JUNE 1987 VOL.12, NO.6

$3.50 IN UNITED STATES
$4.50 IN CANADA / £1.75 IN U.K.
A McGRAW-HILL PUBLICATION
0360-5280

BYTE

THE SMALL SYSTEMS JOURNAL®

THEME

Computer-Aided Design

The IBM Personal System/2

Microsoft's New DOS

by the BYTE editorial staff

FIRST IMPRESSIONS:
The IBM PS/2 Computers

The Personal System/2—including a 32/16-bit bus, new operating systems, and new graphics systems—redefines IBM's microcomputer standards

The timing was almost perfect: Just weeks after Apple launched the 68020-based Mac II, establishing a new standard that will dominate Apple products for some time to come, IBM announced an entire new line of personal computers (complete with a different bus and two new operating systems) that might similarly set the standard for 80x86-based systems.

IBM's Personal System/2 family includes a low-end 8086-based machine, two mid-range 80286 systems, and a 32-bit 80386-based system that is arguably one of the most powerful microcomputers yet. (See table 1.)

Unlike the previous line of IBM desktop PCs, all the new systems have: 3½-inch floppy disk drives (not a 5¼-inch floppy in the group, though you can add one externally), on-board graphics support, heavy use of custom logic chips and surface-mount technology, and a simple, modular assembly technique. IBM claims that, because of the modular construction, the new computers are three times more reliable than the previous IBM desktop machines. Service, when needed, will be simpler: with practice, you can assemble or disassemble the PS/2 machines in less than a minute.

Principal contributors to this article include (alphabetically) Richard Grehan, Philip Lemmons, Rich Malloy, Tom Thompson, Eva White, Gregg Williams, and Stanley Wszola. All are BYTE staff members.

The PS/2 systems feature colorful analog video displays and a keyboard that resembles the "enhanced" AT keyboard, except for three LED indicators for the three Shift-Lock keys. They can also use an optional two-button mouse ($95), the first mouse ever offered by IBM.

Contrary to rumor, all the systems use off-the-shelf Intel microprocessors and do not appear to employ any extraordinary measures to dissuade imitators—although the complex custom gate arrays will give clone makers pause. IBM also will not publish the PS/2 BIOS listing or the circuit diagrams and electrical characteristics of the new gate arrays, but it will publish the entry points of the BIOS and the electrical signals on the new expansion slots.

Basic Hardware: The Model 30

The Personal System/2 Model 30 uses an 8086 microprocessor running at 8 MHz with no wait states. It comes with 640K bytes of memory and two 3½-inch floppy disk drives that store 720K bytes each. It also has three standard IBM PC–style expansion slots, which are mounted sideways in the machine to conserve space. Much of the circuitry formerly provided by expansion boards now resides on the motherboard: an improved version of the IBM Color Graphics Adapter (CGA), serial and parallel ports, a clock/calendar, and a floppy disk drive controller.

Because of the higher clock speed, a 16-bit-wide data path, and new support chips around the 8086, IBM says the Model 30 can perform at up to 2½ times the speed of a PC XT.

A two-floppy Model 30 costs $1695; a version with a single floppy drive and a 20-megabyte hard disk costs $2295. All you need to complete a Model 30 system are a monitor ($250 to $685) and version 3.3 of DOS ($120).

Models 50, 60, and 80

The group of higher-end machines consists of the 80286-based Models 50 and 60 and the 80386-based Model 80. They have all the features of the Model 30, with three major differences: They use a proprietary bus called the Micro Channel, they have on-board support for a new graphics standard that is better than the Enhanced Graphics Adapter (EGA); and they use 1.44-megabyte floppy disk drives that can also read and write to the 720K byte floppies.

These systems also use a high-speed hard disk controller, with a 1:1 interleave factor (AT-class hard drives usually use a 3:1 interleave). This interleave factor is made possible in part by a "burst" mode in the bus that allows high-speed data transfers. Models 60 and 80 also have an ESDI (enhanced small device interface) adapter available for high-speed data transfer to a hard disk. With these features Models 60 and 80 have six times the data-transfer rate of the AT.

Models 50 and 60 are essentially the same machine; they differ primarily in size and storage capacity. Both use an 80286 running at 10 MHz and can support an optional 10-MHz 80287. Both computers come with a megabyte of memory and a 16-bit version of the Micro

continued

The IBM Personal System/2 Computers.
From left to right,
the Models 80, 50, 30, 60.

