

Infoperspectives®

The Information Systems Strategy Journal

VOLUME 19, NUMBER 12

DECEMBER 1998

Dangerous Equation

During the past several months we have run across (and published) data suggesting that, compared to mainframes (and many other platforms) Intel-based servers are comparable in power, lower in hardware price and potentially superior in functional advantages for Internet activities. Even in an enterprise context, where mainframes remain the strategic central host of choice for very good reasons, planners must reckon with this development. The facts, however disconcerting, could affect their company's competitive position.

During the next several months it will become very clear that Intel 32-bit Pentium II Xeon chips will power servers with up to 8 engines. These servers will offer performance in commercial applications — as measured by SAP R/3 benchmarks, for instance — that is greater than the performance of 9672 G5 processors at a fraction of the hardware and systems software cost.

Right now, Nasdaq is working on the replacement of a Tandem system in the mainframe class with a Wintel server farm. Nasdaq is not fond of crashes of any kind. If this system works as expected, it will become an example of an Intel platform taking on a job that conservative computer experts would most likely feel ought to be done by a mainframe or well established Unix machine.

The internal case at Nasdaq undoubtedly centers on value and functionality, although it could not be untouched by non-technical factors, such as corporate politics. Nor is the Nasdaq installation going to be based on

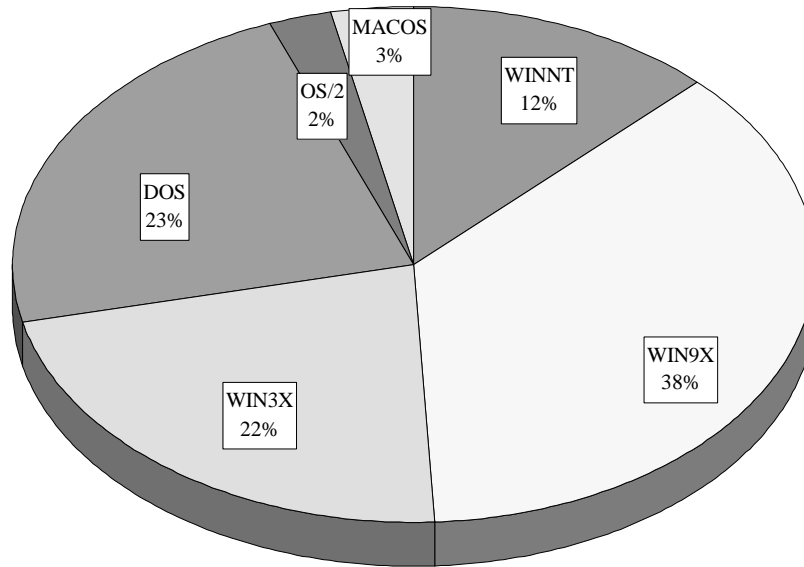
Windows 2000, not at first, anyway. Moreover, NT is not the only Intel option for enterprises. Linux is catching on at a fast pace. It is well regarded for uniprocessor systems and solid support for SMP is on the way. Moreover, 64-bit technology is already in Linux (but not NT) so the transition to Merced in 2000 might be easier and earlier for Linux users than NT users.

Properly configured Xeon servers currently yield performance equal to about 75 IBM S/390 MIPS per engine in 4-way configurations using 400 MHz chips. We expect 8-way boxes with 600+ MHz chips to perform R/3 database serving at the equivalent of about 125 to 130 S/390 MIPS per engine, or about 1,000 MIPS per box. The cost of such servers (processors plus main memory and I/O cards) might be \$100,000 per machine or \$100 per MIPS equivalent. Users worried about failures can afford to double up and still keep hardware costs in the \$200 per MIPS range.

What all this boils down to has little to do with the likely persistence of legacy systems for legacy workloads. What the numbers suggest is that legacy businesses that want to grow using the Internet may be in a very disadvantageous position if they think their mainframes can compete with Intel-based servers in the hands of start-ups. In electronic commerce, Web serving expenses and transaction processing costs are a decisive competitive factor. This is the case whether a firm serves consumer or industrial markets.

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At mainframe sites in the US, according to ZD Market Intelligence, 46 percent of the PCs are running DOS or Win3.X, neither of which are year 2000 compliant. Even if these machines are used for little more than 3270 emulation or other applications that ought to float above their environments, the potential for serious problems is too great for user organizations to ignore.

Desktop Software: Crunch Time

The year 2000 issue is not just a server problem. It is a client problem, too. Surveys of enterprise computing sites across the US and Europe indicate that a very large number of desktop systems are running dangerously obsolete systems software. Now it may well be that the survey data is wrong, that the systems have been updated and that the picture of these sites reported by managers to interviewers is askew. But we think the data are likely to be correct...or close enough to signal a problem that many users must soon address.

Not only do we suspect that there are tens of thousands of desktop time bombs in corporate settings, but we also believe that the enterprises owning these machines may have no clear plan for upgrading them in ways that will give successor machines the full strategic value they could attain.

Finding solutions won't be easy. Information processing departments in large enterprises often lack adequate control over clients equipment. Also, in too many instances, information processing departments have

Editor: Hesh Wiener
Infoperspectives®

ISSN 0733-9305

Published monthly by:

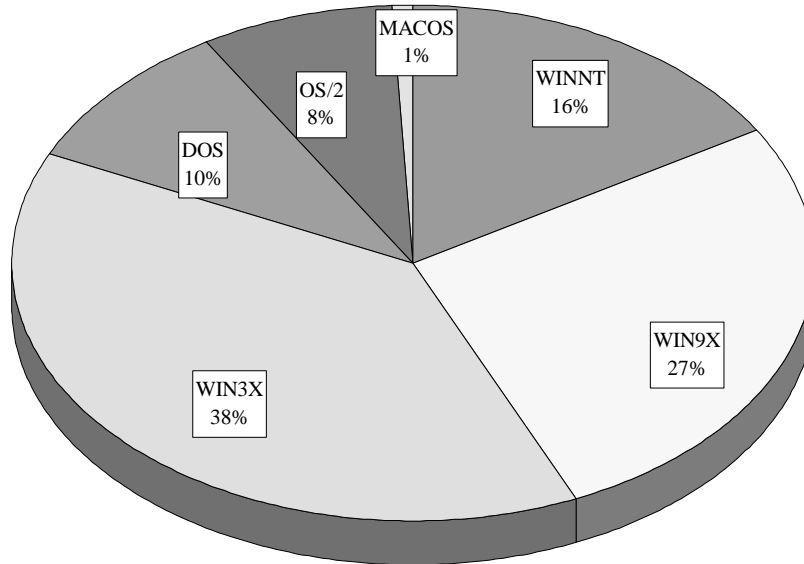
Technology News Limited, 110 Gloucester Avenue, London NW1 8HX

Phone: +44 (0) 171 483 2681 Fax: +44 (0) 171 483 4541 editor@tech-news.com WWW: <http://www.tech-news.com>
Subscription rates: UK £345 per year, all other countries £375 per year (airmail).

Technology News of America Co, Inc, 110 Greene Street, New York, NY 10012

Phone: +1 212 334 9750 Fax: +1 212 334 9491 E-mail: editor@tech-news.com WWW: <http://www.tech-news.com>
Subscription rates: North America \$595 per year, elsewhere \$630 per year (airmail).

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In Europe, DOS boxes are less prevalent at mainframe sites than in the US, but Win 3.X remains very popular. As a result, the impact of the year 2000 issue is likely to be just as severe in Europe as in the US. An additional factor in Europe is the lack of support for the Euro symbol within older environments. This will leave user organizations with client problems even if they update their servers.

neglected client issues because they are overwhelmed by challenges to the integrity and continuity of their central systems. These organizations may have their priorities right, but they still have to come to terms with client side issues and be prepared to take the blame for failures.

Large enterprises do not have a lot of time in which to address the imminent collapse of computing in departments with obsolete software.

These problems can be divided — but not neatly divided — into two classes: systems level problems (in-

cluding operating systems and GUI software issues) and applications level problems.

The two classes of problem may interact. Old systems cannot support current applications. Old applications may not all be portable to new systems. But in some cases the solutions can be separated. Some older applications that run under DOS or Win 3.X can run under Win 9X or NT. In other cases the old applications are canned code from vendors that offer updated versions of their products. In still other cases there are new programs

Viewpoints: Thin clients? Fat chance!

Neglected

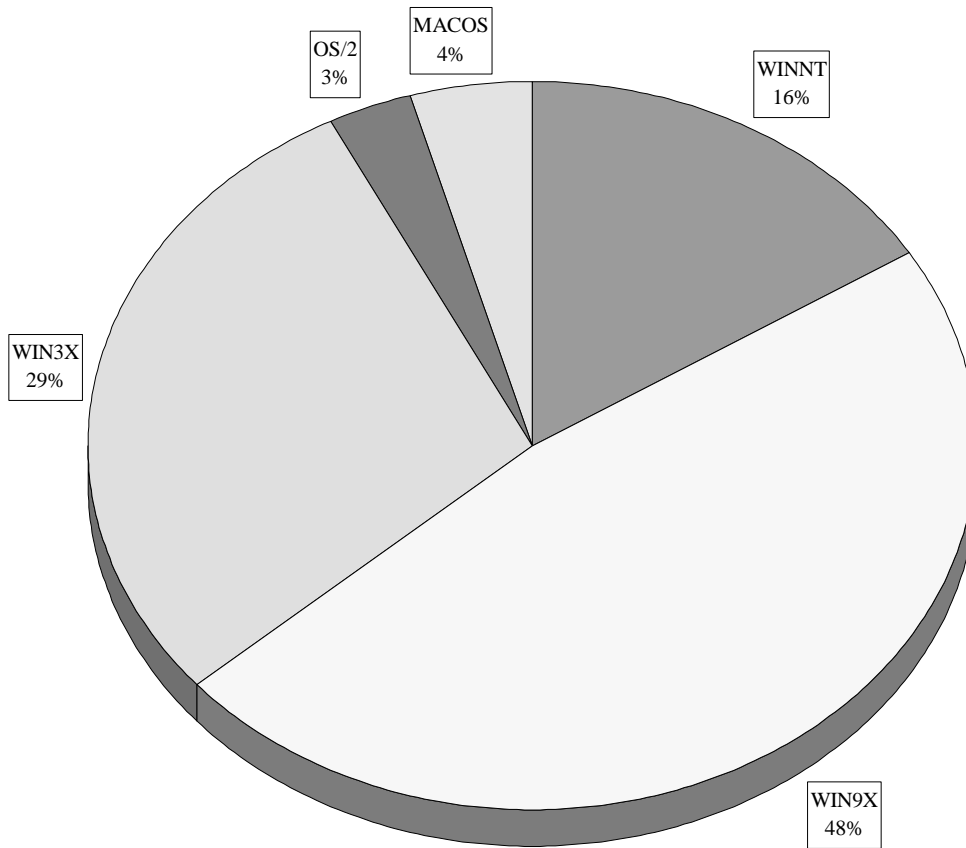
IBM's Network Station was supposed to become not only a low-support alternative to the green screen but, for many end users, a viable alternative to a PC. The product can meet the first goal, as can any X-terminal or any other display box with a browser. But the second goal requires productivity applications, and the Java applications suite under construction at Lotus seems to have faded from view.

Rejected

While there are a number of end users fooling around with thin clients, for the most part user organizations seem to have concluded that the boxes are not yet ready...and that they might never be. The PC support headache lingers on, but the supposed cures are apparently no better than the malady.

Disaffected

Barring a big surprise, continued interest in thin clients by a sufficiently large user base to form a viable market appears unlikely. Instead, user organizations are stuck with Windows clients...and a search for ways to manage them at an affordable cost. How disappointing!



US mainframe shops report that about half their PCs with graphical user interfaces are using Win95 or Win98. The systems software on these machines may not have much of a future if Microsoft sticks to its plans to end that software series and switch emphasis to NT. But users of any Windows variant are generally confident their current applications will survive intact as Windows evolves.

that can at least accept the data or perform the functions of the old applications.

