and client/server message formats. Standardization of SQL communication is handled by the ISO's Remote Data Access committee. The SQL Access Group is making the following contribution to the ISO/RDA Formats and Protocols work:

- Mapping of SQL statements to RDA services
- Encoding of SQL data (including ASCII and EBCDIC)
- Authentication and access control
- Diagnostic messages
- Choice of communication protocol
- Extended Get Diagnostics statement
- Inclusion of Dynamic SQL (RDA currently doesn't allow it)

The SQL Access Group will make its technical specification available to the X/Open Consortium for inclusion in the 1991 edition of its Portability Guide.

The SQL Access Group (996 Redondo Ave., Suite 515, Long Beach, CA 90804, (213) 438-5788) is a nonprofit association and is open to all vendors of RDBMS or server products. There are two levels of membership: reviewers and producers. Reviewers have access to the technical specification and provide feedback to the group. Producers must also provide technical resources, in the form of software developers and equipment, to help develop the technical specification.

The group was founded in 1989; its members include Ashton-Tate, Bull, Cincom Systems, Digital Equipment, Fujitsu America, Hewlett-Packard, Infocentre, Informix, Ingres, Metaphor, Microsoft, NCR, Oracle, Progress Software, Retix, Sun Microsystems, Sybase, Tandem Computers, Teradata, Unify, and X/Open.

market and to respond to user needs. As more power is moved closer to the user, companies are changing the way they allocate computer resources. The trend over the last several years has been toward decentralization. Now, instead of companies keeping all their data on centralized mainframes, they distribute the information throughout the enterprise to minicomputers and workstations. Large corporations often have one brand of mainframe and other brands of minicomputers and workstations. In fact, large computing environments usually have a mix of on-line transaction processing software, application development tools, RDBMSes, and hardware, along with user-developed applications and off-the-shelf software.

Decentralized or distributed computing is an excellent way to put information closer to the user. Over the last few years, the client/server architecture has enabled companies to access and manage their data more efficiently. Today, workstations perform many database operations that were once relegated to minicomputers or mainframes. They let users update, store, and send data without having to rely on a host computer.

In client/server computing, the client, or workstation, sends requests for data to the server (which is usually a minicomputer or mainframe) and then receives data. The server receives requests and sends data. SQL-based RDBMSes play an important role in client/server computing. On the client, or front end, a

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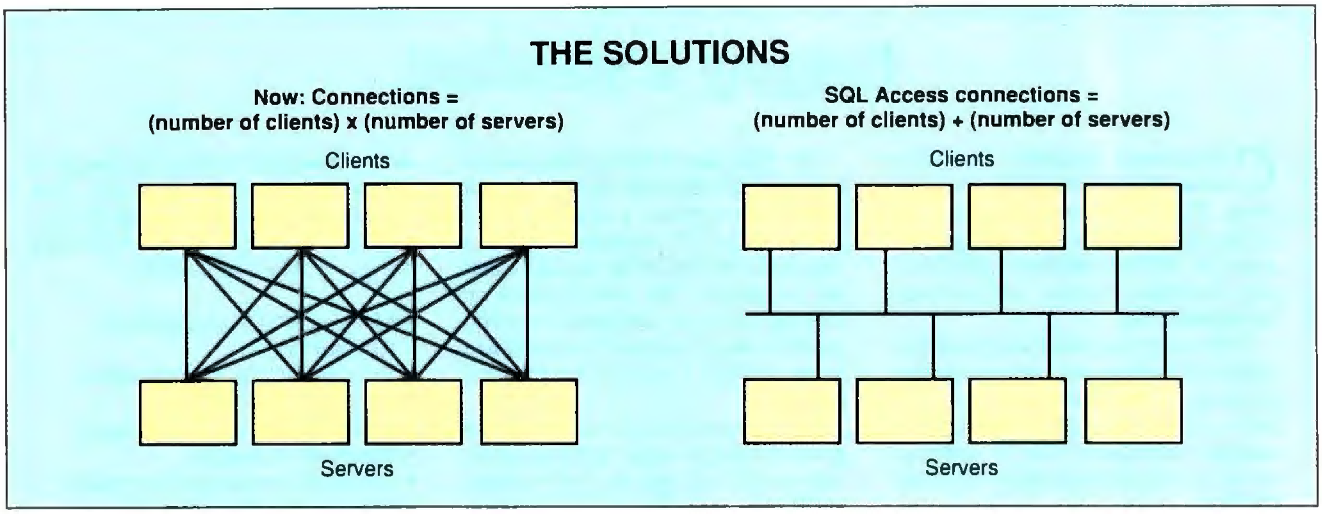

Figure 2: *Without a SQL standard, a separate gateway has to be written for each client and server in use. The SQL Access Group technical specification, when adopted by the industry, will enable SQL software interoperability, as well as portability of SQL applications.*

program is written using 4GL tools to write applications that access data from a SQL-based RDBMS on the server, or back end. And because each brand of SQL is different, users must single-source their SQL software. This prevents them from achieving true intervendor SQL interoperability—the ability of SQL-based RDBMSes and application tools from multiple vendors to work together.

SQL Tower of Babel

Graphical user interfaces and distributed networking don't guarantee a user the ability to interoperate with multiple heterogeneous databases. Currently, two problems prevent intervendor SQL access. First, each vendor's implementation or brand of the SQL standard differs enough that one vendor's SQL client cannot access data in other vendors' SQL servers, rendering the different SQL dialects incompatible. According to industry estimates, there are more than 140 implementations of SQL RDBMSes in use. Second, because of different client communication protocols and message formats, one vendor's SQL client cannot connect to other vendors' servers.

Users are requesting connectivity between multiple databases on disparate personal computers, minicomputers, and mainframes. They would like to build applications with interoperable components to run on personal computers and workstations that access databases on mainframes and minicomputers. This kind of access is called heterogeneous access, because it involves at least two different RDBMSes.

To allow access to multiple heterogeneous databases, two items must be considered: the Application Programming Interface, which allows SQL dialects to understand each other, and the Formats and Protocols Standard, which determines how SQL is sent over a network. The API, seen only by an application programmer, consists of SQL and the syntax for the protocol services. The FAP defines message formats for SQL requests and replies, and for connection to a SQL server. It also defines data types, lengths, and representations.

Until these items are addressed, users can't move applications from one client/server platform (e.g., DOS/Unix) to another (e.g., Unix/MVS). The inability to access multiple databases is very limiting to users who need information from different back-end databases through a single front end.

For the most part, users have to acquire their SQL client and server software from a single vendor. They can't mix and match client software and server software; nor can they write vendor-independent applications. Thus, users can't implement different clients and servers that are best suited for their jobs.

In multivendor computing environments, having access to multiple heterogeneous SQL RDBMSes is more critical than ever, as is the ability to mix and match front ends. For example, you may have a checking account, a credit card, overdraft protection, and a loan all at the same bank. Information for each of these bank services could very well reside on different databases. If you move and submit an address change, the chances are that all the records will have to be updated individually, because each bank service's information likely resides on a different heterogeneous database.

Recognizing the industry's need for access to multiple clients and servers, many vendors and industry associations are working toward the interoperability of multiple heterogeneous RDBMSes. Although most database vendors support SQL, there are differences in syntax, functionality, schema, and data type. For example, some vendors support decimal numbers, while others don't. Also, there are differences in how tables and columns are supported.

