Personal Systems

IBM PC Servers
Reliable
Compatible
Expandable

High Availability Servers
Servers in an ATM Environment
Servers and Lotus Notes

PC Server 500

IBM

You Talk and We Listen

Earlier this year *Personal Systems* asked an independent survey company to find out what you think about our magazine. Do you read it? Do you keep it for reference? Do you share it with co-workers?

Thanks to those of you who took time out of your busy schedules to answer the survey. And we know you have busy schedules, based on the size of organizations in which you work and the number of end users you support! Most of you (85 percent) work in companies with more than 200 employees, while 80 percent of you support 200 or more end users. That's certainly enough right there to keep you busy, but in addition to supporting all those end users, your systems run on all platforms: OS/2 (75 percent), DOS (78 percent), Windows NT (55 percent), UNIX/AIX (25 percent).

With all that to keep you busy, you still take an average of an hour and a half to read *Personal Systems*, share it with two or more of your co-workers, and keep it in your reference library for a year or more. That tells us that what we're including in *Personal Systems* is valuable to you in your work environment.

The only way we can keep that information valuable is for you to keep telling us where you need our focus to be. We get frequent requests for articles on hardware—not just software. This whole issue focuses on client/server hardware. We've had many requests to feature the "look and feel" of OS/2 Warp's next release. One reader asked, "How about a review with pictures of the new [OS/2] Warp." November/December's issue will cover the latest release of this advanced operating system in depth, including screen images.

How do we find out what you want and need? We're in the midst of a global communications revolution! You can "talk" to us with almost any electronic device you have handy: e-mail, voice mail, snail mail, fax, Internet—why, I might even be at my desk when you call! At various locations in *Personal Systems*, you'll find our staff's phone numbers, e-mail addresses, and fax number. Plus, we include a postage-paid card and a Fast FAX Feedback form for you to tell us what you think about this issue and what you would like to see in future issues.

Be sure to check out *Personal Systems'* World-Wide Web site at http://pscc.dfw.ibm.com/psmag/. We post many of our current and past articles in their entirety, including articles by Phil Lieberman, who brought *Personal Systems* special honor by having two of his recent articles win awards for excellence from the International Association of Business Communicators and APEX '96. Thanks, Phil! Our Internet site also provides another option for you to give us your feedback.

Next year (yes, 1997 is almost upon us), we'll start the year with an issue about the Internet and network-centric computing, then we'll follow that in March with more in-depth technical detail on application development tools. We're looking forward to a great future and a great relationship between *Personal Systems* and our readers!

Betty Hawkins

Betty Hawkins, Editor

Check out *Personal Systems'* Web site at:
http://pscc.dfw.ibm.com/psmag/

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What's New?

RemoteWare Enhances Lotus Notes

XcelleNet, Inc. has enhanced its *RemoteWare* product to boost performance and reduce operating costs of Lotus Notes systems supporting large numbers of dial-in users. XcelleNet's *RemoteWare Agent for Lotus Notes Replication* promises to reduce the duration of dial-in replication sessions by 50 percent or more while adding powerful systems management options for Notes administrators.

RemoteWare Agent lets you service the messaging and data transfer needs of non-Notes applications during the same dial-in session, thus reducing overall connection times and simplifying your users' working environment.

RemoteWare Agent for Lotus Notes Replication delivers many systems management benefits for Notes systems administrators, including:

- Cost-effective scalability for Notes implementation through reduced server hardware requirements

- Reduced training costs for novice Notes users

- Ability to "force" replication to Notes clients

- Ability to launch outbound as well as inbound sessions, including wireless mail delivery

- Centralized delivery and management of Notes database applications, as well as other general software updates

For more information, circle 1 on the reader service card.

IBM Gets Ready for Year 2000

Are your applications and data files ready for the year 2000? Can they handle dates with the years 1999, 2000, and beyond? Avoid costly problems by asking IBM to help you update your applications to ensure they are year-2000-ready.