.Among the specific issues enterprise sites must address as they tackle systems software problems are:

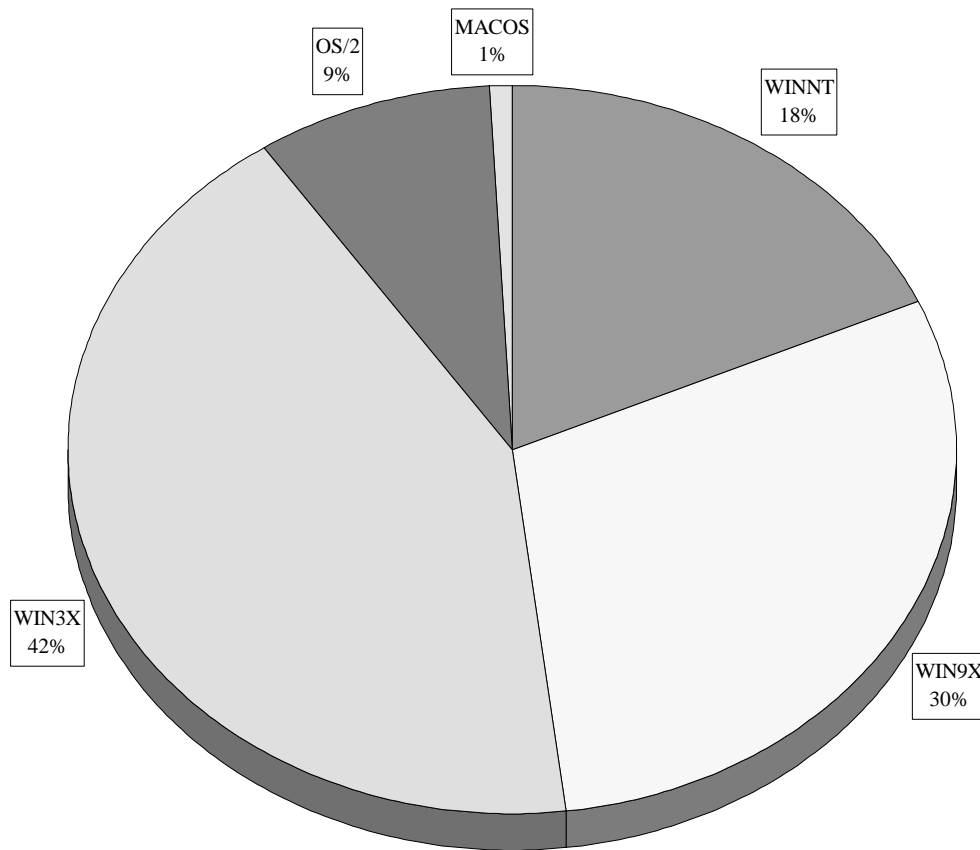
- The need for year 2000 compliance.
- Access to documents that include the Euro and other new symbols (which is as much an issue for US companies trading overseas as for indigenous European firms).
- The likelihood that Win 9X will be phased out as Microsoft has said, despite customer resistance.
- The need for software that can be run on not only current platforms but those that will be offered in the future, when hardware support for 8- and 16-bit programs will diminish and then disappear.
- The selection of software that will minimize support costs and, if possible, increase centralized client management and control.
- The growing requirement to support browser technology for intranet as well as Internet services

- Opening the door for Unicode data even it that may seem like a distant requirement for now.
- Providing an environment that can support current and likely emerging applications and functions including ERP client side code, secure network activities, interaction with the outside world via current and emerging email technologies, etc.
- Providing a setting that minimizes the multi-layer software that has enabled some old applications to survive only at a huge cost in computer and network overhead, systems complexity and software licensing expenditures.

At the applications level, some of the systems problems may be echoed. In addition, there are other difficulties that enterprises can expect to encounter as they try to choose the least hazardous path:

- File interchange issues that stem from any work performed locally and, in some cases, even from work done on clients in conjunction with server-based applications.

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In Europe, the large base of Win 3.X boxes may have to be moved all the way to NT, because transition to Win 9X could take longer than that environment will be offered by Microsoft. The high price of NT (and the hardware it requires) will inhibit migration, but what choice do customers really have?

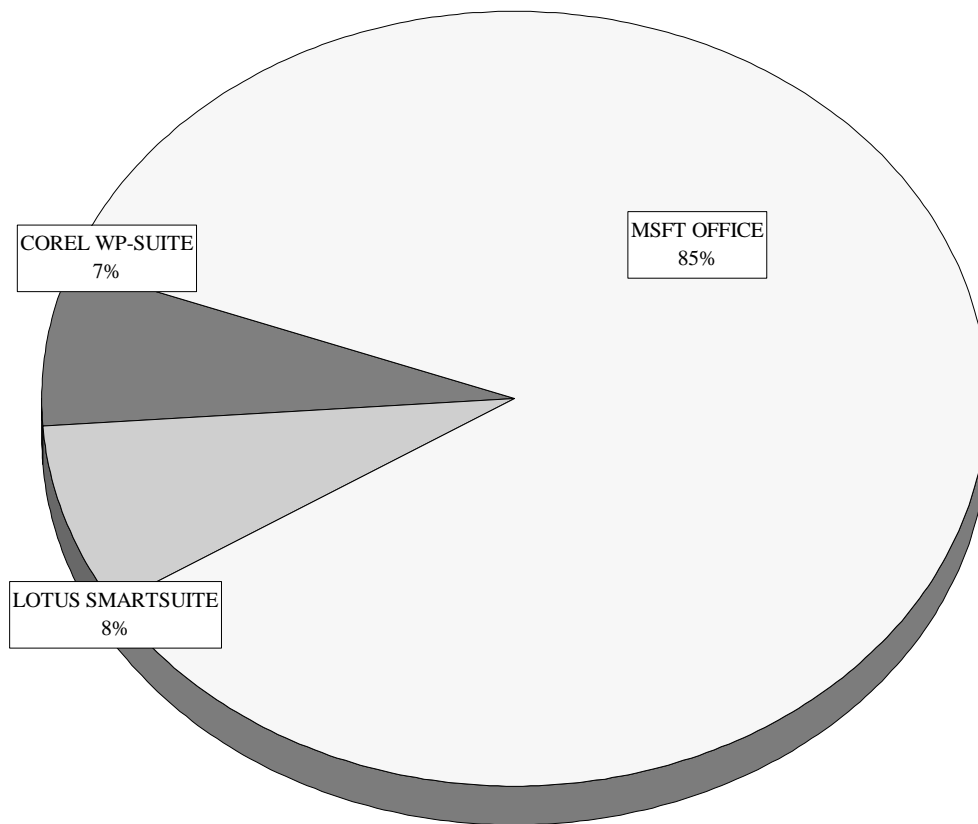
- Training and support costs that can be reduced by selecting and creating standard applications for an enterprise...and which quickly spiral out of control when divisions or departments are allowed to act on their own.
- Management of upgrades and patches on an enterprise basis.
- Transferring applications and localized data to new hardware when PCs are replaced.
- Permitting interaction with diverse internal applications that may be hosted on disparate systems.
- Allowing communication and information interchange with customers and other outsiders.
- Improving end user productivity.
- Matching required skills to labor pools.
- Preserving corporate security and data integrity across all applications.

To a considerable extent, companies that shape their desktop software around a major enterprise applications suite will, as a byproduct of their decision, address many of their systems and applications issues. But the

basic requirements of an ERP package might not provide for all the functions an enterprise will in the end require. Of particular importance to user organizations — but not to ERP packages — are access to internal and external email and Internet services and access to legacy applications not included at all in an ERP installation.

There can even be conflicts or inconsistencies between the requirements of an ERP suite and those of other software elements. These conflicts will call for extra effort on the part of support personnel. For example, the optimal presentation display settings on PCs running a particular ERP suite might be 1024x768x16 while a legacy program might be designed to run at 640x480x8. The legacy application could produce illegible screen images at the higher resolution and color depth.

While the particulars may not be so important, the general issue of compatibility between ERP software and other applications is an important one. No enterprise wants to sacrifice control over its systems to meet the requirements of a software package, even a very comprehensive software page.



In the US, according to surveys of mainframe shops by ZD Market Intelligence, Microsoft is the dominant supplier of productivity applications suites.

Still, quite a few large enterprises, particularly in manufacturing, have essentially given up much of their autonomy in return for the benefits of R/3 or one of the other ERP suites.

At first, the user organization may rejoice over its defeat of anarchy (or, if it is not quite so exuberant, a reduction in disorganization). But in the end, many users of ERP packages will come to realize that the pendulum can swing too far in the direction of order as well. No vendor of ERP software can anticipate all the needs of its customers. Despite this, the ERP vendors sell systems that are not merely comprehensive but dominating.

The ERP vendors' practices can be overwhelming, and they can prevent corporate information processing departments from circumscribing their influence.

What a dilemma!

A company gains control over its business only to lose control over its information processing strategy.

The companies that are most vulnerable to this ominous possibility are those that find themselves in great jeopardy as the year 2000 approaches. They probably do not have the time or resources to belatedly work with an

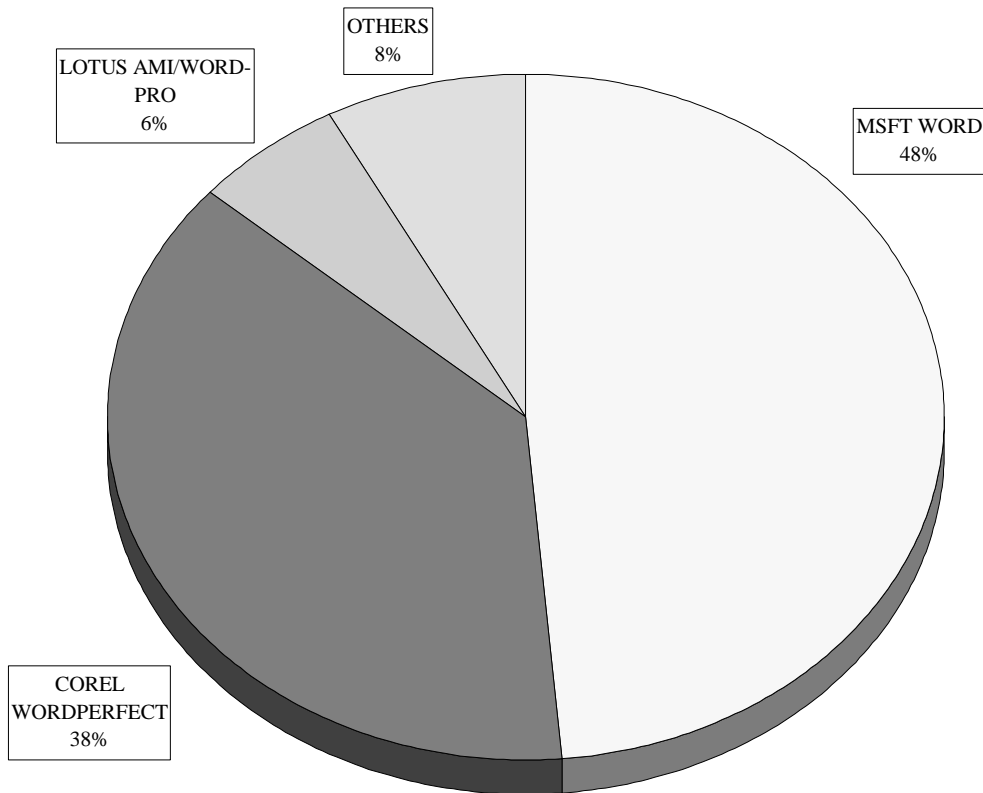
ERP vendor to achieve a sophisticated result. Instead, unless they resign themselves to a middle-of-the-road implementation, they may not even be able to get key ERP functions running in time to avoid big problems.

Evidence of the vulnerability corporate client systems can be drawn from data showing the unfortunate state of desktop software at large enterprises, data that emerge from detailed surveys of user organizations.

While theoretical solutions are available, and even abundant, practical approaches are much more elusive.

Many large enterprises find themselves in an untenable situation because they have, for quite a long time, been in a state of denial. They took a look at client/server computing when it was mainly hype, ignored the rise of Unix and the Internet, underestimated the Wintel juggernaut and failed to connect the rapid deflationary trends in MIPS, communications bandwidth and storage costs to their own strategies.

Now these very enterprises are facing the possibility that their every activity will be subject to a transaction tax charged by AOL or Microsoft on top of the MVS tax they pay to IBM and the other financial burdens they have



When enterprises with mainframes select word processing software on a program-by-program (rather than a suite) basis, Microsoft is not nearly as successful. WordPerfect has a very large base in these sites, showing strength that is greater than many observers recognize.

learned to carry during the past few years. If these costs and potential costs are a matter of concern today, when times are good, what will they look like tomorrow, if economic conditions make business more challenging?

It turns out that the best approach, as usual, will be the most simple and direct one.

Enterprises must get their desktop software into shape, not only because there will be problems when the calendar reaches 2000 but because the disorganization on desktops will impose unsupportable costs on business.

The first step is to set standards for environments user interfaces. It requires migration to consistent operating systems. In nearly every case, this will have to be Windows 95, 98 or NT. There is no other desktop environment with as much immediate practical value.

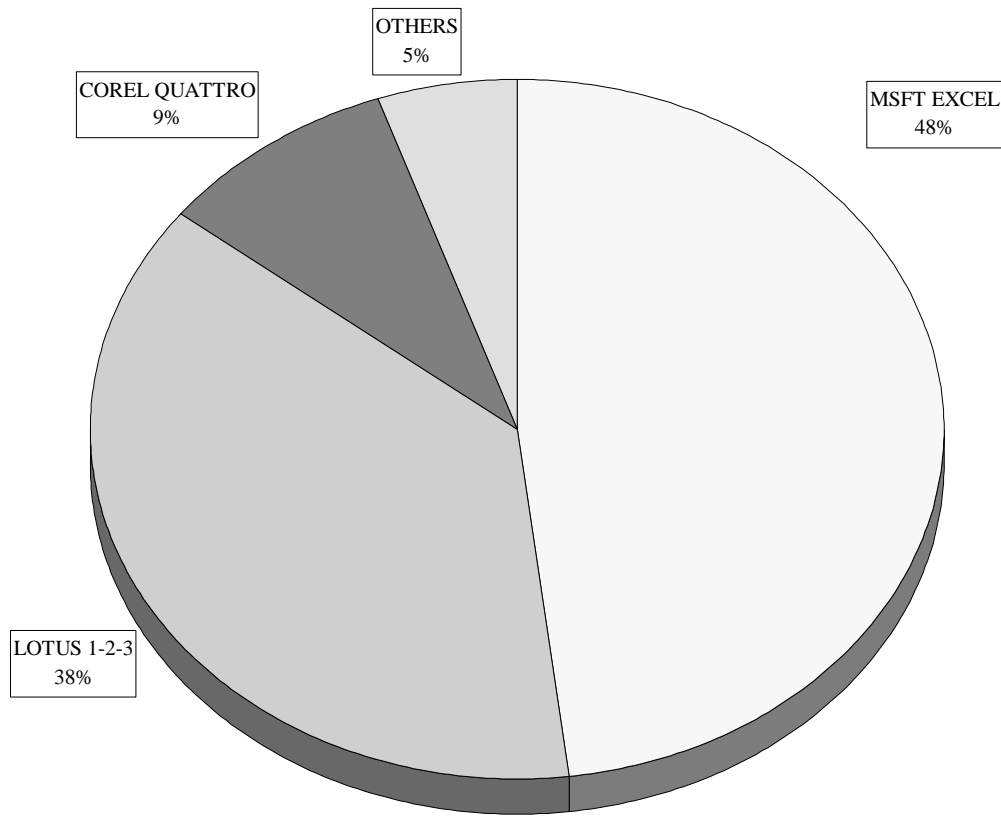
At shops where there are still huge numbers of DOS, Win 3.X and OS/2 desktop systems, bringing PCs into line will not be easy. But the old software is at the brink of collapse.

