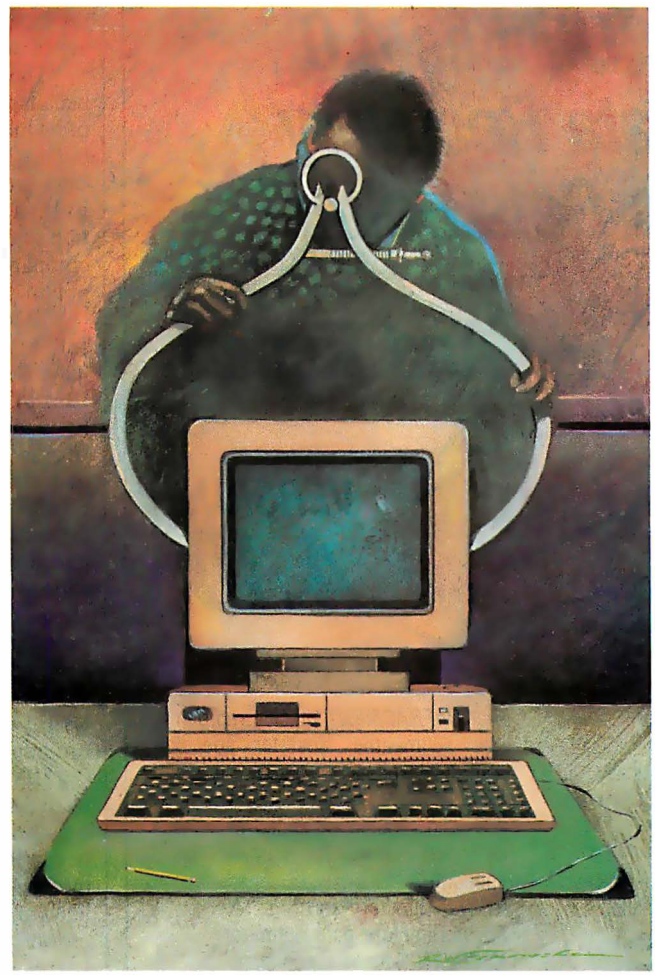
The importance of IBM's latest microcomputer offering

The Technical Implications of the PS/2

G. Michael Vose

Is there any real technical substance to IBM's new Personal System/2 lineup of machines? Or is IBM simply peddling yesterday's technology augmented by new graphics and an as-yet-unseen, complex, untested new operating system?

These questions form the context for the analyses on the following pages. I've assembled the thoughts of staff editors here at BYTE and combined them with a sampling of opinions offered by people from the microcomputer industry whose ideas we at BYTE respect.



The introduction of the PS/2 generated thousands of column-inches of type given over to endless discussions of what the PS/2 means to clone makers, what it portends for software vendors, and what may happen to a soon-to-be-orphaned generation of machines. Our intent here, however, is to focus on the technology of the PS/2 computers to ascertain whether this technology will make significant changes in the future of personal computing on an IBM platform. These collected ideas may help shed some light on what implications the PS/2 generation holds in store.

The Big Picture

Overall, the observations that follow paint a very positive picture of the direction staked out by IBM's newest product line. The two most significant technologies include the Micro Channel bus and the OS/2 operating system. Closer looks at both of these technologies, as well as the PS/2's new VGA graphics, are offered elsewhere in this issue. [Editor's note: *See "The 32-bit Micro Channel" by Jon Shiell, "TSRs Past and Future: MS-DOS and OS/2" by Ray Duncan, and "PS/2 Video Programming" by Richard Wilton.*]

Several general observations can be made about the PS/2 family's technology. First, Intel's 80x86 architecture is well-understood, even though it's disliked by many people. This understanding makes possible chip sets and application-specific integrated circuits (ASICs) for building machines more cheaply, as well as reasonable development tools for writing software. Therefore, it is safe to say that an Intel microprocessor-based line of computers is fairly mature.

Maturity may not be considered a technical advantage in science, where creativity in problem-solving is more important. But in the venue of the average microcomputer user, maturity means compatibility and reliability.

In fact, some people think that software has replaced hardware as the standard target for building new computers. John Roach, chief executive officer of Tandy Corp., recently noted, "Most people don't care much about hardware anymore. They just want to know if their favorite software will run on a machine." If this attitude is widely shared, then the hardware of the PS/2 machines will satisfy many people—at least until the OS/2 finally arrives.