IBM recognizes that the year 2000 poses a significant challenge for the information technology industry. Businesses need to update programs and data fields that do not handle century markers or dates beyond the current century. To help you prepare for the new century, IBM's Integrated Systems Solution Corporation (ISSC) offers a broad range of services called *TRANSFORMATION 2000 Solutions* that help you develop solutions for applications, system software, and hardware in the following areas:

- *Assessment and strategy*–Provides you with a documented strategy, cost estimates, time frames, and resources required to implement year 2000 changes

- *Detailed analysis and planning*– Provides an in-depth analysis of the year-2000-affected areas of your business

- *Implementation and testing*– Automates the changes required to source code and data

- *Year 2000 clean management*–Protects your investments in application modifications

For more information, contact your IBM or ISSC representative.

Get Control of Your Network Desktops

If you need a powerful and easy-to-use tool to control your network desktops without REXX, *Desktop Commander* from Pinnacle Technology is for you. Designed specifically for the OS/2 operating system, Desktop Commander helps reduce network support costs by delivering consistent and protected desktops.

Once installed on a server or host, Desktop Commander lets you "snap" a picture of an ideal workstation for a group of workers. You can then apply restrictions for this group, such as Move, Rename, Copy, and Delete, or even completely hide applications. The completed desktop profile is centrally stored to a small configuration file, and you can associate the desktop with specific LAN user identifications. Users can then log into any system on the LAN and see their assigned desktops. Moreover, with Desktop Commander's Machine Independent Desktops (MID) function, users can make changes to their personal desktops that follow them around as they log into different machines.

Desktop Commander is fully compatible with many popular LANs, including LAN Server, Novell NetWare, Banyan Vines, and TCP/IP. It includes the following features:

- Instant restoration of lost or changed desktops

- Support for an unlimited number of desktop objects and configurations

- Standardized mobile desktops, updated as mobile users log in

- Small (20 KB average) configuration files

For more information, circle 2 on the reader service card.

Don't miss the next GUIDE!

November 17-22 San Antonio, Texas (312) 644-6610

★ **Network-Centric Computing ★ OS/390 ★ Year 2000**

Book for Busy PC Users

Busy users who are increasingly dependent upon their PCs but have neither the time—nor the interest—in becoming fluent in high-tech computer jargon can benefit from *PCs for Busy People*, published by Osborne/McGraw-Hill. Author David Einstein responds to this growing, time-strapped audience by focusing on the essentials to ensure that readers will make the smartest use of their time at the computer.

PCs for Busy People is a one-stop guide to purchasing, owning, and making the most of a PC, whether for business or home use. Written for both the beginner who needs to get up to speed quickly and the more experienced user seeking to stay abreast of significant advancements, *PCs for Busy People* begins with the basic hardware and software options. It discusses the advantages of plug-and-play for integrating printers, modems, and other add-ons and gives full consideration to the important issues of connecting to the online community.

Organized for a quick orientation to all aspects of PC use, *PCs for Busy People* presents time-saving features, including:

- *Fast Forwards*—Quick reference sections that list all the essential tasks and features

- *Shortcuts*—Accelerated routes to completing a task or solving a problem

- *Habits and strategies*—Time-saving tips and convenient techniques

- *Definitions*—Fast, clever ways to learn and remember the jargon

- *Cautions*—Known pitfalls and problems to avoid, saving readers time and headaches

PCs for Busy People–ISBN 0-07-882210-6

For more information, circle 3 on the reader service card.

Link Web Pages to Host Systems

Telegenisys Inc. has announced **WEB-***Alive*, a toolkit to build Web pages with real-time access to host applications. It enables you to create dynamic windows or complete sites that interface with existing applications running on hosts or third-party systems. Replacing static displays, the information appearing on each site using WEB-*Alive* is retrieved live from the host company's own application for each query. Users can look up current account records, shop for discounted prices, and complete live transactions, all in a secure, restricted-access environment.

WEB-*Alive*, a middleware server providing a simple development process for performing dynamic Web page applications, allows you to mix internal and external third-party systems applications. Using the WEB-*Alive* server, you can deploy platform independent (OS/2, Mac, UNIX, and Windows) applications on clients with a Web browser and TCP/IP support.