Photographs by Paul Avis

Channel bus. The Model 50, however, is a small-footprint desktop system with three open expansion slots, while the Model 60 is a larger, floor-standing "deskside" system with seven available expansion slots.

The Model 50 comes with a 20-megabyte hard disk and costs $3595. The Model 60 is available in two versions: The Model 60-041 has a 44-megabyte drive and costs $5295; the Model 60-071 includes a 70-megabyte hard disk and an ESDI for $6295.

IBM estimates that with the faster clock speed, the new bus, and the faster drive controller, these systems will perform at over twice the speed of the AT.

The Model 80 is IBM's first 80386-based system. It uses a standard Intel B1-version 80386 CPU chip—the same chip used in the Compaq Deskpro 386. The Model 80, which will be available in July, comes with 1 to 2 megabytes of memory (using 1-megabit chips) and a 32-bit version of the Micro Channel bus. It is a deskside system that resembles the Model 60 and, like the 60, it has seven expansion slots, three of which are for 32-bit boards. The Model 80-041 has a 44-megabyte hard disk and will sell for a base price of $6995. The 80-071 has a 70-megabyte hard disk and a base price of $8495. Both of these systems have a clock speed of 16 MHz. The third version of the Model 80, the 80-111, will have a clock speed of 20 MHz, 2 megabytes of memory, and a 115-megabyte hard disk. It will be available in the fourth quarter of this year for $10,995. IBM estimates the performance of the Model 80 to be about 3½ times that of an AT.

The Model 80 will compete with Apple's powerful 32-bit Mac II, at least on the hardware level. However, the Mac II's system software is already in place and available; OS/2, the major new operating system for the PS/2 family, might still be as much as a year away from release. See the text box "IBM PS/2 Model 80 vs. Mac II," which highlights some of the similarities and differences between the two machines.

New Video Standards

The PS/2 family uses three new video standards: the low-end Model 30 has an MCGA (multicolor graphics array) system; the Models 50, 60, and 80 have a VGA (video graphics array) system; and there is an optional high-resolution system called the 8514/A.

Model 30's MCGA system consists of two special gate arrays, 64K bytes of dual-ported RAM, a 16K-byte static RAM character generator, and custom

continued

The Model 80—IBM's first 80386-based system—will compete head-to-head with Apple's powerful 32-bit Macintosh II.

Table 1: *A summary of the characteristics of the IBM Personal System/2 computers, Models 30, 50, 60, and 80.*

Model (notes 1,2)	**Model 30-021** (8530-021)	**Model 50-021** (8550-021)	**Model 60-041** (8560-041)	**Model 80-041** (8580-041)	**Model 80-111** (8580-111)
Microprocessor	8086	80286	80286	80386	80386
Processor speed	8 MHz	10 MHz	10 MHz	16 MHz	20 MHz
Socket for which numeric coprocessor?	8087	80287	80287	80387	80387
Width of system-bus data path	16 bits	16 bits	16 bits	32 bits (note 12)	32 bits (note 12)
Standard RAM	640K bytes	1 megabyte	1 megabyte	1 megabyte (note 9)	2 megabytes
Maximum RAM	640K bytes (note 3)	7 megabytes	15 megabytes	16 megabytes	16 megabytes
Standard ROM	64K bytes	128K bytes	128K bytes	128K bytes	128K bytes
Total number of slots	3	4 (note 5)	8 (note 5)	8 (note 5)	8 (note 5)
Type of slots	IBM PC	Micro Channel	Micro Channel	Micro Channel	Micro Channel
Operating system(s) available	DOS 3.3	DOS 3.3, OS/2	DOS 3.3, OS/2	DOS 3.3, OS/2	DOS 3.3, OS/2
Standard floppy disk size and capacity	3½-inch, 720K (note 4)	3½-inch, 1.44 megabytes (note 6)	3½-inch, 1.44 megabytes (note 7)	3½-inch, 1.44 megabytes (note 7)	3½-inch, 1.44 megabytes (note 7)
Hard disk supplied	20 megabytes	20 megabytes	44 megabytes (notes 8 and 10)	44 megabytes (note 9)	115 megabytes (note 13)
Maximum hard disk capacity	(note 4)	20 megabytes	88 megabytes (note 11)	88 megabytes (note 10)	230 megabytes
Standard graphics modes	MCGA	VGA, EGA, MCGA	VGA, EGA, MCGA	VGA, EGA, MCGA	VGA, EGA, MCGA
Able to use 1024 by 768 IBM 8514 Color Display?	no	yes, with optional board using 1 slot	yes, with optional board using 1 slot	yes, with optional board using 1 slot	yes, with optional board using 1 slot
Location of main system unit	on desk	on desk	on floor, standing vertically	on floor, standing vertically	on floor, standing vertically
System price (note 14)	$2295	$3595	$5295 (note 8)	$6995 (note 9)	$10,995
Availability	now	now	now	July 1987	4th quarter 1987
Major improvements over model to the left	N/A	80286, more memory, VGA, Micro Channel slots	more slots, more memory	80386, 32-bit slots	20-MHz clock, more RAM on motherboard