Gateways

Most vendors who address the problem of interoperability do so through gateways. For example, a 4GL developer can write gateways so that his or her programming toolset works with different RDBMSes. Conversely, a database vendor can write gateways so different 4GLs work with that particular database. The drawback is that a separate gateway has to be written for each client and server in use (see figure 2). Thus, if you are working with four clients and four servers, gateways must be written for every device (number of clients × number of servers). Also, users can't transparently access data from each RDBMS being addressed.

Another alternative is to develop a technical specification, to be adopted by the industry, that will enable SQL software interoperability and portability of SQL applications. In the above example, instead of multiple gateways, only one gateway would be needed for each client

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and server (number of clients + number of servers).

Vendors doing notable work in this area include Gupta Technologies, Oracle, Ingres, Sybase, Teradata, and Information Builders. All these companies provide interoperability among their systems on different hosts, both for heterogeneous hardware and homogeneous database software. These vendors tend to use private protocols that prohibit them from exchanging data using SQL tools. Gupta, Oracle, Ingres, and Teradata provide import/export of data with DB2 and IMS, again using proprietary tools.

IBM's LU 6.2 is another protocol for remote server invocation, sending and receiving data, client/server authorization/authentication, transaction management, and maintenance services. Developed in the early 1980s, it is widely used in IBM mainframe environments.

The SQL Access Group is not competing with the standards organizations or individual companies. It is basing its technical specification on ANSI SQL, ISO/RDA, and ISO SQL, as well as on emerging guidelines from consortia like X/Open. The group has taken the work of the standards organizations a step further. For example, in ANSI SQL, many areas were left user-definable (e.g., column length and table name lengths). The SQL Access Group is bringing definitions and conventions to the ANSI and ISO standards work by contributing to the syntax and communications protocols the two organizations have developed.

The SQL Access Group is developing a technical specification to accomplish the interoperability and portability of SQL RDBMSes and application tools. The technical specification, which was completed last spring, is vendor-independent, not a proprietary implementation of an individual company's product offering. A benefit of the specification is that it will allow 4GL vendors to build, package, and market software independently of back-end RDBMSes. Conversely, RDBMS vendors will be able to package and market database servers independently of front-end vendor applications.

When the SQL Access technical specification is implemented, users will be able to mix and match the clients and servers that best suit their applications, and to access data from multiple heterogeneous databases without building multiple gateways.

SQL Evolution

Client/server computing is changing information management, and SQL will continue to play a major role in bringing data closer to the user. As the SQL standard evolves, through the efforts of individual vendors and consortia, users will have access to more information and the ability to interoperate across multiple heterogeneous RDBMSes.

Clearly, we are in an information revolution, and a major challenge facing the industry is to achieve true SQL portability. By achieving it, the industry will enable users to mix and match RDBMSes and application tools from multiple vendors, giving them more choices and, hopefully, fewer gateways and easier access to information. Through this, the industry will experience true "open" computing in the database area. ■

Robert J. Crutchfield, a former journalist, is a consultant to the SQL Access Group in Long Beach, California. He can be reached on BIX c/o "editors."

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In addition, the PC can support one of two modes: control unit terminal or distributed function terminal. CUT is simpler but more limited; it supports only one simultaneous mainframe session. DFT supports multiple simultaneous mainframe sessions. A PC with an attached printer can usually emulate an IBM printer as well.

Some IBM minicomputers (e.g., the System/3X) emulate a 5250 terminal rather than a 3270; this requires different hardware and software. However, more recent IBM minicomputers (e.g., the AS/400) support 3270 terminal emulation as well.

Gateways

Until a few years ago, the only way you could provide 3270 terminal emulation was to take the following three steps: Install an adapter card into each PC that might require mainframe communication, string cable from each PC to the mainframe, and run terminal-emulation

You'll need a communications scheme so that the PC and mainframe can talk to each other.

as half that of an individual link. Factors that can affect gateway performance include the type of PC that you use for the gateway itself, the speed between the gateway and the mainframe (a 4-megabit-per-second Token Ring link provides better performance than a 9600-bps modem link), the amount of traffic on the LAN, and the amount and type of data being transmitted to the mainframe.

ler itself communicates with the mainframe via a special kind of high-speed modem called a synchronous modem. (The more standard kind of modem used by PCs is called an asynchronous modem.) The cluster controller communicates over the modem by means of a protocol called synchronous data-link control. The mainframe communicates with the modem via a front-end processor. Stand-alone PCs can also communicate with mainframes via a synchronous modem, SDLC, and a front-end processor.

Another way that PCs can communicate with remote mainframes is by using an asynchronous ASCII connection. This method uses the more typical asynchronous modem and is best suited for users who don't require a great deal of mainframe communication. In this method, the mainframe needs an additional device called a protocol converter, which converts the asynchronous transmission to synchronous for communication with the mainframe.

configuring a large number of PCs is tedious and requires more mainframe resources. Some organizations do both: They individually configure some PCs (perhaps those that are used the most or that are used for different functions), and they create a pool of mainframe sessions that other users can share.

Talking the Mainframe Talk

In the same way that LANs require both adapter cards and network operating-system software to function, micro-to-mainframe communication has both hardware and software components. If you just want your PCs to act as terminals to the mainframe, all you need is terminal-emulation software. If you wish to write programs for the PCs that communicate with programs on the mainframe, you need additional software.

The type of software that organizations use depends on what kind of application programming interface they want for the mainframe. There are three kinds of APIs, which require increasingly more programming on the mainframe side than the one before it.

The first type is High-Level Language API (HLLAPI). With software that supports this interface, you can write applications that communicate with mainframe applications as though they were terminals. The mainframe applications don't need to be modified to communicate with the PC applications. You would use this type of interface for programs that transfer files between the PC and the mainframe.

In earlier software releases, IBM also supported Entry-Emulator HLLAPI. This provided a subset of HLLAPI and was designed for use with smaller, simpler LANs. EEHLLAPI is no longer available.

The second type of API is Server-Requester Programming Interface (SRPI). With software supporting this interface, you can write applications that treat the mainframe as a server by communicating with relational databases on the mainframe. However, to provide this function, the mainframe also requires another type of software, Enhanced Connectivity Facility (ECF). This type of interface is used for programs that extract data from a mainframe database.

The third type of API is Advanced Program-to-Program Communication. APPC differs from the other two APIs. In other types of communication, the mainframe "master" transmits and receives data from a PC "slave." With APPC, the mainframe and the PC are peers, and either one can request information from the other. You would use this type of interface for client-server applications, where both the PC and the mainframe do some of the processing. However, to support APPC, you must write programs on the mainframe; you cannot use the existing applications that were written for dumb terminals.

APPC also uses a different type of communications protocol than the other two APIs. While HLLAPI and SRPI can communicate with the mainframe by using 3270 protocols, APPC uses a type known as Logical Unit 6.2 (LU 6.2).

LU 6.2 supports peer-to-peer communication on the hardware level; APPC provides it on the software level. However, the two terms—APPC and LU 6.2—are often used interchangeably.

Another term often associated with APPC is System Network Architecture. IBM is attempting to migrate its users toward a certain group of strategic communications protocols; it uses the term SNA to refer to these protocols. APPC/LU 6.2 are in SNA; 3270 communications protocols are not.

The Software Connection

The type of software you need depends on the APIs you choose and what operating system your PCs run. For example, many vendors offer 3270 terminal-emulation software for use with MS-DOS and OS/2. This software generally supports HLLAPI and other basic programming interfaces. If you want to support APPC, you need additional DOS software.

IBM recommends that OS/2 users who want both 3270 terminal emulation and support for APPC should move to OS/2 Extended Edition. Extended Edition includes a communications manager that provides both of these functions. Another advantage of Extended Edition is that it supports Ethernet LANs as well as Token Ring networks.

