IBM PS/2 Models 90 and 95 True 486 Power At Last

Long after its competitors have brought out 486 machines, IBM has finally delivered a pair of PS/2s with true 486 power. The new PS/2s promise to give Compaq and other high-performance contenders a run for the money.

by Winn L. Rosch

PHOTOGRAPHY: JOHN WILKES

They're late to the party perhaps, but the arrival of IBM's Personal System/2 Models 90 and 95 XP 486 hints that the real fun is just beginning. Finally, there's tough competition at the high-performance end of the PC market. These fraternal twins are IBM's first true 486-based PCs, and they are powerful enough to challenge any machine on the market.

As far as performance is concerned, the twins break new ground only for IBM. At best, they only achieve parity with the processor performance of Compaq's trendsetting Systempro, which won *PC Magazine*'s 1990 Award for Technical Excellence for desktop PCs. While their test results put the Models 90 and 95 in good company— among the fastest computers PC Magazine Labs has ever tested—trailing the leader by a year hardly rates as a remarkable accomplishment.

The real importance of the PS/2s runs deeper. These are showcase machines that demonstrate new technologies and new directions for IBM's PC program. They just may be the catalysts that help put IBM back into a leadership role.

The Models 90 and 95 show off several technologies and attempt to set new industry standards. Bus mastering, heretofore a promise made but not kept by the Micro Channel architecture, is delivered in force. The long-awaited next step in high-resolution display systems—the 1,024-by 768 Extended Graphics Array, or XGA—is standard equipment in both new systems.

Many mysterious changes in system design mark radical departures from IBM's previous practices. Case construction is unlike that of any previous PS/2. The system boards of the new machines lack microprocessors. Even the 5.25-inch floppy disk drive is back. (See the sidebar "IBM's Slim High Drive: New Tricks for an Old Form Factor.") If the Models 90 and 95 foretell the future of the IBM product line accurately, it is a future we had not expected.

PLOP AND SWAP

More than any previous IBM PC, the Models 90 and 95 are machines designed to be upgraded. Not only can you plop in new peripherals, you can upgrade both the microprocessor and the entire control system of the Micro Channel expansion bus simply by swapping an expansion board. You don't even need tools to make the change.

If you're a prospective purchaser, that's the good news. When technology changes, the Models 90 and 95 can adapt while preserving much of your admittedly steep investment. But if you're competing with IBM in the PC market, the new designs are bad news indeed. The new PS/2s can serve as the foundations for PCs with much higher performance. The cases and system boards of the Models 90 and 95 could be the building blocks that allow IBM to offer the first 50-MHz 486s and the first 586 PCs on the market.

Such quick upgrades are a definite possibility. Already IBM has shown the willingness and the ability to bring new power to the marketplace. For example, the PS/2 Model P75 introduced at Fall Comdex 1990 was the first 486-based portable PC to earn the FCC Class B approval needed to be legally sold in the U.S. (See the sidebar "IBM's P75 Puts a Handle on 486 Power.") The Models 90 and 95 give IBM the potential for making similar strides in desktop hardware. Although latecomers to the high-performance party, the twins may be able to bring back the excitement that's been missing for such a long time.

FACT FILE

IBM Personal System/2 Model 90 XP 486
IBM Corp.; contact local dealer or 800-426-2468.
List Price: Model 90 XP 486-OJ5, with 4MB RAM, 80MB hard disk, 8K caching controller, 1.44MB floppy disk drive, one parallel and two serial ports, mouse port, 80486/25 processor, 101-key keyboard, $12,495. Model 90 XP 486-OJ9, with 160MB hard disk, $13,095. Model 90 XP 486-OKD, with 320MB hard disk, 80486/33 processor, $16,695. IBM PS/2 Color Display 8515, $950.
In Short: This is IBM's first true 486 desktop system. Using a design akin to passive backplaning, it puts the CPU and other circuitry on a Processor Complex board, so you can choose between a 25-MHz and a 33-MHz chip now and migrate to more-powerful processors in the future. XGA, IBM's new high-resolution graphics spec, is built into the system board.

CIRCLE **405** ON READER SERVICE CARD

IBM Personal System/2 Model 95 XP 486
IBM Corp.; contact local dealer or 800-426-2468.
List Price: Model 95 XP 486-OJ9, with 4MB RAM, 160MB hard disk, 8K caching controller, 1.44MB floppy disk drive, one parallel and one serial port, mouse port, 80486/25 processor, 101-key keyboard, $14,145. Model 95 XP 486-OJD, with 320MB hard disk, $16,095. Model 95 XP 486-OKD, with 320MB hard disk, 80486/33 processor, $17,745. IBM PS/2 Color Display 8515, $950.
In Short: One of the fastest machines that ever dashed through PC Labs, the Model 95 (with its 33-MHz 486 Processor Complex board) is as powerful as the Compaq Systempro. This network server employs the same design as the Model 90. XGA resides on an expansion board called the XGA Display Adapter/A rather than on the system board.

CIRCLE **406** ON READER SERVICE CARD.

CHOOSE YOUR CONFIGURATION

IBM introduced the Models 90 and 95 on October 30, 1990. Twins only in processor power and function, they offer similar features but are packed in different cases and built around different electronics. The Model 90 is a desktop chassis in the tradition of the PS/2 Models 50, 55, and 70. The Model 95 is a deskside tower à la the Models 60, 65, and 80. IBM offers three configurations of each model, for a total of six different units, differentiated by processor speed and the size of the standard hard disk.

The Model 90 XP 486-OJ5 (also known as the 8590-OJ5) includes a 25-MHz chip and 17-millisecond 80MB hard disk for—$12,495. (Swallow hard; the prices only get higher.) Upgrading to a 16-ms. 160MB hard disk produces the Model 90 XP 486-OJ9 (or 8590-OJ9) and pushes the price to $13,095. Moving up to a 33-MHz chip and increasing disk capacity to 320MB with a 12.5-ms. access time produces the Model 90 XP 486-OKD (or 8590-OKD), which lists for $16,695.

The Model 95 configurations have a narrower range in price. At the bottom of the line is the Model 95 XP 486-OJ9 (8595-0J9), which operates at 25 MHz with a 16-ms. 160MB SCSI hard disk and costs $14,145. Substituting the 12.5-ms. 320MB hard disk changes the moniker to Model 95 XP-486-OJD (8595-OJD) and raises the list price to $16,095. Choose a 33-MHz chip, and you've got the Model 95 XP 486-OKD (8595-OKD), with a list price of $17,745.

IBM offers the $1,060, 80MB hard disk and $1,780, 160MB hard disk separately for system upgrades. For even more disk expansion, IBM also sells a floor-standing external chassis called the PS/2 External Enclosure that can hold up to 2.24GB of additional SCSI storage. Equipped with a single 320MB disk, this enclosure costs $6,500. Core International has also announced a series of companion hard disk arrays with individual capacities up to 4 gigabytes. (See the sidebar "When You Need More Gigabytes: Drive Array Subsystems from Core.")