1. For details of the graphics modes, see the main text.
2. All the computers have their video circuitry, serial port, parallel port, pointing-device port, and time-of-day clock on the motherboard. They connect to an analog RGB or monochrome monitor. A two-button mouse is available but not required. All computers can interface to an IBM 200-megabyte optical disk drive (external for Models 30 and 50, internal or external for Models 60 and 80).
3. You can expand memory further by using plug-in boards that meet the Lotus/Microsoft/Intel memory-board specification.
4. Another version of the Model 30, the Model 30-002, has a second 3½-inch floppy disk drive in place of the 20-megabyte hard disk; it costs $1695. Presumably, the Model 30 can use any hard disk that attaches to the computer via an IBM PC plug-in board.
5. The hard disk interface board occupies one of these slots.
6. The Model 50 contains space for another internal 3½-inch, 1.44-megabyte floppy disk drive.
7. This computer has room for another internal 3½-inch, 1.44-megabyte floppy disk drive and for a second internal hard drive or optical disk drive.
8. The Model 60 comes in a second model, Model 60-071, that is identical to the 60-041 except for its hard disk size, which is 70 megabytes; its price is $6295.
9. The 16-MHz Model 80 also comes in a second model, the Model 80-071, that is identical except for its hard disk size, which is 70 megabytes, and a total of 2 megabytes of RAM; its price is $8295.
10. The -071 model's 70-megabyte drive uses an ESDI disk interface running at 10 megabits per second, which is twice as fast as the ST 506 interface used on the 44-megabyte drive.
11. The Model 60-071 can have a maximum of 185 megabytes of hard disk storage.
12. All Model 80s have 8 slots, 3 of which can support either 16- or 32-bit boards. One 16-bit slot is used by the hard disk.
13. Both the standard and the optional hard disk on the Model 80-111 use the ESDI disk interface and are driven at 10 megabits per second.
14. Prices do not include operating system(s) chosen by user ($120-$795) or manuals ($45-$125 each).

IBM PS/2 Model 80 vs. Mac II

How does the price of IBM's new 32-bit machine compare with Apple's recently introduced 32-bit Macintosh II? At first glance, the prices look pretty even, but look closely at the standard equipment:

IBM's PS/2 Model 80-041	**Apple's Mac II** Model HD40
16-MHz 80386	16-MHz 68020
1 megabyte of RAM	1 megabyte of RAM
1.44-megabyte floppy	800K-byte floppy
44-megabyte hard disk	40-megabyte hard disk
3 open 32-bit slots	5 open 32-bit slots
4 open 16-bit slots	
keyboard	keyboard
video card	video card
	68881 coprocessor
	system software
	13-inch color monitor
Price: $6995	**Price:** $6996

To get a PS/2 that has features comparable to what comes standard with the high-end color Mac II, you'd have to add these options: an 80387 math coprocessor ($795); a 12-inch color monitor ($685); and the OS/2 operating system ($325), which doesn't yet have graphics and windowing. Tack the costs of the options onto the cost of the Model 80 and the price tag reads more like $8800, making the Mac II about $1800 less expensive. You'd have more than enough left over to buy AST Research's Mac286 board ($1499), which lets the Mac run MS-DOS programs.

The 8514 color monitor provides resolution up to 1024 by 768 pixels.

circuitry that implements a 256- by 18-bit color palette.