Compatibility implies standards, and as a standard, the PS/2 machines' technology seems solid. But whether IBM allows it to be adopted by other manufacturers concerns BYTE'S editor in chief, Philip Lemmons, who says, "With the introduction of the PS/2 machines, IBM has begun to compete in the personal com-

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puter arena on the basis of technology. This development is welcome because the previous limitations of the de facto IBM standard were painfully obvious, especially in systems software. The new PS/2 'standard' offers numerous improvements: The Micro Channel is a better bus than the PC and AT buses, and it provides a full standard for 32-bit buses. The VGA graphics standard improves on the EGA. The IBM monitors for the PS/2 series take a new approach that will ultimately deliver superior performance at lower prices. IBM is using 3½-inch floppy disks that offer more convenience, capacity, and reliability than 5¼-inch floppy disks. And OS/2, the new system software jointly developed by Microsoft and IBM, will offer advances such as true multitasking and a graphic user interface.

"Yet a cloud hangs over all this outstanding new technology. Like other companies that have invested in the development of new technology, IBM is asserting proprietary rights in its work. When most companies do this in most product areas, we expect and accept it. When one company has the special role of setting the de facto standard, however, the aggressive assertion of proprietary rights prevents the widespread adoption of the new standard and delays the broad distribution of new technology.

"The personal computer industry has waited for years for IBM to advance the standard, and now, depending on IBM's moves, may be unable to participate in the advancement. If so, the rest of the industry and the broad population of computer users still need another standard for which to build and buy products—a standard at least as good as the one embodied in the PS/2 series."

Whether or not the PS/2 machines set a standard, BYTE senior technical editor Gregg Williams finds noteworthiness in the technology of the machines for a variety of reasons:

"The PS/2 design is noteworthy more because it was done by IBM than because of its inherent worth. The design is good, but not great; it opens large areas of future growth (and present incompatibility); and it determines what a large portion of the microcomputer industry, both companies and individuals, will and will not do.

"IBM's use of the Intel 80286 processor in the PS/2 Models 50 and 60 will have a strong fragmenting effect on the IBM PC market (in which I'll include the PC and PS/2 computers and all clones). Imagine what life would be like if IBM had introduced only 80386 machines: An 80386-based operating system, with its protected 8086 mode, would have allowed multiple *existing* MS-DOS applications to run in the same machine. This means that most of your existing IBM PC programs would do multitasking on the new machine, and software developers wouldn't have to agonize over whether to write MS-DOS– or OS/2-compatible programs.

"IBM's exclusive use of 3½-inch floppy disks puts the final nail in the coffin of 5¼-inch floppy disks, a process that was begun by Hewlett-Packard, Apple, Commodore-Amiga, and Atari. On the other hand though, IBM's insistence that the mouse pointing device be optional may hurt the company. If less than 75 percent of the installed user base buys mice, developers will think twice before writing programs that use them heavily—and that will limit the range and power of applications that can (and will) be written. With a huge number of PS/2 machines being sold before the graphic interface is available, the fate of the mouse as part of the standard PS/2 configuration is very uncertain.

"I'm not sure how many people will pay $395 for OS/2 (IBM may bring down

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the price) or how many vendors will design boards that use the 32-bit version of the Micro Channel bus. Another critical factor is IBM's Systems Application Architecture (SAA), which promises to provide a standard user interface for *all* applications. Noting that Apple's success with the Macintosh stems largely from its extremely consistent user interface, I cannot emphasize the role of SAA too much. If it's a lackluster design, it will either cripple the software that conforms to it, or designers will ignore it and go their independent ways—and I don't know which of these is worse.

"A computer design always grows, in both software and hardware, well beyond what is immediately planned for it, and both the PS/2 hardware and the OS/2 operating system have a lot of elbowroom for future growth. Once the PS/2 becomes the machine on most IBM users' desks, things will be quite nice. It's just the transition that's going to be messy, as usual."

A messy transition also worries Ed Tolson, president of SoftLogic Solutions (Manchester, New Hampshire), who states, "OS/2 is the missing link between promise and reality. Even once OS/2 is in general use, it will take an additional one to two years before applications developers fully exploit the potential of the PS/2 machines.