STANDARD EQUIPMENT

Each of these six new PS/2 models has a similar offering of standard features. Each one comes with 4MB of 70-nanosecond RAM factory-installed. The basic configuration can currently be expanded to a maximum of 32MB in each machine, and more when higher-capacity memory modules become available.

IBM does nothing to match microprocessor memory in the base-priced systems, relying instead on the 8K RAM cache that's part of the 486 chip. Any of the new PS/2s will also host an optional 256K RAM cache, priced at $1,995—perhaps the most expensive memory in the world today, at $8,000 per megabyte.

Expanding the ordinary system RAM of the new PS/2s isn't quite so costly but

is still substantially more expensive than adding generic memory. IBM lists 2MB modules for $565 and 4MB modules for $1,095. On the other hand, those prices are somewhat more modest than what Compaq demands for its Systempro's memory ($799 for 2MB modules, $1,599 for 4MB modules).

IBM does not provide a socket for a Weitek 4167 coprocessor on either machine. But that's okay, because Intel's 486 chip has its own built-in numeric coprocessor.

Each of the new systems comes with a 1.44MB 3.5-inch floppy disk drive. A second floppy disk drive can be added, either another 1.44MB model for $263 or—surprise—an internal 1.2MB 5.25-inch model. The latter, which IBM calls a Slim High drive, lists for $310. (See the sidebar "IBM's Slim High Drive: New Tricks For an Old Form Factor.") IBM also sells an external 5.25-inch floppy disk drive for the desktop Model 90 (both 360K and 1.2MB units are available). These are entirely new floppy disk drives; external IBM drives designed for earlier PS/2 machines will not work with the Model 90.

NEW GRAPHICS: XGA

IBM's new XGA capabilities come standard with both the Models 90 and 95. (For more on XGA, see the article "Boosting Video Performance under *Windows* 3.0," in this issue.) In the Model 90, the XGA circuitry is built into the system board. In the 95, it is delivered in the form of an expansion board, IBM's XGA Display Adapter/A. This board, which uses a 32-bit Micro Channel bus connector, can be purchased separately for $1,095 should you want to upgrade your existing Micro Channel computer. The price of the board is included in the cost of the Model 95, which IBM does not sell without the adapter.

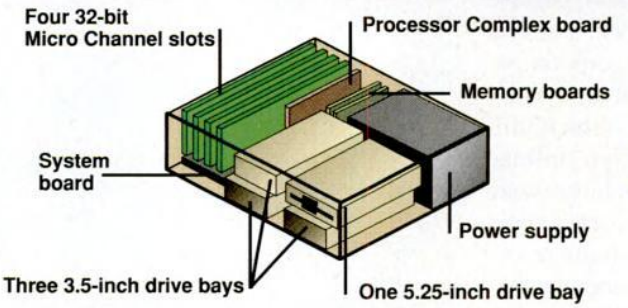
The XGA output of the new PS/2s will work with all existing VGA monitors, monochrome and color. As with VGA systems, the XGA circuitry detects what sort of monitor is connected and adjusts itself accordingly. But to get the full 1,024-by-768 resolution of the nascent XGA standard, you'll need a monitor that's compatible with the scanning frequencies of IBM's interlaced 8514/A adapter (35.5 kHz horizontal, with an 88-Hz field rate and 44-Hz frame rate). In the IBM product line, the recommended monitor is the $950 Color Display 8515.

UNDER THE HOODS OF THE NEW PS/2s

by Winn L. Rosch

IBM's new pair of PS/2 computers share some essential features. Both machines are available with either 25-MHz or 33-MHz 486 CPUs. They both come with IBM's new XGA video capabilities and the IBM SCSI 32-bit bus-mastering adapter. The two IBMs share the same Processor Complex, an expansion board that houses the CPU and allow users to make easy upgrades. But being designed for two completely different markets, the two Big Blue machines are like fraternal rather than identical twins.

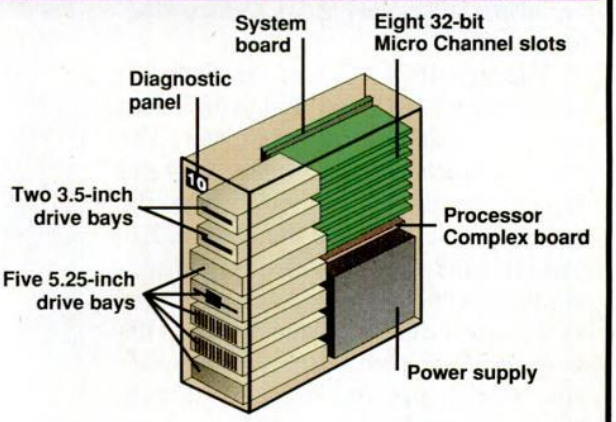
IBM Personal System/2 Model 90 XP 486



Geared toward the desktop market, the IBM PS/2 Model 90 provides four Micro Channel slots, only one of which is occupied—by the SCSI host adapter. The Model 90 also has two proprietary memory boards. XGA resides on the system board.

IBM Personal System/2 Model 95 XP 486

Designed for network server applications, the IBM PS/2 Model 95 tower offers seven drive bays, eight Micro Channel slots, and even room for AT-size expansion boards. One of the 32-bit slots is occupied by the SCSI adapter, while another holds the XGA adapter. The system board has eight SIMM sockets and no proprietary memory boards.



Both the Models 90 and 95 use the Micro Channel architecture for expansion. After the standard-equipment bus-mastering 32-bit SCSI host adapter is installed to control the hard disk, the desktop Model 90s can hold three expansion boards. Once the SCSI adapter and the XGA board are in place in the tower Model 95s, they each can hold six boards. All slots in both machines offer the full 32-bit data path.

The Model 90 comes equipped with one parallel and two serial ports. The Model 95 offers one of each. Both machines also include mouse and keyboard ports that use miniature DIN connectors (PS/2 style).

The input/output ports in the Models 90 and 95 are substantially different from those of other PCs in that they use direct memory access (DMA) control. Coupled with the Micro Channel's bus mastering, a DMA printer port can cut the CPU overhead required in printing. In serial ports, DMA operation allows higher data rates. For example, the serial ports in the Models 90 and 95 are rated at up to 345,600 bits per second. In previous IBM models,

supported serial port speeds topped out at 19,200 bps.

PASSIVE BACKPLANE

There's very little on the system boards of the new PS/2s—just the DMA printer and serial ports, video (in the case of the Model 90), and the system clock. IBM has moved the CPU, its support circuitry, and even the Micro Channel bus control logic to a special expansion board called the Processor Complex, which fits into a dedicated proprietary expansion slot. This option makes the Models 90 and 95 awfully close to passive-backplane computers—a big switch from IBM's practice of making single-board PCs with all the brains on the system board.