The system supports several modes: 80-column text (with 640- by 400-pixel total resolution, 8- by 16-character box, 16 of 256K colors), 320 by 200 graphics (with 256 of 256K colors, 8- by 8-character box), 640 by 200 graphics (with 2 of 256K colors, 8- by 8-character box), and 640 by 480 graphics (with 2 of 256K colors, 8- by 16-character box). An optional board lets the system boost the text mode resolution to 720 horizontal pixels and allow a 9- by 16-character box.

In each mode, you can use any of 262,144 possible colors. Although the resolution in the 320 by 200 graphics mode is low, the large number of colors available on the screen at one time (256) and the large number of possible colors (262,144) gives the system the ability to produce some striking graphic images.

The MCGA can emulate the old CGA graphics for programs that use it, but cannot emulate EGA graphics without a special adapter card.

The VGA system is standard on Models 50, 60, and 80, and optional on Model 30. VGA is based on one gate array containing 12,750 gates. In addition to the modes supported by the MCGA, the VGA supports the EGA graphics standard and the following additional modes: text (720 by 400 total resolution, 9- by 16-character matrix) and 640 by 480 graphics (16 of 256 colors). The VGA arbitrates between the video memory and the processor, and the video memory and display circuitry.

The optional 8514/A graphics adapter uses the systems' *auxiliary video connector*, a 20-pin connector in line with one of the 16-bit Micro Channel slots. A video card plugged into this slot can substitute its own pixel and/or timing signals for those on the motherboard, providing a way to produce different kinds of video displays without replacing the video circuitry on the motherboard. In this way, the 8514/A supports a high-resolution mode of 1024 by 768 pixels on one of IBM's new monitors, the 8514. With an optional memory-expansion card, it can display 256 colors out of a possible 262,144 at this resolution. At a lower resolution (640 by 480), the 8514/A adapter can provide additional capabilities such as programmable character fonts, proportional spacing, and patterned area fills. The 8514/A costs $1290.

Analog Monitors

Both the MCGA and the VGA systems can work with any of four new analog monitors: a medium-resolution monochrome monitor, two medium-resolution

continued

color monitors, and a large, high resolution color monitor. Each monitor has a horizontal refresh rate of 31.75 KHz and a vertical refresh rate of either 50 or 70 Hz. Total bandwidth is up to 70 MHz.

The Model 8503 monochrome monitor measures 12 inches diagonally and costs $250. It uses IBM's version of a paper-white phosphor and shows no flicker or unsteadiness. Both the MCGA and the VGA can automatically detect the presence of this monitor and generate a monochrome image by using the 6-bit green component of the video signal to get 64 shades of gray.

The 8512 color monitor measures 14 inches diagonally and costs $595. The 8513 is similar to the 8512 but is slightly smaller (12 inches) and has a finer dot pitch (0.28 mm); it costs $685.

The 8514 is a 16-inch color display that is compatible with the 640-by-480 mode of the VGA and MCGA, and can accommodate the 8514/A video system's 1024-by-768 resolution. It costs $1550.

All of the monitors except the high-resolution 8514 are available now; the 8514 will be available in July.

The Model 30 is up to 2½ times as fast as an XT.

BIOS Compatibility

The biggest news about the BIOS (basic input/output system) contained in the ROM of all the PS/2 computers is that it is almost entirely entry-point–compatible with the old BIOS. This means that any software that accesses system functions by calling BIOS routines (e.g., using the disk, changing the video display) will work on the new PS/2 machines.

The PS/2 Model 30 is compatible at the BIOS level with the older IBM PC, PC XT, Portable PC, and PC Convertible and with most hardware interfaces. It is designed to maintain compatibility with as much software developed for the PC as possible. Unfortunately, code that depends on a set execution time will not run correctly because the Model 30 runs faster than the PCs (8 MHz versus 4.77 MHz).

The PS/2 Models 50, 60, and 80 have a superset of the standard PC BIOS. The compatibility BIOS (or CBIOS) can address up to 1 megabyte of memory; it lets you run most of the currently available software. The Advanced BIOS (or ABIOS) provides support for multitasking operations and can address up to 16 megabytes of memory.

The BIOS on the Model 30 resides in two 27256 ROMs. The BIOS for the Models 50 and 60 is contained in a set of four 27256 ROMs and takes 128K bytes. As with previous models of IBM computers, each BIOS ROM module has a model identification byte located at FOOO:FFFE hexadecimal.