We favor NT over 95 or 98 for enterprise desktops, despite potentially greater hardware requirements. (We

will review desktop hardware next month, so our treatment in this issue will be brief.) Basically, current and emerging desktop software is designed around computers using Intel or compatible processors, Intel BX or functionally compatible chip sets and a handful of interface standards. These standards are supposed to help customers keep desktops uniform even as processors get faster, video standards are updated to use AGP sockets and the whole PC industry moves away from things like serial and parallel ports to Universal Serial Bus (USB) interconnection for external devices.

Current and emerging systems software attempts to insulate the end user experience from variations in PC technology that are aimed at improving some key aspects of desktop computers. In particular, during the next year features that reduce the cost of PC maintenance will get support from client and server operating systems.

No environment older than Win95 (and, for some features, no environment older than Win98) will provide very good support for client maintenance features, even though the features have been implemented to a consider-



Just as WordPerfect has a substantial base in the word processing market at mainframe shops, Lotus has a very large share of the spreadsheet software market. However, to the extent that the installed versions of WordPerfect and Lotus are legacy programs, both applications are vulnerable to Microsoft's alternatives if users decide that they must go to integrated suites from independently selected applications programs.

able extent in PC hardware for the past year. Software just doesn't catch up that fast.

Even Windows NT 4 does not yet provide support for client health monitoring or USB interfaces, although such support may be forthcoming. (Windows NT does not even understand printer port interrupts!)

The layer of systems software the user sees, the GUI, is only a shell. It is possible to replace that shell with a variant in the form of a Web browser interface. In Microsoft's opinion, these two layers should be integrated. Most of the rest of the computer industry recognizes the difference between a shell with a GUI and the operating system underneath.

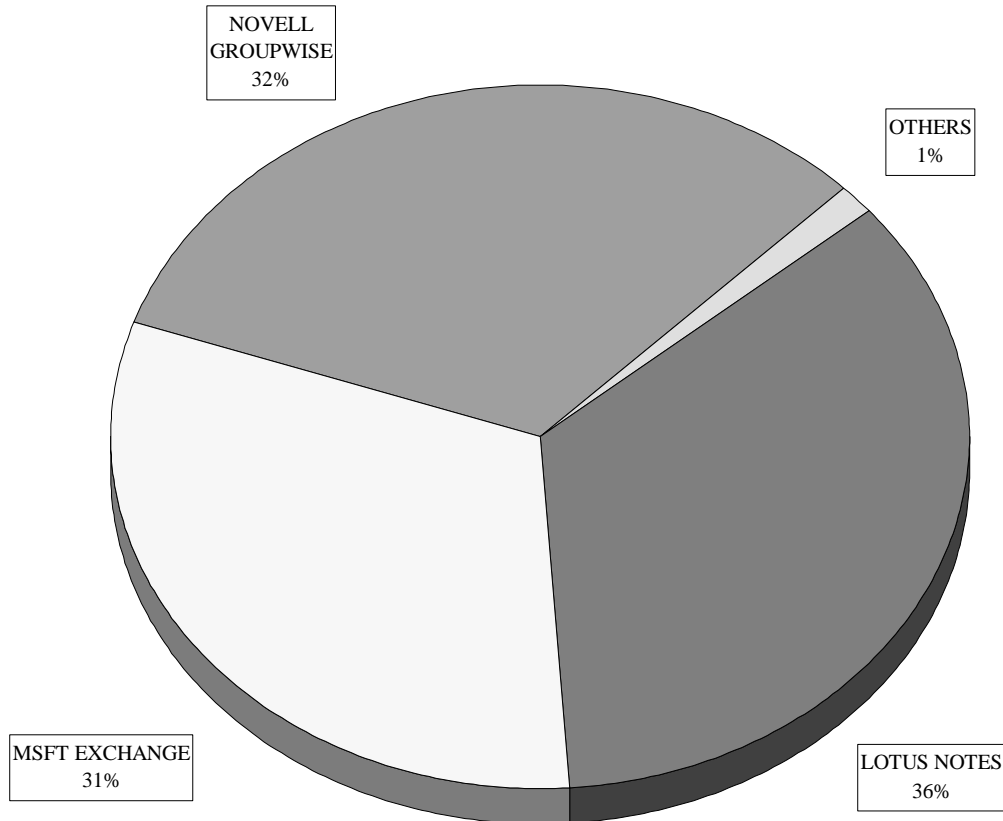
The distinction may not directly affect end user organizations focused on standardizing desktop appearance. Information processing executives can let the antitrust lawyers decide where an OS ends and a GUI begins. But users cannot let Microsoft, Netscape or the government decide how to best implement a uniform user experience

that can make the support process considerably easier. For users, the issue is not semantics, but productivity.

Most computing executives don't realize that under Windows 95, 98 or NT you can open a word processing document, a spreadsheet or just about any other kind of file in a browser window...if the browser and the application program for which the file is a native type are current. For example, you can open a Word document in a Netscape Navigator 4+ window and even make it go live so you can use Word editing commands to modify it. You can bring a current Lotus spreadsheet into Internet Explorer even if you don't have 1-2-3 on your PC if you have Excel loaded with its 1-2-3 translation enabled.

There is no apparent reason — except that it takes work on the part of programmers — for dialog screens in any application to require a GUI other than a Web browser. Even if the presentation package does not generate HTML, all it takes is for it to conform to the requirements of OLE, the dynamic process manager in all

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The groupware market is split evenly among three alternatives, according to surveys of mainframe shops conducted by ZD Market Intelligence. While Lotus and Microsoft often get the most attention from the press, Novell remains a very well established vendor in this important applications segment.

current and recent versions of Windows. So if a data entry page is served up to a PC, an end user using that frame can see familiar icons and entry options. If a page includes standard features found on HTML pages — text entry blanks, radio buttons, drop-down menus — an end user can have essentially the same experience as another end user in an unrelated department performing a very different task. All it they need in common is a PC with the same GUI. And if a problem arises, first level support, sitting at a PC that also has the standard GUI, can more easily help the end user that has run into trouble.

The next level of technology is the set of applications various end users must access.

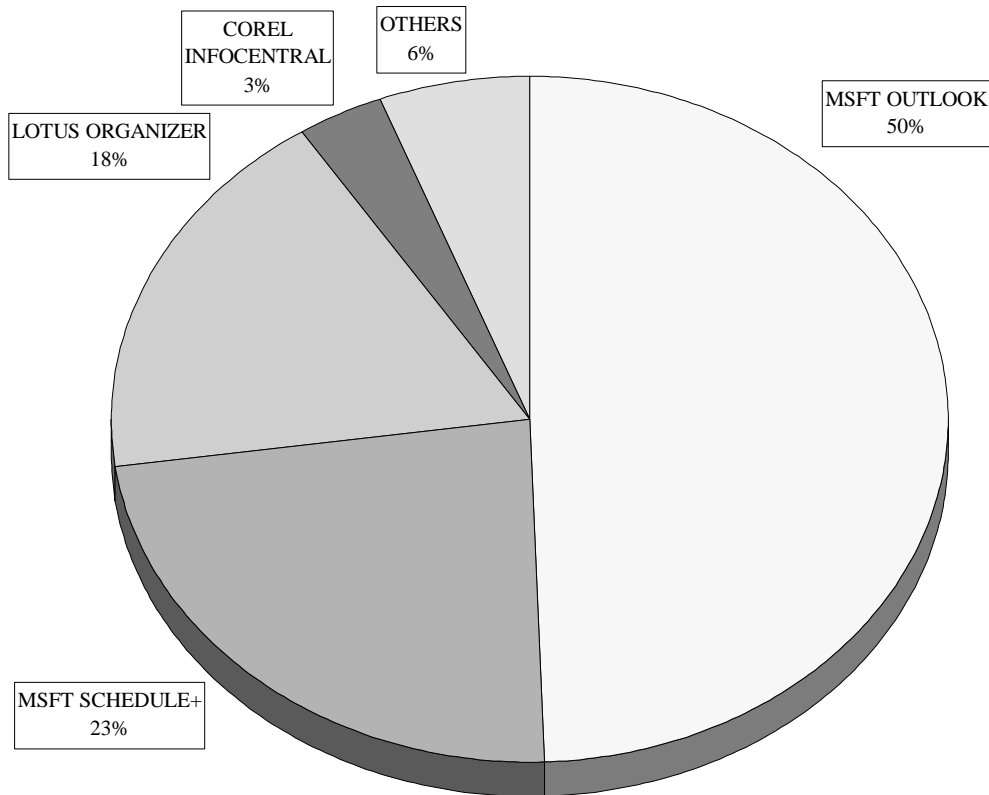
Microsoft is very strong in standardized applications and arguably the leader in all categories despite the large installed base of competitive word processing, spreadsheet and other programs. Moreover, as enterprises increasingly decide that they want productivity applications to be installed in suites, Microsoft looks like it will be the winner. Word and Excel files are de facto interchange standards and no effort by Lotus or Corel could

dislodge Microsoft right now. Whether this is good or bad for enterprise computing is not the issue. One thing is clear. Unless new standards emerge — most likely from the Internet community — Microsoft file formats are going to be as much a part of corporate life as IMS databases. People will live with these standards whether they like them or not...for they have no other immediate practical alternative.

In addition to generic applications, every industry has vertical applications. Here, the canned software markets remain fragmented. And even in every economic segment, enterprises have large numbers of programs that have been developed by their own personnel.

These programs may or may not mix well with the operating systems, GUIs, productivity packages and other standardized software that creates a uniform end user experience. To the extent that these home grown applications can be updated survive 2000 and to work well with emerging desktop software technology they will survive. To the extent that these applications can only be preserved by imposing screen scrapers and installing other patch-

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The class of programs called personal information managers is a long way from maturity. These applications have tremendous potential in business settings and they could grow into the core of some very sophisticated support suites. For now, Microsoft has the lead at enterprise computing sites. But this segment is still young enough for a new entrant to come along with a killer concept and win the market.

ware, they may become problem packages. The popular technique of interposing middleware and translation servers between central systems and end users can preserve legacy applications, but not necessarily do so in a way that adds to corporate productivity.

Enterprises that adopt what are inherently interim solutions and then hope that these solutions will provide a permanent means of coping with the challenges of business are hoping for a lot, perhaps too much.

In too many settings, central information processing is moving ahead and solving all the big problems that come up, but avoiding the chaos that reigns on desktops.

This situation has led to client computing costs that are soaring out of control. These end user costs can only be managed if central information processing departments are given the resources and authority to propagate practical solutions all the way to the desktop.

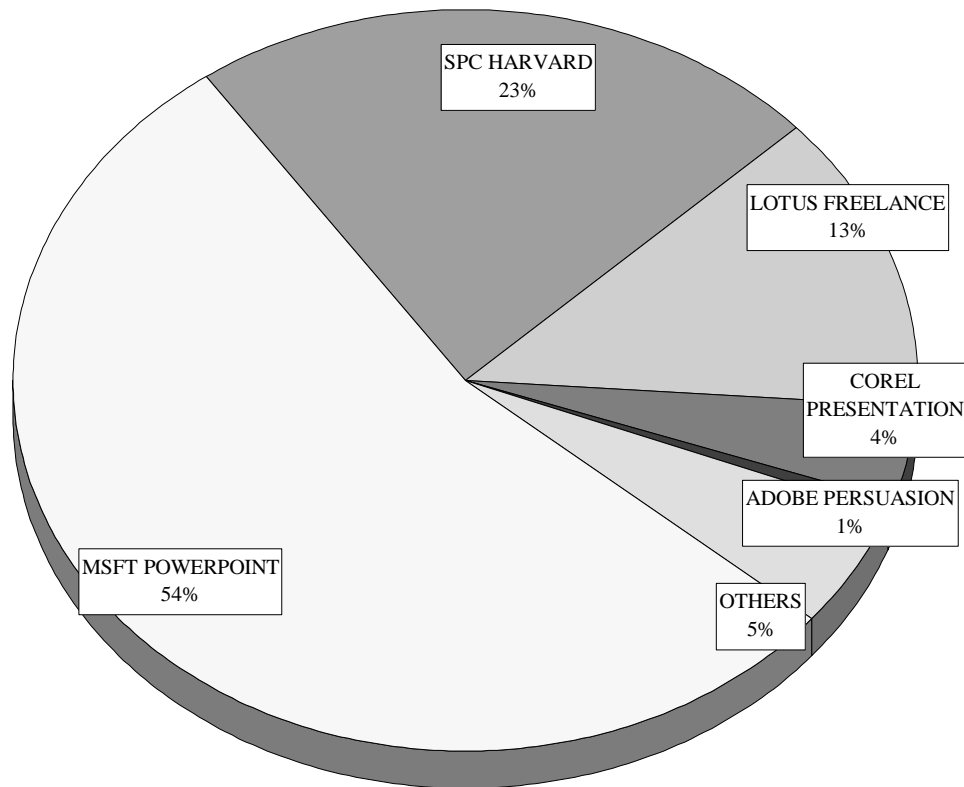
At enterprises where this is a managerial or political impossibility, the best that central information processing departments can do is provide a server complex

that might, given the chance, deliver all the required information and functionality to end users' terminals. They cannot, however, make end users particularly productive, even if the applications they deliver are very well thought out, when end users' systems are a mess.