Although it's radical for IBM, passive backplaning is not a new idea. Back in 1981, the Z80-based CP/M microcomputers (the most powerful at that time) were based on S-100 architecture, which utilized a passive-backplane design. Instead of a system board, these machines were made from several expansion connectors linked together with printed circuit traces on a circuit board. Nothing fancy here—the traces were just like ordinary wire. The main board was the backplane (which was installed flat in the back or bottom of the computer). And it was called passive because it lacked any active semiconductor circuitry.

The first IBM PC sent the fledgling micro industry in a new design direction, toward the single-board computer. The PC's intelligence—its microprocessor and support circuitry—was built onto the system board that lined the chassis. Expansion slots were provided for enhancing the machine's capabilities, but a PC would operate even without boards in the slots. (If you wanted to be able to see what you were doing, you needed a display board of some kind, but IBM even integrated display systems in its first PS/2 designs.) While some manufacturers have toyed with the passive-backplane design in PCs—NCR and Zenith are included in this list—their backplaned computers have drifted far from the mainstream.

The Models 90 and 95 are not truly passive-backplane systems. A full-fledged passive-backplane design would put all of the system's guts on a single card that plugs right into any expansion slot. But the PS/2's Processor Complex design embodies the most important element of passive backplaning: All the circuitry that determines the power and compatibility of the new PS/2s is relegated to a plug-in board. The only functions left on the system board are the time-of-day clock, the floppy disk controller, the display circuitry, and the I/O ports. Ironically, these are the very same features that the original PC left to expansion boards. The obvious advantage of the new PS/2 design is that you can upgrade easily as faster chips, such as the forthcoming 50-MHz chip, become available.

On the surface, the Processor Complex may sound similar to the Model 70's Power Platform, a small board with a chip and support circuitry on it. By plugging a new Power Platform into the Model 70, you can upgrade from a 25-MHz 386 to a 25-MHz 486. (Now that IBM has two real 486s, the company has slashed the price of the Power Platform from $3,995 to $1,900.) But as an upgrade path, the Power Platform has limitations; it can't change the CPU's speed or other capabilities.

Likewise, the Processor Complex's design may sound like designs from other manufacturers such as ALR, AST, and

IBM'S SLIM HIGH DRIVE: New Tricks for an Old Form Factor

by Winn L. Rosch

Just when you thought it was safe to switch to the 3.5-inch format, IBM brings out a new 5.25-inch internal floppy disk drive called the Slim High.

One innovation introduced along with the IBM PS/2 Models 90 and 95 appears to be something of an anachronism: a 5.25-inch internal floppy disk drive called the Slim High. And you thought that old floppy disk form factor had gone the way of the dinosaur! IBM's explanation for this seemingly backward step is that the $310 drive takes advantage of the new PS/2s' 5.25-inch bays, which are slated for technologies far more important than floppies: CD-ROM players and rewritable magneto-optical disk drives.

The new 5.25-inch drive is a perfect swan song for that format. Measuring about one-third the height of a full 5.25-inch bay (hence the "Slim High" moniker), the new drive is perhaps the most technically sophisticated floppy disk drive ever created. Instead of twisting an arm or closing a door to latch in a disk, you need only slide a floppy disk into the waiting slot. A servomechanism clamps the disk in place and presses the read/write heads against it. To eject the disk, simply press a button and the mechanism will unload the heads and pop the disk out the slot. According to IBM, one of the driving forces behind this sophisticated design was to aid people with special needs who might not be able to operate a conventional floppy disk mechanism.

Although the new Slim High drive has all the technical specifications of a conventional high-density floppy disk drive—1.2MB formatted capacity per disk across 80 tracks, 500-kilobit-per-second data transfer rate—it uses the PS/2 3.5-inch disk drive connector scheme. Ordinary floppy disk drives won't plug into the cables inside the new PS/2s.

To accommodate the Slim High drive, the new PS/2s use a variation on IBM's 3.5-inch drive mounting scheme. The Slim High mounts on a sled that slides into a bay and snaps into place. Although wider than the sleds used by 3.5-inch drives, the 5.25-inch sleds are mechanically similar. In fact, the 5.25-inch bay of the Model 90 is fabricated with two sets of guides, one set that accommodates a 5.25-inch sled and one that accommodates a 3.5-inch sled.

As with 3.5-inch PS/2 floppy disk drives, the decorative front panel of the Slim High is separate from the drive itself. It snaps into place as part of the system unit fascia. ■

BENCHMARK TESTS: IBM PS/2 486s

When it comes to raw speed, IBM's new PS/2 Model 95 XP 486 and Compaq's Systempro are pretty evenly matched. Both rank among the fastest machines ever to dash through PC Labs.

PROCESSOR AND MEMORY BENCHMARK TESTS

80386 Instruction Mix

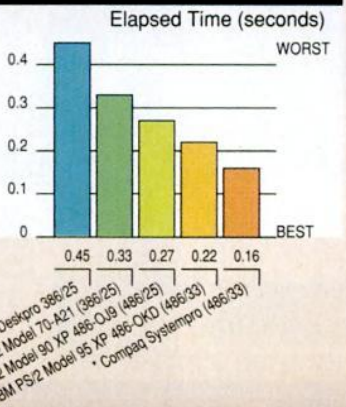
The **80386 Instruction Mix** benchmark test times a series of tasks specific to the 80386 chip. Since this test shows how the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

Floating-Point Calculation Without Coprocessor

The **Floating-Point Calculation Without Coprocessor** benchmark test sets up a floating-point emulation program in RAM and then exercises the processor and tests RAM access speeds during floating-point calculations.

Conventional Memory

The **Conventional Memory** benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

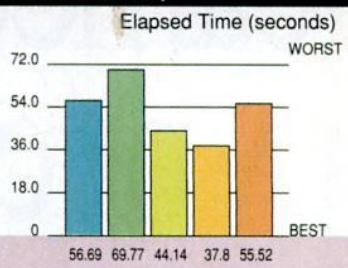


* Reported for comparison.

DISK BENCHMARK TESTS

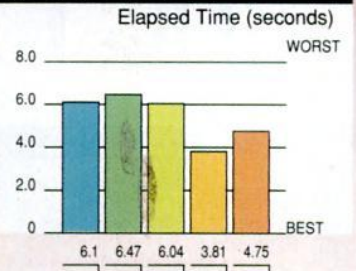
DOS File Access (Small Records)

