Patricia Seybold's

UNIX IN THE OFFICE

VOL. 4, NO. 10
ISSN: 0887-3054
OCTOBER 1989

INSIDE

PRODUCTS • TRENDS • ISSUES • ANALYSIS

Reality Check

Commercial Users Speak Out on Barriers to Unix Acceptance

By Judith S. Hurwitz

THE STANDARDS MOVEMENT: Is it an aberration or the wave of the future?

The concept of standards and consistency is not new. In fact, in a way, each vendor of a proprietary system has always had this goal in mind. The idea was that a user organization would become dependent on one vendor's "standard." As long as a particular vendor had the wherewithal to provide all that the customer needed, there were few problems. IBM achieved its powerful position in corporations because it could *(continued on page 3)*

• E D I T O R I A L •

MIS at the Crossroads

By Judith S. Hurwitz

THE OTHER DAY, we were asked to consult for the MIS director (we'll call him Sam) of a medium-sized insurance company (we'll call it Standard Mutual Life). Sam was shaken and worried. It seemed that while the president of his company (we'll call him Mr. Smith) was playing golf with a fellow insurance company president, they got around to talking about computers. Mr. Smith's friend had recently decided that his company would change its corporate computing environment from proprietary to open systems and Unix. He found the possibility of moving to a heterogeneous environment free from the shackles of the proprietary world quite compelling. And anyway, openness seemed like the right thing to do. When Smith's friend asked for his opinion about his new philosophy, Smith agreed vigorously—naturally, open was the way to go.

Two days later, Smith waltzed into Sam's office, proclaimed that open systems was the wave of the future, and wanted to know what Standard Mutual Life planned to do about it. Our harassed MIS director promised to look into the matter. After Smith left, Sam was perplexed. What was this open stuff? Had the president lost his mind? What did Smith know about the real computing environment, anyway?

Needless to say, Sam was faced with a new set of acronyms and a new set of criteria to consider. He had been scoffing at the open systems and Unix material that had been bombarding him in all the trade journals for the past two years. Suddenly, his closely worked-out five-year strategy based on IBM mainframes and departmental minicomputers seemed to be crumbling before his eyes.

Is this a fairy tale? No. A new dynamic is taking shape in corporations these days. MIS suddenly finds itself out of the power loop. Corporate management has started realizing over the last few years that information is a company's most valuable resource—too valuable to be left to the discretion of MIS alone. Another factor is the new breed of CEOs and senior managers. Unlike the last generation, who tended to look at computers with awe and fear, the new senior managers are computer literate. They understand the power and the costs of technology and are not about to wait for MIS to slowly change.

Therefore, MIS management is being forced to move from its comfort zone into the new world of open systems. Many of these managers lack the knowledge and understanding of Unix, but they have been in this industry long enough to be afraid of fads. Because they have played it so safe over the years, they have not paid enough attention to the messages from the industry and their own corporations. Many have waited too long before realizing how much they really need to know about their own company's business.

At the same time, senior management understands the importance and the ramifications of the next-generation technology, and they are also smart enough to understand the risks. So senior managers are not buying systems today. They are waiting, watching, and studying the structure of their companies in conjunction with their information needs.

No wonder our friend Sam is worried and confused. He is embarking on a new world of technology unlike anything in the past. He is faced with changing from proprietary to open systems. Will Sam make the transition?

We think that he had better try very hard this time around. In earlier decades, MIS managers fought hard against the influx of the PC and the encroachment of the local area network. These technologies were implemented anyway. We therefore challenge MIS to get on the open systems bandwagon and work together with corporate management. MIS veterans have some valuable knowledge about the realities of implementing new technology in the commercial environment. They should provide that input to make the next-generation technology better for everyone.

Patricia Seybold's Office Computing Group

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Patricia Seybold's UNIX in the Office (ISSN 0887-3054) is published monthly for $495 (US), $507 (Canada), and $519 (Foreign) per year by Patricia Seybold's Office Computing Group, 148 State Street, Suite 612, Boston, MA 02109. Second-class postage permit at Boston, MA and additional mailing offices. POSTMASTER: Send address changes to *Patricia Seybold's UNIX in the Office*, 148 State Street, Suite 612, Boston, MA 02109.

•USER SURVEY•

(continued from page 1) continue to produce the centralized mainframe solutions for its customers, fulfilling all the organizations' computing needs. However, as the needs of MIS organizations began to change, it became clear that software innovation would come from many different directions and from many different companies. Eventually, a large number of operating systems were designed to take advantage of new and innovative hardware, and, because these organizations were captive to the proprietary systems of their chosen vendors, it became more difficult for MIS departments to respond quickly to change. Financially justifying a change of platforms was difficult once the organization had thousands of programs closely linked to a particular operating system.

From an economic perspective, this made the job of the computer vendors easier. They would work hard to secure a contract with a commercial customer, offering, in some cases, substantial discounts and support to win a bid. But once the customer was sold, the vendor's life was fairly easy. The customer would put considerable time and money into developing systems on this proprietary base. Then, even if the vendor was less responsive after the sale than before, the customer had little choice but to stay with the chosen system and vendor. The traditional minicomputer vendors maintained their market strength for many years due to the magnitude of their installed bases.

What happened to change this delicate balance? Most directly, the entry of the PC. The introduction of this single-user, single-tasking machine turned the market upside down. Like most significant events in this industry, the true fallout of the PC revolution was not anticipated by anyone. In a subtle way, it began the standards movement. The first generation of PC applications was written to nonstandard versions of DOS; users could not exchange information from one version of, say, a spreadsheet program to another. But, at the time, there was no overwhelming call for a single version of DOS. No consortia were formed to take control of DOS away from Microsoft. No conferences were held about a standard DOS operating system. The DOS standard emerged for economic reasons: developing software for a variety of DOS versions was too expensive. So software vendors put considerable pressure on Microsoft and on the hardware vendors, and a DOS standard emerged. Ironically, had DOS not stumbled on the scene, Unix might have emerged as a standard operating system at that time.

It is not necessary to repeat the tale of the success of the PC marketplace. However, it is necessary to understand the impact that this low-end standard had on the software and hardware community. Software vendors began to understand the economics of the mass market. They realized that they could make a lot more money by investing their development dollars in the platforms where they could sell the most copies. Thus, many began to concentrate on the PC, or standard DOS, market. General purpose minicomputer vendors that did not shift focus

Methodology

TO GET A SENSE of commercial Unix in the real world, we conducted two different surveys, questioning a total of approximately 100 commercial users of computer systems. In each survey, we asked a variety of questions to determine just what data processing managers are thinking and what they are planning to do about implementing open systems and Unix in their organizations.

The first survey solicited information from the managers of 40 traditional, IBM-dominated data processing organizations that have not necessarily indicated any interest in Unix. We'll refer to this group as "Traditional MIS." These companies ranged from medium to large companies (at least 1,000 employees). Most tend to employ more than 10,000 people, and they represent a variety of industries, including government organizations, insurance/financial services, real estate, manufacturing, and medical (see Charts 1 and 2). The respondents were asked questions ranging from "Is the meaning of the term 'open systems' clear to you?" to "Do you expect open computing standards to raise, reduce, or not change the cost per seat in your organization?"

We also surveyed another group of 60 users, those who attended the recent Executive Uniforum Symposium. These users differ from the Traditional MIS group in that they chose to attend a commercial Unix seminar. Therefore, they either have already begun to implement commercial Unix or are taking a hard look at the Unix option. From now on, we'll call this group "Unix Aware MIS." Unix Aware MIS were asked a series of questions related to the acceptance of Unix in their organizations, including issues such as "What do you see as the major stumbling blocks on the road to commercial Unix?" and "Which of the following graphical user interface characteristics are most valuable to you?"

In addition to gathering statistics about commercial Unix, we also talked directly to a cross-section of commercial data processing managers. We interviewed not only those who are already convinced that Unix is wonderful, but also those who have no interest and those who plan to implement Unix only sporadically in their organizations.