End user productivity is not merely a matter of transactions per hour per seat (when things are going well). The big costs, the costs that shape productivity, include all the money spent on support, on training, on end user remuneration, on infrastructure support and on coping with the consequences of inevitable end user errors and mishaps.

There are complex problems to solve and they are not amenable to easy answers.

What enterprise managers don't realize — and what computer specialists know but don't want to think about too carefully — is that many departments or even whole companies are currently on the verge of collapse. Conditions are sometimes so bad that computing departments seem to lurch from crisis to crisis.



Microsoft is the leader in presentation management software at enterprise computing sites. This segment could become very important as more advanced software products make it easier to deliver presentations via the Internet and intranets. Properly integrated with Web software, presentation packages can make it easy for non-technical personnel to prepare complex Web-based productions.

Desktop Software: Strategic Considerations

The last best hope for client management in enterprise computing is to give corporate computing executives the power to bring uniformity to end user computing.. The ultimate authority over client boxes should be centralized and reside at the top of the enterprise information processing department, because that is where the responsibility for computing success ultimately lies.

The standards that must be enforced can be divided (no so neatly) into three groups: Two groups — operating systems issues and GUI issues — are closely tied and may be considered a single level, the systems level. The third group is at the applications level.

Systems level solutions can be very similar if not identical across an enterprise. That is, all PCs can be made to run the same operating system or one of a group of similar operating systems. All PCs can be set up to

provide the same GUI, which can be part of the operating system or a Web browser. System level standards allow networking and other infrastructure functions to be managed centrally. They don't guarantee that this can be done easily, but at least they provide a reasonable opportunity, which is, sadly, as good as it gets.

This uniformity only provides the potential for a consistent user experience, however. Because there are so many kinds of end users in any enterprise, so many applications (applications modules in settings where ERP has been installed) and so many variations in end user capability and authority, systems level standards by themselves cannot yield end-to-end consistency.

Applications must then be selected or tailored to deliver additional consistency. If every application in an enterprise has its own scheme for data entry, screen navi-

gation, error correction, scrolling, help and data presentation, it is impossible for an enterprise to provide good support at an affordable price. The result will be unnecessarily high costs and, where computing is a major expense, a severe impact on corporate earnings. In some businesses, this can be harmful, in others fatal.

The immediately available choices may not be the ones information processing executives would prefer, but this is the way conditions shape up right now:

- The most popular PC systems software in corporate settings is going to be Windows 2000, the successor to Windows NT. Windows 95 and 98, with their DOS roots, may survive in the consumer market, but they are not going to provide all the features necessary for enterprise computing.
- In addition to the basic Windows GUI, enterprises will have to consider the two strong browser interfaces as additional options. Choosing between Netscape and Internet Explorer is not easy. Netscape has an advantage for now in the consistency of its GUI across browsing and email functions. Internet Explorer is getting there but it is not yet quite as focused. Enterprises that use a different email package, such as the email part of Lotus Notes, are adding one more inconsistent interface to every desktop. This is fine if Notes serves a valid strategic purpose, but it clearly adds to training, support and operating costs. (Why Lotus does not offer a browser and why IBM did not acquire Netscape are two mysteries to ponder after you get your PCs in order.)
- To the extent possible, legacy applications should be web-enabled so they can offer a consistent interface to end users. All the functions provided by green screen applications can be translated to HTML functions. Using software that provides a green screen type of GUI in a browser window is an alternative, but for many reasons not a particularly attractive one except as an interim measure.
- Productivity applications must be made standard across the enterprise, not only to facilitate document interchange but also to make standard training and centralized support possible. Where there is now no consistency, enterprises will have one-time retraining costs. But other aspects of the transition, such as the translation of legacy files to new formats, can be managed centrally at low cost compared to the long-term cost of translating files on an ad hoc basis.
- Canned applications, even prestigious ERP packages, must be selected with interface consistency in mind. If a strategic package requires special training, the cost of that training and the ongoing cost of support must be figured into the total cost

of using the package. User enterprises cannot let their ERP vendors make policy.

- Wherever possible, Internet technologies should be used to manage information and its presentation. While this may pose some inconveniences at inception, in the long haul there are very great benefits. Companies that have similar or identical screens available to internal users and external customers will be able to more readily provide self-service options to customers that internal end users who are familiar with the same (or similar) applications can support.

These general practices, to the extent they can be implemented, will provide a foundation for management that is as solid as that of the long lost green screen era.

There is no going back to the kind of top-down computing that was wholly devoted to applications with character displays. And there is no way to take those old applications and bring them forward without harmonizing their end user aspects with all the other elements of a graphical desktop environment.

The transition from the desktop environments we have described in a statistical way to those that are shaped by current technology and current employee pools cannot be an easy one.

If your company is typical, a third to half your PCs are not capable of providing an effective end user experience. And while the work performed at these PCs may be up to your current productivity standards, it is doubtful that your support costs are acceptable and it is unlikely that the software on these PCs will be able to function reliably for much longer. Consider yourself lucky if you are not amid almost intolerable turmoil.

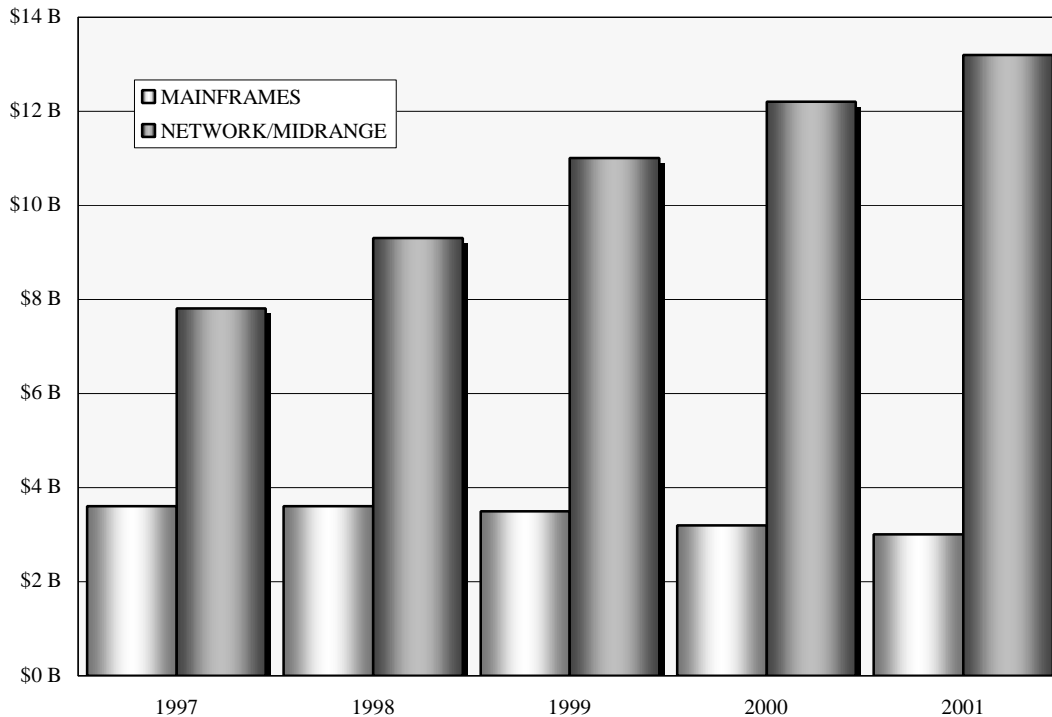
While Microsoft operating systems seem to be an almost compulsory choice, you have options in the choice of a GUI and applications. The Netscape browser GUI is an alternative to Internet Explorer. Lotus and Corel productivity suites are available if you prefer not to standardize on Microsoft Office. And the ERP vendors all understand that some (and eventually all) of their customers will want presentation level software that is compatible with Internet standards and browser GUIs.

IBM has made tremendous strides in providing ways to web-enable databases and related applications that reside on mainframes and AS/400s, as have all the Unix and Intel architecture systems software vendors.

So, the tools you need are within reach.

The most arduous part of bringing your enterprise into a stronger position will be the management of your transition. Chances are, you will have to lay out your strategy like a battle plan, choosing departments for your initial forays that will serve as dramatic and persuasive proofs of your concept for end user computing.

Go get em!



The disk array market is booming mainly due to installations of arrays on network servers and midrange servers, not because of orders from mainframe users, according to data just published by Disk/Trend in its annual report on Disk Drive Arrays.

Midrange Systems Drive The Disk Array Market

The disk array business is booming...but not because of mainframe users. The driving force in this big market is the midrange, where sales will exceed \$13 billion by 2001. Mainframe sales in 2001 is expected to fall to about \$3 billion from current annual volume closer to \$4 billion.

This prediction comes from Disk/Trend, the Mountain View, California, research firm that is recognized as the storage industry's preeminent authority on market conditions (<http://www.disktrend.com>). Disk/Trend just published its annual in-depth report, *Disk Drive Arrays*, and the study, already making waves in vendor country is beginning to attract the notice of consultants and end users.

Among the forces that are reshaping storage are:

- The rapid decline in component prices,
- The universal desire for faster and more reliable storage subsystems,
- Growing availability of standardized array controller boards and chip sets,

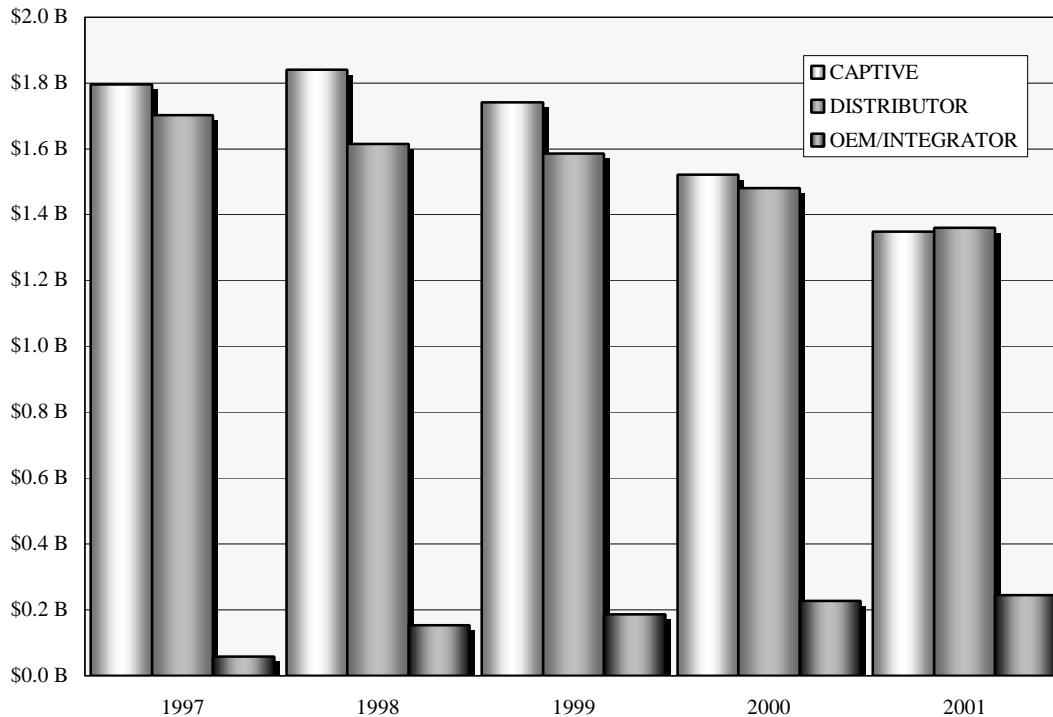
- The boom in midrange servers fueled by the Internet and growing computing intensity in every business segment, and
- The appeal of applications that depend on very large volumes of data.

One byproduct of falling component prices has been the persistent appeal of mirrored disks despite their higher costs compared to other RAID schemes. The price difference is not viewed as significant when the faster response of mirrored systems is taken into account. RAID-5 and other schemes that yield lower costs but which also have lower performance remain important in applications where system response time is not of the utmost importance.

Currently, disk arrays are not common on systems used by individuals — workstations, for instance — but abundant on servers of all sizes.

Customers in the midrange generally favor disk arrays provided server vendors. Compaq, for example, is the dominant supplier of arrays to buyers of its servers. But there is still a big market for arrays that are used with servers

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The captive mainframe disk array market really means IBM. And in Disk/Trend's view, it also means less than a 50% share, in revenue terms, by 2001. EMC and HDS are the vendors whose arrays constitute the bulk of non-captive sales, with EMC outpacing HDS by a wide margin.

from vendors that do not offer their own storage subsystems, and a brisk trade in arrays that are added to servers or server farms after the servers' initial installations. There is, according to Disk/Trend, plenty of opportunity for companies that have array designs that offer superior value, performance or reliability.

In the mainframe segment, unique conditions have brought about a market structure that is quite different from that in the midrange. IBM made severe errors when it moved from linear disks to arrays, offering products that were superior to its own prior disks but weak compared to the potential promised by advances in disk drive, memory and controller technology.

This gave EMC an opening comparable to the one StorageTek recognized in the automated tape library segment. By the time IBM reacted, EMC had established itself as a powerful force in enterprise storage. In the meantime, Hitachi Data Systems was able to enter the race and, with time, develop a line of arrays that garnered significant sales volume.