IBM has changed some of the BIOS interrupts, but the changes make little practical difference. For example, interrupts 0B and 0C hexadecimal (communications), 0D (alternate printer), and 0F (printer) are now reserved. Interrupt 15 hexadecimal, which was the Cassette I/O System Extensions, has been relabeled System Services, though it still performs the same functions. Interrupts 40, 41, 46, and 4A hexadecimal were reserved, but now control Diskette BIOS Revector, Fixed Disk Parameters, and User Alarm respectively. Interrupts 71 through 74, 76, and 77 hexadecimal are now reserved; they had been IRQ 9 through 12, 14, and 15 (decimal). And interrupts F1 through FF hexadecimal, previously not used, are now reserved for User Program Interrupts.

To the average user running most IBM software, these changes to the BIOS will be invisible. Some non-IBM programs will need extensive rewriting, however. A good example of the extent to which IBM has maintained compatibility with the previous PCs: the ROM chips also contain Cassette BASIC Version C1.10.

Micro Channel: The New Bus

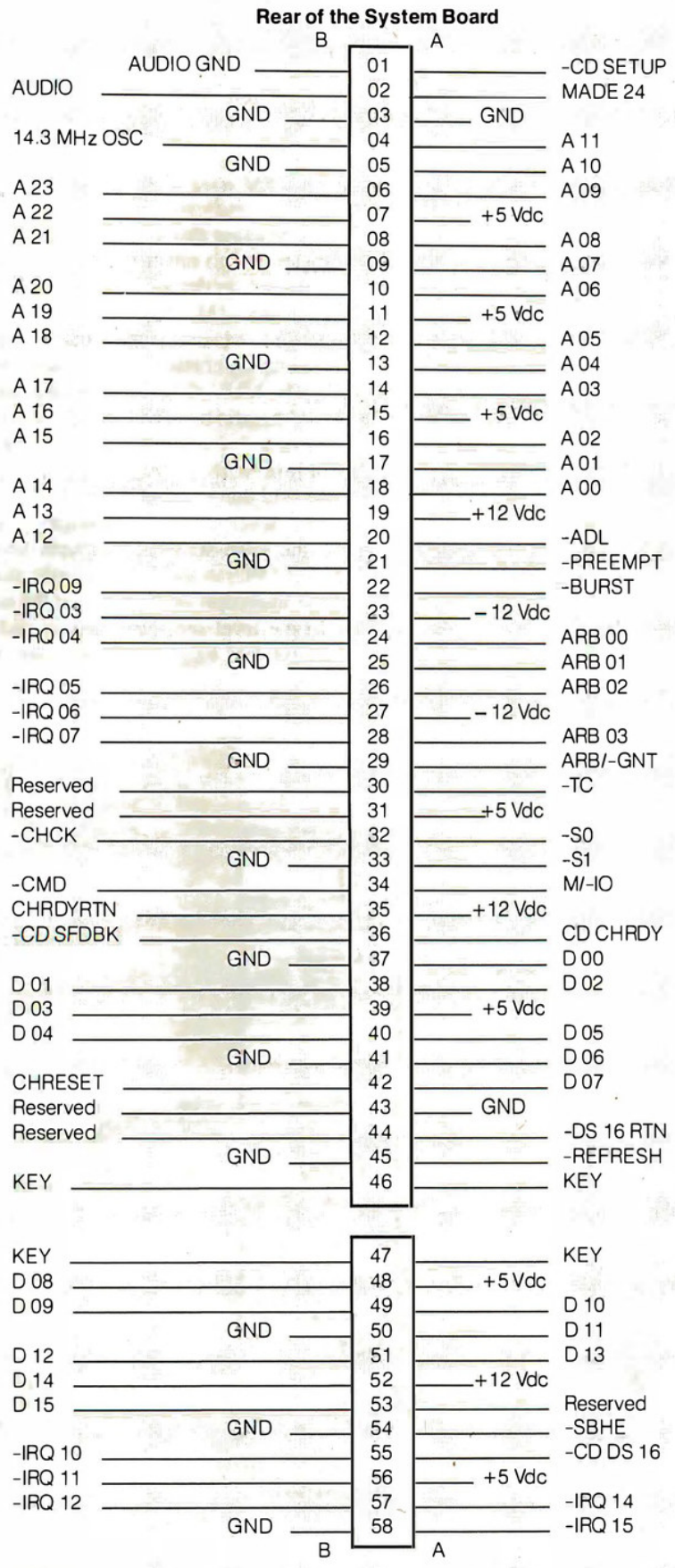
The Micro Channel bus is neither electrically nor mechanically compatible with the old IBM PC bus. The trade-off for the lack of compatibility is that the new design is capable of high-speed data and I/O transfers, sharing resources, and multiprocessing support. The Models 50 and 60 use a 16-bit-wide variant of the bus, while the Model 80 supports a full 32-bit-wide data path on 3 of its 8 slots. (However, at press time, we had not yet received full documentation on the 32-bit version.)