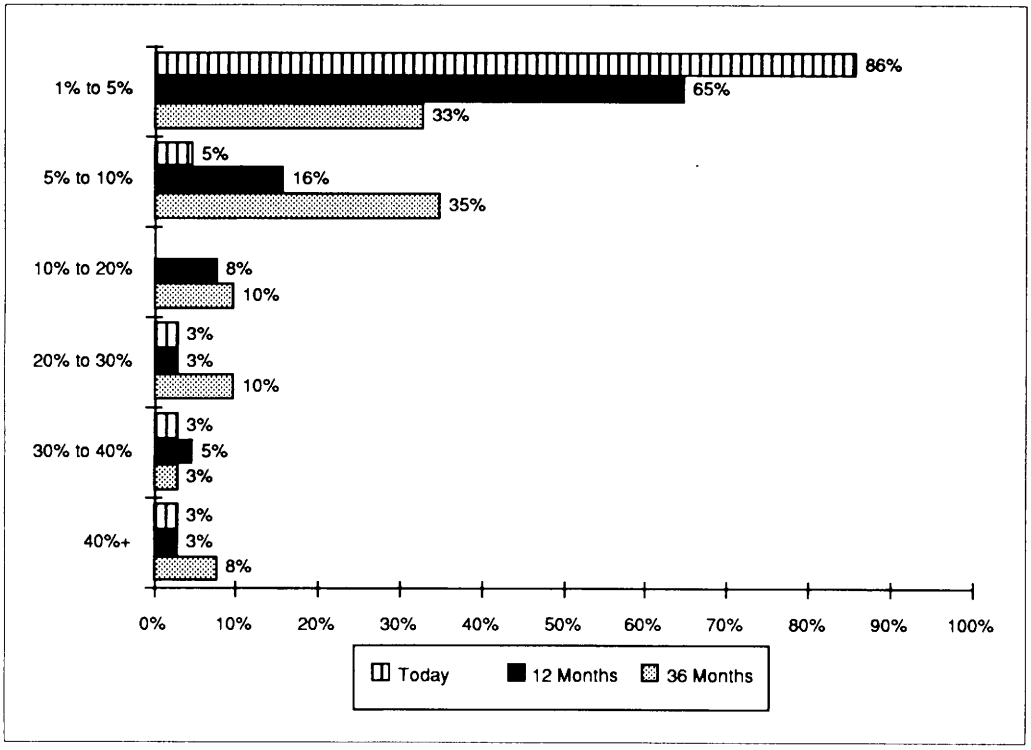


Chart 1. Response of "Traditional MIS" managers to the question: "What percentage of MIS budget will go towards systems based on Unix over the next 36 months?"

found that they were unable to attract as many developers as they or their customers would have liked. At the same time, user buying patterns began to shift away from traditional minicomputers to PCs.

Two groups of vendors found a way to circumvent this problem, coming at the market from two directions:

- Those who took the engineering and scientific approach and became the workstation vendors
- Unix hot-box makers

The workstation vendors tended to come from the universities, where Unix had traditionally been given virtually free. These vendors produced highly specialized hardware designed for technical engineering applications to meet the needs of a specialized market segment whose users were willing to pay a premium for innovation and speed. In contrast, the hot-box makers discovered that, by using standard hardware and software, they could mass-produce systems that were both powerful and inexpensive. They then turned to the value-added resellers (VARs), which had made leaders of companies like Data General and Prime. By using Unix as their operating system, these hot-box makers could, in a few months, port more software than a traditional minicomputer vendor with a proprietary operating system could port in a year.

Government computing was another factor in the PC market. The U.S. government, the largest user of computers in the world, is concerned about software portability. Any problem faced by an MIS department in migrating to new hardware and a new operating system would be magnified a hundredfold for the federal government. It is, therefore, not surprising that government departments were among the first to cry out for standardization.

So where does the traditional MIS department fit in this scenario? For an organization that has used a single operating system for its IBM mainframes for the past 20 years, a nonproprietary operating system standard is not a priority. Traditional MIS departments tend to react very slowly to change and are skeptical of the entire standards and Unix movement. Ironically, this reluctance to adapt has begun the erosion of the MIS power base. When the traditional centralized MIS organization could not meet the expanding needs for departmental data processing, the departments began taking matters into their own hands. Their independence was responsible for fueling the PC and minicomputer revolutions. And we suspect that the standards and Unix revolutions have started in these same departments. Centralized MIS, because of the size and cost of purchases, has had to act conservatively. Each system purchased had to be justified over many years. The cost in terms of programmer time and productivity often outweighed the hardware cost. In contrast, a department within a corporation was much less constrained. A PC could be purchased with discretionary funds without any higher approval than a manager's. The payback for an accountant to use a PC for budgeting was immediate and obvious. A departmental minicomputer could be justified on the basis of how many charge-back dollars from MIS were saved. Often, these systems could be cost-justified over three to five years.

MIS today is at a crossroads. Management understands that it no longer has the luxury of a single-vendor environment. Conditions have become too chaotic. The computer vendors have been forced to implement standards-based systems simply to survive. Companies like Prime, Data General, Digital Equipment, and IBM have been forced to compete with companies like Altos, Arix, and Pyramid. And these hot-box makers could keep costs down. High-production Motorola 68000 or Intel 80386 chips cost less than proprietary processors. Likewise, licensing a widely available operating system was less expen-

sive than developing and maintaining a proprietary one. Also, by using a widely licensed operating system, hot-box vendors could gain access to a large portfolio of applications more quickly than could a vendor with a proprietary operating system.

No one was particularly surprised when so-called second-tier vendors began to adopt Unix. But when industry forces like Digital and IBM began to build their bases of Unix offerings, it had an important effect on MIS. The rules were changing. If safe and trusted IBM had a strong commitment to Unix, something was afoot. As a result, traditional MIS directors have been forced to reconsider the importance of Unix.

Many of them have been caught off guard when a company president or key vice president innocently asked if the company is looking at Unix. It is not uncommon for two presidential peers to meet on the golf course and compare notes on the directions of their respective MIS departments. An offhanded remark such as, "We've decided to take a look at IBM's Unix strategy" could cause ripples in competing companies that fear being left out of something important. For some MIS departments, the fact that IBM and Digital have given their blessing to Unix suddenly makes it seem mainstream.

It is clear that the computer industry is entering a new age. The old world of centralized MIS, which controlled the heart and soul of computing, is gone forever. MIS's role as the owner of the corporate repository of data and the manager of the corporate network is continually being redefined. Even the cost-conservative MIS directors are anticipating spending more and more of their resources on standards-based products. At the same time, they have to contend with a world where interoperability with customer and supplier systems is becoming increasingly important. Interoperability with systems based in other countries is also increasing in importance as corporate consolidations lead to the creation of larger multinational companies.

Against this backdrop, a poll of MIS managers to see how they are preparing to cope with the coming changes is significant. Some are moving slowly, piloting Unix-based systems as a way of coming up to speed in open systems. Others are holding back, fighting against the intrusion of Unix into their organizations.

In the July issue of *Unix in the Office*, we presented part of the research data about the trends in commercial Unix. In this article, we provide additional information about Unix spending plans over the next 36 months, barriers to Unix acceptance, and the way Unix is being used in companies today.

What Cost Open Systems?

Perceptions on the cost issue varied depending on how Traditional MIS managers felt about open systems. Those opposed to Unix stated that open systems were, in general, more expensive. Overall, our respondents were neutral on the issue of whether standards reduce the cost of systems. However, at the same time, a majority stated that the cost per seat was reduced with Unix and open systems. These managers also indicated that, over the next three years, an increasing percentage of their budgets would be spent on Unix. A small percentage will spend as much as 40 percent of their MIS budgets on Unix three years from now. (See Chart 1.)

Three questions were asked relating to how Traditional MIS managers perceived the cost of moving to open systems and the percentage of budgets that will be devoted to open systems. First, managers were asked, "In your experience, do systems products based on open standards like Unix and OSI protocols cost more, less, or about the same as products that are proprietary to a vendor?" (See Chart 2.) The answer to this question reflected the bias of the manager responding. Those managers committed to implementing open systems in the future always replied that these standards cost less or the same (depending on how conservative they were feeling). Those who had reported that MVS, SAA, and SNA were open said that standards cost more or the same as proprietary offerings. Thus, true to form, 18 percent felt that Unix and OSI are more expensive than proprietary systems, and 20 percent thought

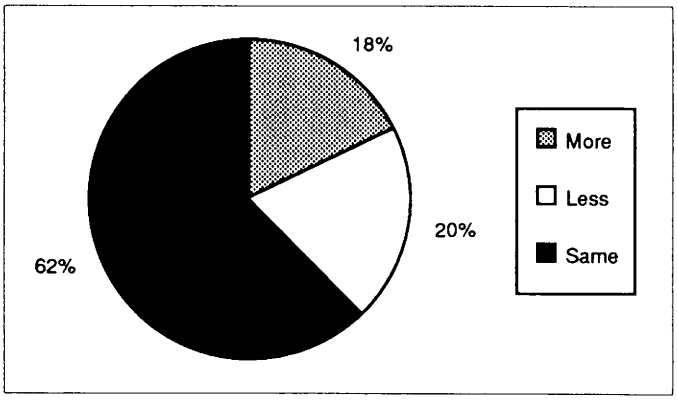


Chart 2. Response of "Traditional MIS" managers to the question: "Do open systems cost more or less than proprietary systems?"