"In the meantime, the abrupt and radical shift in system architecture may create major headaches for large user's groups with quantities of both PCs and PS/2 machines. Support and maintenance, in particular, will be significantly complicated by the difficulties of data-swapping and software compatibility created by the 3½-inch disks and by the lack of compatibility of virtually every piece of hardware in the system, necessitating different spare parts for each family.

"Finally, one of the more subtle implications of the PS/2 line relates to the large-scale integration of the components on the motherboard. While this is ostensibly aimed at providing systems that are more reliable, the real motivation behind it is lower manufacturing costs. The upshot for users is that board-swaps for these highly integrated systems promise to be very high in price after the warranty period expires.

"It is hard to be completely comfortable with this new standard when confronted by the tremendous divergence of paths created by new hardware that lacks a clear commitment to the 80386. Although there is an 80386 member of the PS/2 family, it currently just mimics an 80286 machine, albeit twice as fast. The 80286 seems to be the legitimate heart of the PS/2 line. Does this mean there will be another quantum leap in technology in just another couple of years?"

The Micro Channel Bus

The most intriguing technology in the PS/2 family is the high-speed system bus, called the Micro Channel. This bus opens up many new approaches to distributing computing tasks, since it permits a variety of bus masters equal access to a common data path.

Jim Truchard, president of National Instruments (Austin, Texas), a maker of IEEE-488 bus devices, thinks the Micro Channel holds much promise. He says, "The Micro Channel architecture replaces the I/O adapter system found in previous IBM PCs. The new architecture supports the functionality of its predecessor but is not compatible with it, since it attempts to eliminate most of the PC's design deficiencies.

"The Micro Channel architecture supports three connector systems: a 16-bit system with 24-bit addressing, a 16-bit system with a video extension, and a 32-bit system with matched memory cycles

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and 32-bit addressing. Eight high-performance direct-memory-access channels provide DMA transfer rates from 4 to 8 megabytes per second. These rates are substantially higher than those of the PC AT.

"Nimble support of multiple bus masters makes possible the support of high-performance multiprocessor systems. The Programmable Option Select (POS) feature eliminates the headaches associated with conventional hardware jumpers and switches. The features of the Micro Channel combine to provide the simplicity and flexibility needed to carry the PS/2 machines into the next generation of applications, including networking and multiprocessing.

"On the negative side, the reduced form factor imposed by the Micro Channel (the cards are 40 percent smaller than AT cards) will tend to limit the variety of I/O options to high-volume applications that can support custom chips and surface-mount technology (SMT) or simple applications that require only small amounts of board real estate. The bandwidth of communication between devices plugged into the backplane is limited because the main processor shares its bandwidth with backplane devices. The option between boards with 16- and 32-bit data paths will encourage vendors to support only the 16-bit I/O function, thereby *reducing* performance on 80386 machines."

The Micro Channel's form factor has Trevor Marshall, vice president of engineering at Definicon Systems (Chatsworth, California), worried as well. He explains, "The biggest surprise I got from the PS/2 announcements was the Micro Channel architecture. I had certainly expected a proprietary bus with 32-bit capability, but I was astonished to find that the new expansion card was so much *smaller* than the old AT profile card (only 59 percent of the surface area).

"The effects of that change are really quite profound. Unless new technologies, such as ASICs or surface mounting, are used, it is not possible to continue to supply complex systems (such as 32-bit coprocessors) for the Micro Channel. Since these technologies require high-production volumes to be economical, small independent (and innovative) add-in houses will be unable to effectively compete in the Micro Channel marketplace.

"Even if a product's development can be commercially justified, a limitation has now been placed on the complexity and performance of the add-in system. For instance, looking at our latest coprocessor product, the IC package surface area of the CPU, the floating-point interface, and the Weitek floating-point chips alone take nearly 40 percent of the available Micro Channel board space. Our AT profile board is fully packed with 48 square inches of support circuits, including only 1 megabyte of high-speed RAM.

"The use of SMT or ASICs is necessary to increase this available RAM to a useful figure, even with the AT add-in technology. Porting such a product to the Micro Channel would require a size compression of these support circuits from 48 square inches to 22 square inches, an impossible task using SMT alone. Thus, IBM has mandated that we develop ASICs to meet the new form factor. This means fewer product variations and significantly increased lead time to market new CPU technologies.