The two major vendors for PC communications hardware and software are IBM and Digital Communications Associates. These vendors provide products like 3270 terminal-emulation boards, terminal-emulation software, and gateway hardware and software. But more than a dozen other vendors also provide some subset of these products.

At present, Extended Edition/Communications Manager is available only from IBM. However, IBM announced in November 1989 that it would make its Communications Manager functions available to other vendors for incorporation into their products. IBM has not yet said how or when it will do this.

Some organizations wish to make their micro-to-mainframe programs user-friendly, yet don't have time to rewrite the entire application. Many vendors have released products that let you develop icon- and menu-driven interfaces for their applications without requiring changes in the mainframe application.

Futures

At this point, IBM and the marketplace are pushing users toward communications methods that take advantage of the PC's intelligence (e.g.,Token Ring connections and APPC) for writing new applications. The new crop of client-server OS/2-based applications demonstrate the value of this method.

Moreover, in response to user demand, IBM is beginning to support types of communication other than those it has developed itself. For example, OS/2 Extended Edition supports Ethernet LANs as well as Token Ring networks.

IBM has said that it will support Open Systems Interconnection protocols, which are intended to be used by all vendors to let you set up heterogeneous networks of computers. In addition, IBM is already beginning to support TCP/IP, a set of older communications methods that many vendors support and many products provide now.

On the other hand, the mainframe isn't likely to go away. While new micro-to-mainframe communications possibilities are opening up, the huge installed base of mainframe applications will guarantee that older terminal-emulation protocols and the applications that support them will continue to be used for the foreseeable future. ■

Editor's note: *For more information on micro-to-mainframe communications, contact Attachmate (13231 Southeast 36th St., Bellevue, WA 98006, (800) 426-6283 or (206) 644-4010) and ask for the "Evaluator's Guide to 3270 Micro-Mainframe Products." Although Attachmate produces its own line of 3270 products, most parts of this guide are fairly bias-free and do a good job of presenting the information.*

ACKNOWLEDGMENT

Thanks to Bob Spaziano, consulting support representative for LANs of IBM's telecommunications system support center, for providing some of the information in this article.

Sharon Fisher is a San Francisco-based freelance writer specializing in computer communications. She can be reached on BIX as "sharonfisher."

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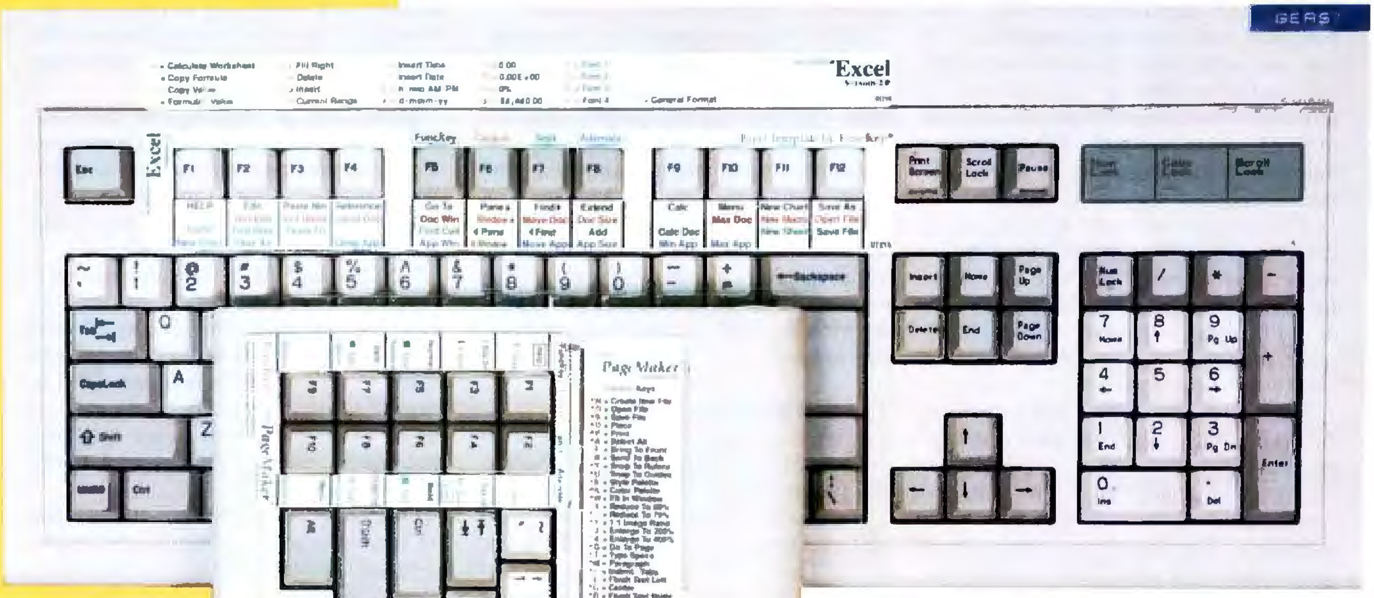

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DON'T WORRY, USE HLLAPI

Cooperative applications development that involves both microcomputers and mainframes draws on the strengths of each

Mike Fichtelman

One of the biggest surprises of the last decade, at least to IBM, was the phenomenal success of the IBM PC. IBM's original sales projections for the PC indicated that only about a quarter-million of the little machines would be sold. Of course, these projections may have been skewed by IBM's interest in mainframe computers—IBM makes a 60 percent profit on every mainframe. Therefore, just about everything that IBM does, makes, or sells is traditionally geared toward bolstering the sale of mainframes.

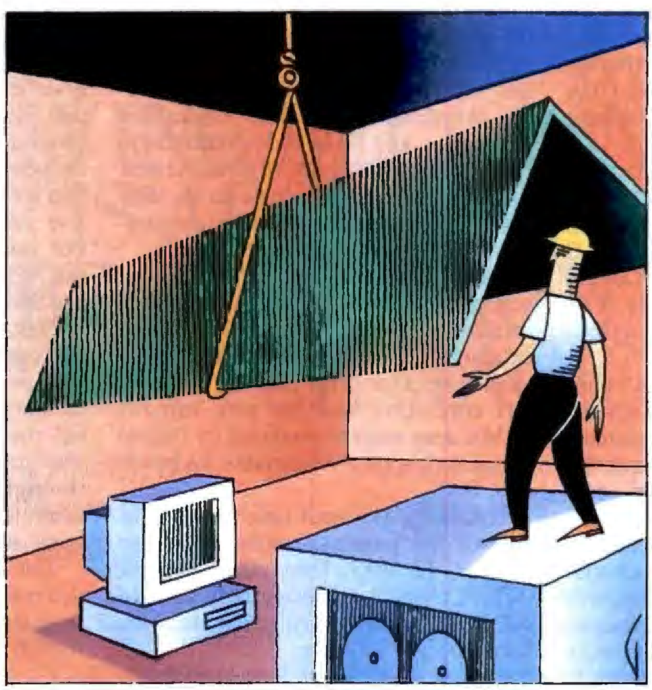
Despite IBM's predilection for mainframes, sales of PCs grew far beyond the original projection. People all over the world, in homes, offices, and factories, are using PCs to do just about everything that a "real" computer can do. In fact, the balance has shifted so dramatically that last year sales of PCs eclipsed sales of mainframes for the first time.

The reasons for this are simple. Given a choice between a mainframe terminal and a personal computer, people will almost always choose the latter. A personal computer is under your control. Response time and performance are usually excellent, because you're not competing with hundreds of other users for the machine's attention.