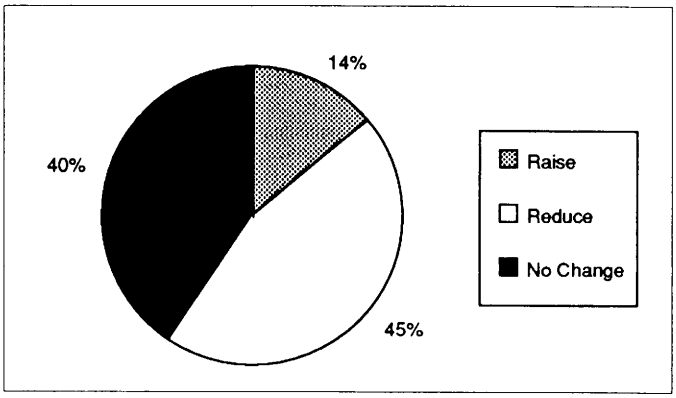


Chart 3. Response of "Traditional MIS" managers to the question: "Do you expect open computing standards to raise, reduce, or not change the 'cost per seat' in your organization?"

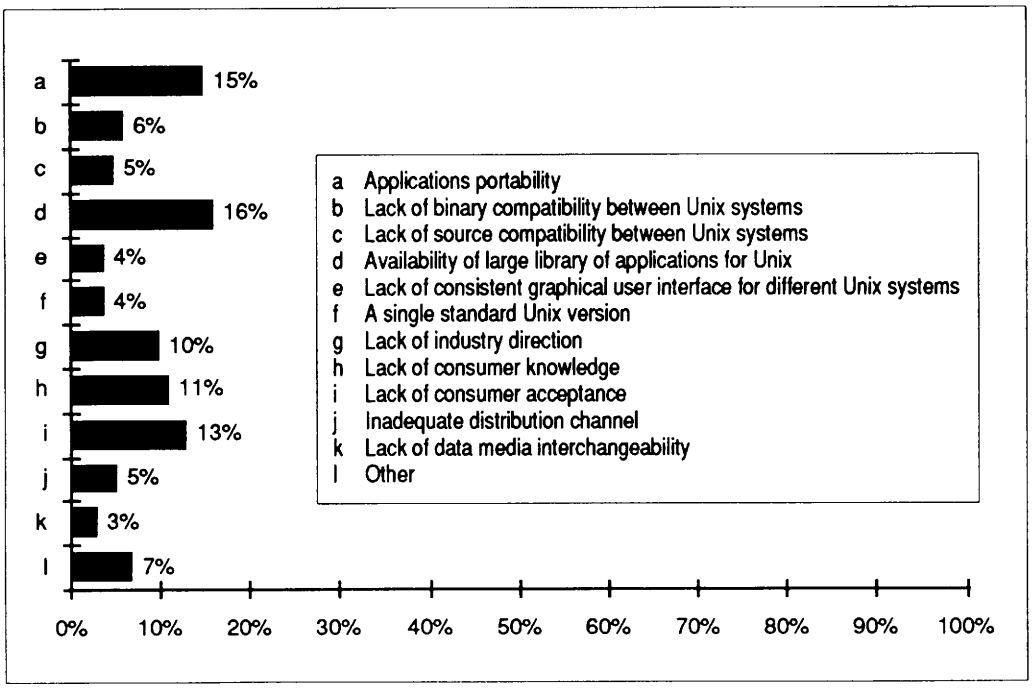


Chart 4. Response of "Unix Aware" users to the question: "What are the major stumbling blocks to commercial Unix?"

they were less expensive. The vast majority (62 percent) felt that the cost would remain the same. Another 6 percent offered no opinion at all. The fact that over 60 percent remained neutral is an indication that many of these managers haven't really considered whether standards are less or more expensive.

Another question, though similar, provided vastly different results. Traditional MIS managers were asked, "Do you expect open computing standards to raise, reduce, or not change the cost per seat in your organization?" (See Chart 3.) Only 14 percent of the respondents indicated that open computing standards would raise the cost per seat. We can assume that these are the MIS managers who want nothing to do with Unix. It is significant that 45 percent of the respondents stated that the move to standards would reduce the cost per seat. Forty percent stated that there would be no change in cost per seat under open computing standards. This could indicate one of two things (one is never quite sure of a respondent's motivation or interpretation of the question): Traditional MIS managers either think that the competitive pressure in the marketplace will lead to lower prices, or that, because Unix can run on multiuser systems supporting dumb terminals, the cost will be lower than a workstation solution.

The third question focused on the dollar number Traditional MIS managers intend to spend on Unix over the next three years (see Chart 1). The question asked managers to indicate anticipated Unix spending in the following percentage ranges:

- 1-5 percent of budget
- 5-10 percent of budget
- 10-20 percent of budget
- 20-30 percent of budget
- 30-40 percent of budget
- 40+ percent of budget

Given the orientation of this group, it is not surprising that 86 percent of respondents are spending only 1-5 percent of their budgets on Unix today. However, despite their ambivalence towards Unix, it is clear that many are going to be increasing their Unix budget allocations. In three years, only 33 percent will be spending 1-5 percent on Unix, 35 percent will spend 5-10 percent of their budgets on Unix, and 10 percent will be spending 10-20 percent. At the high end of the scale, a few organizations intend to spend more than 40 percent of their budgets on Unix systems. Admittedly, this is a very small percentage, but it will grow. Only 3 percent of those surveyed indicated that they will spend 40+ percent of their budgets on Unix today and in 12 months. But 8 percent, more than two and a half times that number, stated that they would devote almost half their budgets to Unix systems in 36 months.

While 5-10 percent of budget is not an overwhelming amount, it indicates a trend. If conservative MIS managers from large corporations are planning to increase their overall spending on Unix over the next three years, we predict that the more adventurous organizations will commit even larger percentages of their budgets to open systems.

Barriers to Unix

Users (both Traditional MIS and Unix Aware MIS) see many barriers to wide Unix acceptance. However, most pointed to the lack of sufficient applications software and staff training issues. The lack of a single Unix operating system standard was not a significant barrier for most users.

As we expected, the lack of applications was one of the major stumbling blocks for Unix Aware users. This factor was selected as the most critical problem for Unix by 16 percent of respondents. (See Chart 4.) Ironically, the second most important barrier was applications portability (it was also judged the most important factor in favor of Unix). This hits at one of the most troubling aspects of Unix and the center of much of the debate. Users are saying that, while they like the

fact that it is easier to move a Unix application from one hardware platform to another, there are still too many differences among Unix implementations. The third barrier most often mentioned by Unix Aware users was the lack of consumer acceptance of Unix. If this survey had been conducted two years ago, this barrier probably would have ranked as the most important.

Given the uproar during the past year over a single Unix standard, we might have expected that this would have been a major barrier to Unix acceptance. Therefore, we were somewhat surprised to find that this group of Unix Aware users did not seem concerned about whether or not there was a single version of Unix. Only one manager selected it as the most important factor, and only three chose it as the second most important factor.

The Traditional MIS managers were also asked to rank the greatest barriers to their acceptance of open systems. They were asked to indicate barriers in three categories: software, networking, and hardware. (See Chart 5.) The selection criteria were:

- Decentralized purchasing authority
- Lack of confidence in quality of products
- Lack of standards-based products
- Need to retrain IS staff
- Cost-accounting requirements
- Corporate inertia

In all three categories (software, networking, and hardware), the lack of standards-based products was the most important barrier (22 percent for software, 21 percent for networking, and 22 percent for hardware) to the adoption of open systems in these organizations. The second most important barrier was corporate inertia (18 percent for software, 19 percent each for networking and hardware). These are indeed significant barriers. If these large cor-

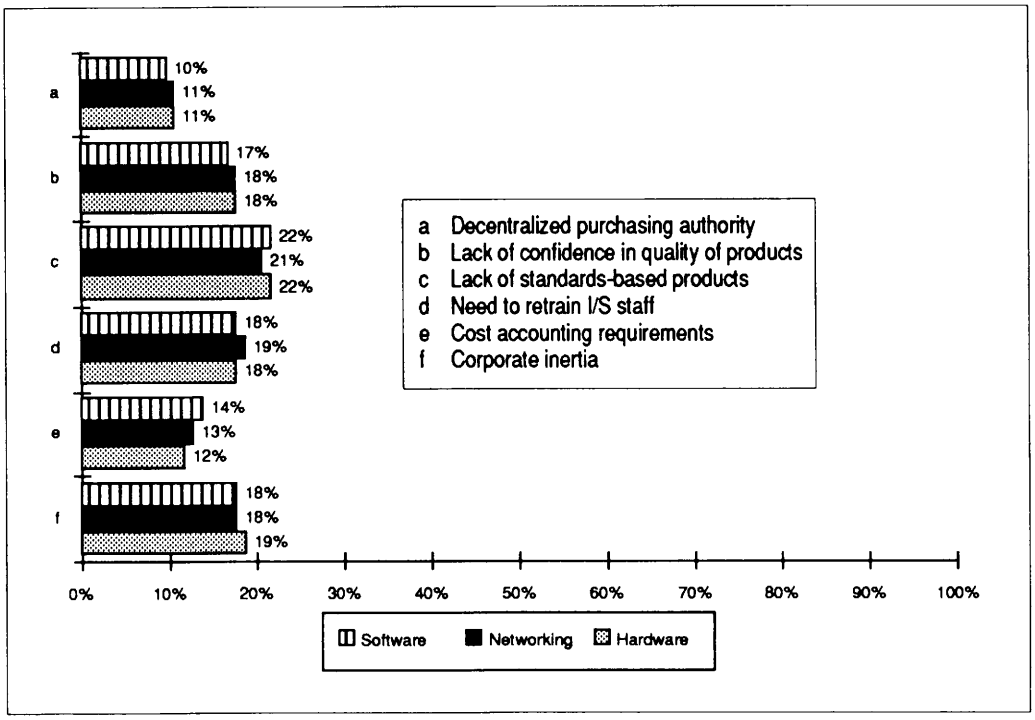


Chart 5. Response of "Traditional MIS" managers to the question: "In each category (software, networking, and hardware), which are the most important barriers to the adoption of open systems in your organization?"