"In addition, there is *no way* that such a system could be implemented on a Micro Channel board without considerable manufacturing investment, which would raise the cost to the end user.

"It is often said that the features of the Micro Channel are its high speed and its multiple bus-master modes. Why not just use the Micro Channel itself for the ex-

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pansion RAM? Well, it is already three times too slow for today's CPU technology. Cycle times on today's advanced microprocessors, such as Sun's SPARC, are typically 60 nanoseconds. As early as the first quarter of 1988, cycle times will have fallen to 40 ns. When the emitter-coupled logic (ECL) bipolar version of the SPARC is available in 1989, then 10 ns will be the system speed requirement.

"The Micro Channel has an absolute minimum cycle time of 200 ns. Clearly, the Micro Channel alone is not the bus for the future. Innovative add-in technology will be required if the PC is to keep pace with the expanding world of the supermicrocomputer workstation."

Another view of the Micro Channel reveals some other interesting quirks. Jon Shiell, systems architect at CGAA (Sunnyvale, California), who writes about the new bus in his article entitled "The 32-bit Micro Channel" on page 59 in this issue, sees it this way:

"The Micro Channel is a big step in the right direction, even though it's not complete; the current 32-bit Micro Channel slots don't appear to support matched memory cycles for anything other than the system microprocessor. In addition, the current versions of the Model 80 don't support 32-bit addresses for DMA, or, for that matter, 32-bit data. There is nothing that precludes future machines from doing so.

"POS is another good move; the fewer switches, the better. However, I suspect that as time goes on, either the POS setup program that IBM provides will have to get smarter or some people will end up with unconfigurable PS/2 machines. (Note that I am ignoring the idea that someone else could provide an equivalent program.)

"My major problem with the Models 50 and 60 is that they should have been zero-wait-state machines, and the Model 50's hard disk drive should have been a faster, 32-megabyte unit. I would also like to see a version of the Model 80-111 running with a cache at 20 megahertz with zero wait states and 32-bit DMA and MMC (matched memory cycle) for other bus masters. Such a system would be great for adding a second processor as a bus master with its own cache.

"However, there is no question in my mind that the most important thing about the new machines is that they are not closed. Whether they can be cloned is another question from the legal sense, but I see nothing in the technical sense that would prevent it."

Fitting the Pieces Together

The Micro Channel is an obviously important technical innovation, but how do

the pieces of the PS/2 puzzle fit together? Ray Duncan, president of Laboratory Microsystems (Marina del Rey, California), suggests that the new machines change the nature of the whole ball game. He notes, "The new IBM PS/2 Models 50, 60, and 80 are slick machines in their own right, but I think that their real significance lies in their role as portents of the future.

"First, the PS/2 machines dramatically raise the baseline level of computing power that people can reasonably expect of any desktop computer. Whereas today's clone maker can still foist off 8088-based machines with floppy disk drives on the buying public, the low-end clone builder of two years from now will have to provide, at minimum, an 80286- or 80386-based machine with 2 megabytes of RAM, a hard disk drive, and a high-resolution graphics system with an analog monitor—or be shut out of the marketplace. And I would hate to try to predict what kind of machine the high-end clone manufacturers, like Compaq, will be delivering in two years.

"Next, the long-range significance of the new Micro Channel bus can only be dimly imagined at this point. As designers learn to exploit its wider data path and ability to support multiple bus masters, we should see the emergence of coprocessor, disk-controller, and graphics expansion cards that will triple or quadruple the power of a bare PS/2 machine. We may also see network adapters with an on-board processor and RAM that will allow a PS/2 machine to be used as a server with no degradation whatsoever in its performance for the local user.

"Finally, the PS/2 line represents a significant redirection of some of IBM's most prized resources. These machines remind us what formidable high-tech talent IBM can bring to bear—when it chooses to—in the areas of styling, mechanical design, large-scale integration, and efficiency of manufacturing. By comparison, the original PC line of computers are just clunky-looking boxes built from off-the-shelf components from the corner electronics store.