Personal computers are also easier to use. Applications can be built using virtually endless levels of help screens, windows, and other techniques that make using the application more intuitive.

These kinds of things can't be done on a mainframe without enormous expenditure and effort. It's like giving people a choice between a black-and-white TV and a color TV. Just as most people will take the color TV, most people will take a personal computer over a mainframe terminal.

In the mid-1980s, IBM began to realize that mainframe sales were ebbing away to the less profitable but enormously popular PC. But wait a second. What about all that information on the mainframe, all those huge data files? What about the tremendous investment that companies all over the world have made in mainframes and mainframe data communications networks?



To keep the PC people in the game, protect customer investment, and salvage its bread-and-butter business, IBM began to produce alternatives that were needed to provide connectivity between PCs and mainframes. Enter Systems Application Architecture (SAA).

You don't SAA

PCs weren't the only reason for IBM's sagging sales. Another culprit was IBM's disjointed product line. IBM produces a large portfolio of software products that run on

continued

ILLUSTRATION: JOE GAST © 1990

a plethora of hardware platforms. IBM's product picture is so big that its own staff has trouble getting a handle on it; forget about the customers. Customers were having some problems integrating these products because of dissimilar protocols, file structures, operating systems, naming conventions, user interfaces, and so forth.

Meanwhile, competitors like Digital Equipment were promoting tightly integrated product lines that allowed users to port applications unchanged (theoretically) from a microcomputer to a mainframe and back again. This approach permitted the development of systems that distributed the work load across platforms, allowing different machines to do the part of the work that each did best.

IBM confronted the problems of personal (distributed) computing and its fragmented product line by announcing SAA in 1987. SAA is an attempt by IBM to pull everything it produces under a single umbrella of standardization.

SAA is not a product, but rather a set of guidelines that IBM and third-party vendors will adhere to in order to provide both users and vendors with the benefits that usually come from standardization. Along with SAA, IBM also announced the PS/2 family of microcomputers, the OS/2 operating system, and the Micro Channel architecture. These hardware and software components form part of

SAA is a great idea, but it won't happen overnight, and it won't come cheap.

Needless to say, SAA is an ambitious proposition. It's a great idea, but it won't happen overnight, and it won't come cheap. The chronic delays and relatively high cost associated with the development and implementation of IBM's first SAA application, OfficeVision, underscore this fact.

Hello, HLLAPI

The High-Level Language Application Programming Interface (HLLAPI—pronounced "ha-lap-pee") is a valuable programming tool. HLLAPI lets programmers develop applications that deliver what SAA only promises. It can quickly, easily, and relatively inexpensively produce cooperative-processing applications between PCs and mainframes that draw on the strengths of both: PCs are great for fast, friendly user interfaces; mainframes can't be beat for storing and retrieving gigabytes of information reli-

tured; this dedicated approach was replaced by the 3278/3279 coax adapters. These adapters can be purchased for both the PC and Micro Channel buses.

The emulation software changed as well. The 3270PC control program gave way to two different programs. The full-blown workstation program provides support for four mainframe sessions, a PC session, and a lot of other features. The stripped-down version is called the 3270PC entry-level emulation program. The entry-level program provides one mainframe and one PC session; it meets the requirements of most users.

Various terminal-emulation products provided access to mainframe applications. Some even provided file transfer between the PC and the mainframe, but they weren't really programmable. With the introduction of HLLAPI, IBM has provided a mechanism for effectively controlling the interaction between the PC and the mainframe.

HLLAPI is exactly what the name purports: an interface to the low-level functions of the terminal-emulation program that can be accessed by applications written in a high-level programming language like C or Pascal. These functions are invoked in the typical manner of the particular programming language, by linking the application program with a language interface module (LIM).

Keystrokes can be sent to the mainframe, automating the actions of a human operator. The mainframe display can be searched, tested for an update, copied to a file, or sent to the printer. Data can be entered into a mainframe CRT form or extracted and processed by another PC program.

In addition to these and other presentation services, HLLAPI provides functions that perform support tasks, such as session status generation, connecting to and disconnecting from the mainframe, and system reset. The table provides a list of all the HLLAPI functions, as well as the function codes and a brief description of each.

HLLAPI FUNCTIONS

HLLAPI functions are executed by passing the function number as an argument to the TSR program's interface function, HLLC.

Function	Function number	Description
PRESENTATION SERVICES		
Connect presentation space	1	Establish connection.
Disconnect presentation space	2	Break connection.
Query cursor location	7	Find the cursor.
Query field attribute	14	E.g., is current field highlighted?
Search field	30	For presence of specified data.
Find field position	31	Locate a specified field.
Find field length	32	Get the length of a field.
Copy field to string	34	Move field contents to a string.
Copy string to field	33	Move string contents to a field.
Copy OIA	13	Move 3270 operator information area to a string.
Copy presentation space	5	Copy entire mainframe display to

Across the Great Divide

The primary problem that I encountered when I began exploring HLLAPI was a dearth of information. IBM provides documentation on all the functions in a terse manual, and the functions just weren't intuitive. Once I started to build a library of the functions in C, however, it was relatively simple to combine the functions to satisfy a variety of requirements.

Since a picture is worth a thousand words, I've included listing 1 as an annotated example of a program that uses HLLAPI. The program is short, but it ties together several important HLLAPI

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Listing 1: *BYTEAPI.C, a little HLLAPI program.*

```
#include <stdio.h>

/* HLLAPI parameters */
int    API_FUNC, API_LEN, API_RETC;
char   API_STRING[255];

/************ HLLAPI DECLARATIONS **************/
void connect_host();
void disconnect_host();
void pause (int API_LEN);
void receive_file ();
void reset_system();
void search_pres(char *API_STRING,int API_RETC);
void send_key(char *API_STRING);
void wait();


main( )
   {

   reset_system ();            /* initialize HLLAPI TSR program */
   connect_host();             /* connect to mainframe presentation space */

 /* perform the log-on process */
   puts("Logging On To Mainframe VM System");
   send_key ("@C");            /* clear the screen */
   wait();                    /* wait until mainframe is ready for input */
   send_key ("LOGON userid@E"); /* enters user ID */
   wait();
   pause(20);                  /* pause for 20 half-seconds */
   send_key ("password@E");  /* enters the password */
   wait();

/* search the presentation space for the signal from another user */
/* ID that it is time to download the file */
   strcpy(API_STRING,"OK TO PROCEED");/* move search string to string parameter*/
   API_LEN = 0;                /* initialize length parameter */
   /* loop until the search string is found in the presentation space
         ( as long as API_LEN = 0 or until a key is hit */
   while ( API_LEN == 0 && !kbhit() )
   {
    clrscr();                  /* clear the PC screen */
    puts("Searching Presentation Space For Message To Proceed");
    search_pres(API_STRING,1); /* invoke the search function */
   }

 /* when the signal is received, begin download process */
   puts("Proceeding To Download File From Host");
   disconnect_host ();         /* must disconnect before receive */
   /* invoke the receive function with parameters for the PC filename,
      the mainframe filename, file type, and mode; convert the file to ASCII;
      carriage return/linefeed marks the end of records */
   receive_file("GLFILE GENERAL LEDGER * (ASCII CRLF");
   connect_host();             /* reconnect to mainframe presentation space */
   send_key ("@C");            /* clear the screen */
   wait();

 /* send a message to the other user ID that the file has been downloaded */
   send_key ("MSG otherid GL FILE RECEIVED @E");
   wait();

 /* reinitialize and exit */
   reset_system ();
   exit(0);
}

/* Connect to Host Session*/
void connect_host ()
    {
    API_FUNC = 1;              /* function code */
    strcpy(API_STRING, "E" ); /* connect to session E */
    API_LEN = 1;               /* length of string is 1 */
    /* call Language Interface Module */
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    if (API_RETC != 0)        /* handle the return code */
       {
       puts("Warning : could not connect to Host." );
       printf("Return Code : %d\n" ,API_RETC);
       return;
       };
    }

    /* Disconnect from  Host Session*/
void disconnect_host ()
    {
    API_FUNC = 2;
```

continued

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```
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    if (API_RETC != 0)
       {
       puts("Warning : could not disconnect from Host." );
       printf("Return Code : %d\n" ,API_RETC);
       return;
       };
    }