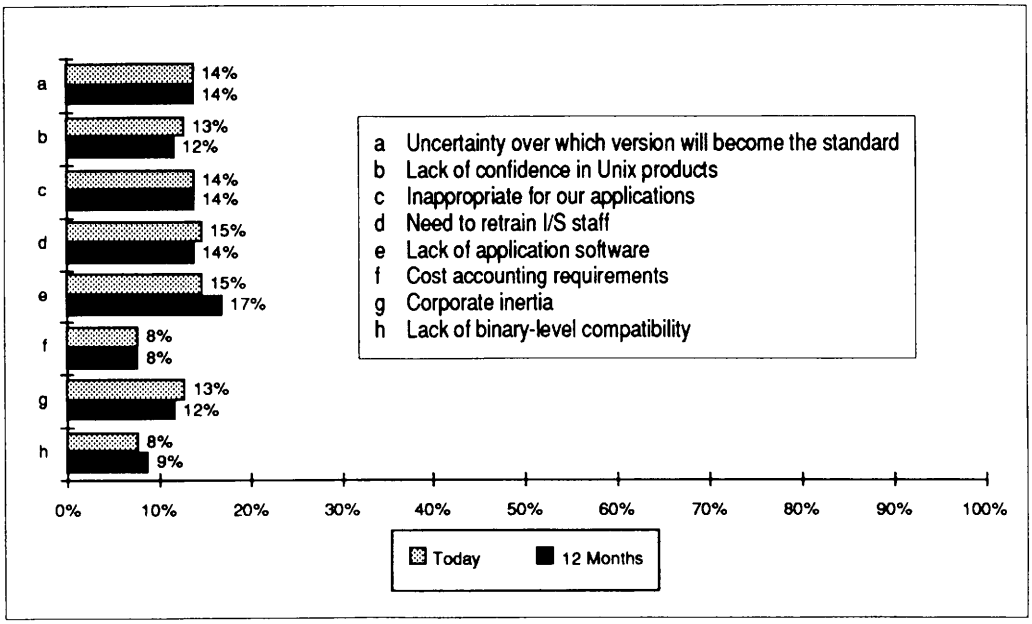


Chart 6. Response of "Traditional MIS" managers to the question: "Which are the most important barriers to the adoption of Unix in your organization today and in 12 months?"

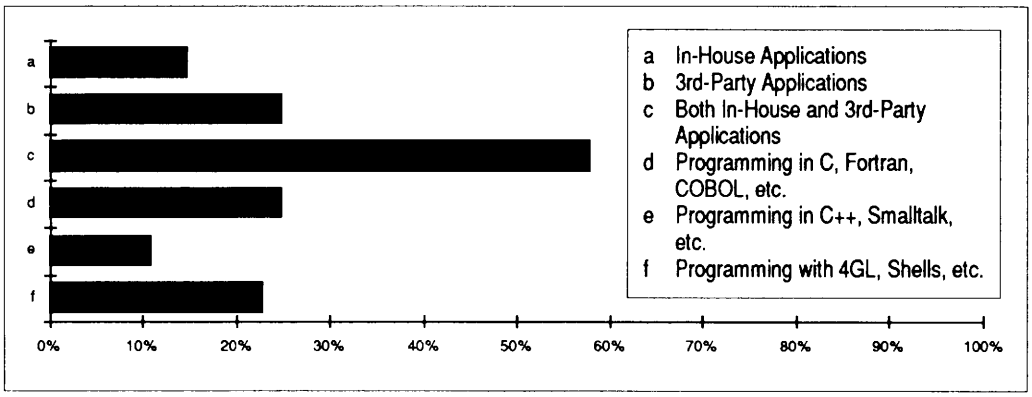


Chart 7. Response of "Unix Aware" MIS managers to the question: "What do your average end users do with Unix?"

porate MIS organizations already have large systems in place that can adequately run a business, there is no justification for making a change. In line with this, managers indicated that another barrier was the need to retrain their staffs (18 percent for software, 19 percent for networking, and 18 percent for hardware). When a company has a large installed base of hardware, software, and networking, it is difficult to justify radical changes. Thus, corporate inertia is an explanation of why many Unix systems are showing up in individual departments of large companies rather than in a centralized MIS department.

Another key factor is that many conservative MIS managers are uncomfortable about committing to unfamiliar concepts and technology. Not surprisingly, these same managers also suggested that open systems would cost the same as proprietary systems (see Chart 2). Another question was asked to gain more insight into the reason why these managers are inclined to avoid Unix (see Chart 6). Managers were asked to speculate on any change that might occur within the next 12 months. The issues listed included:

- Uncertainty over which version will become the standard
- Lack of confidence in Unix products
- Inappropriateness for our applications
- Need to retrain IS staff
- Lack of application software
- Cost-accounting requirements
- Corporate inertia
- Lack of binary-level compatibility

In this case, most of the possible reasons for avoiding Unix were given even weight by respondents. For example, no category for "today" received higher than 15 percent share and none lower than 8 percent. The two options receiving the highest percentages were "Need to retrain IS staff" and the "Lack of applications." We suspect that these two responses are related. Combining the responses to these two options indicates that 30 percent of these managers are suspicious of Unix as a commercial operating system. An MIS manager will not waste time retraining personnel unless the available applications meet critical business needs.

Another 14 percent felt that a major barrier to the acceptance of the open systems was "Uncertainty over which version of Unix will become the standard." This barrier is a direct result of the turmoil over control of Unix during the past year. While Traditional MIS managers may have avoided Unix anyway, the confusion over which version of Unix would become "the standard" has provided them with more reasons to stay away.

It is interesting that only 8 percent of the respondents indicated that the lack of a binary standard was a barrier to commercial Unix acceptance. The notion of shrink-wrapped Unix may be an issue in the future, when Unix becomes widely accepted in the commercial arena, but it is not the key issue on the minds of MIS managers today.

What about 12 months from now? Do Traditional MIS managers expect that their reasons for staying away from Unix will change? Apparently, they don't. In fact, the only real change is a 2 percent increase, from 15 percent today to 17 percent in the next 12 months, in the number of MIS managers who said that the lack of applications was a key barrier to the acceptance of Unix. Is this significant? Yes, in a subtle way, because these managers realize that many of the other barriers may weaken. For example, they understand that, over time, Unix may add more of the commercial features that older versions lack (security, file system robustness, etc.). However, even if Unix becomes a more acceptable operating system, it will not succeed if it does not offer enough of the applications they require to run their businesses.

The Applications Environment: What Do You Use Unix For?

MIS organizations that have begun to implement Unix are overwhelmingly implementing databases, ad hoc query tools, production systems, and some transaction processing.

How are Unix Aware MIS managers using Unix? Are they doing their own development? Using third-party packages? (See Chart 7.) We gave these users six options. Your average end user will:

- Use in-house applications
- Use third-party applications
- Use both in-house and third-party applications
- Program in C, Fortran, Ada, Cobol, etc.
- Program in C++, Smalltalk, Objective C, etc.
- Program with 4GL, shell, etc.

Here, too, the responses were predictable. Fewer and fewer Unix Aware users are doing their own development. Most are using third-party applications and fourth-generation languages to make development easier. However, many are still using traditional languages such as Cobol and Fortran to accomplish their tasks. A few (11 percent) are beginning to use object-oriented languages such as C++, Smalltalk, and Objective C. These tend to be the pioneers and are not typical of the development environment in most MIS organizations. (An aside: We recently asked Andrew Palay, senior system designer and head of the Andrew project at Carnegie Mellon University (CMU), which programming languages were being used at CMU. We expected that, at the very least, C was being taught to these next-generation developers. To our surprise, Palay stated that Pascal was one of the most frequently taught languages at CMU. Because this university, which is at the leading edge of new technological development, is still not teaching object-oriented languages to students, Cobol and other traditional languages may not be supplanted for a long time.)