WEB-*Alive* can reduce transaction-capable Web server development time by 70 to 80 percent. It performs the transactions on the application using a terminal-emulation subsystem to access and interact with the in-house application while serving Internet users through the Web server.

Internet Navigating and Charting Tool

CLEAR Software has announced *CLEARweb*, a software utility that collects URLs, FTPs, and e-mail addresses and organizes them into manageable CLEARweb maps and/or outlines, which you can save, edit, share, and link to each other. CLEARweb helps you manage and publish custom Internet information maps for direct access to frequently visited Web sites.

Its key features include:

■ Bookmark/outline editor

■ Map editor

■ FTP librarian

■ Collection of shapes

■ Map viewer

■ CLEAR Image clip art viewer and a collection of clip art

Enhanced Customer Service and Support

Repository Technologies Inc. (RTI) has announced major new capabilities for its comprehensive customer support software package, *CustomerFirst*. Version 2.6 includes the ability to automatically escalate incidents based upon a variety of conditions, create new CustomerFirst incidents via e-mail and the Internet, and break incidents into multiple tasks.

CustomerFirst provides complete control of the support process from the time a user calls with a question until a fix is ultimately incorporated into the product. The product's new escalation facility

enables organizations to set individual, departmental, and global rules for escalating incidents based upon a number of conditions, including priority, maintenance type, status, customer type, problem type, and elapsed time.

Because of the Internet's ever-increasing importance as a vehicle for day-to-day information exchange within businesses, and because many (if not most) large organizations have implemented e-mail software for internal communication, RTI has enabled CustomerFirst to automatically create incidents based upon e-mail and Internet messages.

CustomerFirst 2.6 includes a task facility that enables users to define one or more tasks required to resolve a given problem and to assign a person or department to each task. This facility is particularly useful in development organizations where several developers may be assigned to the same project.

OS/2 Disk and File Utilities

SofTouch Systems has made available a corporate version of *GammaTech Utilities*, its award-winning set of disk and file utilities for OS/2. The *GammaTech Utilities Corporate Version* consists of two components: *GammaTech Utilities Server Edition* and *GammaTech Utilities Client Edition*.

The GammaTech Utilities Server Edition includes all the functionality of the current GammaTech Utilities product, including the ability to graphically display disk fragmentation and optimize High-Performance File System (HPFS)- and File Allocation Table (FAT)-formatted drives, undelete files, recover HPFS-formatted volumes and files, and repair and write-protect partition boot sector records. Other functions in the suite of 22 disk and file utilities include the ability to identify and mark bad sectors, recover damaged FAT files, back up and restore user desktops, and wipe free space to accommodate US Department of Defense security requirements.

A modified subset of the full version, the GammaTech Utilities Client Edition is specifically designed for deployment on client desktops. The desktop utilities include disk analysis/bad sector marking, DiskMap, HPFS optimization, desktop backup and restore, system information, and undelete. A file management utility is also included to copy, move, or delete one or a group of files that meet several search criteria. The command-line utilities include HPFS optimization, list directory, and beep utility.

Book Unlocks Secrets to C++

Osborne/McGraw-Hill has published **Schildt's Expert C++**, an advanced sourcebook designed for C++ programmers who want to venture beyond the basics to master the most powerful and intricate C++ features. Herbert Schildt, best-selling author and leading authority on C and C++ programming, has written a no-nonsense, powerful programming book that promises to turn C++ programmers into C++ experts.

In *Schildt's Expert C++*, Schildt demonstrates how to apply this cutting-edge programming language to a wide variety of real-world, practical programming tasks, enabling both the new and experienced C++ programmer to put the power of C++ to work instantly. Each chapter contains numerous, ready-to-run programs that fully comply with the current draft of the ANSI C++ standard. These solid code examples are compatible with virtually all C++ compilers.

In this book, you'll discover how to:

- Unlock the power of generic functions
- Create general purpose container classes, including stacks, queues, linked lists, binary trees, and safe arrays
- Implement sparse arrays
- Take advantage of run time type identification (RTTI)
- Supercharge string handling using the new ANSI-defined string class
- Interface C++ with assembly code
- Use C++ to create encryption and data compression functions
- Implement language interpreters using C++

Schildt's Expert C++–ISBN 0-07-882209-2

File Server Switches and Splitters

Network Technologies Inc. offers a line of splitters and improved switches for your file servers. The splitters allow multiple keyboards, monitors, and mice to control one computer. The switches have added features to control multiple PCs from one keyboard, monitor, and mouse.