/* Pause for host event, APILEN in half-seconds */
void pause (int API_LEN)
    {
    API_FUNC = 18;
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    }

/*Receive File*/
void receive_file(char *API_STRING)
    {
    API_FUNC = 91;
    API_LEN = strlen(API_STRING);/*length of API string*/
    API_RETC = 3;               /*receive.com located on c: drive*/
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    if (API_RETC != 3)
       {
       puts("Warning : could not receive file." );
       printf("Return Code : %d\n" ,API_RETC);
       }
    else
       {
    puts(" ");
    puts("File Received.");
       };
    }

  /* Reset System */
void reset_system ()
    {
  API_FUNC = 21;
  HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    }

/*Search presentation space*/
void search_pres(char *API_STRING,int API_RETC)
    {
    API_FUNC = 6;
    API_LEN = strlen(API_STRING);/*length of API string*/
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    if (API_RETC != 0)
       {
       puts("Warning : Could not find string in presentation space." );
       printf("Return Code : %d\n" ,API_RETC);
       };
    }

/* Send Key*/
void send_key (char *API_STRING)
    {
    API_FUNC = 3;
    API_LEN = strlen(API_STRING);/*length of API string*/
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    if (API_RETC != 0)
       {
       puts("Warning : could not send keystrokes." );
       printf("Return Code : %d\n" ,API_RETC);
       return;
       };
    }

/* Wait for mainframe to catch up */
void wait ()
    {
    API_FUNC = 4;
    HLLC(&API_FUNC,API_STRING,&API_LEN,&API_RETC);
    }
```

the HLLAPI TSR program using reset system. It's the safe thing to do and resets everything to default values. Next, connect to the mainframe presentation space. The send key function clears the screen and enters the log-on ID. Certain keystrokes are preceded by an @ sign, such as @C (the Clear key) and @E (the Enter key). These are known as *attention/interrupt* keys because they initiate some kind of action on the part of the mainframe system.

Next, use pause to let 10 seconds pass and let the mainframe session catch up before entering the password. The difference between pause and wait is subtle. The wait function waits until the

continued

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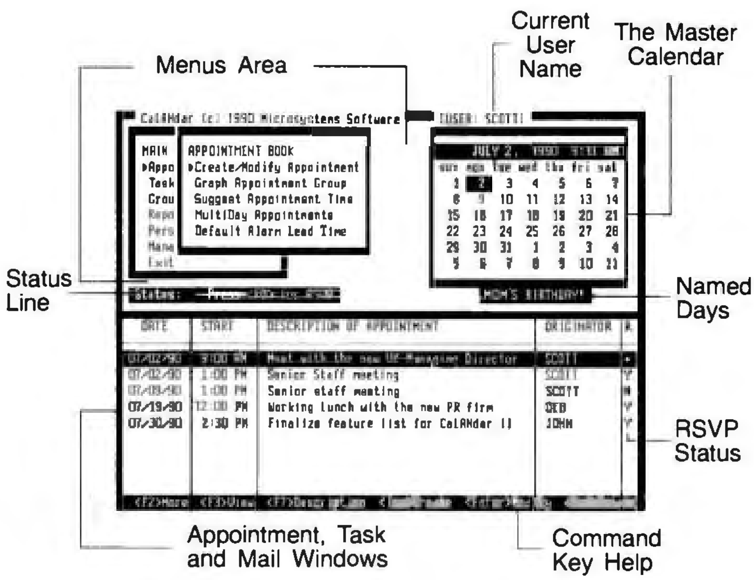

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Circle 222 on Reader Service Card (RESELLERS: 223)

communication line is no longer busy; this doesn't necessarily mean that the previous action you requested has been completed. The pause function waits for the length of time you specify.

To find out when it's safe to start the download, the automated operator will repeatedly search presentation space until it detects the notification string "OK TO PROCEED," or until somebody presses a key. Obviously, the notification string could have been anything. Please be aware that there are more sophisticated (and more complicated) ways of handling this kind of notification detection.

Once the automated operator gets the OK to continue, the download process begins. However, you must first disconnect from the presentation space; this is mandatory. The `receive file` function accepts the following parameters for receiving a file from a VM mainframe system: the PC filename (GLFILE), the VM filename (GENERAL), the VM file type (LEDGER), the VM file mode (*), and the conversion parameters (ASCII CRLF). When the file has been downloaded, reconnect to the presentation space, clear the screen, and send a message to the other virtual machine saying that the file was received.

If you examine the functions themselves, you'll notice that they are modular. They can be mixed as necessary to create the desired result. There could have been other functions added to make this application more robust.

Once you've written your HLLAPI application program, you must compile it and link it with the appropriate LIM. In the case of C, there are three LIMs. For the small, medium, and large memory models, use HLLC_S.OBJ, HLLC_M.OBJ, or HLLC_L.OBJ, respectively.

The following is a batch file implementation that could be used to compile and link the BYTEAPI program using Turbo C.