What applications are run under Unix in Traditional MIS departments that have implemented some Unix? Will this situation change over the next three years? (See Chart 8.) Respondents were asked to choose from the following application areas:

- Ad hoc query DBMS
- Production DBMS
- Accounting
- Engineering
- Personal computing
- Transaction processing

One might expect that engineering applications would be the overwhelming winner. Traditionally, Unix applications have had the greatest acceptance in scientific and engineering application areas. Surprisingly, however, this was not the case with our respondents. Only 15 percent stated that engineering applications were widely used under Unix in their organizations today. In contrast, 25 percent said that applications typically run on personal computers, such as word processing, were widely used Unix applications. And 15 percent are using Unix for ad hoc DBMS query today, an area that is expected to show the biggest application increase over the next three years. Users expect it to constitute 20 percent of Unix applications in the next 12 to 36 months. Transaction processing applications show a small increase, from 15 percent today to 17 percent in three years. All other applications areas actually show small decreases.

What does this mean? Most of these organizations have only small installed bases of Unix applications today. Therefore, it is much more significant to look at what they predict they will be doing with Unix three years from now, when the presence of Unix in their companies increases. Here, database applications are the clear winner. If you add the percentages for ad hoc DBMS query, production DBMS, and transaction processing, the total is 54 percent.

Conclusion

Is the patient (commercial Unix) healthy? Will it survive into the new decade? From this initial survey work, we feel that there are signs that commercial Unix is indeed beginning to emerge. It will take time to become well established in the traditional MIS organizations, but, if one pays attention to what is happening at the departmental level, it is clear that Unix is making subtle inroads.

There will be hurdles. Many involve providing Unix with the same security, reliability, applications, and production environment available under proprietary operating systems. We encourage users who have a mandate to implement "open systems" to put pressure on the vendors to make these issues top priority.

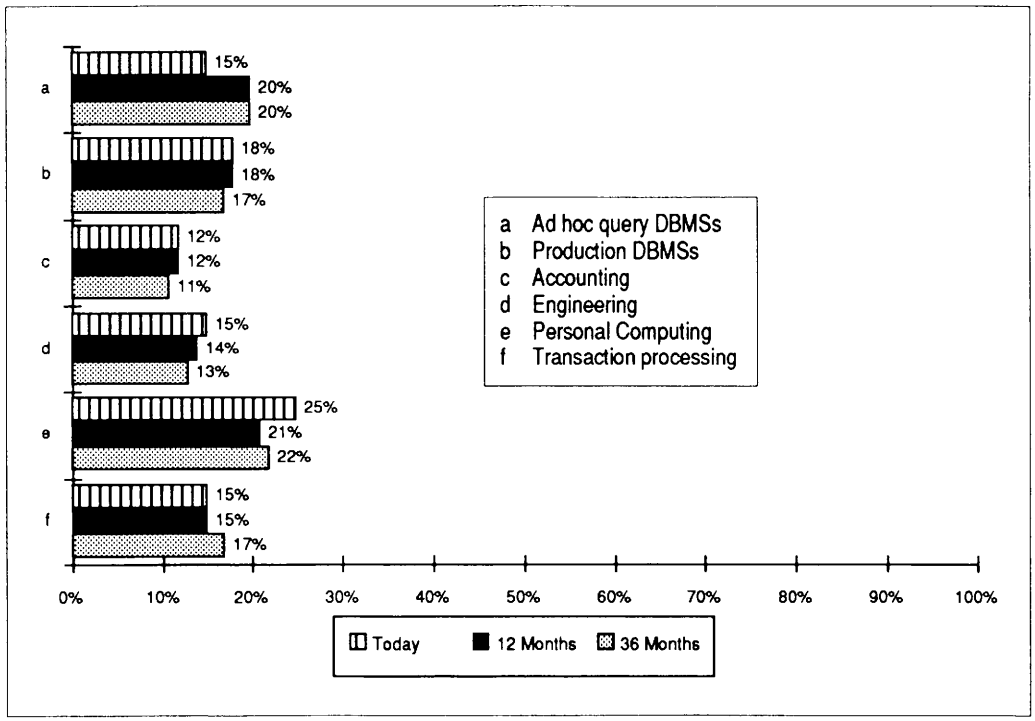


Chart 8. Response of "Traditional MIS" managers to the question: "In which categories is Unix most widely used in your organization today and over the next 36 months?"

NEWS ANALYSIS

PRODUCTS • TRENDS • ISSUES • ANALYSIS

• INSIDE •

• RPC STANDARDS •

Sun Steals a March

With a single swift maneuver last month, Sun Microsystems gained a place at the bargaining table in upcoming negotiations to craft a standard distributed network computing environment. The negotiations will be part of the Open Software Foundation's (OSF's) definition of its Distributed Computing Environment based on Unix, scheduled to begin in late fall. OSF will confront an industry split between a base-function option supported by PC LAN vendors—Sun's Open Network Computing (ONC)—and Hewlett-Packard/Apollo's Network Computing System (NCS), a more ambitious solution supported by the likes of IBM and Digital Equipment. We recommend that OSF craft a compromise position that at least bridges the two sides.

Sun's approach was to revamp its Remote Procedure Call (RPC), package it with Netwise Incorporated's RPC Compiler, and enlist the support of the PC LAN community. PC LAN vendors have been the "silent majority" in development of standard distributed computing tools so far. NCS and its large-system licensees—IBM, Digital, HP, and others—have dominated the discussion of RPC and distributed computing standards. Bringing the largest three PC LAN vendors—Novell, 3Com, and Banyan—into the debate on its side was a masterstroke by Sun.

CLIENT-SERVER API. Sun appealed to the PC LAN vendors by promising to give the PC industry a single API (application programming interface) to develop client-server applications on a variety of transport mechanisms. PC LAN and applications vendors predict the Sun/Netwise combination will at last stimulate a flood of new applications that use workstations and servers to optimum efficiency. Indeed, vendors predict that, taken together, Sun's ONC RPC and Netwise's Compiler will support development of shrink-wrapped client-server applications.

Currently, developers writing client-server applications must either write their own network-aware code within distributed applications or use a tool like Netwise's Compiler to develop transport-specific application code. Netwise sells versions of its RPC Tool for NetWare, NETBIOS, DECnet, and SNA (MVS and VM). Writing custom network interfaces is beyond most software development firms. A transport-specific approach is inadequate because it splits the market along platform lines. Ideally, developers want to leverage their software across many operating systems and transports.

The combination of Netwise's RPC Tool and Sun's new ONC RPC Library gives developers two APIs to a variety of network transports. The first is based on Sun's library of RPC routines, which use Sun's External Data Representation Format (XDR) to allow heterogeneous systems to communicate. The second is the option everyone in the industry is waiting for: OSI-sanctioned RPC software. Netwise already uses a version of the OSI data representation format, Abstract Syntax Notation (ASN.1) in its transport-specific RPC products. And this will make for an easy migration from the Sun RPC/XDR libraries to OSI equivalents.

NEW TWISTS ON OLD STUFF. The Sun-Netwise combination leverages two pieces of existing technology. First, Sun has incorporated AT&T's Transport Level Interface (TLI) into a new version of ONC to make it independent of specific network transport protocols. TLI establishes common definitions of interactions between clients and servers. Sun added an interface to TLI to the RPC it first introduced with its Network File System (NFS) in 1984, and rewrote some of the calls to make them network transparent.

Netwise's RPC Compiler is at the heart of its RPC Tool. Netwise pro-

vides users of Sun's revamped RPC with a proven RPC compiler, supplanting, in effect, Sun's own compiler. The RPC Compiler in Release 3 of Netwise's RPC Tool, available during the first half of next year, will support Sun's common RPC library.

ONC VS. NCS. With some irony, the Sun/Netwise combination has been dubbed the Common Distributed Computing Platform. HP/Apollo could also appropriate that label, but the fact is that neither of the alternatives is dominant. Sun's new-found strength is with PC LAN vendors, a group that Apollo has been unable to attract, although it won the allegiance of large-system vendors. IBM, Digital, HP, and the other vendors with commitments to NCS license Sun's ONC components almost as a matter of course in licensing NFS. But their commitments to the two options are decidedly different.

The differences between Sun's ONC and HP/Apollo's NCS go back to their origins. ONC is the son of NFS, a distributed file system designed to help networked users share files. NCS came after NFS, and its goal is to allow networked users to share computing resources. Both goals—file-sharing and compute-sharing—require RPCs. But NCS layers additional procedures atop the basic function of an RPC to ensure the integrity of remote procedure calls across big and interconnected networks. These procedures add overhead to a local environment that Sun's RPC doesn't impose. Sun's scheme is more streamlined and simpler than NCS's.

NCS, in its ambitious pursuit of compute-sharing, also provides a full-blown directory, or naming, service, called the Location Broker, to support RPC operations. "Full-blown" means that NCS's Location Broker can itself route remote procedures to target machines based on their availability. Sun's directory service, called Yellow Pages, keeps track of network resources but can't automatically route procedures. Rather, it presents the application with a list of available resources and lets it decide which to use. The difference here is subtle, but even Sun acknowledges that it needs a directory service that provides function closer to NCS's Location Broker. Sun expects to partner with other vendors to provide a more robust directory.