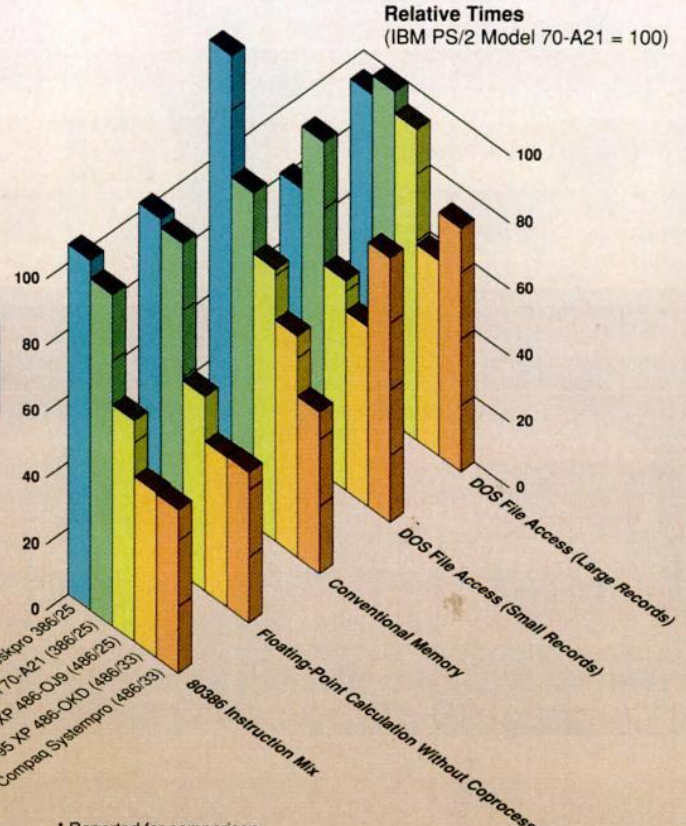
The **DOS File Access (Small Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.



DOS File Access (Large Records)

The **DOS File Access (Large Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are better when large files are loaded.





* Reported for comparison.

PROCESSOR, MEMORY, AND DISK BENCHMARK TESTS: COMPOSITE VIEW

The IBM Personal System/2 Model 95 XP 486 and the Compaq Systempro are two of the fastest systems ever tested at PC Magazine Labs. With 33-MHz 486 processor boards installed, the two delivered comparable performance on our 80386 Instruction Mix and Floating-Point Calculation benchmark tests. The desktop IBM Personal System/2 Model 90 XP 486, which had only a 25-MHz 486 installed, naturally lagged slightly behind. All three 486s executed our processor tests significantly faster than such 25-MHz 386 machines as the IBM PS/2 Model 70-A21 and Compaq Deskpro 386/25.

On our Conventional Memory test, however, the Systempro—with its 512K of external processor RAM cache (PRC)—is the clear winner. Although such a cache does not come standard with the PS/2 Model 90 or 95, the configurations we tested both had a 256K external PRC board installed.

On our DOS File Access tests, the Model 95 performed better than the Systempro. IBM's advantage under DOS stems from the SCSI controller. The controller has 512K of disk cache RAM, which helps move the data from the 32-bit-wide Micro Channel bus to the 8-bit-wide SCSI bus. No numbers are reported for the BIOS Disk Seek test, which does not produce meaningful results when run on a SCSI controller.

CONTINUES

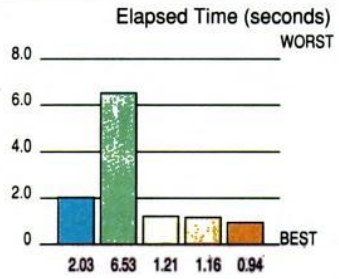
BENCHMARK TESTS: IBM PS/2 486s

PC Magazine Labs ran these tests with video and system shadowing enabled, if possible, and we left the buffers at their default values. We used no software disk caches when performing disk benchmark tests, and no RAM-resident programs were loaded for any tests. The margin of error for the processor, memory, and video benchmark tests is 0.05 seconds, so take this into account when making purchasing decisions based primarily on speed.

VIDEO BENCHMARK TESTS

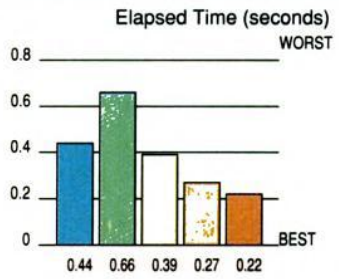
Direct to Screen

The **Direct to Screen** benchmark test indicates the speed of the video adapter memory. Good scores indicate that information can get to the screen quickly, particularly for programs that avoid the computer's BIOS and go directly to the screen.



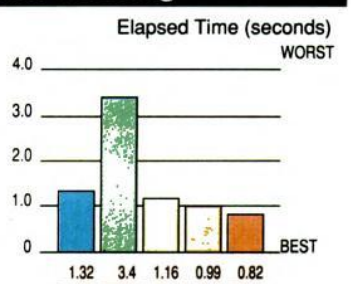
Video BIOS Routine Without Scrolling

The **Video BIOS Routine Without Scrolling** benchmark test measures how quickly the BIOS on the video adapter writes text data to the screen. Fast video writing helps with programs that show full or partial screens of data without scrolling the screen.