```
REM compile and link byteapi.c
      using turbo c
tcc -IC:|tc|include -LC:|tc|lib
      byteapi.c hllc_s.obj
```

To execute BYTEAPI, first run the terminal-emulation program from the DOS command line: `C> pc3270` for the entry-level program, and `C> indcipl` for the workstation program. Next, execute the IBM HLLAPI program: `C> EEHLLAPI` for the entry-level version, and `C> HLLAPI` for the workstation version. Finally, execute the application program: `C> BYTEAPI`. That's all there is to it.

Take a Mainframe to Lunch

The ways in which you can use HLLAPI are limited only by your imagination. You needn't stretch too far to see the potential of a PC database that uses HLLAPI to pass data back and forth between a mainframe database and a PC database, or a PC front end to a mainframe-based application that provides a graphical user interface, or perhaps an expert-system shell that invokes a HLLAPI program to perform mainframe problem determination and resolution without human intervention.

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Mike Fichtelman is the systems planning officer at EAB in New York, New York. He can be reached on BIX c/o "editors."

ADDING VALUE TO YOUR DATA

Whatever way you choose to share data, the process is essential

George Bond

D*ata sharing* is one of those phrases whose fuzziness masks the immense value of what it describes. Its meanings and uses span a wide range. Moving data from one computer to another is so central an issue that it is impossible to overstate its importance.

Data sharing can mean slipping the answers to today's quiz to the kid across the aisle in an elementary-school history class. Or it can refer to the National Oceanic and Atmospheric Administration computer's pulling weather data from sensors and broadcast gear in a satellite miles above the earth and feeding it into a network that your local TV weatherperson uses to prepare the 6 p.m. report.

In down-to-earth, real-world terms, data sharing can mean maintaining a central file of procedures and functions for use by a programming team, the pooling of mortality statistics by insurance companies, or providing a statewide master card catalog for libraries.

You can even share data with yourself by cutting and pasting between applications, doing mail merges, importing information, or using Dynamic Data Exchange (DDE) procedures. You can share data with others through something as simple as a null modem (or a peer-to-peer, zero-slot LAN).

Despite its importance, the world of data sharing is far from robust. The lack of hardware and software standards has caused enough problems to drive many users back to their isolated PCs after tentative and often unsuccessful attempts to talk with the world. Users have needlessly rekeyed millions of characters instead of having them read from a file.

Thousands and thousands of people use databases, telephone directories, and accounting systems that don't really meet their needs. They do so because it takes too much work to manually transcribe years of data from an old program to a new and improved one. What follows is a discussion of basic ways that you can share data and of what tools are available that you can use today.

Footpower Transfers

The "sneakernet" is the simplest way to share data between one computer and another. You store data on a floppy disk in computer A, remove the disk, carry it to computer B, insert it in a disk drive, and read it. It is simple, fast, and cheap.

Of course, this method of sharing data assumes that both computers use compatible disk formats and sizes (your PS/2 will have problems reading a disk from your DEC Robin). It also assumes that the programs that generate the data are compatible (for

continued

ILLUSTRATION: KAREN STOLPER © 1990

example, WordStar 4.0 is not happy trying to digest a raw WordPerfect 5.1 file). If you experience compatibility problems, there are solutions.

When all your data is stored in ASCII, all is well on the network. Of course, not everything is stored in ASCII. PageMaker stores data one way, dBASE another, and SuperCalc a third. WordPerfect 5.1 stores its data differently than WordPerfect 4.0. An early Lotus worksheet is different from a current Lotus worksheet.

There are several ways to deal with this problem. When you're working with Microsoft Windows applications, you can use DDE to move data around automatically. Smart clipboards, such as the ones in Windows and Desqview, can handle data from diverse programs and do the necessary conversion. Many programs now have very good import/translation programs built in. Excel, for example, can read files generated by many other spreadsheet programs. Most of the major word processors can read each other's files. And dBASE formats have become a virtual lingua franca of databases.

Slide-in, Slide-out Data

The Bernoulli Box, an early, removable-media, high-capacity disk drive that was introduced a decade ago by Iomega, has become a dependable data-sharing medium. It uses removable high-capacity disks protected by a hard shell. Bernoulli Boxes are available in both 8- and 5¼-inch formats and operate with most microcomputers. The 5¼-inch drives can be mounted internally. The 8-inch drives are available with capacities of 10 megabytes and 20 MB, and the 5¼-inch units are available with 20 MB and 44 MB. A Bernoulli Box can read data recorded on any other Bernoulli Box of the same size.

Removable hard disk drives are another option. These devices are like standard hard disk drives, but they come in two parts: a docking section installed in the computer, and a separate disk pack (see photo 1). You can unplug the disk portion from the docking section and plug it into another computer.

In other words, you could work on a spreadsheet all day at the office, store it on a removable hard disk drive, and, at the end of the day, snap out the disk and cart it home. After dinner, you could plug it into the docking socket in your home computer and continue working. Or you could ship it across the country so your partner in Boston could check your work before submitting it to the bank to document your qualifications for a loan. Such widely known manufacturers as Plus Development, SyQuest, and Sysgen, as well as lesser-known vendors like Axonix and Mega Drive Systems, are offering removable hard disk subsytems.

Tape storage uses recording tape instead of floppy disks to store or transfer information. The principle is the same, but the medium is different.

Photo 1: *One way to share data is with a removable hard disk system like this Sysgen 45-MB device. With a setup like this, you can snap out the disk pack, plug it into another system, and use the information somewhere else.*

Dis and DAT

Tape storage, a variant of the sneakernet, uses recording tape instead of floppy disks to store and/or transfer information. The principle is the same, but the medium is different. Tape is available in three configurations: cassette, cartridge, and open-reel.

As a computer-data medium, cassettes are unreliable and difficult to use. A caveat: If you are considering using cassettes to transfer your data, discuss your needs with someone who owned a Tandy Model I with a cassette drive.

Digita audio tape (DAT) recorders modified for data use are beginning to show up on the market. You will find them handy for backing up LANs, because they have advantages such as their capability to store more than a gigabyte of data on a cartridge about the size of a standard audiocassette.

However, DAT devices are expensive—about $2000 and up. If all you want to do is share data, they aren't very cost-effective. But if you're interested in this technology and can justify the expense, they're available from Jasmine Technologies, GigaTrend, and Tallgrass Technologies.

Generally, traditional magnetic cartridge tapes and drives make a lot more sense. They are available in several form factors and are growing in popularity as backup devices for small-computer hard disks. These drives are relatively inexpensive and compact. You can install them internally in many PCs, saving valuable desktop space.

The cartridges themselves are inexpensive, small, and easy to store. They are available in capacities of up to 320 MB (data compression techniques are generally used to attain such higher-capacity figures). Standards for this type of cartridge have been set and adopted by the industry. They are published by the Quarter-Inch Cartridge (QIC) committee, but not by ANSI, the International Standards Organization (ISO), or any other internationally recognized standards organizations.

The granddaddy of data-tape systems is open-reel. This is a configuration, usually called "9-track," that stores data at 800, 1600, 3200, or 6250 bits per inch on a ½-inch tape in nine parallel tracks. The data is read nine tracks at a time, making data transfers very fast.

Nine-track drives are common on mainframes, and you can install them on most PCs. They are more expensive than cartridge systems, and because they use large reels, they also present storage

continued

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problems. But if you need to exchange data with a wide variety of computers, 9-track may be the way to go. Most 9-track drives can read tapes written by other drives at the same density. Some 9-track vendors are Flagstaff Engineering, Overland Data, Contech, and Qualstar.

Peer-to-Peer Data Sharing