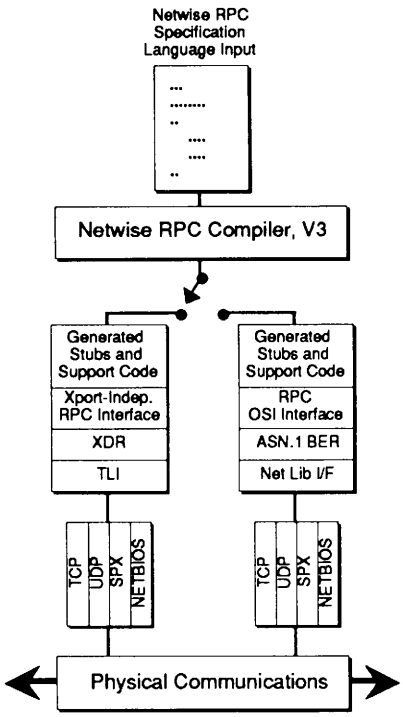
The two combatants—ONC and NCS—are clearly very different in nature and are aimed at different markets. ONC can be seen as a low-end solution, in that it delivers a no-frills RPC that works well on LANs. NCS is the high-end product with additional functionality—or baggage, depending on your point of view. Dwight Davis, director of marketing for Novell's Development Products Division, says that the Sun/Netwise combination is appealing because it offers a straightforward way to write LAN applications today. There's no question, he adds, that, in the long term, developers will need the kind of functions found today in NCS.

VINTAGE SUN. Sun's new initiative puts it back in a game it had been losing to HP/Apollo. Sun had laid claim to the de facto standard for distributed file systems with NFS years ago. But it had been lagging behind arch rival Apollo, now a subsidiary of Hewlett-Packard, in defining the additional services needed to build a distributed applications environment on top of NFS.

With the OSF's DCE (Distributed Computing Environment) project emerging as a bellwether for the industry, Sun found itself in a weak position. However, as it has before, Sun was able to package existing technology with effective marketing to create an aura of power and influence. Sun's key to success is Novell, 3Com, and Banyan, which account for the lion's share of PC LAN connections but have been cool to NCS. The OSF will not be able to ignore the votes these vendors have cast in Sun's behalf.

WORKING OUT A CONSENSUS. After all the headlines about Sun's apparent coup fade, the Open Software Foundation will be left to craft a consensus that bridges the Sun ONC and Apollo NCS alternatives. OSF has requested technology submissions for a new Distributed Computing Environment initiative that includes an RPC, naming services, authentication services, presentation services, and a distributed file system. Sun and Netwise plan to submit their technologies separately, but to cross-reference them. Apollo will jointly submit NCS's RPC with Digital, and Apollo will also submit the Location Broker. We can only hope that OSF will be as successful in defining an RPC compromise as it was in crafting a compromise user interface. —*J. Rymer*

The Sun-Netwise RPC Solution



With one command-line switch, the RPC Compiler generates RPC code compatible with existing ONC clients and servers. With an alternate switch, the generated code provides a high degree of OSI compatibility.

•KERNEL WARS•

OSF Flirts with Mach

The Open Software Foundation (OSF) has been making plenty of noise in the Unix community these days. With two RFTs (Requests For Technology) in progress (ANDF and Distributed Computing Environment, or DCE), OSF has upped the industry's awareness of some key issues. The latest bombshell dropped by the organization came in a letter to members from OSF president David Tory. It seems that, at recent members meetings, company representatives have expressed the need for multiprocessing and B1/B3 security to show up in an operating system sooner than might be possible with AIX Version 3. Therefore, OSF is taking steps to pick up some of this technology from Mach, Carnegie Mellon's next-generation operating system (see Vol. 4, No. 6). Mach gained the spotlight when Steven Jobs's NeXT chose it as its operating system.

Initial reaction to OSF's inclusion of Mach will be unfavorable. We expect that OSF detractors will use this as an example of how unstable OSF really is: "See? They can't even decide on their operating system—they keep changing their minds."

In reality, the decision to combine the best of AIX and Mach is a sound move. While Mach isn't a full operating system yet, it does have some key components that would be valuable additions to AIX, such as multiprocessing support. It is also important to remember that, at this point, OSF is only studying feasibility. Over time, OSF might be able to add more of Mach's strengths.

OSF is taking a risk by considering changes to its operating system component. When the organization was formed, it came out so strongly for AIX as its operating system that the industry took it at its word. A midcourse correction may come across as a weakness rather than a strength. On the other hand, the risk may be worthwhile. Rumor has it that AIX Version 3 delivery has been delayed. If this is true, it may make OSF/1 delays more palatable. In addition, finessing an advanced operating system could position OSF effectively for the future.

But how important are these kernel wars anyway? In the long run, the base operating system offered by OSF or AT&T won't make much difference. Since both organizations are committed to Posix, the X/Open Portability Guide, they should begin to look more and more alike. In addition, each platform will work quickly to add features that the industry needs, such as multiprocessing and security. OSF's management seems to understand this. In an earlier conversation, Tory confessed that he is ready to concede the kernel if necessary. OSF will concentrate instead on winning the pieces surrounding the kernel, such as user interface, administration, and networking, which are more visible. In the end, this may be a prophetic plan. —*J. Hurwitz*

•WORKSTATIONS•

Breakthrough Price Keys HP Assault

With one fell swoop, Hewlett-Packard, with its acquisition of Apollo, grabbed the lead in the technical workstation market. This accomplished, HP is showing no signs of complacency. Rather, the company is putting forth a hardware- and software-based strategy designed to further outdistance the competition, particularly Sun Microsystems.

On the software side, HP is putting together the pieces of a multiplatform, interoperable office environment, where Unix, MPE, and eventually OS/2 are the server operating systems (with connections to the Digital and IBM environments) and DOS, OS/2, Unix, and Macintosh are the clients, using the NewWave environment where possible (see illustration, page 13).

The key to the success of this strategy is the ability to provide network-wide applications and services. Thus, the introduction of the Unix-based OpenMail Server (see below) is a critical step in its implementation.

HP has also enhanced its software offerings with its new release of HP/UX (Version 7.0), which will include OSF Motif as its default user interface. In addition, Version 7.0 brings HP/UX in compliance with Posix 1003.1 standards. Other enhancements to Version 7.0 include disk mirroring capabilities and increased security (level C2).

On the hardware side, HP is pushing its competition at both the high end and the low end. HP is approaching the high end by opening up its RISC-based Precision Architecture, and has created alliances with Hitachi and Samsung to codevelop and comarket it.

But it is on the low end that HP is making the biggest splash. With its Apollo Division's introduction of a 4 MIPS workstation for under $4,000 (see "Apollo Series 2500" below), HP has single-handedly set a new entry level price point for workstations while claiming a one-third to one-half price/performance advantage over chief competitors Sun and Digital.

HP has thrown down the gauntlet, and the questions are how and how quickly can the competition respond. Certainly we will see a new round of price wars on the low end from those who are flexible enough and can afford to play. Those who are too slow to react may have to cede the price/performance issue and hope to retain share through superior marketing.

Apollo Series 2500. The Apollo Series 2500 is based on Motorola's 20 MHz MC68030 microprocessor and 20 MHz MC68882 floating-point coprocessor, providing 4 MIPS. The Series 2500 supports from 4 to 16MB of main memory, a choice of 15-inch (1,024 by 800) or 19-inch (1,280 by 1,024) monitor, and up to seven SCSI devices, including up

to 2.3 GB of mass storage, a floppy disk, and tape drives. It can be configured as a desktop or deskside model.

The entry level system (15-inch monitor, 4MB, diskless) lists for $3,990. This compares to $5,995 for a similarly configured Sun 3/80. A system configured with a 19-inch monitor, 4MB, and 200MB disk lists at $8,495. First deliveries are due in December.

The Series 2500 runs under the Domain/OS operating system, which lets users choose among Unix System V.3, Berkeley 4.3, and Apollo's Aegis operating system. The system also includes a DOS emulation facility that enables workstation users to run DOS applications along with Unix applications in a multitasking environment.

The system supports Ethernet, IBM Token-Ring, Apollo Token Ring, and Token Bus for MAP (Manufacturing Automation Protocol) networking. The workstation also supports a range of communications and applications protocols such as DECnet, TCP/IP, IBM LU6.2 and SNA, OSI and Apollo XNS-based systems, FTAM (file transfer, access, and management), FTP (file transfer protocol), IBM 3770, UUCP (Unix-to-Unix Copy Protocol) copy program, X.400, DEC VT-100, and a general purpose virtual terminal.