The Micro Channel is worth examining in some detail: Basically, it's a nonmultiplexed bus (i.e., data and addresses have their own separate lines) that has additional lines for transfer control, arbitration, support signals, and power. All logic signal lines on the channel are TTL-compatible. The channel slots are dual-pin card-edge connectors that accept 11½- by 3-inch peripheral cards. (See figure 1.)

The bus, and indeed the entire system architecture, shows attention to detail in reducing electromagnetic interference: every fourth pin on one side of each slot has a ground line, and the motherboard and all the cards have ground planes. The designers said they think such an architecture is effective for reducing interference, not only for current machines but

continued

MODEL 30



Key

Abbreviation	Full Line Name
A0 to A23	Address Bits 0 to 23
D0 to D15	Data Bits 0 to 15
-ADL	-Address Decode Latch
-CD DS 16(n)	-Card Data Size 16 (note 1; indicates 16-bit data on bus)
-DS 16 RTN	-Data Size 16 Return
-SBHE	-System Byte High Enable
MADE 24	Memory Address Enable 24 (active if current address is in the first 16 megabytes of the address space)
M/-IO	Memory/-Input/Output (distinguishes memory from I/O cycle)
-S0, -S1	Status Bits 0 and 1 (define the type of bus cycle)
-CMD	-Command (denotes valid data on data bus)
-CD SFDBK(n)	-Card Selected Feedback (note 1)
CD CHRDY(n)	Channel Ready (note 1)
CHRDYRTN	Channel Ready Return
ARB0 to ARB3	Arbitration Bus 0 to 3
ARB/-GNT	Arbitrate/-Grant (used in arbitrating access to bus)
-PREEMPT	-Preempt (used to request use of the bus)
-BURST	-Burst (used to signal extended use of bus in burst mode)
-TC	-Terminal Count
-IRQ3 to 7, 9 to 12, 14, 15	-Interrupt Request Lines (used to signal I/O slave's need for servicing)
-CD SETUP(n)	-Card Setup (note 1)
-CHCK	-Channel Check (indicates serious system error)
AUDIO	Audio Sum Node
AUDIO GND	Audio Ground
OSC	Oscillator (14.31818 MHz)
CHRESET	Channel Reset
-REFRESH	-Refresh

1. These are separate, dedicated lines running to each slot.

Figure 1: *The Micro Channel slot pin-outs.*

MODEL 50

for future systems as well. And in fact, all of the PS/2 systems have FCC Class B certification despite the fact that they are running at high clock speeds.

The Micro Channel uses asynchronous protocols for channel control and all data transfers. Two lines (–BURST and –TC) control block transfers of data. (Editor's note: *IBM uses the notation "–signal-name" to indicate an active low signal. We'll be using this notation here.*) A data transfer can go either to memory or to an I/O device, as determined by the state of a signal line (M/–IO). Two status lines (–S0 and –S1) define the transfer as a read or write operation. The lines –PRE-EMPT, ARB/–GNT, and ARB0 through ARB3 handle bus arbitration.

Lost or "phantom" interrupts can be a problem with concurrent processing. IBM said that to avoid the problem, it designed level-sensitive interrupts (replacing the edge-sensing interrupts used in the IBM PC) to allow for intrinsic sharing of the interrupts on all levels of the bus.

In the level-sensing scheme, each peripheral card toggles an "interrupt pend-

continued

The 80286-based Models 50 and 60 are about twice as fast as current ATs and come with the new Micro Channel bus and the Video Graphics Array system.