The simplest way to share data is by stringing a wire between the computers' RS-232C ports (using a "null modem"). Null modems really aren't modems at all. They are simply cables that have some of their connector pins cross-wired. For example, pin 2 at the sending computer may be tied to pin 3 at the receiving computer. Sender pin 6 may become receiver pin 20. The actual configuration depends on the serial ports involved.

Getting two computers to talk to each other over a null modem used to be a challenge—to say the least. You had to make your own cable, configure a serial port, and write or diddle software to get the computers to communicate. However, the advent of the laptop computer has changed all that.

The need to move information on a regular basis between portable and desktop computers created a sizable market for software and hardware to handle this job. Although such programs were designed for laptop-to-desktop connections, they also work with desktop-to-desktop connections. These programs often include hydra-headed cables that connect to just about any port on a PC, and they are a breeze to configure.

LapLink, Brooklyn Bridge, and File Shuttle are examples of available products in this market. Some of these transfer programs have become so sophisticated that they are virtually a LAN for a pair of computers; besides doing all the error checking needed to transfer both text and binary files, they allow you to use remote printers and disks. Unlike a full-featured LAN, however, these programs operate in a master/slave configuration. When you are using a disk on the remote computer, that computer cannot be used from its keyboard.

Plugging into the World

The next step up from a null-modem connection is a real, physical modem connection. Although you lose speed with a real modem, you gain distance. Null modems have a limit of 50 to 100 feet for serial connections and about 12 feet for parallel connections.

Null-modem serial connections allow data transfers at speeds exceeding 115K bytes per second; parallel connections allow for much faster transmission. Consumer modem speeds top out at 19,200 bps. But real modem connections can span continents and oceans if necessary (as long as the modem on the receiving end is compatible with that on the sending end).

The two basic types of external modems are *acoustic-coupled* and *direct-connect*. Acoustic modems make no permanent connection with the telephone system. Instead, they use transducers that press against a telephone handset's mouthpiece and earpiece.

Acoustic couplers don't handle high data speeds well. They are mostly relics today, but they still have some valuable uses. For instance, if you're stuck in a hotel room where the telephone cable is anchored into the wall the way Excalibur was anchored into the stone, acoustic couplers are essential. A 300-bps transmission through electronic earmuffs on the phone is better than no transmission at all. And technology is changing things, as usual. For example, a new modem from Eurolink comes with an acoustic coupler that the company says supports speeds of up to 4800 bps with MNP level 5 data compression.

You can obtain both external or internal direct-connect modems. External modems have one or two phone jacks and one serial connector. You plug a phone cord into one of the jacks in the modem, and the other end into the telephone wall outlet, just as you would plug in a phone. The jacks are generally RJ-11 and accept a standard Bell Telephone extension cable. Often, the modem has a second jack to allow connecting a telephone to the line. Internal direct-connect modems also come as self-contained cards that fit into a bus slot and provide their own serial connection.

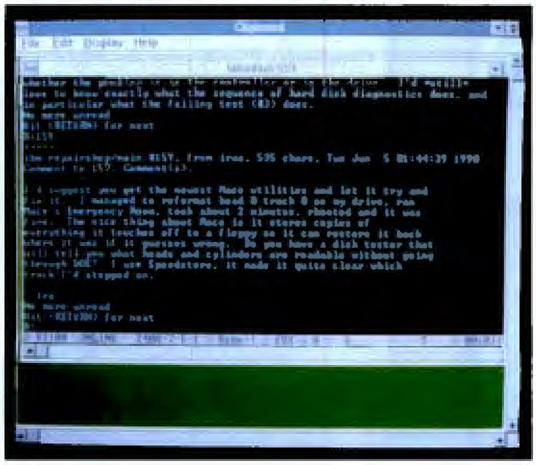

Photo 2: *One way of sharing data is on a BBS. Shown here is a screen from BIX, which has several hundred different interactive conferences covering a huge variety of subjects.*

The slowest standard modem these days operates at 300 bps. I've seen these modems advertised for as little as $25, and selling for $2 to $5 at swap meets. Unless you're on an absolutely rock-bottom budget, don't bother with them. Get at least a 1200-bps modem ($50 to $100) or, better yet, a 2400-bps unit ($75 to $200). If you need to move large amounts of data, consider 9600-bps or faster modems ($600 and up). The 1200-bps modems are probably the most common today, but as prices fall, 2400-bps units are catching up fast.

Both the acoustic and direct-connect modems require a serial card that you can configure as a communications port on your computer. COM1 and COM2 are the most common, but you can often use COM3 and COM4 as well.

There are some amazing telecommunications software packages on the market today—public domain and shareware as well as commercial. You really have to look hard to find a bad one. You may find an interface you don't like, but the program is likely to do what it says it will do, and do it well.

Sophisticated packages like Crosstalk for Windows and DynaComm can support DDE while running in the background and can feed numeric data directly into an Excel spreadsheet. Kermit, a public domain program, can interact with everything from mainframes to microcomputers. With shareware programs (e.g., Telix, Qmodem, and Procomm) that include command languages, you can automate much of your telecommunications activity. If you choose other software (e.g., Remote2 and Carbon Copy), you can set up one computer as a host and and control it remotely from another computer. For example, you could run Remote2 on your office desktop while you travel and have access to all your files from the field.

Data telecommunications with on-line systems may be the best way to share data. No one knows for sure how many public computer BBSes exist today, but estimates for the U.S. alone begin at 6000 and go as high as 15,000. Most of these are free services run by individuals or companies.

Their content ranges from civil rights, freedom-of-the-press, and National Rifle Association gun policy support to product support. There are specialized BBSes for pilots, doctors, health-food fanciers, Buddhists, channelers and mystics, children, senior citizens, members of Alcoholics Anonymous and other 12-Step groups, and science fiction fans. You name it. . . there's probably a BBS group somewhere that addresses issues that interest you. Thousands of megabytes of text and program code are available for the price of a phone call.

Many commercial BBSes exist as well. Among those that provide information at moderate prices are BIX, CompuServe, GEnie, Delphi, Dow Jones, and a dozen or so others (see photo 2). High-end services that cost $25 per hour and up (e.g., Nexis and Dialog) provide specialized information on demand. This may be the ultimate in data sharing. When you use one of these services, you literally have the collected wisdom of the world sitting in data banks waiting for you to drop by and collect it. ■

George Bond is a communications consultant with more than 20 years' experience and a cofounder of BIX. You can reach him on BIX as "gbond."

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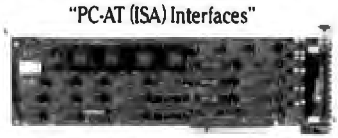

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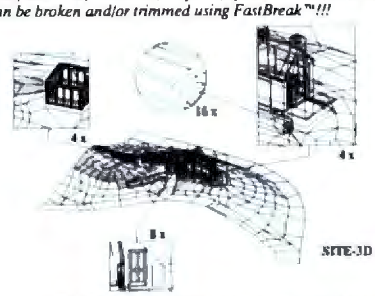

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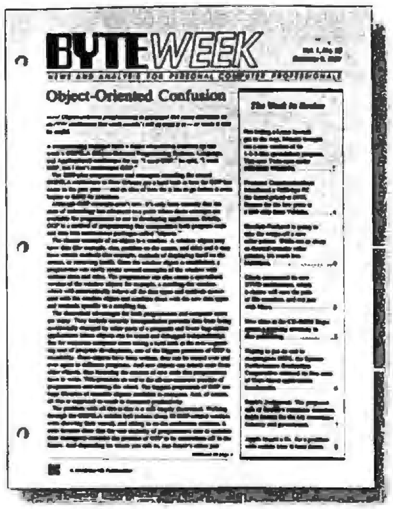

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Company ____________________

Address ____________________

City ____________________

State/Province ____________ Zip ________

Country ____________________

(   ) ____________ Phone Number

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A. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes   11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1-25
19 ☐ 26-50
20 ☐ 51-99
21 ☐ 100 or more

Inquiry Numbers 1-495

1	2	3	4	5	6	7	8	9	10	11
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Inquiry Numbers 991-1479

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1475	1476	1477	1478	1479						

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1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?
7 ☐ Senior-level 9 ☐ Professional
8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)
12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?
18 ☐ 1-25 21 ☐ 100 or more
19 ☐ 26–50
20 ☐ 51–99

IBM
IRSE009

Inquiry Numbers 1-493

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
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Inquiry Numbers 494-986

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Inquiry Numbers 987-1479

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A. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes
11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1-25
19 ☐ 26-50
20 ☐ 51-99
21 ☐ 100 or more

IBM
IRSE009

Inquiry Numbers 1-493

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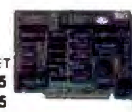

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COMPANY INFORMATION

Ergo
1 Intercontinental Way
Peabody, MA 01960
(508) 535-7510
Inquiry 1075.

MetaWare, Inc.
2161 Delaware Ave.
Santa Cruz, CA 95060
(408) 429-6382
Inquiry 1076.

Phar Lap Software
60 Aberdeen Ave.
Cambridge, MA 02138
(617) 661-1510
Inquiry 1077.

Watcom Systems, Inc.
415 Phillip St.
Waterloo, Ontario,
Canada N2L 3X2
(519) 886-3700
Inquiry 1078.

small program shown in listing 2. When it is in real mode, it peeks at the BIOS timer count located at 0040:006C, but when it runs in protected mode under the Phar Lap DOS extender, it produces the following message:

```
C:\PHARLAP>run386 ticks
Abnormal program termination:
Memory protection fault CS:EIP =
      000C:0000000C.
```

at 000C: 0000000C; what instruction does that correspond to?

```
0002        xor ax,ax; AX = 0
0005        mov fs,ax
0007        mov eax,0000046cH
000c        push fs:[eax]
```

Note that loading 0 into FS (one of two additional segment registers on the 386) did not cause a GP fault. You use selector 0 to create null pointers in protected mode. Loading these pointers is always legal; however, if you try to dereference one, it causes a GP fault. That's what happened with PUSH FS:[EAX]. Furthermore, an equivalence between 0040:006C and 0000:046C was assumed, and this doesn't hold in protected mode.

So how can you peek at memory location 0040:006C? You often hear statements like "you can't do that in protected mode." But rather than take these as injunctions, you should just regard them as problems to solve. Obviously, you *can* execute data in protected mode: otherwise, how would executables ever get loaded and executed? Likewise, there must be some way to peek at arbitrary physical memory locations: otherwise, how could anyone write graphics code?

There are several ways to read the BIOS data area at real-mode segment 40h. Phar Lap executables (whether run under the Phar Lap or the Ergo DOS extender) provide a protected-mode selector, 34h, that maps to the first megabyte of physical memory. (Note how the entire DOS address space occupies a tiny portion of one 32-bit protected-mode selec-

an executable alias selector for a data segment or a writable data selector to a code segment. You can call a real-mode service (software interrupt or far call) not transparently handled by the DOS extender (e.g., NetBIOS or undocumented DOS calls like INT 21h AH=52h). Or you can query virtual-memory statistics. These APIs are quite small, but they're proof that you don't need 500 functions to provide a powerful API.

Future Directions

Now is a good time to get into 386 development. There is healthy competition between the two major 32-bit C compiler manufacturers, MetaWare and Watcom. The new release of Watcom's compiler includes not only the first source-level debugger for 32-bit DOS extenders, but also a superb execution profiler. Microsoft itself finally has a 32-bit C compiler (C 5.2) targeted for OS/2 2.0. Several C++ compilers are available for 32-bit DOS. Meanwhile, the entire DOS extender "industry" is working together in a committee with Microsoft and others to put together the DPMI specification. Windows 3.0 incorporates the DPMI specification, and OS/2 2.0 is expected to. Perhaps it will even find its way into a future version of MS-DOS itself.

All these developments should ensure a long life for 32-bit DOS applications, and they should ensure that the 386 won't remain a code museum for ancient 8088 code. Now is the time to stop finding workarounds for limitations that the 386 is only pretending to have. ■

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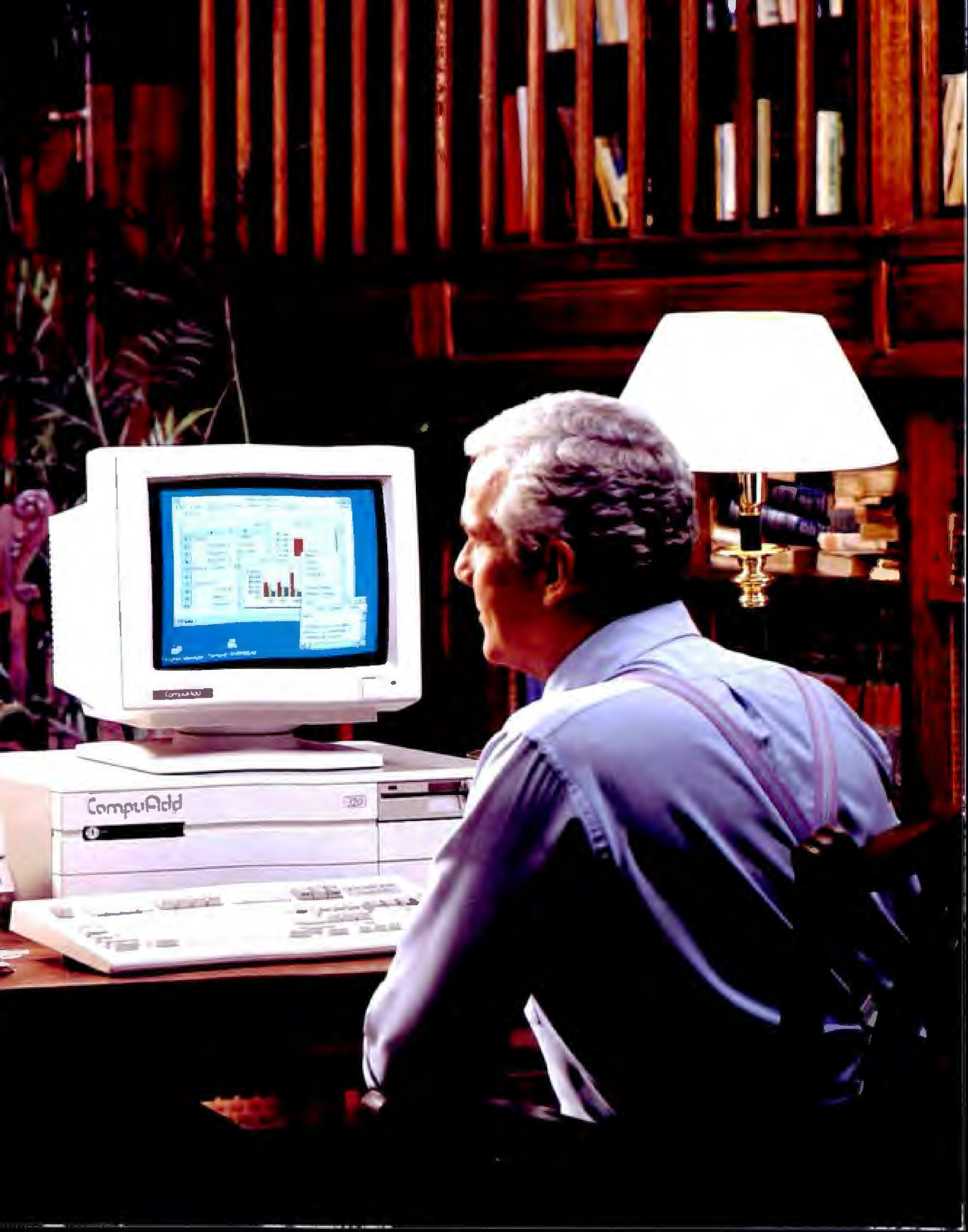
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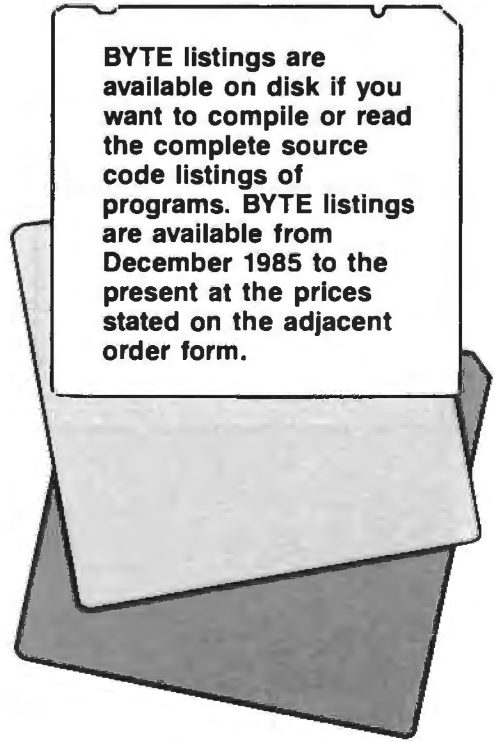

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