Choose the switches to consolidate PCs and end clutter caused by excess keyboards, monitors, and mice to save space and money. Use the splitters to access one PC from multiple locations. Combine switches and splitters to create dual access to multiple servers or to provide local and common access to multiple computers, with a manager having access to all individual computers.

These file server switches and splitters are easy to use and require no special software. They are ideal for use in network control centers, applications where monitoring multiple file servers is essential, and when several users need access to one or many computers.

Manufacturing Software

Tangible Vision, Inc., a worldwide provider of manufacturing software and solutions, offers **Imprimis 1.5**, its object-oriented, graphical user interface (GUI)-based, client/server manufacturing software product.

Imprimis is an enterprise resource planning/manufacturing execution system that supports multi-country, multi-facility, multi-currency, and multi-language environments, while it addresses make-to-stock, make-to-order manufacturing operations. Imprimis provides management with timely information to make key decisions in areas such as improving customer service, improving on-time delivery, increasing productivity, enhancing quality, reducing inventory and work-in-process, reducing costs, and increasing profitability.

Imprimis is portable across a wide choice of client/server hardware platforms (HP9000, IBM RS/6000, Compaq Proliant, etc.), ODBC-compliant RDBMSs (Oracle, Sybase, etc.), network operating systems (Novell NetWare, UNIX, Windows NT, etc.), client operating systems (OS/2, Windows 3.1, Windows NT 3.51, MacOS 7.x, and UNIX), and graphical user interfaces (OS/2 Presentation Manager, Windows 3.1, Windows NT, and MOTIF).

Book About OpenDoc

OpenDoc is touted as the wave of the future for programmers. Promoted by a consortium of computer and software companies, OpenDoc is a set of standards for developing cross-platform, object-oriented applications. Authors Andrew MacBride and Joshua Susser explain the ins and outs of this new technology in **BYTE Guide to OpenDoc**.

Published by Osborne/McGraw-Hill and written for software developers, system administrators, and information managers, *BYTE Guide to OpenDoc* explains what OpenDoc is, how it works, how to program for it, and why people need to know about it. This book examines in depth all aspects of OpenDoc, including where it stands today and where it will be tomorrow.

A major section is devoted to enabling OLE and OpenDoc applications so they can work together on the same system. Finally, the authors expose the potential problems of OpenDoc and provide thoughtful, realistic solutions.

BYTE Guide to OpenDoc–
ISBN 0-07-882118-5

New Bar Code Printers

Kroy has released two new bar code printers, the **K4200** and **K4300** thermal-transfer and direct-thermal printers, which feature fast and powerful bar code, graphic, and text printing at an affordable price.

With one of the industry's smallest footprints, the Kroy K4200 is the economical choice for printing high-resolution bar code and text labels. Designed for a wide array of medium to low volume applications, it prints up to two inches per

second at 203 dpi with a maximum print width of four inches; features advanced memory management, allowing users to store and retrieve table formats, graphics, and smooth scalable fonts; and prints on a variety of media, including roll-fed, die-cut, continuous, or fan-fold labels, tags, and tickets.

For medium to high volume users, the K4300 offers an economical alternative. It prints up to six inches per second in widths of one to four inches. Offering features found only in printers costing far more, the K4300 prints crisp 203 dpi bar codes, text, and graphics on both plain and thermal-sensitive labels, tags, and tickets, as well as on a broad range of Kroy specialty media. Both units print on polyolefin shrink tubing.

For more information, circle 10 on the reader service card.

Flexibility and Security for OS/2

With *DeskMan/2 2.0*, Development Technologies, Inc. (DevTech) has taken the next step in desktop management by creating this feature-rich, easy to use software package that enables users to customize, manage, enhance, protect, and distribute the OS/2 desktop environment to each user's exact requirements and specifications.