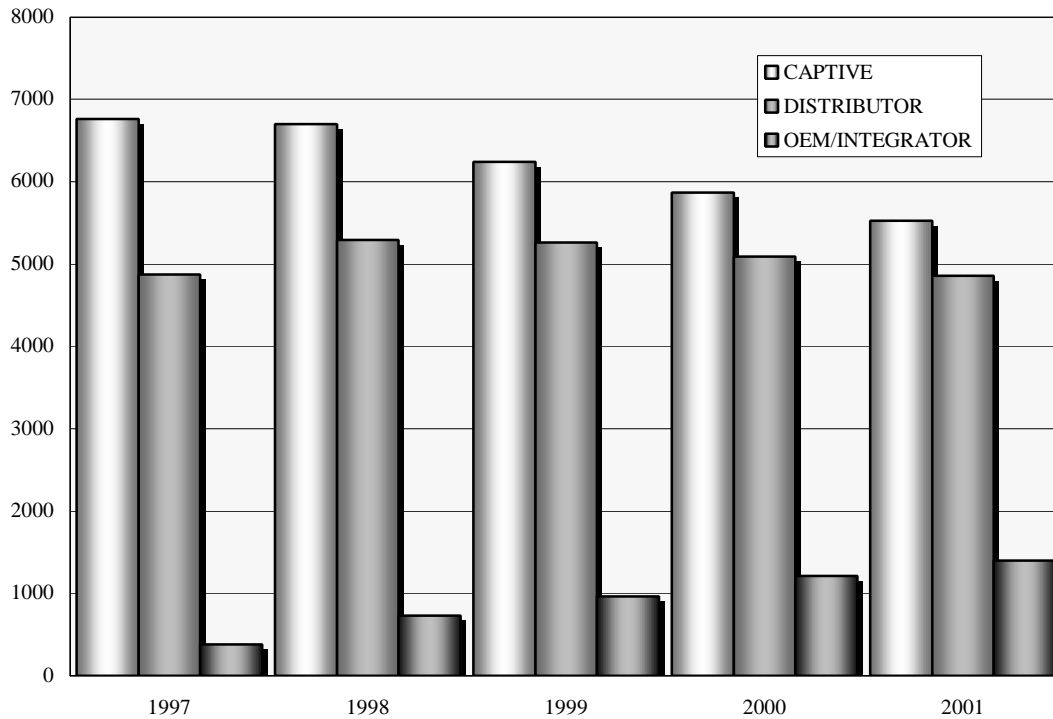
The result is a market in which captive sales (by IBM, basically) account for just over half the revenue today and where captive revenue is predicted to fall to less than half the total market during the next few

years. By contrast, in the midrange captive array sales account for about three-fourths of all array sales, by revenue. So IBM, even after taking over the marketing StorageTek's mainframe array products, remains in a continuing (and continually frustrating) battle for market share.

Conditions in the mainframe segment will change again in the new few years. Available technology has created new opportunities for companies with different ideas to enter the market. Disk/Trend believes that sales of mainframe disk arrays created by OEMs will push toward \$250 million in revenue by 2001. Even without taking the market by storm, as EMC did, the entry of more vendors will keep the big players under pressure.

However the market is cut up by the vendors, the total revenue is big but not growing. Dollar volume will, in fact, erode during the next few years. To increase its business, EMC will have to continue its press into the midrange, where selling against vendors can be a lot tougher than it is in the mainframe segment. EMC has overcome market resistance by cutting deals with server makers, most importantly Hewlett-Packard.

In contrast to the shrinking dollar volume, the total storage capacity going into mainframe shops will continue to rise. Disk storage subsystems are getting larger as vendors



IBM — the captive vendor in the mainframe market — continues to sell more arrays than all its rivals combined and will remain the largest vendor in footprint terms for the foreseeable future, according to Disk/Trend. But EMC remains a powerhouse in the largest sites because the performance and capacity of its Symmetrix subsystems match the needs of users with the heftiest processors.

try to maintain their unit prices by giving customers more storage per machine. New drives entering the market have capacities in the 36 gigabyte range and 72 gigabyte drives are going to come out of the labs before long. These very high capacity drives cannot deliver the performance of smaller disks — there is too much data per actuator — but for data sets used in applications that don't demand the utmost in random access performance, such as batch runs, they offer superior value. Software to stage data in subsystems with disks of varying capacity will become increasingly important as drives and arrays grow more capacious.

One trend that could slow the rate at which disk subsystems decline in price is an upturn in memory chip costs. Memory prices have eased upward lately after a long period of declines. Demand for PCs is probably the most significant factor in this trend. PC sales keep rising (although not as rapidly as in the past) and typical machines now come with 64 to 128 megabytes of main memory, more than twice as much as common PCs had a year ago.

Still, the cost of memory for cache is only a fraction of the total cost of a disk array. Staging arrays

that use fast disks between cache and main disk clusters could alter the ration of cache memory to total capacity that currently characterizes the mainframe array market.

One strategic issue that affects the markets watched by Disk/Trend but which is not addressed in any of its published reports is the nature of demand for enterprise storage.

During times when mainframe applications changed slowly, storage requirements generally corresponded to installed MIPS. If installed MIPS doubled, so did the aggregate capacity of mainframe disk farms.

ERP software and the Internet are changing the rules. First, ERP packages depend on relational databases like DB2 that use more disk capacity per unit of actual data than flat file systems like IMS because relational databases have more extensive indices than flat files. Second, even in settings where the mainframe is a file server and not an applications server — applications services in ERP systems are usually provided by Unix boxes or NT machines — very intensive use of data by file servers means that a user will have more MIPS per gigabyte of data than legacy software characteristics would dictate.

The upshot is that mainframe storage capacity is not likely to grow as fast as mainframe MIPS.

Netscape, AOL, Microsoft And You

The most interesting deal in the acquisition binge now underway around the world is the takeover of Netscape by America Online. The leading online computing service — in terms of user population, anyway — has eaten the company that made the browser a household source of chagrin. Also in the deal, kind of, is Sun, which is supposed to play two roles, peddling Netscape server software (on its own hardware, anyway) and becoming the big server vendor to AOL.

Sun's role may not be critical, even it is thought-provoking, so if Scott McNealy has overbitten off more than he can chew, the course of history might not be altered very much at all. Sun's presence is nonetheless noteworthy, however, because Sun and Microsoft are so adversarial. It may even be accurate to describe the two companies as bitter enemies since their dispute over Java-ness led to horrendous legal bills for both parties.

AOL and Microsoft are currently direct competitors pretending they are oblique competitors. AOL uses Microsoft's Internet Explorer as a Web browser, and it may continue to do so for a while, but it is hard to imagine AOL not wanting to milk its \$4.2 billion investment to the max by popularizing Netscape software in every possible way.

Various industry analysts believe that 65 to 75 percent of all users of the Internet or online services have an AOL account or use Netscape software (or both). A larger percentage has Windows, which includes Internet Explorer, but Microsoft's MSN network does not have AOL's penetration of the consumer market. So, in terms that might characterize the power of these companies to touch online consumers, AOL v Microsoft looks like a sporting contest.

AOL is not much of a power in the business world, by which we do not mean small business (where AOL has a large number of users) but big business, where Microsoft has a monopoly on desktop operating systems and, depending on how you define monopoly, productivity suites. With Netscape, AOL has a much better shot at getting into corporate offices, if that's what it wants to do.

AOL is believed to have a bout a third of all the ad revenue generated by online promotion. This figure by itself is not all that revealing, because it disregards the power of Web sites run by companies that sell merchandise directly. Direct Internet sales is a large and growing business, and so far it is very much done by companies that build their own sites or work with Internet hosting services to create the impression that they have their own sites. Still, from advertising to electronic commerce is a very small step, and AOL is far ahead of Microsoft when it comes to getting a hand on consumers' charge cards.

There is no doubt that AOL is going to try to make itself into the world's leading Internet commerce company (and here we are not drawing a distinction between AOL's online service that is apart from the Internet and true Internet services). IBM may own that silly e with @ sign genitalia, but AOL is going to be going to the bank a lot more on behalf of itself and online merchants.

And if Sun gets lucky it will not only be putting a lot of servers into AOL but also into the offices of companies that buy storefront space on AOL and want back office technology that provides assured consistency with the AOL front end.

A lot of the trade press has been full of speculation about AOL's ability to retain the Netscape talent pool. But if AOL now is pitted against Microsoft, it won't in fact need the kind of creative software genius that Netscape is said to have nurtured. Microsoft sure doesn't have it. At this point, Microsoft's top programmers are simply very skilled, which actually makes them easier to manage and easier to replace if they bail out or burn out.

We don't mean to suggest that AOL would not benefit from the continued creative brilliance exhibited by Netscape, merely to point out that much of what it plans to do is mundane in creative terms even if it is demanding in quality terms. So if some of the Netscape hotshots moved their desks to Sun, so what. Well, that might lead to a bit of hostility between AOL and Sun, but we can't imagine AOL and Sun not finding excuses for hostility anyhow. Their tiffs will interfere with their collaboration but not destroy it. They just got married in public while in the sights of Microsoft's shotgun. The worst thing that is likely to happen is an eventual separation, the best just another bad corporate marriage.

The most prominent outside beneficiary of these developments is Yahoo, the most popular portal, which must look like an awfully attractive buy to IBM, AT&T, MCI and a number of other Goliaths who fear the electronic commerce gravy train will pull out of the station without them.

These fears are completely groundless, since it already has.

And with the greedy eyes of so many giants on Yahoo, Compaq has a very good chance of turning its Alta Vista property into something as valuable as Yahoo or AOL, or to sell the unit off to some company that doesn't get to buy Yahoo.

Right now it looks like girth is going to be as important in electronic commerce as it is in sumo. But we wish to point out that agility is of equal importance in the Japanese sport and, to milk our little metaphor, in the emerging world of electronic business, too.