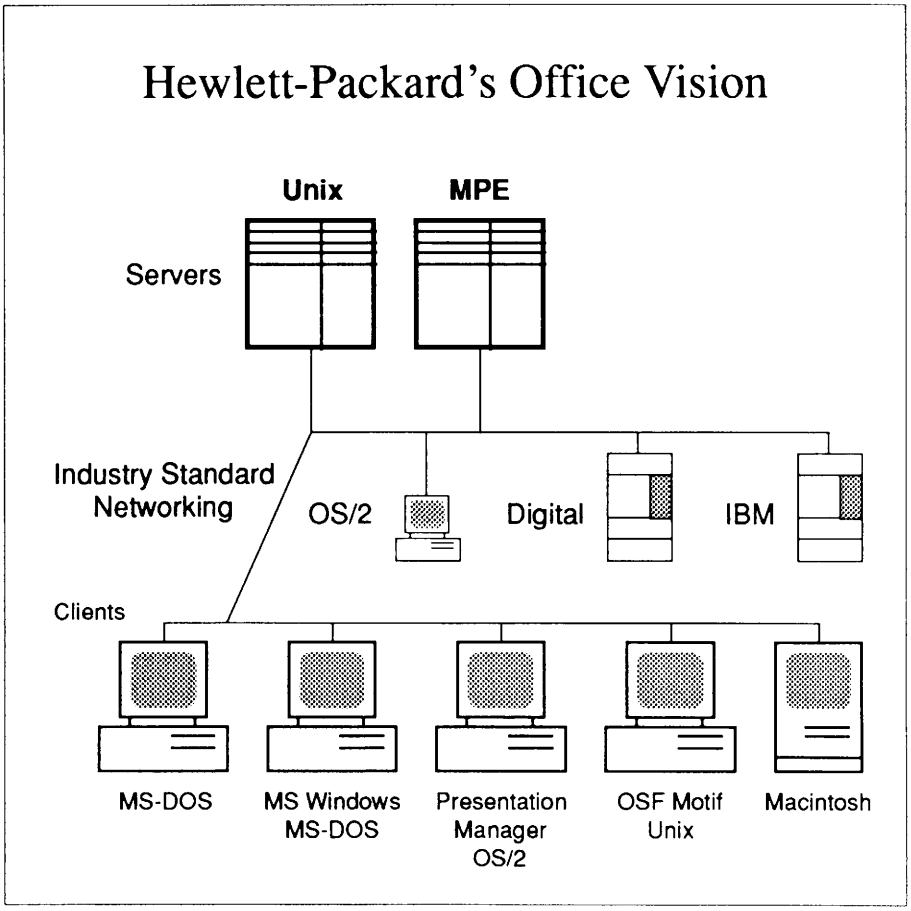
APOLLO DESKTOP VISUALIZATION SYSTEM. In addition to the entry-level workstation, Apollo also announced the Series 3500 and Series 4500 high-performance desktop graphics workstations aimed at two- and three-dimensional (2-D and 3-D) graphics-intensive applications. The Series 3500 and Series 4500 are based on the 25 MHz and 33 MHz versions of the 68030, delivering 5 MIPS and 8 MIPS respectively. Dubbed "desktop visualization systems," the two workstations are specifically enhanced for graphics applications, providing up to 20,000 3-D smooth shaded polygons and 300,000 3-D vectors per second.

The systems come standard with a dedicated drawing engine and transformation processor to accelerate redrawing of wireframe images and solid models and to speed up floating-point intensive operations, such as the manipulation of 2-D and 3-D images. The systems also feature a Z buffer, to remove hidden surfaces from the displayed image; double-buffering, for smoother movement of images; a 19-inch (1,280 by 1,024) monitor; and support for 4MB to 32MB of main memory.

The systems come in 8-plane and 40-plane versions, permitting both 2-D and 3-D applications. Pricing for sample configurations are as follows:

- Series 3500—4MB, diskless, 8-plane—$19,495
- Series 4500—8MB, 348MB disk, 8-plane—$30,990
- Series 4500—8MB, 348MB disk, 40-plane—$34,990

Networking and communications support is the same as with the Series 2500. Both the Series 3500 and Series 4500 are due to ship in the fourth quarter of 1989. —*D. Marshak*



Hewlett-Packard's Office Information Systems strategy.

•HEWLETT-PACKARD•

A First: Interoperable Mail Server

Hewlett-Packard has announced its first Unix-based communications software package: HP OpenMail. With this announcement, HP becomes the first major system vendor to provide Unix-based electronic mail services that are interoperable among multiple operating systems—HP MPE, DOS, Unix, and Macintosh.

Hewlett-Packard's OpenMail and DeskManager

	Now	Future
Client Support	DOS Unix Workstation NewWave Macintosh Terminal	X.400 P7* LAN Manager* OS/2
Server Support	X/Open* X.400 P1, P2 SendMail*	X.500* X.400 P7*
Network Support	X.25 UUCP* 802.3	LAN Manager*
Operating Systems Support	HP/OSF Unix MPE	OS/2* Other Unix*

* HP OpenMail only

Standards supported by HP OpenMail and DeskManager.

In addition to the Unix mail server, HP also announced enhanced support for DOS and Macintosh mail clients.

OPENMAIL SERVER. OpenMail is an electronic mail server that runs on HP's Precision Architecture-based 9000 Series, under HP/UX. HP also plans to license OpenMail to other Unix systems vendors and third-party developers.

OpenMail provides X.400-based messaging services, allowing communication with public or private systems such as MCI, Geisco, and PROFS. Specific interfaces are available to HP DeskManager and Unix mail, with a future interface to HP NewWave Mail planned (see illustration above). Users can send or receive a wide variety of media including text, graphics, voice, image, video, and binary objects.

NEW CLIENT SUPPORT. HP has also upgraded client support for its mail products by introducing an enhanced version of AdvanceMail and two new terminal emulation products for MS Windows and Macintosh.

AdvanceMail is a cooperative mail application between PCs and hosts. AdvanceMail III allows the user to transparently exchange mail through either DeskManager on the HP3000 or through OpenMail on the HP9000.

Mail access has been extended to Windows and Mac users with AdvanceLink for Windows and AdvanceLink for Macintosh. These provide terminal emulation and file transfer capabilities for MS Windows and Mac environments to HP3000, HP9000, and HP1000 hosts, while taking advantage of their native windowing environments to run multiple sessions concurrently.

PRICING STRATEGY. HP is pricing the OpenMail server software very aggressively—from $4,300 to $21,900 supporting 32 to 400 users. The strategy is to quickly grab a lot of market share in the Unix server environment at a low entry price and make the money on the client-side applications: sort of a "razors and razor blade" approach. Server shipments should begin by the end of the year.

HOLDING THE MOMENTUM. HP has staked its claim as a leader in the development of the next generation's distributed application environment. And it is backing its vision up with significant building blocks, both in hardware and in software, building blocks that both play into the overall strategy and are highly competitive by themselves.

The challenge for HP is to keep up the pace, to play on its strengths—the ongoing development of the NewWave object-oriented environment, the licensing of the Precision Architecture, the low-end workstations, the commitment to standards, and the reputation for excellence in service and support. At the same time, the company must take care of its unfinished business—adding the Agent facility to NewWave, moving NewWave to distributed platforms and other operating systems, and finding a satisfactory way to merge its two interface environments, Motif and Presentation Manager.

Can HP do this? The company is off to a good start. It has begun to establish credibility with the small but growing commercial Unix base. But it won't have time to rest on its initial successes. This market will continue to be too competitive for HP to take anything for granted. —*D. Marshak*

•A/UX•

Back in the Saddle

When Apple first announced A/UX two years ago, we Macintosh fans were excited. The power of Unix coupled with the intuitiveness of the Macintosh user interface seemed an ideal combination. But the promise was better than the product. First, the operating system was buggy. Developers told us that A/UX was slow and prone to crashes. In addition, it was difficult for developers to design applications on A/UX. We had wanted to see a direct connection between the Mac toolkit and Unix—it turned out to be a pretty difficult task and one that Apple couldn't deliver. Apple received some bad press, and, needless to say, the enthusiasm faded.

But, lately, the A/UX folks have been making noise again. Apple was very visible at the Boston UniForum show in August. Problems with the operating system seem to have been fixed. Apparently, a number of software developers have been lured into A/UX; several applications developed by third parties such as Claris, Microsoft, Informix, and WordPerfect were on display at Apple's booth. Perhaps the most notable A/UX coup was the $164 million, five-year government contract. In it, Apple will supply anywhere from 10,000 to 80,000 Mac II-based A/UX workstations in support of the Worldwide Military Command and Control System (WWMCCS). The UniForum show came on the heels of the contract announcement, and the Apple representatives we met at the show seemed to feel vindicated.

RELEASE 1.1. Release 1.1, announced last January, answered many of the complaints of the first version—at least, complaints from developers. The biggest advantage is the integration of the Macintosh Toolbox, a set of development resources that lets programmers more easily create Macintosh applications that run in both the Mac and A/UX environments. File transfer between Macintosh and A/UX file systems has also been refined. In addition, Apple has created two service programs for the development community.