MODEL 60

ing" latch and holds the interrupt line active until it is serviced. By having the interrupt handler check all the cards' latches until none are pending, multiple peripheral cards can service interrupts without losing any of them. Level-sensing interrupts have the additional advantage of being resistant to line noise. In the Micro Channel, 11 prioritized interrupt lines use level-sensing interrupt signals. (From highest priority to lowest, they are –IRQ9 through –IRQ12, –IRQ14 through –IRQ15, and –IRQ3 through –IRQ7.)

Each slot also has several lines that are not shared (see figure 1, note 1) and others that are used to indicate the data-transfer width (16 or 32 bits wide; 8-bit transfers do not require a signal), card-selected feedback (which indicates slot occupancy at a specific address), and card setup (used to select cards during system configuration). The bus also contains provisions that allow cards to slow down the system speed, and in some cases to speed it up. By taking advantage of this, designers can build cards that will run in any Micro Channel system, whether it uses a 10-MHz 80286 or a 16- or 20-MHz 80386.

The AUDIO and AUDIO GND (audio ground) lines provide a single audio line that can be fed to the system's audio output or used as a path for an audio signal between peripheral cards. The frequency response of the line is 50 Hz to 10 kHz.

A central arbiter device (located on the motherboard) coordinates bus access. A card requests use of the bus by driving the –PREEMPT line active. The central arbiter permits an arbitration contest to take place as soon as the current card releases the bus: The central arbiter signals the start of an arbitration cycle (the ARB/–GNT line is driven to the arbitrate state), and the competing cards drive their arbitration levels onto lines ARB0 through ARB3. The fixed arbitration level for the card is set at system boot-up by a system configuration program. The card with the lowest arbitration level, and thus the highest priority, wins the contest. The winner gets access to the bus as soon as the central arbiter drives ARB/–GNT to the grant state.

The arbitration logic is fair in that it gives each card that entered the competition a chance at the bus before starting another arbitration contest. The arbitration mechanism, by the way, is the same as that used to arbitrate the DMA channels. This should reduce the work for some designers.

Because each card can have its own priority level, you might expect to have to set DIP switches to configure the system and its cards. But instead, a feature called Programmable Option Select (POS) auto-

mates the process. (As one IBM designer told us, "We think DIP switches are appropriately named.") Under POS, each card has its own identity code. Of more than 64,000 possible codes, IBM has reserved half for itself; the rest will be divided up among third-party developers. At boot-up, the system determines which cards are present and compares this with a list of cards stored in nonvolatile RAM during the last power-up. If it detects no new cards, the system loads any registers on the cards with data from the nonvolatile RAM. No switches or jumpers are needed on either the motherboard or on any expansion cards. If the system discovers a new card (or fails to recognize an old one), it can disable the card and give you the option of running a configuration utility to assign system resources to it. This ability to disable unknown cards also adds a measure of security; a malfunctioning peripheral card is less likely to remain on-line and crash the computer.

New Operating Systems

The PS/2 machines can use either of two new operating systems: PC-DOS 3.3, which is available now, and Operating System/2, designed for 80286 and 80386 systems, which won't be available until next year.

DOS 3.3 is an enhanced version of the DOS 3.2; it costs $120, but you can upgrade from previous versions of PC-DOS for $75.

DOS 3.3 solves some of the problems of its predecessors. For example, it can address a hard disk larger than 32 megabytes by dividing it into several partitions (former versions allowed multiple partitions, but PC-DOS could address only one of them).

Several new commands help DOS 3.3 meet the needs of an increasingly sophisticated environment. The `APPEND` command makes it easier for your program to find files in other subdirectories. `CALL` allows a batch file to execute another batch file, then return to continue its own execution. `FASTOPEN` is a terminate-and-stay-resident routine (the kind that gives you pop-up desk accessories) that creates a filename cache to speed up the reopening of recently used files; this command improves the performance of the computer when it has files that are opened and closed often (as with networked files).

IBM's OS/2 promises to have some very impressive capabilities when it becomes available. OS/2 is a multitasking system that can access up to 16 megabytes of memory. The new operating system will incorporate several features of IBM's newly announced Systems Application

continued

What IBM Didn't Do

For months (years even), rumors have been flying about what IBM would do with its next generation of microcomputers. Discussions with IBM personnel have contradicted many of the more prominent rumors. What follows is a list of what IBM says it did *not* do with its new machines.