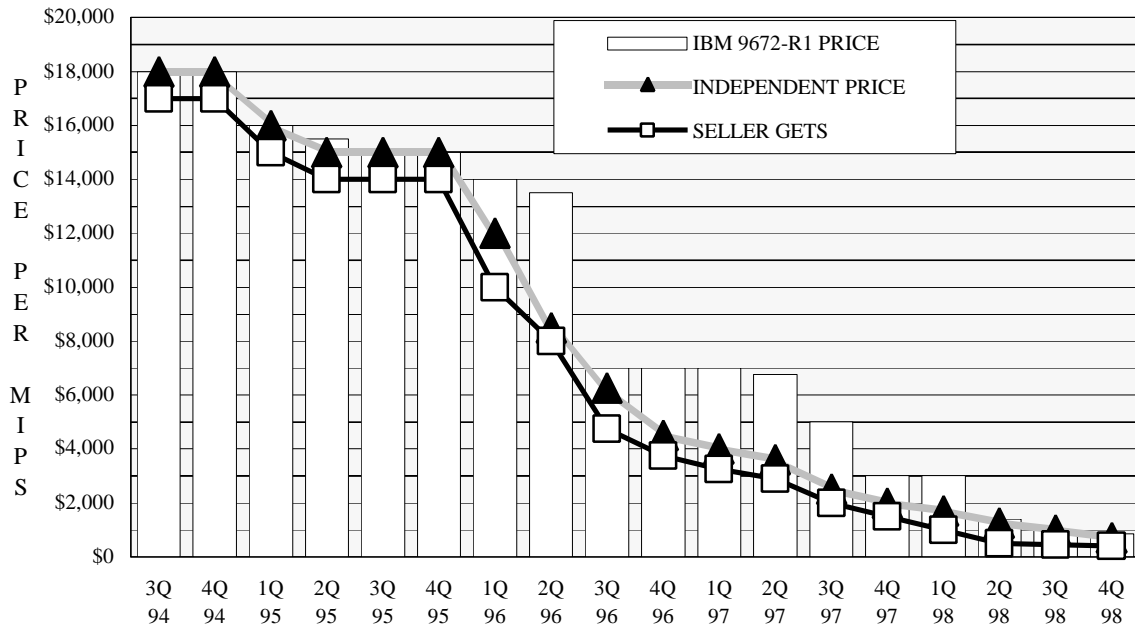
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| CPU MODEL (ENGINES) | MEM & CHNNLS | APPROX MIPS | MSU PER HR | FIRST AVAIL | IBM US PRICE | IBM US MAINT \$ | SELLER GETS | | BUYER PAYS | |
|------------------------|-----------------|----------------|---------------|----------------|-----------------|--------------------|-------------|----|------------|----|
| | | | | | | | % | \$ | % | |
| 9672-R11 (1) | 128x12 | 15.0 | 2.5 | 3Q 94 | 13,000 S | 785 | 6,000 | 46 | 11,000 | 85 |
| 9672-R21 (2) | 256x18 | 27.5 | 5.0 | 3Q 94 | 23,000 S | 1,045 | 11,000 | 48 | 19,000 | 83 |
| 9672-R31 (3) | 256x24 | 39.0 | 6.0 | 3Q 94 | 33,000 S | 1,345 | 16,000 | 48 | 27,000 | 82 |
| 9672-R41 (4) | 512x30 | 49.0 | 8.0 | 3Q 94 | 42,000 S | 1,975 | 20,000 | 48 | 34,000 | 81 |
| 9672-R51 (5) | 512x30 | 57.0 | 8.0 | 3Q 94 | 48,000 S | 2,195 | 23,000 | 48 | 40,000 | 83 |
| 9672-R61 (6) | 1024x36 | 63.0 | 10.0 | 3Q 94 | 54,000 S | 2,395 | 25,000 | 46 | 44,000 | 81 |
| 9672-RA2 (1) | 128x12 | 15.0 | 3.0 | 4Q 95 | 18,000 S | 505 | 11,000 | 61 | 15,000 | 83 |
| 9672-R12 (1) | 126x16 | 21.0 | 4.0 | 4Q 95 | 25,000 S | 840 | 15,000 | 60 | 21,000 | 84 |
| 9672-R22 (2) | 256x24 | 39.0 | 7.0 | 4Q 95 | 47,000 S | 1,575 | 28,000 | 60 | 39,000 | 83 |
| 9672-R32 (3) | 512x24 | 56.0 | 10.0 | 4Q 95 | 67,000 S | 2,240 | 41,000 | 61 | 56,000 | 84 |
| 9672-R42 (4) | 512x32 | 72.0 | 13.0 | 4Q 95 | 86,000 S | 2,905 | 52,000 | 60 | 72,000 | 84 |
| 9672-R52 (5) | 1024x48 | 86.0 | 15.0 | 4Q 95 | 103,000 S | 3,465 | 62,000 | 60 | 86,000 | 83 |
| 9672-R72 (7) | 1024x48 | 107.0 | 19.0 | 4Q 95 | 128,000 S | 4,340 | 78,000 | 61 | 107,000 | 84 |
| 9672-R53 (5) | 512x24 | 99.0 | 18.0 | 3Q 95 | 134,000 S | 3,745 | 79,000 | 59 | 109,000 | 81 |
| 9672-R63 (6) | 512x32 | 116.0 | 20.0 | 3Q 95 | 157,000 S | 4,340 | 93,000 | 59 | 128,000 | 82 |
| 9672-R73 (7) | 1024x32 | 131.0 | 23.0 | 3Q 95 | 177,000 S | 4,935 | 105,000 | 59 | 144,000 | 81 |
| 9672-R83 (8) | 1024x64 | 145.0 | 26.0 | 3Q 95 | 196,000 S | 5,495 | 116,000 | 59 | 160,000 | 82 |
| 9672-RX3 (10) | 2048x64 | 170.0 | 30.0 | 3Q 95 | 230,000 S | 6,405 | 136,000 | 59 | 187,000 | 81 |
| 9672-RA4 (1) | 512x64 | 33.0 | 6.0 | 3Q 96 | 80,000 S | 1,120 | 54,000 | 68 | 76,000 | 95 |
| 9672-R14 (1) | 512x64 | 48.0 | 8.0 | 3Q 96 | 120,000 S | 1,575 | 79,000 | 66 | 110,000 | 92 |
| 9672-RB4 (2) | 1024x96 | 63.0 | 11.0 | 3Q 96 | 160,000 S | 2,135 | 104,000 | 65 | 145,000 | 91 |
| 9672-R24 (2) | 1024x96 | 92.0 | 15.0 | 3Q 96 | 230,000 S | 3,045 | 152,000 | 66 | 212,000 | 92 |
| 9672-RC4 (3) | 1024x96 | 120.0 | 16.0 | 3Q 96 | 300,000 S | 4,025 | 198,000 | 66 | 276,000 | 92 |
| 9673-R34 (3) | 1024x96 | 133.0 | 21.0 | 3Q 96 | 330,000 S | 4,445 | 219,000 | 66 | 306,000 | 93 |
| 9672-R44 (4) | 2048x128 | 172.0 | 28.0 | 3Q 96 | 430,000 S | 5,460 | 284,000 | 66 | 396,000 | 92 |
| 9672-R54 (5) | 2048x128 | 209.0 | 34.0 | 3Q 96 | 520,000 S | 7,000 | 345,000 | 66 | 481,000 | 93 |
| 9672-R64 (6) | 2048x128 | 243.0 | 39.0 | 3Q 96 | 610,000 S | 8,155 | 401,000 | 66 | 559,000 | 92 |
| 9672-R74 (7) | 4096x128 | 273.0 | 46.0 | 3Q 96 | 680,000 S | 9,240 | 450,000 | 66 | 628,000 | 92 |
| 9672-R84 (8) | 4096x128 | 300.0 | 51.0 | 3Q 96 | 750,000 S | 10,185 | 495,000 | 66 | 690,000 | 92 |
| 9672-R94 (9) | 4096x192 | 322.0 | 55.0 | 3Q 96 | 810,000 S | 10,990 | 531,000 | 66 | 741,000 | 91 |
| 9672-RX4 (10) | 4096x192 | 339.0 | 59.0 | 3Q 96 | 850,000 S | 11,655 | 559,000 | 66 | 780,000 | 92 |
| 9672-RY4 (10) | 4096x192 | 374.0 | 64.0 | 4Q 96 | 940,000 S | 12,600 | 617,000 | 66 | 860,000 | 91 |
| 9672-RA5 (1) | 1024x96 | 49.0 | 8.0 | 2Q 97 | 180,000 S | 1,680 | NA | NA | NA | NA |
| 9672-R15 (1) | 1024x96 | 63.0 | 11.0 | 2Q 97 | 230,000 S | 2,135 | NA | NA | NA | NA |
| 9672-RB5 (2) | 1024x96 | 89.0 | 15.0 | 2Q 97 | 320,000 S | 2,975 | NA | NA | NA | NA |
| 9672-R25 (2) | 1024x96 | 117.0 | 20.0 | 2Q 97 | 420,000 S | 4,025 | NA | NA | NA | NA |
| 9672-RC5 (3) | 2048x128 | 146.0 | 24.0 | 2Q 97 | 530,000 S | 4,900 | NA | NA | NA | NA |
| 9672-R35 (3) | 2048x128 | 165.0 | 28.0 | 2Q 97 | 590,000 S | 5,775 | NA | NA | NA | NA |
| 9672-R45 (4) | 2048x128 | 209.0 | 35.0 | 2Q 97 | 750,000 S | 7,350 | NA | NA | NA | NA |
| 9672-R55 (5) | 2048x128 | 264.0 | 45.0 | 2Q 97 | 950,000 S | 9,275 | NA | NA | NA | NA |
| 9672-R65 (6) | 2048x128 | 301.0 | 51.0 | 2Q 97 | 1,080,000 S | 10,675 | NA | NA | NA | NA |
| 9672-R75 (7) | 4096x192 | 333.0 | 57.0 | 2Q 97 | 1,200,000 S | 11,725 | NA | NA | NA | NA |
| 9672-R85 (8) | 4096x192 | 361.0 | 61.0 | 2Q 97 | 1,300,000 S | 12,600 | NA | NA | NA | NA |
| 9672-R95 (9) | 4096x192 | 383.0 | 65.0 | 2Q 97 | 1,380,000 S | 13,300 | NA | NA | NA | NA |
| 9672-RX5 (10) | 8192x192 | 401.0 | 69.0 | 2Q 97 | 1,440,000 S | 14,000 | NA | NA | NA | NA |
| 9672-RY5 (10) | 8192x192 | 446.0 | 78.0 | 4Q 97 | 1,610,000 S | 15,750 | NA | NA | NA | NA |
| 9021-942 (4) | 256x64 | 210.0 | 38.0 | 1Q 93 | 74,000 S | 31,725 | NA | NA | 12,500 | 17 |
| 9021-952 (5) | 384x64 | 265.0 | 46.0 | 1Q 93 | 93,000 S | 37,070 | NA | NA | 17,500 | 19 |
| 9021-962 (6) | 512x128 | 315.0 | 53.0 | 1Q 93 | 110,000 S | 43,515 | NA | NA | 22,500 | 20 |
| 9021-972 (7) | 512x128 | 360.0 | 60.0 | 1Q 93 | 126,000 S | 49,815 | NA | NA | 27,500 | 22 |
| 9021-982 (8) | 512x128 | 400.0 | 67.0 | 1Q 93 | 140,000 S | 55,515 | NA | NA | 32,500 | 23 |
| 9021-9X2 (10) | 512x128 | 475.0 | 78.0 | 4Q 94 | 166,000 S | 66,295 | NA | NA | 42,500 | 26 |

Used IBM Mainframe Spot Prices

Please note: The spot prices in this table represent the cost of configurations we consider indicative of market values on or about November 30. IBM prices are street prices and marked S. List prices are have become

meaningless for the purchase of most new equipment. Trading is thin and IBM's captive credit agencies are by far the largest owner of mainframes, so markets can be volatile when IBM adjusts its portfolio strategy.



The used 9672-R1 market is showing signs that it may develop a peculiar pricing pattern. Systems with one or two engines may in the end hold value better than boxes with more total processor power. There are plenty of users for whom 15 to 30 MIPS is plenty...but not so many who want more power and who don't want the advantages offered by the faster engines of subsequent 9672 systems.

Used IBM Mainframe Market Trends

Used mainframes of a particular generation generally are priced uniformly (per MIPS) whatever their power. When there are exceptions, these exceptions usually have their roots in technical factors that have shaped the market. For instance, IBM 9021s with more than six engines have faster engines at the top to offset the degradation that is a byproduct of their multiprocessor architecture. As a result, two five-way machines cannot be re-configured as a 10-way. The faster engines are relatively scarce (or were during the 9021's heyday) and traded at a higher price.

The 9672 product line may exhibit just the opposite pricing pattern. And if so, the first place it will first show up is in the R1 market.

While R1 machines sell for less per MIPS than any of the newer 9672s, they have a disadvantage. Their engines are not very powerful. Even though a complete R31 can deliver 39 MIPS, so, too can an R22. This power is midway between that of a 33 MIPS uniprocessor RA4 and a 48 MIPS uniprocessor R14.

Depending on a user's workload, an RA4 might actually yield better results than either an R31 or R22, because the effective engine MIPS of an R31 is 13 and that of an R22 is 19.5, both well under that of the RA4.

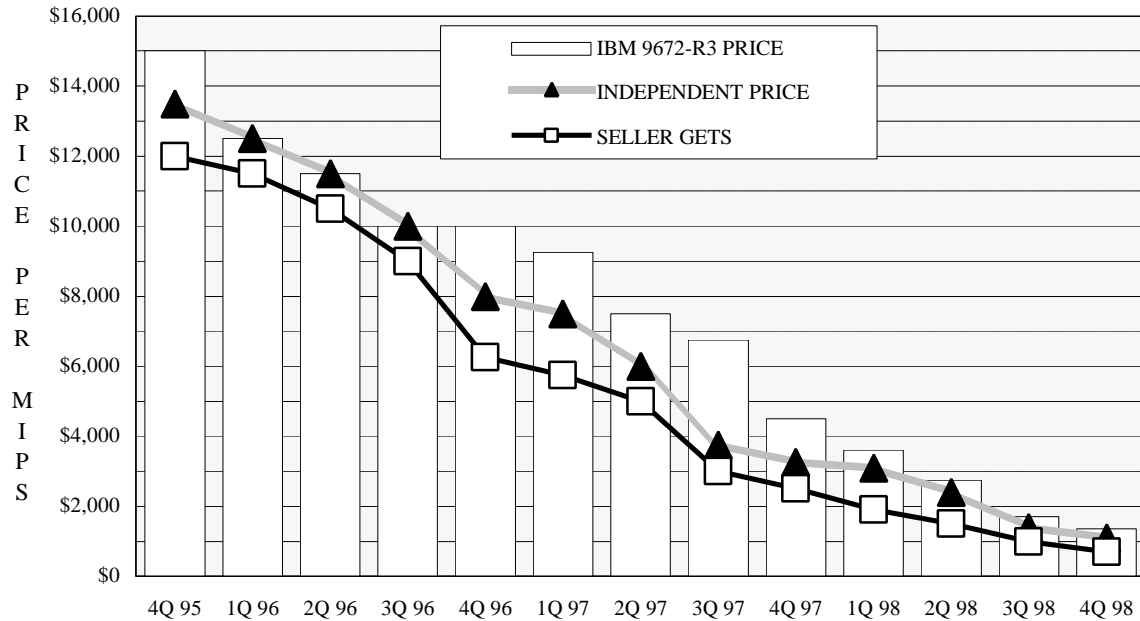
Where systems performance depends on effective engine power more than total systems power, a machine with fewer big engines will outrun a more powerful system that has smaller engines, but more of them.

The result, in shops that have a lot of batch work (or other jobs that don't run very well across multiple engines) is an inclination to move to larger engines. The obvious reason is that a uniprocessor system with fewer MIPS (and lower software costs) can sometimes do more real work than a more powerful platform with smaller individual engines. Big engines give better value.

What it boils down to is this: MIPS and MSU ratings may describe the potential of a system, but they don't always characterize that system's performance with great accuracy. This is the case not only in the mainframe world but in every segment of the computer industry. It is the basis of good arguments in favor of per-seat or flat rate software pricing and clear evidence that MSU-based pricing doesn't work out equitably for every customer.

It is also the reason Hitachi Skyline processors did so well in the market against 9672s until G5 and one of the reasons the fast-moving PC server business will speed the retirement of older mainframes. It lies at the heart of the unfortunate history of IBM's 9672-E processors, the

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The issues affecting first generation 9672 machines will in the end affect all later models, including the 9672-R3s. These machines have adequate total system power for many users but they do not offer impressive batch performance compared to newer machines with higher engine power.

CMOS systems that IBM hoped in vain would give it an edge in the mainframe segment. And it is the reason we urge customers not to sign long leases on CMOS systems if they have workloads that are sensitive to engine size.

The engine size issue is one reason IBM does not produce motherboards that can accept chip upgrades, the way PC makers do. PC makers want customers to have a chip upgrade option as well as a motherboard upgrade option, while IBM wants users to have an engine activation option and a swap option. Engine activation does give more system power but it does not increase effective engine speed. It will, in fact, decrease it. As a result, a customer who buys an engine activation will get more total system performance but very possibly less batch performance. This problem doesn't occur at all sites, because many users have batch workloads that do not tax the engine power of their computers...but it is common enough to affect the base in aggregate and therefore the resale value of older CMOS machines.