"Where does the PS/2 Model 30 fit in? In my opinion, nowhere. Its inclusion of the old bus, an 8086 processor that can't run protected-mode operating systems, and an idiosyncratic video controller, mark it as an interim machine with no growth path. This is a machine that will, or at least ought to, quietly fade away in a couple of years like its philosophical predecessors, the IBM Portable PC, PCjr, PC AT/370, and PC XT/286. If you like the Model 30, maybe you'd also be interested in this neat Osborne computer sys-

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tem that I've got in the closet . . ."

The long-range potential of the PS/2 line also impresses Carrell Killibrew, graphics processor manager at Texas Instruments (Houston, Texas), who says, "The IBM PS/2 architecture is the foundation of the most powerful personal computing systems of the next 10 years. PS/2 systems will have adapters for performing almost any computer-capable task, and they will be able to access hundreds of megabytes of disk storage and display results on monitors with speeds and resolutions surpassing today's best engineering workstations. These capabilities are not available today, but are the promise of the PS/2 machines' more sophisticated and flexible bus structure, the Micro Channel architecture (MCA); faster disk subsystems; and standard display interface.

"The MCA is a work of art. There will be more variation in the types and numbers of adapters available for the PS/2 family, since the MCA extends I/O device addressing to the full 64K bytes supported by the Intel 80x86 family (the PC and PC AT only supported 1K-byte addresses). The POS registers required to be in each adapter will allow the system to determine what each adapter is, what it does, and how to communicate with it. A nice benefit of this feature is that users will no longer worry about setting adapter-card switches to avoid address conflicts. Support for multiple system bus masters is much better thought out than it was for the PC AT bus that preceded it.

"Gone are the days of plugging strange and delicate cables into the original motherboard when upgrading to the next-generation Intel processor—your 80986 option adapter (available perhaps in the year 2001) will have no trouble taking over PS/2 system resources. And if you are the type who wants to have multiple (and possibly different) processors in your system, the MCA supports arbitration between 16 different bus masters.

"The 1-to-1 sector interleave available in PS/2 hard disk subsystems will make data-intensive applications and database programs run noticeably faster than they do on the more primitive PC AT versions. This situation will be improved even further when the IBMCACHE.SYS driver is used to create fast disk-caching.

"Note that disk-caching is inherently superior to RAM disks, since disk writes cause an actual write to the hard disk media. Need more hard disk capacity? The PS/2 machines should be capable of supporting many physical (not logical) disk subsystems with the MCA's eight DMA channels (of course, what I would do with eight 115-megabyte disk systems,

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I can't imagine). The one drawback to all this disk performance and capacity is the probability that it is the bare minimum necessary to support disk-hungry operating systems, such as Unix and (I suspect) OS/2.

"The PS/2 line will never suffer the display schizophrenia of the PC/XT/AT family, thanks to IBM's placing the VGA on the motherboard and providing an auxiliary video extension (AVE) as part of the MCA. The VGA, regardless of the display monitor used, will allow developers to write to a single display device for the majority of applications.

"For those who need or want to take advantage of the performance and capabilities offered by display adapters with high-performance drawing processors, the AVE supports redriving VGA-sourced display information through the added display adapter. This clever architectural innovation should result in an increasing flood of display adapters available to the PS/2 market, since providing backward compatibility with the VGA is unnecessary. IBM's own 8514/A display adapter uses this feature of the MCA to supply VGA compatibility."

OS/2: The Missing Link

Another important technology driving the PS/2 systems is the multitasking operating system, OS/2. Few people have experience with OS/2, but the people who have seen it are very excited by what they've observed. But all the experts queried for this article agreed that it was much too early to speculate on the potential of OS/2.

Skeptics of OS/2 were dismissed by Bill Gates of Microsoft in a speech to the Silicon Valley User Society recently as "the same kind of people who were reluctant to switch from CP/M to MS-DOS."

The Implications

From these reactions, we can conclude that the PS/2 machines inject just enough new technology into the PC milieu to enliven our lot for a year or two. But the Micro Channel and 80286-based machines by themselves do not usher in a new generation of computing power. And OS/2's potential is still long on promise and short on reality.

The real technological breakthroughs peek over the horizon, however. The 80386/80486-based machines running OS/3 (or whatever the next operating system will be called) and built around an even higher performance bus will be the machines we await most eagerly.

In the meantime, we'll be busy porting and adapting software for the VGA and OS/2. That will keep us occupied until the next wave unfurls. ■