LAN managers, administrators, and executives need desktop management tools that are powerful, flexible, and secure. DeskMan/2 2.0 incorporates powerful new and enhanced features, including the following:

- *PM Image*–Provides full access to the DM/2 Image component.

- *Configuration Image Facility*–Lets you take a complete snapshot of the OS/2 configuration. Snapshot definitions even include commands to run automatically before making and/or after restoring the configuration.

- *Workspace Facility*–An expanded VUEMan/2 lets you define separate, named, PM workspaces or "rooms," each with its own windows, task list, desktop, and context sensitive tools.

- *MultiDesk Personal Desktop Facility*– Lets you have your own completely separate, personal Workplace Shell desktop while the enhanced Workplace Shell extensions give you complete fingertip control over all operations including object styles, menus, and IDs.

- *Live desktop synchronization*–Lets you save and restore objects "on the fly." Changes to an object are automatically saved when its folder is closed and updated automatically the next time that folder is opened.

- *Access Control Facility*–Addresses an area of increasing importance: whether mobile- or LAN-based, corporate- or home-based users require a suitable means of access control.

For more information, circle 11 on the reader service card.

New Oracle Book

Oracle Developer/2000 Handbook, by veteran programmer Robert J. Muller, is for experienced client/server programmers who are ready to move to the "suite" life of Oracle Developer/2000. This comprehensive handbook provides an authoritative view of Oracle's latest suite of application development tools. Clearly organized and filled with step-by-step lessons, this book shows experienced programmers how to build clean, accurate, and efficient Oracle applications with Oracle Developer/2000.

From Osborne/McGraw-Hill, this book guides readers through an application development cycle using Oracle Developer/2000's robust tools, including Oracle Forms (the suite's database access application development program), Reports (its report generator), and Graphics (its graphing utility). The handbook is divided into four sections for thorough coverage and easy reference:

- *Part I* begins with the nuts and bolts of building applications, including a discussion of the application development life cycle and tips on how to organize work for optimal success.

- *Part II* focuses on designing and prototyping, as well as code reusability and security techniques.

- *Part III* explains implementing, testing, and debugging.

- *Part IV* covers deploying applications and integration with other tools.

Oracle Developer/2000 Handbook– ISBN 0-07-882180-0

For more information, circle 3 on the reader service card.

PC Servers—Now and the Future

Today's increased focus on network-centric computing defines a new generation of computing solutions, especially in the PC server market. Michael Coleman, general manager, IBM PC Servers, speaks out on IBM's PC Server strategy—how we got where we are today and where we're going.

Two years ago, when I took over the PC Server family of products, IBM had been concentrating on the desktop and mobile markets in the PC marketplace. Quite frankly, we'd fallen behind the industry in bringing customers the latest in PC server technology.

To get us back on track in this key segment of our industry, I put in place six key strategies.

The first was to listen to the customer to make sure we had market-based requirements—probably the most important goal of any business. It's paid off for us because it's led us to bring many more relevant products to the marketplace in a timely fashion, such as our PC Server Internet bundles that have proven to be so popular.

The second was to stay with open industry standards in both hardware and software. Perhaps the best example of this is that we were the first PC server vendor to support PCI bus architecture throughout our entire product line.

In addition, we fully support all the major network operating systems with our PC Servers—OS/2 for SMP, Microsoft NT Server, Novell NetWare, and SCO OpenServer.

Our third strategy was to focus strongly on systems management. And I'm proud to say that TME 10 NetFinity, our systems and asset management software, has been widely recognized as an industry leader. And the feature we call WEBability is an industry first! It gives LAN administrators the tools to go out over the Internet, take over a NetFinity-based server, and manage it as if it were a local or a dial-in remote server. This provides some especially interesting possibilities for customers who are establishing intranets!

Later in 1996, we plan to add specially built diagnostic cards to both our desktop PCs and our servers. The superstructure already built into NetFinity combined with these cards will enable much more discrete diagnostics—detailing which SIM has a problem, for example, rather than just alerting the LAN manager to a memory problem.