If there is an orderly market in any kind of CMOS mainframe — a market with a sufficient number of buyers and sellers for the forces supply and demand to actually work — then the value per MIPS of CMOS machines with more engines will be lower than the value per MIPS of contemporary machines with fewer engines. The boxes with fewer engines suit the needs of users whose total MIPS requirements can be satisfied by one, two or three engines. The boxes with many engines are not as

attractive to customers as newer machines with fewer, large engines. Everyone can use the large engine boxes but not everyone can get as good results with the small engine boxes.

If IBM offered affordable engine upgrades instead of activation upgrades, this pattern would change. But for a number of reasons, IBM has not designed 9672 processors with CPU chipset upgrades in mind. This philosophy contributes to reliability and ease of maintenance but also militates against upward migrations to faster engines.

Ironically, IBM offers engine upgrades in other product lines, notably in the Netfinity family and also for some servers in the RS/6000 group, where replacing a whole server is cheap compared to any kind of an upgrade in the mainframe arena.

This issue may lose importance as engine speeds rise, because the number of users who need more than 63 or 115 MIPS effective engine speed for batch work is very small. But in the current market, where used systems with much smaller engines are the only available second-hand CMOS mainframes, there will be less interest in boxes with several engines than in boxes with one, two or at most three. Lessors, including IBM's captive credit companies, will eventually factor this into the cost of their leases. But they have not done so yet and it would not be surprising if the worst results in 9672 leasing came from systems with high engine counts. This is a reversal of the pattern in bipolar mainframe leasing.

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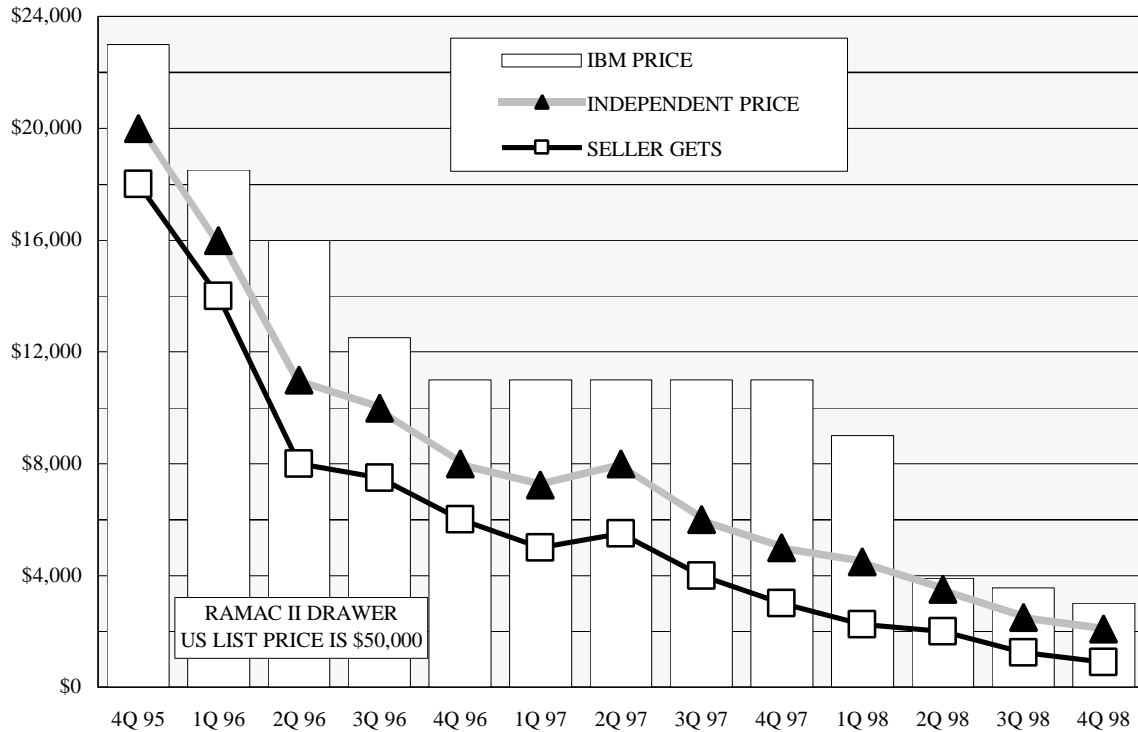
| DISK OR CTRL | CAPACITY (MB) | AVERAGE ACCESS | TRANSFER RATE | FIRST AVAIL | IBM US PRICE | IBM US MAINT \$ | SELLER GETS | | BUYER PAYS | |
|-----------------|------------------|-------------------|------------------|----------------|-----------------|--------------------|-------------|-----|------------|-----|
| | | | | | | | % | \$ | % | \$ |
| 3390-A24 | 7,560 | 19.6 MS | 4.2 MB/S | 4Q 89 | 132,550 | 175 | NA | NA | 200 | < 1 |
| 3390-A28 | 15,100 | 19.6 MS | 4.2 MB/S | 4Q 89 | 219,000 | 315 | NA | NA | 200 | < 1 |
| 3390-B24 | 7,560 | 19.6 MS | 4.2 MB/S | 4Q 89 | 115,300 | 150 | NA | NA | 200 | < 1 |
| 3390-B28 | 15,100 | 19.6 MS | 4.2 MB/S | 4Q 89 | 201,750 | 290 | NA | NA | 250 | < 1 |
| 3390-B2C | 22,700 | 19.6 MS | 4.2 MB/S | 4Q 89 | 288,200 | 430 | NA | NA | 250 | < 1 |
| 3390-A34 | 11,350 | 22.1 MS | 4.2 MB/S | 3Q 91 | 152,450 | 175 | NA | NA | 250 | < 1 |
| 3390-A38 | 22,700 | 22.1 MS | 4.2 MB/S | 3Q 91 | 258,850 | 315 | NA | NA | 300 | < 1 |
| 3390-B34 | 11,350 | 22.1 MS | 4.2 MB/S | 3Q 91 | 135,200 | 150 | NA | NA | 300 | < 1 |
| 3390-B38 | 22,700 | 22.1 MS | 4.2 MB/S | 3Q 91 | 241,600 | 290 | NA | NA | 300 | < 1 |
| 3390-B3C | 34,050 | 22.1 MS | 4.2 MB/S | 3Q 91 | 348,000 | 430 | NA | NA | 300 | < 1 |
| 3990-604 | CTRL, 256 MB | NA | NA | 3Q 93 | 400,720 | 903 | 700 | < 1 | 1,800 | < 1 |
| 9390-001 | CTRL, 512 MB | NA | NA | 4Q 96 | 413,860 | 981 | NA | NA | NA | NA |
| 9390-002 | CTRL, 1 GB | NA | NA | 4Q 96 | 824,370 | 1,888 | NA | NA | NA | NA |
| 9343-C02 | CTRL | NA | NA | 1Q 92 | 45,650 | 190 | NA | NA | NA | NA |
| 9343-C04 | CTRL | NA | NA | 1Q 92 | 69,300 | 305 | NA | NA | NA | NA |
| 9343-D04 | CTRL | NA | NA | 1Q 92 | 69,300 | 305 | NA | NA | NA | NA |
| 9343-CC2 | CTRL, 32 MB | NA | NA | 4Q 92 | 57,200 | 215 | NA | NA | 1,300 | 2 |
| 9343-CC4 | CTRL, 64 MB | NA | NA | 4Q 92 | 92,400 | 355 | NA | NA | 1,600 | 2 |
| 9343-DC4 | CTRL, 64 MB | NA | NA | 4Q 92 | 92,400 | 305 | NA | NA | 2,900 | 3 |
| 9345-B22 | 3 GB | | | 1Q 92 | 31,790 | 60 | NA | NA | 1,200 | 4 |
| 9391-A10 | RACK | NA | NA | 3Q 94 | 50,000 | 55 | NA | NA | 500 | < 1 |
| 9392-B13 | 5,670 | 15R/17W | 5.2 MB/S | 3Q 94 | 30,000 | 50 | NA | NA | 250 | < 1 |
| 9392-B23 | 11,350 | 12.1R/13.6W | 9.5 - 12 MB/S | 3Q 95 | 50,000 | 65 | 900 | 2 | 2,100 | 4 |
| 9392-B33 | 22,700 | 16.6 MS | 4.4 MB/S | 4Q 96 | 90,000 | 85 | 3,500 | 4 | 7,500 | 8 |
| 9394-001 | CTRL, 64 MB | NA | NA | 3Q 94 | 135,000 | 415 | 3,000 | 2 | 4,500 | 3 |
| 9394-002 | CTRL, 64 MB | NA | NA | 3Q 94 | 150,000 | 425 | 5,000 | 3 | 10,000 | 7 |
| 9394-003 | CTRL, 128 MB | NA | NA | 3Q 94 | 215,000 | 550 | 11,000 | 5 | 18,500 | 9 |
| 9395-B13 | 5,670 | 15R/17W | 5.2 MB/S | 3Q 94 | 30,000 | 50 | NA | NA | 250 | < 1 |
| 9395-B23 | 11,350 | 12.1R/13.6W | 9.5 - 12 MB/S | 3Q 95 | 50,000 | 65 | 1,000 | 2 | 2,750 | 6 |
| 9393-1-A22 | 1GB x 180GB | NA | NA | 3Q 96 | 540,832 | 1,414 | 9,000 | 2 | 17,000 | 3 |
| 9393-1-A32 | 1.75GB x 270 GB | NA | NA | 3Q 96 | 678,129 | 1,726 | 12,500 | 2 | 21,000 | 3 |
| 9393-1-A42 | 2GB x 360GB | NA | NA | 3Q 96 | 725,152 | 1,833 | 14,000 | 2 | 27,000 | 4 |
| 9393-002 | 1GB x 160GB | 5.8 MS | NA | 4Q 96 | 837,376 | 1,423 | 8,000 | < 1 | 14,000 | 2 |
| 9393-T42 | 420 GB+2GB CACHE | 4.8 MS | NA | 2Q 97 | 175,111 | 4,491 | NA | NA | 115,000 | 66 |
| 9393-T82 | 420 GB+2GB CACHE | NA | NA | 3Q 97 | 192,622 | 4,491 | NA | NA | 135,000 | 70 |
| 9396-1 | 464 GB+1GB CACHE | NA | NA | 4Q 96 | 229,431 | 3,003 | NA | NA | 185,000 | 81 |
| 9396-200 | 456 GB+1GB CACHE | NA | NA | 2Q 97 | 301,987 | 4,833 | NA | NA | 235,000 | 78 |

The upturn in demand that usually occurs at year-end has helped support prices of used disks. Even so, secondhand storage subsystems have shed value. The prospects for very sharp declines during the first half of 1999, when Y2K related storage increases will wane, seem quite ominous now.

Used IBM Disk Drive And Controller Spot Prices

The figures in this table are drawn from actual transactions reported to us on or about November 30. The information on which the table is based has been obtained from sources we believe to be reliable. We suggest you

read the essay on the next page before making plans based solely on current prices. Transactions arranged for future execution will be carried out at prices that are almost always lower than those reported here.



Users in search of storage they can throw away when their year 2000 testing is done can get Ramac capacity very cheaply. While Ramac is not a competitive solution in performance or price terms for strategic purposes, it remains a good tactical choice for many users.

Used IBM Disk Drive And Controller Price Trends

In nature, it takes a long time for icebergs to melt. In the disk business, all it takes is one lease. As IBM has improved the specifications of its RVA disk subsystems and reduce their cost, older versions of the machines have faired poorly in the used equipment market. The biggest seller of secondhand Icebergs, IBM Credit Corp, has had to offer the boxes at very reasonable prices to get them out of the way. The bargain RVA boxes have ended up in competition with not only used EMC Symmetrix equipment but also new IBM RVA subsystems. The consequence has become a headache for the whole mainframe disk business.

As we indicate elsewhere in this issue, the mainframe disk array market is probably now at a peak in terms of revenue and subsystem shipments. Next year the market will be flat or down and after that almost certainly down. The only measure of the disk market that will show increases is capacity, and capacity growth is not rapid enough to offset the lack of growth in subsystem units or the decline in cost per gigabyte of storage.

There are some barriers that have prevented all older disks from totally losing value. Users with Ramac

capacity often prefer to add to existing strings than install whole new subsystems. And users who still have linear disks may find it easier to hang Ramacs off their controllers than move to new technology.

Nevertheless, with name brand SCSI disks, the latest IBM and Seagate drives, for example, selling in the OEM market for a few pennies a megabyte, the mainframe subsystem market will soon have to digest new entries. Intel-based RAID file servers, a major force in the midrange, can be equipped with channel attachments and suitable interconnecting software. We expect such devices to be initially sold into the low end of the mainframe market as auxiliary disk farms and only later as primary storage solutions. But users who need only a handful of disks — total uncompressed RAID capacity of less than 150 gigabytes — will compare these minifarms with used IBM and EMC alternatives.

We don't believe small Intel-based arrays will completely knock out used mainframe subsystems, but they could very well cloud the economic outlook for older and less capacious mainframe disks. This will ultimately feed back into the market for new high end storage.