- IBM did not alter the masks of the Intel 80286 or 80386 chip.
- IBM did not, and said it has no plans to, introduce a VM-type OS.
- IBM did not decide to hold off the 80386-based system until 1988. It is scheduled to be available in July of this year.
- IBM did not divide communications functions between the motherboard and a proprietary card to make third-party communications products harder to build.
- IBM did not arbitrarily change the bus and the card size—the 32-bit bus introduced on the Model 80 appears to be a solid foundation that can be built on for years to come, supporting multiprocessing and very high speeds.
- IBM did not change the floppies to 3½-inch drives without good reason; the double-sided microfloppies hold 1.44 megabytes of data and are faster and more reliable than 5¼-inch drives. IBM also predicted much higher densities to come on 3½-inch drives.

IBM *did* announce its own windowing system, the Presentation Manager; it will be about two-thirds Microsoft Windows and one-third proprietary. The windowing system, shown in simulation, looks significantly different from Windows, the Macintosh environment, GEM, or anything else. Microsoft has announced that Windows 2.0 (which will run under DOS 3.3, but not OS/2)will be visually identical to the Presentation Manager..

Architecture (SAA), which will reportedly present a common user interface across all of IBM's systems. Eventually, it will have a user interface based on windows, graphics, and icons. And a later Extended Edition will include a relational database and communications functions.

The first version of OS/2, called Standard Edition 1.0, will appear in the first quarter of 1988. It will have no graphics or windows and will cost $325.

The next version of OS/2, Standard Edition 1.1, will contain a Presentation Manager, which IBM said will include graphics, windows, typographic-quality text fonts, and icons. The Presentation Manager is based on Microsoft's Windows and on the Graphical Data Display Manager (GDDM) interface on IBM's 3270 systems. However, IBM said that the Presentation Manager's interface will be significantly different from those of Windows, the Apple Macintosh, or Digital Research's GEM.

A later version of OS/2, the Extended Edition, will have all the features of the Standard Edition plus a version of IBM's DB2, a mainframe-based relational database, and a version of SQL, IBM's structured query language. In addition, it will

continued

Bluespeak

IBM is one of the few entities that, like Big Brother or the Cheshire Cat, can make a word mean what it wants it to mean. If you should ever encounter unfamiliar words in reference to IBM products, the following list might help:

IBM word	Real-world definition
adapter	peripheral card
channel	bus
facility	usually a combination of hardware and software
feature	a hardware add-in, usually a peripheral card or a disk drive
fixed disk	hard disk
pel	pixel
planar	motherboard

contain an advanced communications manager, which lets users communicate concurrently via several different protocols. It will cost $795. For more details on the general structure and operation of OS/2, see "Microsoft's New DOS," on page 116 of this issue.

Only The Beginning

Overall, the PS/2 computers are a respectable design with considerable room for growth. One of the most significant aspects of the announcement is the announcement itself: Now that IBM has shown its hand, the rest of the industry can move forward again.

We were pleased to find that IBM has not, as some rumors said, created a proprietary (and therefore hard-to-copy) computer by having Intel create a custom version of the 80286 and 80386 processors. Though IBM is secretive about many aspects of its design, it has pledged to document BIOS entry points and Micro Channel signals, thus opening the design to software and peripheral-card developers (but not to designers of compatible computers). A critical issue for companies making PS-compatibles is whether or not IBM will sue to defend its patent of the Micro Channel bus.

Unfortunately, the absence of the OS/2 software until sometime in 1988 leaves us, for now, with a line of computers that are little more than high-speed IBM PCs with large hard disks. Worse, software to exploit the unique features of the Model 80's 80386 processor appears to be even farther off (OS/2 is written in 80286 machine code and does not use any 80386-specific features). The PS/2's ability to run multiple processors off the Micro Channel bus and to run up to a gigabyte's worth of programs under OS/2 offers a promise of high performance sometime in the future. We will not be able to gauge the true worth of this product line until we begin using these new features. ■

Editor's note: *In the next issues of BYTE, we'll continue to examine the underlying technology and implications of the new IBM hardware. Our coverage will include full product reviews of the new systems. And in a new series of articles called "The New Generation" we'll begin in-depth ongoing comparisons between the two major new families of 32-bit personal computers: the 80386-based machines (such as the IBM PS/2 Model 80), and the 68020-based machines (such as the Mac II).*