Among the other features of Release 1.1 are:

- X-Window 11.3
- A full set of BSD 4.3 extensions
- Posix compliancy
- Support for LocalTalk and HyperCard
- Color support
- SL/IP (Serial Line/Internet Protocol) support

THE IRIS INTERMEDIA SYSTEM. Judging by the number of recent A/UX applications and a few developers we spoke with, Release 1.1 seems to be a much more accommodating operating system for developers than were the preceding A/UX releases—and not just commercial developers such as Claris, in whose best interest it is to port to Apple platforms. One of the more interesting AU/X-based systems was developed at Brown University's Institute for Research in Information Scholarship (IRIS).

IRIS Intermedia is a networked hypermedia development system. It lets you create and follow interconnected pieces of information, across a network, which is called a web. The web can contain text, graphics, timelines, and scanned images. The multiuser environment encourages groups of users to simultaneously create and annotate shared hypermedia pools of information. At Brown, Intermedia has been used by both faculty and students to teach and learn in a broad range of disciplines. Interrelated concepts in multidisciplinary areas, such as Shakespeare and astronomy (yes, there are astronomical allusions in Shakespeare), can be represented with references to related ideas and events.

Integrated Applications. Intermedia contains a set of integrated applications that can be used concurrently to create and display materials:

- InterWord, a basic word processing program with style sheets and formatting
- InterDraw, a structured graphics editor
- InterPix, a scanned-image viewer that can be used together with InterDraw to create and display diagrams and bit-mapped images
- InterVal, a timeline editor for managing chronological material

Webs. The links created in Intermedia are not stored as part of the document, but become a *web*, part of a separate database or repository, of links associated with a specific set of documents. A link exists only in the context of a particular web and can only be viewed when both the web and the document are opened.

Intermedia provides a Web View feature that graphically illustrates the connections between linked information. Web views help users determine where they are in a web, and where in the web they want to go next.

Architecture. The Intermedia system is client-server based. The client includes the integrated applications, and the server manages both the document file systems and the web database. An IRIS InterLex Server is an optional component that provides network-wide access to Houghton Mifflin's *American Heritage Dictionary* from within any of the other applications (particularly useful for students).

Availability. Intermedia is an educational tool, but it is commercially available from both IRIS and the Apple Programmers and Developers Association (APDA) for $150 per machine. The price includes the client-server soft-

ware, tutorials, and documentation. IRIS is also selling a sample Intermedia web called "Exploring the Moon" for $25, and the InterLex Server for $250.

CONCLUSION. The fact that IRIS chose A/UX as its development platform brings a degree of legitimacy to the much-maligned operating system. Further legitimacy is being sought as Apple becomes more active in pursuing standards. Release 1.1 supports X-Window, NFS, and Posix. As for other standards organizations and technologies, Apple says it's playing a wait-and-see game. If customers want A/UX to be Motif-compliant, for example, it will be. In the meantime, Apple assumes that the Mac interface is *the* interface, and wants to get the user-interface component finished as soon as possible. (How soon is soon? Well, we don't know. "Soon enough that we [Apple] can't talk about it" is what we were told. Your guess is as good as ours.) And that's the thing we're looking forward to. —*L. Brown*

The Series5 Servers: Tale of the Tape

Model	Processors	RAM	Performance	Price
Series5/531	1	16MB	22 MIPS	$33,400
Series5/532	2	32MB	40 MIPS	$60,800
Series5/671	1	16MB	22 MIPS	$44,400
Series5/674	4	32MB	65 MIPS	$107,500
Series5/801	1	16MB	22 MIPS	$55,800
Series5/804	4	64MB	$172,600	$172,600

•SUN CLONES•

Solbourne Marches On

It is safe to say that Solbourne Computer and the market for Sun-compatible workstations are for real. Eighteen months after its founding, Solbourne has implemented a second generation of workstations based on Sun's SPARC (Scalable Processor ARChitecture) RISC (Reduced Instruction Set Computers) design and its own multiprocessing Unix variant. Solbourne's Series5 is the first commercial utilization of gallium arsenide (GaAs) chips, illustrating the company's willingness to innovate in a standards-based market. Solbourne is using GaAs RAM chips from Vitesse Semiconductor to implement a 128KB cache on its new line.

In addition, Solbourne has attracted some $50 million in reseller commitments both in the United States and overseas. This fact says a lot about the company's marketing efforts as well as about the general potential of the market for Sun-compatible workstations and servers.

The Series5 is Solbourne's answer to Sun's SPARCstation line of workstations and servers. With the Series5, Solbourne keeps its lead over Sun in developing Unix-based multiprocessing support and offers better price/performance than Sun's genuine articles.

Sun and Solbourne look a lot like IBM and Compaq did in the early days of the PC-clone market. Solbourne is using generally available components to produce its workstations and servers and is stressing absolute compatibility with Sun's originals. The two companies also share an operating system base. And Solbourne's price/performance points better Sun's by 20 percent or more. One key difference between the Sun-clone market today and the PC-clone market at a similar stage is Solbourne's early technological leadership. OS/MP, Solbourne's multiprocessing operating system, is the best evidence of this fact.

SERIES5 WORKSTATIONS. The Series5 is Solbourne's intermediate step on the way to putting 25 MIPS on the desktop for under $10,000. The products are the first to use the CY7C601 32-bit SPARC chip from Cypress Semiconductor. The chip runs at 33 MHz. Solbourne is also offering users of its current Series4 an upgrade board with the new chip.

The Cypress chip gets Solbourne 22 MIPS on the desktop for just under $40,000. The next step is for Solbourne and its Japanese partner and backer, Matsushita Electrical Industrial Company to offer a series of processors using an ultra-large-scale integration (ULSI), 64-bit SPARC implementation. This is planned for next year. The rapid pace of innovation doesn't compromise users' investments in current equipment; Solbourne systems are designed to be upgraded with board swaps. The new machines are available this month.

The Series5 machines (see chart, above) allow Solbourne to maintain a healthy differential in price/performance from Sun's SPARCstations. Solbourne calculates, for example, that its single-processor Series5/531 has a 28

percent advantage over the equivalent SPARCserver 330. The dual-processor Series5/532 has an almost 48 percent advantage over a SPARCserver 330.

Aside from the Cypress chip, the hardware difference between Sun's SPARCstations/servers and Series5 is Solbourne's use of ECC memory. The Series5 units offer almost double the memory capacity of Sun's SPARCstations and servers. Solbourne asserts that parity-checking memory, which Sun uses, isn't reliable enough in large-memory configurations. Solbourne's ECC adds four or five bits to Sun's nine-bit byte to detect and correct bit errors.

Missing from the current line is a low-end range of products. Solbourne is working on these products and figures to announce them soon.

OS/MP 4.0A. OS/MP remains Solbourne's chief point of differentiation from Sun. Based on SunOS Release 4.0.1, OS/MP adds asymmetrical multiprocessing features to SunOS while maintaining binary compatibility with it. OS/MP allows given Unix processes to be marked as running on a master processor, and others, on slave processors. Typically, input and output operations are handled on the master processor, and non-I/O processes are placed on slave devices.

OS/MP 4.0A enhances Solbourne's basic multiprocessing capabilities with new tools and services. They are:

- Portable Display Shell (PDS). PDS shields users from the underlying operating system. PDS gives users DOS-like forms and menus to interact with system resources.

- New management tools. Included are user-account, group-account, network-account, and network group-account maintenance; network file system (NFS) client maintenance; NFS server configuration; and modem installation.

- Two new X-Window tools. Smail is an interface to the standard Unix mail features. Sproperty is a debugging tool for developing X-Window applications, which displays the property of any visible X-Window.

—J. Rymer

INTRODUCING

P.S.

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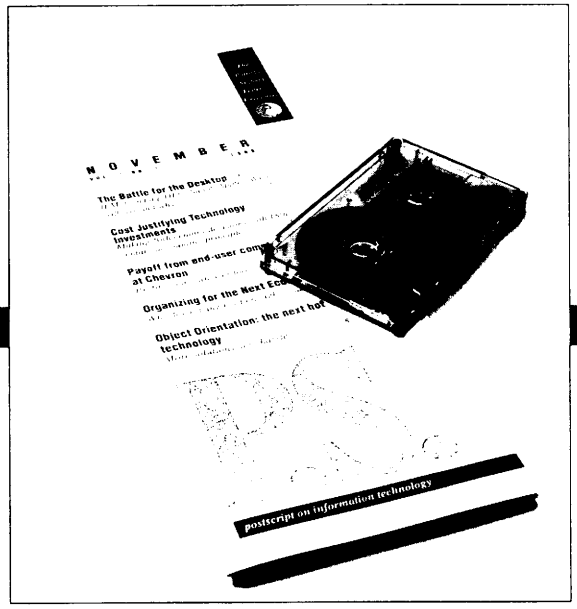

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