Infoperspectives

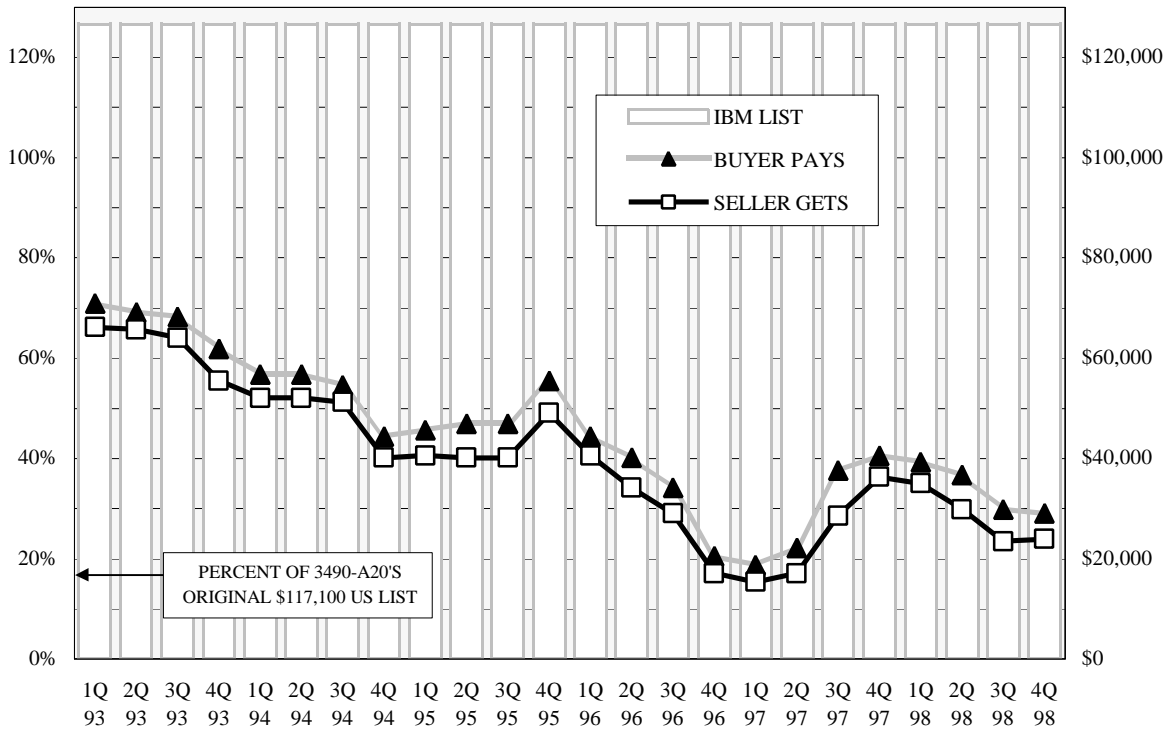
| MAINFRAME PERIPHERALS | PEAK SPEED | FIRST AVAIL | IBM US LIST | IBM US MAINT | SELLER GETS | | BUYER PAYS | | |
|--|---------------|----------------|----------------|-----------------|-------------|-----|------------|-----|--|
| | | | | | \$ | % | \$ | % | |
| TAPE TRANSPORTS AND CONTROLLERS | | | | | | | | | |
| 3480-A22 | CTRL | 1Q 85 | 69,230 | 448 | NA | NA | 650 | < 1 | |
| 3480-A22+3305 IDRC | CTRL | 3Q 89 | 86,590 | 498 | 1,000 | 1 | 2,000 | 2 | |
| 3480-B22 | 3 MB/S | 1Q 85 | 48,450 | 279 | NA | NA | 400 | < 1 | |
| 3480-B22 + 2511 LOADER | 3 MB/S | 1Q 85 | 58,445 | 345 | NA | NA | 650 | 1 | |
| 3490-A02 + 3356 CH ADAPT | CTRL | 1Q 90 | 127,330 | 700 | 17,000 | 13 | 21,000 | 16 | |
| 3490-B04 | 4.5 M B/S | 1Q 90 | 111,100 | 815 | 4,000 | 4 | 7,500 | 7 | |
| 3490-A20 | CTRL | 2Q 91 | 126,600 | 560 | 28,000 | 22 | 34,000 | 27 | |
| 3490-B40 | 4.5 M B/S | 2Q 91 | 122,200 | 692 | 21,000 | 17 | 27,500 | 23 | |
| 3590-A00 | CTRL | 3Q 96 | 7,500 | 80 | 600 | 8 | 900 | 12 | |
| 3590-A14 | RACK | 3Q 96 | 21,000 | 25 | 7,000 | 33 | 10,000 | 48 | |
| 3590-B1A (ATL) | 20 MB/S | 3Q 95 | 43,500 | 190 | 16,000 | 37 | 23,000 | 53 | |
| PRINTERS | | | | | | | | | |
| 4245-12 | 1200 LPM | 3Q 85 | 38,410 | 304 | NA | NA | 900 | 2 | |
| 4245-20 | 2000 LPM | 3Q 85 | 44,270 | 488 | NA | NA | 1,150 | 3 | |
| 4248-2 | 4000 LPM | 1Q 87 | 95,760 | 848 | 500 | < 1 | 1,500 | 2 | |
| 6262-14 | 1400 LPM | 3Q 88 | 33,820 | 286 | 2,000 | 6 | 3,500 | 10 | |
| 6262-22 | 2200 LPM | 4Q 89 | 47,940 | 374 | 7,500 | 16 | 12,000 | 25 | |
| 3825-1 | 58 PPM | 3Q 89 | 159,350 | 1,972 | NA | NA | 1,900 | 1 | |
| 3827-1 | 92 PPM | 2Q 88 | 240,200 | 3,235 | NA | NA | 1,500 | < 1 | |
| 3835-1 | 88 PPM | 2Q 88 | 175,300 | 1,525 | 2,750 | 2 | 5,000 | 3 | |
| 3835-2 | 92 PPM | 1Q 93 | 147,400 | 1,200 | 30,000 | 20 | 36,000 | 24 | |
| 3900 | 229 PPM | 2Q 91 | 295,000 | 1,550 | 12,000 | 4 | 26,000 | 9 | |
| CRTS AND CRT CONTROLLERS | | | | | | | | | |
| 3191-A10 | | 2Q 86 | 634 | 6 | NA | NA | 100 | 16 | |
| 3192-C10 | | 1Q 87 | 1,730 | 9 | 40 | 2 | 110 | 6 | |
| 3192-D10 | | 1Q 87 | 754 | 7 | 50 | 7 | 125 | 17 | |
| 3192-G10 | | 1Q 87 | 2,555 | 11 | 55 | 2 | 135 | 5 | |
| 3471-EA1 | | 3Q 89 | 1,060 | 7 | 50 | 5 | 115 | 11 | |
| 3472-FC1 | | 3Q 91 | 1,730 | 10 | 100 | 6 | 190 | 11 | |
| 3472-HC1 | | 3Q 89 | 1,730 | 10 | 100 | 6 | 200 | 12 | |
| 3174-1L | | 3Q 86 | 19,044 | 31 | NA | NA | 360 | 2 | |
| 3174-1R | | 3Q 86 | 13,942 | 25 | NA | NA | 360 | 3 | |
| 3174-51R | | 3Q 86 | 7,520 | 19 | NA | NA | 375 | 5 | |
| 3745-210 | | 1Q 88 | 290,790 | 492 | NA | NA | 20,000 | 7 | |
| 3745-410 | | 3Q 88 | 642,180 | 902 | NA | NA | 35,000 | 5 | |

There is a theory among the dwindling number of companies that trade in used mainframe class equipment that there is some almost irreducible number of CRTs that will remain in use forever. There is no economic case for this and in fact a strong argument that supporting character screens on computers may soon become a bit like supporting dial phones in the telecommunications business, a legacy that nobody knows quite how to terminate. The notion may seem silly, but the market gives it credence.

Used IBM Tape, Printer And CRT Spot Prices

Prices listed in this table are drawn from actual transactions reported to us on or about November 30. The information on which the table is based has been obtained from sources we believe to be reliable. Please note, how-

ever, that some of the equipment listed is subject to rapid price fluctuations. Further, many recent products are not widely available in the used market, so we cannot list prices that are acceptably accurate.



Year-end decisions to add tape here and there have given a small boost to interest in 3490-E equipment. We don't expect the market to experience a sustained upturn, but trading volume is so thin in many items that anything could happen. The strength in the market is an implicit criticism of IBM's pricing and marketing of its Virtual Tape Server, a device that ought to be eating big holes in the 3490 base.

Used IBM Tape, Printer And CRT Price Trends

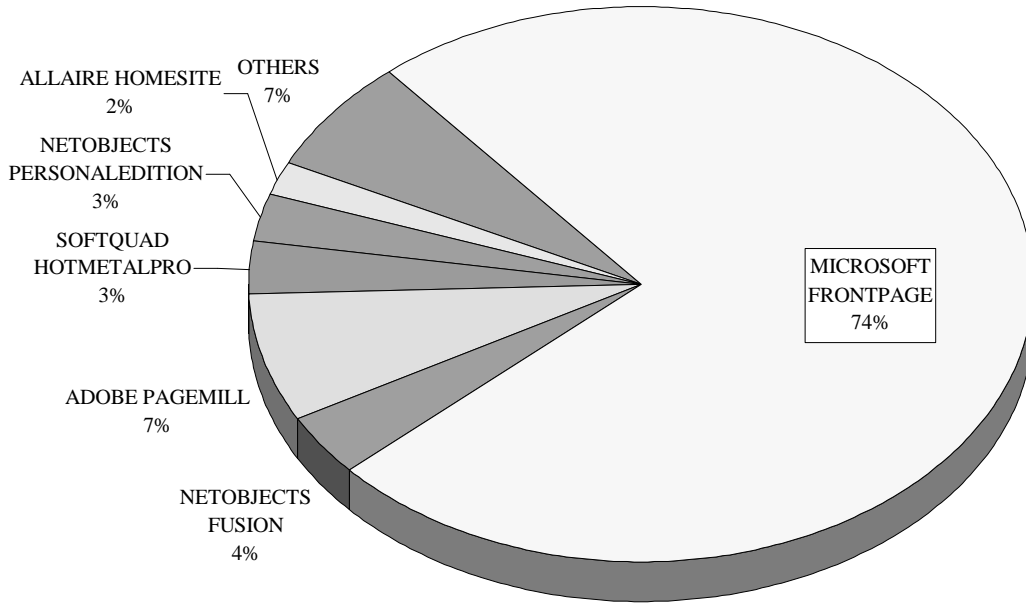
The used 3490 tape market is showing strength, not a complete surprise at the end of a year but still a change from the trend of the past several months. We take the phenomenon as a signal that IBM has misread the opportunities for its Virtual Tape Server, a storage solution that ought to be nearly universal in the small and mid-sized shops that are prominent among buyers of used 3490 tape equipment.

What we think has happened is that IBM did not set sufficiently high volume goals for the VTS and priced the device a bit higher than the market's sweet spot. So it may be getting the sales results is planned for, but it is not getting the sales results it could have achieved if it had based its marketing plan on somewhat different assumptions. The VTS is not only important in itself — it is the way IBM can get users to painlessly switch from 3480 or 3490 technology to 3590 technology — but it is also an icon of the IBM Seascope strategy. Seascope is IBM's much-revised concept of unified storage that could be attached to every processor platform in the industry.

Seascope is the kind of idea IBM could actually sell and which its rivals could not...unless the concept is so appealing that users would turn to another vendor for such a comprehensive storage solution. Obviously, EMC would like very much to broaden its range. Its concentration in the disk segment helped it grow but now that it is a huge company it needs breadth. Because IBM has not found the right combination of products and marketing to capture the imagination of the market, EMC could ease into total solutions even if it does not have the great reach and enormous assets of IBM.

If EMC ever develops the sophistication to offer a comprehensive storage concept, it could move down into the archiving market using DVD or tape in a format other than those in the IBM world. But it could succeed only if there is a vacuum, only if IBM has dropped its guard.

While it might seem daring to assert that IBM, which has set large systems tape standards for decades, could lose control, that is precisely the possibility that arises whenever a dominant vendor slacks off.



This picture of the web page creation tools market (by units), based on US survey data from IDC, is nearly a year old. But we doubt the general pattern has changed. The most popular tool for creating Web pages is Microsoft FrontPage, in part because it integrates well with other Microsoft applications. Still, professional developers favor other packages that can help manage large sites.

Fluctuations: Microsoft Is The Little Guy's Web Helper

Lou Gerstner may believe the battle for the desktop is history, but Microsoft sure thinks it's a daily struggle. Microsoft's perception — and Gerstner's misperception — stem from different notions of the end user experience. Gerstner made his statement while buying Lotus and middleware vendor Tivoli. Microsoft said nothing but moved browser technology to the desktop and decided to become very active in the shaping of Java, a language that is being used to bring applications from a number of server platforms to a presumably standardized aspect of every desktop.

Microsoft's HTML editor, FrontPage, is part and parcel of its desktop computing strategy. It generates Web pages with Microsoft server software in mind. Other Web creation tools may take Microsoft servers into account but are neutral in ways FrontPage is not. (The forthcoming FrontPage 2000 is supposed to be more

server neutral. We'll see.) The upshot is that developers for enterprises favor Web tools that allow sites to be hosted on any platform an enterprise prefers, including those that do not have Microsoft code in them.

Our personal favorite, Allaire HomeSite, is not the world's favorite by a long shot. But our Web work is for sites of modest size and complexity. Users with giant sites might go all the way to Fusion. HoTMetal is another popular choice among the Internectuals. It's worth looking at; too, as it is very good for certain tasks.

Despite our current leanings, we try to stay abreast of Microsoft's progress with FrontPage. Even when a Microsoft package is not our choice, we try (and suggest that others try) to pay attention. All Netscape/AOL has to do is get better at Web editing software and you can bet FrontPage will be given top priority treatment at Microsoft, where no battle for anything every ends.

Coming Up . . .

Next month we will look at the desktop hardware at enterprise computing sites. As this month's software survey indicates, many organizations are under increasing pressure to update their hardware. Down the road, we

will take a look at the PC server scene. With Pentium II and Xeon chips now offering greater engine power than most installed mainframes have and with Linux on the rise, astute buyers can really get a lot for their money.