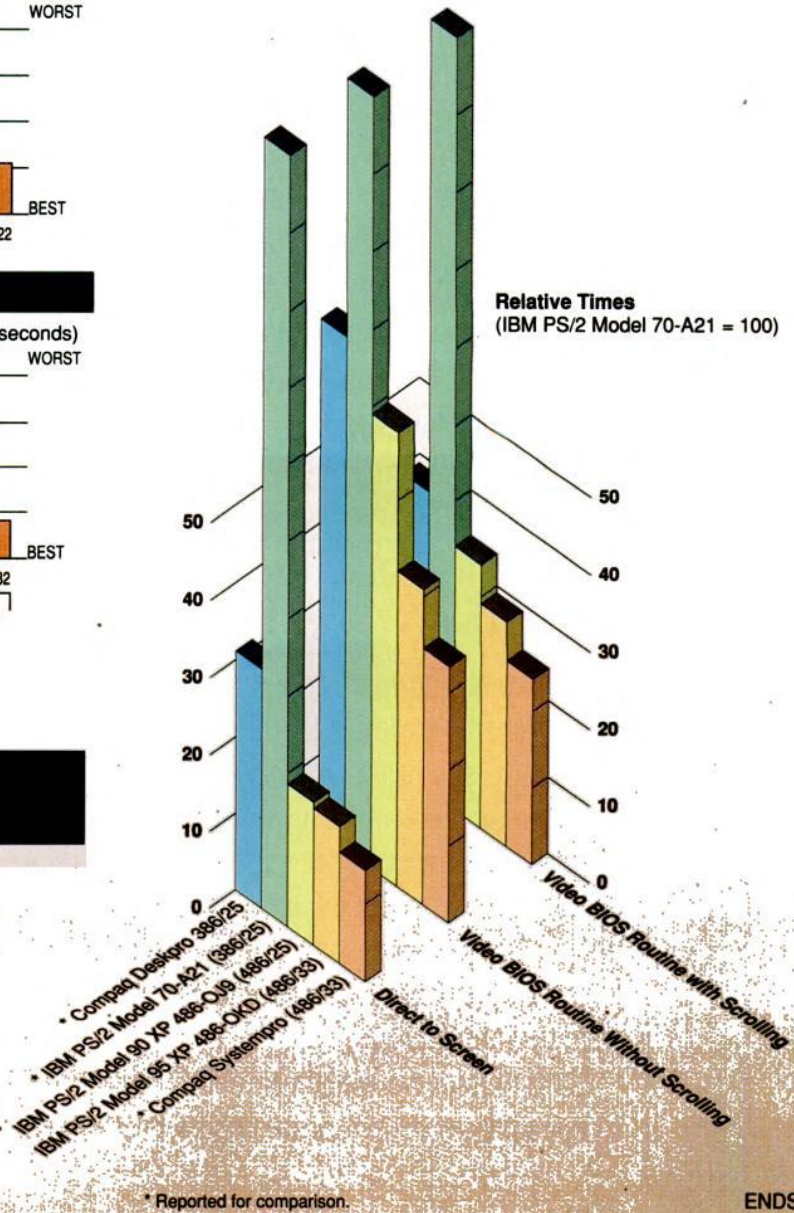


Video BIOS Routine with Scrolling

The **Video BIOS Routine with Scrolling** benchmark test measures how fast the video adapter can scroll the screen, moving the display up one line at a time. Good performance is helpful for scrolling through word processing or spreadsheet files.



* Reported for comparison.



* Reported for comparison.

VIDEO BENCHMARK TESTS: COMPOSITE VIEW

IBM's new XGA video subsystem comes with the new PS/2s. XGA's VRAM doesn't perform as well as the Compaq Systempro's built-in VGA adapter on our Direct to Screen video test. While the IBM and Compaq systems employ some type of hardware assist for graphics manipulation, we did not have these features enabled during the tests.

PC Labs' tests confirm IBM's claim of register-level VGA compatibility. XGA also provides adapter interface compatibility with the IBM 8514 display adapter; moreover, it supports up to 1MB of VRAM and graphics coprocessing. Like the SCSI controller, XGA moves data across a 32-bit channel. And like the controller, it performs bus mastering.

ENDS

Compaq. Although these designs let you increase the clock speed and upgrade the CPU, they don't allow any alterations of the system's basic bus-control logic. IBM goes further in its implementation of passive backplaning.

DRAMATIC UPGRADES

The real advantage of IBM's Processor Complex design is that a new board can bring more than boosted microprocessor performance. Because the bus-control logic for the new computers is on the Processor Complex board, the entire control circuitry of the Micro Channel can be upgraded with a board swap. Whereas the first PS/2s were rendered technically obsolete when IBM altered the Micro Channel specification, the new PS/2s can change as bus standards are upgraded. With the Processor Complex, bus performance can be boosted to match chip upgrades.

Currently only one Processor Complex upgrade is available: For $2,500, you can upgrade to a 33-MHz machine. But bus changes are inevitable.

Neither of the new machines incorporates all the design innovations of the Micro Channel/2 announcement that coincided with the introduction of IBM's RISC-based workstation, the RS/6000. For example, the Models 90 and 95 do not support streaming data mode or multiplexed data transfers.

According to IBM, the maximum data throughput of the bus, when con-

WHEN YOU NEED MORE GIGABYTES: Drive Array Subsystems from Core

by M. Keith Thompson

As we went to press, Core International brought out some interesting alternatives to IBM's external tower of SCSI hard disk drives. Core has earned an excellent reputation for speed and reliability with such products as disk drives for network servers that come with NetWare drivers already installed. Core's new products are high performance, fault-tolerant drive array subsystems designed specifically for IBM's SCSI host adapter, which is used in many of the high-end PS/2s, including the new Models 90 and 95.

Core's CPR-100, CPR-200, and CPR-400 subsystems provide 1.2, 2.5, and 4 gigabytes of storage for $29,650, $39,650, and $59,650, respectively. While these subsystems are not inexpensive, they offer built-in fault tolerance and tremendous expendability. A completely configured system can provide 100GB of disk storage—enough space to store 750 million names, addresses, and phone numbers.

The Core CPR products share some similarities with the drive array Compaq uses in the Systempro: Both product lines offer multiple drives in an array, disk mirroring, disk duplexing, and a data parity drive. The CPRs hold five drives (four for data and one for parity). Users can configure the drive array for data parity or disk duplexing. But that's where the similarity between the Core and Compaq products ends. Core enhances its system with a 386 processor that uses 8MB of memory for disk caching. And Core uses the Berkeley array bus-mastering technique instead of the programmed I/O IDE interface of the Systempro. Since each subsystem looks like one SCSI identification number, you can attach seven subsystems to one SCSI card.

The CPR subsystems provide the fault-tolerant features needed to operate in a production environment. Running transparently to the operating system, the CPR drive controllers duplex the data onto the hard disks or use the fifth drive for a parity drive. Duplexing stores the data on two hard disks simultaneously; the parity keeps a check sum of the data on the other drives, as the parity RAM chip in your computer does. If a drive goes down, the backup drives or the parity drive will service the operating system.

Core International sells high-capacity alternatives to IBM's external disks.

Additionally, the subsystem includes three power supplies operating in parallel. If one power supply fails, the other two step up the current to handle the workload until the defective unit can be replaced. The preproduction unit that we saw did not have a separate power switch for each drive, but the production units will. The power switches should allow you to power down the bad drive and replace it without bringing down the server. After you replace the drive, utilities provided by Core will reconstruct the data.

In this world of rapidly changing software, the CPR series' seamless integration with IBM shops makes it an attractive alternative to Big Blue's drives. Because the subsystems operate on the IBM SCSI Host bus-master adapter, you won't need any special software divers. And the CPR products run under a variety of operating systems—DOS, NetWare, OS/2, Unix, Xenix, and any other operating system supporting the IBM SCSI controller.

The CPR subsystems fulfill the mass storage needs of any modern server. They provide fast access times, huge storage capacity, and expandability. By providing redundant power supplies, the CPRs are an attractive alternative to IBM's offerings for network servers in a real-time environment. The ability to change a defective disk drive without interrupting the server's operation makes this system perfect for a production application. With street prices expected to take 20 to 25 percent off the list prices, the CPRs should offer a cost-effective solution for true on-line performance. ■

CPR Fixed Disk Drive Subsystems
Core International, 7171 N. Federal Hwy., Boca Raton, FL 33487; 407-997-6055.
List Price: CPR-100, with 1.2GB storage, $29,650; CPR-200, with 2.5GB storage, $39,650; CPR-400, with 4GB storage, $59,650.

CIRCLE **413** ON READER SERVICE CARD

trolled by the current Processor Complexes for the Models 90 and 95, is the 33MB per second of the original Micro Channel specification. This, says Big Blue, is sufficient for CPUs at the current performance level (that is, the 33-MHz 486). When new chips demand more bus performance, Processor Complex upgrades can push the bus throughput of both the Model 90 and Model 95 much higher.

The Processor Complex itself does not use the standard Micro Channel bus. Instead, the bottom of the board sports an edge connector that runs nearly its full length. On the positive side, this wide interface gives the Processor Complex a full 64-bit data path. But the very size of the connector subjects the design to the same criticism that some IBM engineers leveled at the initial (unadopted) EISA proposal. They claimed that the multitude of pins on a connector that ran nearly the full length of an expansion board would make EISA expansion boards so hard to slide into their sockets that people would break their motherboards when trying to push the cards in. Ironically, the IBM Processor Complex requires so much pressure to insert that IBM has attached special levers at either end of the Processor Complex board to allow you to force it into its socket.

The Processor Complex design has other weaknesses. It can be an inefficient upgrade in some situations. For example, if you only want to change the CPU in a Model 90, you have to buy new bus interface circuitry that you otherwise would not need. But the vagaries of the marketplace can overrule the downside of this argument. For example, upgrading a Compaq Deskpro from a 33-MHz 386 to a 33-MHz 486 costs $3,999, upgrading a Systempro, $4,999—nearly twice as much as the more complex $2,500 IBM 33-MHz 486 upgrade.

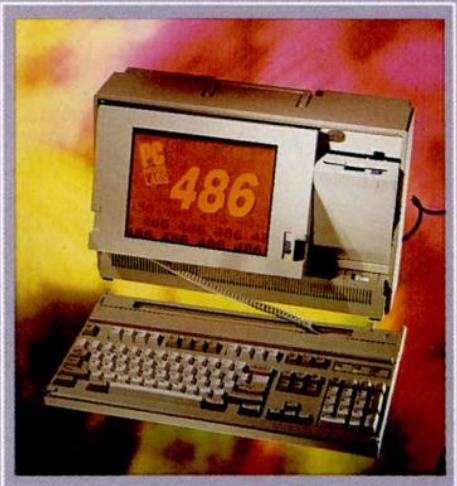
The Processor Complex design also adds a new connector standard to the Micro Channel repertory and makes the Micro Channel a slippery standard indeed. Because the Processor Complex design allows easy revision of the entire operation of the Micro Channel, what was once fixed in stone (or at least published in technical reference manuals) can be altered at will or whim. Manufacturing Micro Channel-compatible computers may resemble trying to hit a moving target. For computer cloners, such a chameleon standard may be a compelling incentive to march into the EISA camp.

On the other hand, the Processor Complex design may open up an entirely new industry: the making of supercharged upgrades for IBM computers. The potential is there. IBM's RISC System/6000 has shown that the Micro Channel bus is adaptable to other microprocessor families. IBM has demonstrated that the Model 95 bus can operate at extreme data rates. And the construction of the new systems'

IBM'S P75 PUTS A HANDLE ON 486 POWER

by Winn L. Rosch

IBM, the company that had but one half-hearted attempt at making a 486 PC, has suddenly put the top-of-the-line chip everywhere; it has even introduced the first 486 portable computer legally sold in the U.S., its PS/2 Model P75 486. Running at 33 MHz, the $15,990 P75 is the fastest PC with a handle on top—the equal of the uncached 33-MHz Models 90 and 95.



Just as we went to press, IBM delivered a powerful 486 portable.

Released at Fall Comdex 1990, just in time for us to take a peek before putting this story to bed, the Model P75 includes many of the features of the Models 90 and 95: built-in bus-mastering XGA graphics, a bus-mastering SCSI interface, and an easily upgradable microprocessor on a card. Except for portability and FCC Class B certification, however, the Model P75 doesn't push technology as hard as the Models 90 and 95.

For example, its standard serial and parallel ports are not DMA-driven, its SCSI performance is more modest because of a smaller cache, and its Micro Channel bus-control logic is kept on the system board rather than a Processor Complex. While standard memory in the Model P75 is the same 8MB as in the Models 90 and 95, it's expandable only to 16MB.

Still, the Model P75 is a formidable computer with few compromises. Built-in is a 10-inch high-resolution gas-plasma VGA screen with a black background and an output for an external XGA display unit. A 160MB SCSI hard disk and a 1.44MB floppy disk drive are standard; an optional 400MB SCSI drive adds $2,900 to the base price. The lightweight keyboard features a layout that is identical to the 101-key IBM desktop Enhanced keyboard.

All of this fits into a 22-pound plastic case that measures 12 by 18.4 by 6.3 inches and totes as easily as an overnight bag. If you need to take power on the road and cost is no object, the PS/2 Model P75 is the machine to wrap your hand around. ■

Editor's note: For an in-depth review of the IBM PS/2 Model P75 486, see our next issue, *PC Magazine*'s second annual special issue on portables.

IBM Personal System/2 Model P75 486

IBM Corp., Old Orchard Rd., Armonk, NY 10604; contact an authorized IBM dealer for information, or call 800-426-2468.

List Price: With 8MB RAM, 160MB hard disk, 8K caching controller, 1.44MB 3.5-inch floppy disk drive, one parallel and one serial port, mouse port, $15,990; 2MB memory upgrade, $565; 4MB memory upgrade, $1,095; 400MB hard disk, $6,400; external 1.2MB floppy disk drive, $509.

CIRCLE 635 ON READER SERVICE CARD

cases is substantial enough to assure FCC certifiability far beyond the present speeds of the machines.

SETUP AND DIAGNOSTICS ON BOARD

Another change revealed in the Models 90 and 95 is a new spin that IBM has put on its Programmable Option Select (POS) system configuration scheme. While other IBM PS/2s have used this software-controlled procedure to eliminate hardware conflicts without the DIP switches and jumpers that plagued earlier PCs (and the people charged with supporting them), the new machines eliminate the weakest link in the POS system: the need to keep track of a reference diskette.

The Models 90 and 95 take the logical step IBM should have made long ago. The system configuration procedures are now delivered and maintained on the hard disk that comes standard with each system; as a result, those procedures are always ready when you need them. In fact, if your new PS/2 is not properly set up, the configuration procedures will automatically jump into action.

In addition to the setup procedures, IBM put full system diagnostics on the hard disk. While the system may boot up with enigmatic error messages—8-digit numbers even less comprehensible than the former 4-digit ones—you can select diagnostics from a hidden menu in the configuration program (all you need to do is hit Ctrl-A as you would with any PS/2). The diagnostics will zero in on most problems.

In fact, when the tested Model 90 developed a memory problem, the diagnostics identified exactly in which SIMMs the problem had occurred. The SIMMs were described by the jacks in which they were installed, so neither map nor chart nor ephemeris was needed to find them.

DISK-BASED BIOS

The Models 90 and 95 take this hard-disk dependence a step further. Extensions to the Basic Input/Output Subsystem (BIOS) are also stored on each machine's primary hard disk. While the new computers still have a conventional ROM-based BIOS, additional code is automatically loaded from the disk. This facility lets IBM more easily modify the personality of the system to match upgrades in design and architecture.

Another twist to the BIOS design of the Model 90 and Model 95 allows you to boot the system from either its standard 3.5-inch floppy disk drive, any optional floppy drive, or any hard disk in the system. The selectable boot feature, incorporated into the POS system, is aimed primarily at people who want to run multiple operating systems. They can put each operating system they want to use on its own disk drive, then select which drive to boot from.

The new PS/2s are flexible and powerful enough to accommodate almost any BIOS or hardware upgrade for years to come.

To protect the vital disk-based POS and BIOS information from accidental erasure or other damage, it's stored on part of the primary hard disk in such a way you cannot normally access it, even when formatting the disk. The reserved space totals 3MB. This space is invisible, and the material stored in it can be altered or updated only by programs specially written to do so.

IBM sees this disk-based scheme as faster and easier to use. Again, the design goal is flexibility, the ability to make the new PS/2s into entirely new computers to keep up with changes in technology. The Model 90 and Model 95 both are platforms sturdy and powerful enough to accommodate nearly any sort of BIOS or hardware upgrade for years to come.

INSIDE THE WORKSTATION

The packages that bring all these new features to life appear as different as two computers in the same model line—or two products with the same power and purpose—can be. One is a staunch tower, the other a desk-hugging monitor stand. The contrasting packages allow for different expansion options for suiting specific target applications. The desktop Model 90 is IBM's premiere workstation. The Model 95 tower is the server that will link a workgroup together.

Measuring 5.5 by 17.5 by 17 inches (HWD), the Model 90 is compact and low-slung, resembling nothing so much as a PS/2 Model 70 that had a last-minute growth spurt. The case and styling of the Model 70 and 90 are much the same: The Model 90 has about 2 extra inches grafted onto its right side—apparently devoted to a half-height 5.25-inch drive slot. Like the Model 70, the Model 90 has a single front-panel control, the power switch. But, in the Model 90, the switch has migrated left and is a white push button instead of a toggle. Adjacent to the switch are two indicator LEDs, one each for power and disk activity.

You remove the heavy steel lid of the Model 90 case conventionally by sliding it forward after loosening its two large knurled screws at the upper rear corners of the chassis. A rear-panel cylindrical key lock prevents unauthorized interior access.

MADE OF STEEL

One peek inside, and the system distinguishes itself as more an heir to Compaq's Deskpro than to IBM's Model 70. The chassis itself is a heavyweight steel fabrication with a sturdy aluminum casting reinforcing the rear panel. Although some parts are visible inside the Model 90, they serve no structural roles. Steel holds the entire system together. Plastic is reserved for odd-shaped brackets and similar sculpture. For example, a one-piece molding serves to hold a cooling fan and to guide expansion cards into their slots. Another plastic molding acts as a baffle to form a wind tunnel for cooling the CPU and its associated circuitry on the Processor Complex.

Built into the steel work are four drive bays—three 3.5-inch and one that will hold either a 5.25-inch half-height device or a 3.5-inch drive. The top two bays have conventional front-panel access. The right bottom bay could too if it had some kind of additional plastic front-panel sculpture in place of the line of ventilation slots that runs the full width of the lower half of the Model 90 front fascia. (Although this lower right bay does appear to be 5.25 inches wide when the cover of the Model 90 is installed, only a 3.5-inch bay is provided in the chassis.)

Drives install into these bays with conventional PS/2 3.5-inch drive sleds. The 5.25-inch bay also accommodates the wider sled of the Slim High drive. The front openings of the two bottom bays are covered with snap-in lightweight metal

stampings to reduce radio-frequency emissions.

Standard equipment fills the two left bays of the Model 90, the top with the 1.44MB floppy disk drive, the lower with the system's factory-installed hard disk.

The bottom of the chassis is lined by the Model 90's 9.5- by 14-inch system board. Although part of the board is hidden underneath the system's 205-watt power supply, all components that you might need to deal with are readily accessible. (That's because there's very little on the system board that you'd need to access.)

The power supply has its own built-in 3.5-inch fan and provides three drive power connectors, sufficient to supply each of the internal bays of the system. (IBM's 3.5-inch floppy disk drive does not require a separate power input cable.) The power supply automatically adjusts to either U.S. (115-volt) or European (230-volt) electricity. No jack to supply switch power for a monitor is available on the Model 90's rear panel.

Because the system board functions more as a passive backplane than a conventional IBM PS/2 system board, only support functions are built into its circuitry. Among them is the system clock, which uses a 3-volt lithium button cell for power rather than the larger battery of IBM's previous PS/2s. Also built into the system board are the Model 90's standard ports—one DMA parallel port, two DMA serial ports, a keyboard port, and a mouse port. Also part of the system board are the floppy disk controller, which can handle up to two drives, and two unused IDE connectors for hard disks (one located behind each of the two lower drive bays).

Although the Model 90's system board XGA circuitry is mostly hidden under the power supply, the only parts of it that you might need to touch—its memory chips—are out in the open. Standard in the Model 90 is 512K of XGA memory in the form of four VRAM chips. An additional four chips will increase XGA memory to 1MB and increase the number of colors the system can simultaneously display at its highest resolution from 16 to 256. The IBM PS/2 Video 512K Memory Kit for making this upgrade costs $350.

The system board also offers four standard 32-bit Micro Channel slots, one of which offers a VGA feature connector extension. Only one slot is filled in standard Model 90 systems—the leftmost slot holds IBM's 32-bit bus-mastering SCSI adapter—leaving three for potential expansion. For external expansion, a SCSI port is available on the retaining bracket of the SCSI host adapter.

Just right of the four Micro Channel slots is the special 64-bit slot for the Processor Complex. Despite IBM's claim of putting all of the Model 90's memory on the system board, system RAM is actually installed on two proprietary memory boards to the right of the Processor Complex.

Each of these two boards can accommodate zero, two, or four proprietary IBM SIMMs with either 1MB, 2MB or 4MB capacity. When 8MB SIMMs become available, the Model 90 can take advantage of them to push its total addressable memory to 64MB. The system will accommodate and automatically adjust itself to any of these SIMM sizes as long as the SIMMs are rated at 70, 80, or 85 nanoseconds, but only 70-ns. SIMMs will yield top performance. Because the memory is interleaved, SIMMs must be installed in pairs of equal capacity.

The two memory boards are held in place by a spidery plastic casting. This same casting also serves to hold in place a large ferrite slug that's wrapped around the SCSI cable running inside the system.

Overall workmanship is very good, as you'd expect from IBM. Wiring is kept to a minimum (except for the snaky SCSI cable, which has to be long enough to connect up to three devices inside the chassis). The only hint of a snarl is the two sets of cables linking the front control panel and secondary cooling fan to the system board.

INSIDE THE SERVER

The Model 95 is designed to be the most expandable machine in IBM's entire PS/2 line. The time-proven hull of the Models 60 and 80 evidently proved insufficient to hold all of the Model 95's expansion potential, so IBM injected its old tower package with steroids. The thing is so big and ominous that you wouldn't want to run into one in a dark alley.

The chief difference between the old and the new bulked-up tower packages is that the latter is wide enough to accommodate 5.25-inch drives mounted horizontally. The Model 80 required vertical mounting of larger forms of disk and tape devices. In all, the new Model 95 is about 25 percent wider than the old Model 80. At the same time, the height and depth of the chassis were reduced to produce a short, squat package that measures 19.5 by 8 by 20.5 inches.

The real gain is inside. Whereas the old towers held but two full-size 5.25-inch drives, the new tower can pack five half-height devices in addition to two 3.5-inch drives (one of which will be the standard 1.44MB drive included in each Model 95). All of these devices except the one on the very bottom of the tower have front-panel access. The bottom bay is reserved for the standard 3.5-inch SCSI hard disk that comes factory-installed.

The unused bays are filled with dummy plastic drives and covered with snap-in blank panels that have been treated with interference-reducing paint. Removing a blanked panel is no longer irreversible (as it can be with some compatibles). The blank panels in the Model 95 fascia remove easily and snap back in place. Inexplicably, however, the blanks for each of the bays are somewhat different, requiring a varied inventory should you harbor and maintain several Model 95s.

Adding or inserting drives is equally easy. Drives are held in place by a large steel panel, normally hidden by the dressy plastic front panel of the system. Laced with cut-outs, one for each drive bay, this steel panel covers the entire front of the chassis. Unsnapping two latches at the top releases the panel and allows the drives to slide forward and out.

The mounting used in individual drive bays varies. For example, IBM has combined a 5.25-inch bay adapter with a rail-mounting assembly to hold the standard 3.5-inch hard disk in place. The rails at the sides of the adapter slide into the molded plastic channels that define the sides of the bay. A small metal spring-snap helps secure the left rail of the drive and hold it in place. The channel-like guides on either side of the bay will accommodate standard-size AT drive rails, although they might not be positively held by the snaps. On the other hand, the two 3.5-inch bays use PS/2-style plastic sleds to hold their drives in place.

Wiring in the system comes in the form of a ribbon cable with the appropriate number of connectors to link together up to five SCSI devices. In addition, IBM provides power connectors for as many as five internal devices. The power cable that runs to the hard disk includes two extra power connectors, and a supplementary power cable with two more power

connectors is supplied on one of the dummy plastic drive inserts. Two additional plastic pieces for adding drive-mounting channels are also included inside the system.

BIGGER, MORE EXPANDABLE

The added width of the Model 95 brings another benefit for the system's expandability. The greater interior space allows expansion boards in the system to be substantially taller than those that could fit into the old PS/2 towers and small-footprint Micro Channel computers, including the Model 90. In fact, the Model 95 allows expansion boards that reach the full height of AT boards to fit comfortably inside the chassis.

While AT expansion boards won't plug into Micro Channel expansion connectors, the taller boards designed for IBM's RS/6000 minicomputer will. In fact, IBM plans to offer many of the same boards designed for the RS/6000 for the Model 95, starting with those that will most enhance the Model 95 when it is used as a file server (the RS/6000 token-ring network adapter, for example). The benefits of such intercompatibility between systems run in both directions. The Model 95 gains access to high performance expansion boards designed for the RS/6000. The RS/6000 gains, too, because board designers have a larger market for their products. This design, IBM believes, will encourage more companies to develop expansion products for both the RS/6000 and the Model 95.

When you try to get inside the Model 95, you'll find the system filled with surprises. The first of these is the tool-and-fastener-free removal of the chassis cover, a steel panel that makes up the right side of the computer. After a cylindrical security key lock at the bottom of the plastic front panel is unlatched, the fascia of the Model 95 can be snapped out, and the right side of the computer easily lifts off.

Attached to the removable side of the Model 95 is a long, narrow squirrel-cage fan that cools the Processor Complex. No wires connect the fan to the rest of the chassis. Instead, two metal fingers contact tabs in the main chassis to receive a supply of twelve-volt DC current to run the fan. This clever expedient makes removing the cover much less of a hassle. Besides the elongated fan, additional cooling is provided by a huge, 5-inch fan in the power supply.

Blocks of foam are attached to the cover to direct the flow of cooling air inside the chassis. We also detected an indication of the Model 95's minicomputer origins: a pair of clear plastic envelopes attached to the side, obviously designed to be carriers of the system's maintenance log.

Another indication of the minicomputer origins of the Model 95 and its target environment is the laconic diagnostic display at the top of its front panel. Unlike some computers with diagnostic displays that attempt to guide you along in a Pidgin English, the eight digits of the Model 95 display speak only a strange engineering dialect. As the machine boots, it steps through such cryptic messages as CP: 20, CP: 40, CP: 85. Once the system has booted, the display blanks off. This marks the Model 95 as a machine to be tended by network wizards who wear black robes and carry magic wands.

Inside the Model 95, the design is more friendly toward normal humans. While about half of the 11- by 18-inch system board is covered by the 329-watt power supply, that's no problem. The big metal box (taped with some afterthought interference protection) pivots down to reveal the whole system board. Holding the

OS/2 1.3: Faster, Slimmer, and Better-Looking

by Gus Venditto

It used to be that the introduction of a new IBM personal computer would herald an upgrade to DOS. But that's not the case in the '90s.

Last fall's introduction of the PS/2 Models 90 and 95 was coupled with an OS/2 upgrade, even though a significant enhancement to DOS was going through the final stages of testing.

OS/2 1.3 started life as a troublemaker. It not only brought IBM and Microsoft strategists to blows, it nearly led to a divorce between the two.

To Microsoft and all other visionaries, OS/2 1.3 is too little, too late. It doesn't use the TrueImage page description language that Microsoft is developing with Apple, and it delays the introduction of OS/2 2.0, the 32-bit version that is nearing completion.

To IBM and pragmatists, OS/2 1.3 is the performance upgrade that the operating system has needed all along.

Version 1.3 is quicker, has Adobe PostScript's display fonts built in for good looks, and runs in less memory. A lot less memory, in fact. The operating system's minimum memory requirement was dropped from 4MB to 2MB to facilitate use with typical applications, making it a realistic proposition on machines where attempting to run Versions 1.1 and 1.2 seemed like an impossibility and a cruel joke.

The latest release of OS/2 requires only half the memory of the old version.

The performance enhancements include small things, like easier addition of printer drivers and faster program loading due to smarter use of rarely needed overlay files. IBM has also made sure that the popular printer drivers are ready, whether you use Epson, Hewlett-Packard, or IBM printers.

And taking a page right out of *Windows*' memory management scheme, OS/2 1.3 automatically manages a swapdisk, looking at the available RAM and adjusting the size of the swapdisk accordingly.

The real improvements in OS/2 1.3 come from old-fashioned code enhancement. Finished copies weren't ready in time for this story, but from previews we saw, it was clear that Version 1.3 has more snap in just about every area.

And on the Model 90, Model 95, or any machine with XGA, OS/2 1.3 should prove very impressive, since XGA includes bit-blitting techniques that were designed specifically to accelerate OS/2's window-centric screen redraws.

IBM regards this latest version of OS/2 as a stable platform for growth. The question now is: Has *Windows* stolen the thunder that this version would have earned by itself? ■