Our fourth strategy was to focus on integrated solutions. So far this year, we've shipped three Internet bundles worldwide, as well as a Lotus Notes bundle. And customers can expect to see much more in this area.

The fifth was to focus on external alliances. The most recent developments in this area can be highlighted by our work with Intel, Microsoft, and SunSoft. We were the first major PC vendor to announce and ship a Pentium Pro-based server—the IBM PC Server 704. And we have dramatically increased our focus on—and work with—Microsoft, especially in our Kirkland Programming Center. (See this issue's "Kirkland Programming Center—IBM's Link to Microsoft" article.) Most recently, we've teamed with SunSoft to become their number one x86 platform for rolling out Solaris and Java Internet packages.

Finally, we wanted to focus on providing customers world-class technical support. We've done a lot to increase technical support worldwide from our center in Raleigh, North Carolina, including investing heavily in NT support.
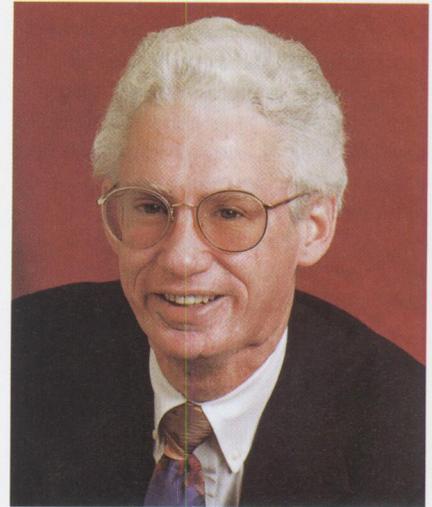
Michael Coleman

We've come a long way in a fairly short time.

We're now shipping a full line of PC Servers from the 310 minitower to our superserver 720 to our latest addition to the family—our Pentium Pro-based PC Server 704. And to that line we've added the PC Server Rack Enclosures that have been very well received because of the pre-assembled cabling mechanism we've installed.

All this puts us in an excellent position to lead the way in bringing clustered solutions to our customers.

The term clustering in the PC world has two rather distinct meanings—meanings that are often used interchangeably—so there's often a lot of confusion surrounding any discussion of the topic.

Let me start by defining clustering from my perspective. At one end of the spectrum is availability and all the technology, both hardware and software, that translates into systems with high availability. At the other end of the spectrum is scalability—spreading work across multiple processors, CPUs, or nodes.

Unfortunately in our business, we tend to oversimplify problems that are highly challenging from a technical perspective. Much of the discussion on clustering has somewhat muddled the two kinds and perhaps misled customers to believe that scalability on the PC Server platform is just around the corner. This is not quite the case. Highly scalable PC Servers are dependent upon software more sophisticated than any yet available in the PC server area.

IBM plans to roll out clustering on the PC Server platform in three phases over a number of years.

Phase I will address the whole area of availability—it is a little easier to get to, and it is the area most customers are ready to implement now.

When talking about either high availability or scalability, most customers know that it's just as much a software challenge as a hardware challenge. Fortunately, we have at our core TME 10 NetFinity. Built into NetFinity are many of the alert procedures and many of the alert and process mechanisms that will enable us to use it as a base for both high availability and scalability.

In simple failover, for example, the most basic high-availability solution, NetFinity, is extremely well positioned to do the system monitoring and alert sending that will make it much easier for us to integrate a variety of hardware alternatives into the solution.

Our PC Server High Availability Solution, announced in June, closely integrates TME 10 NetFinity. Now shipping, it is only the first of many of this type you can expect to see. You will see us announce several high-availability offerings in the second half of this year as well as into 1997. They will be in the area of standby server and failover solutions and will be a combination of hardware and software.

In Phase II, probably beginning in 1997, you'll see us address scalability in addition to providing more sophisticated high-availability solutions. Here's where we'll have a strong competitive advantage, because the industry is coming to a position where IBM has a great amount of experience, skill, knowledge, and tested products to bring to the table.

It's important to note here that we are working very closely with many different clustering efforts that are going on, both inside and outside IBM—Microsoft and the Wolfpack team, Tandem, and others.

In addition, it's important to remember that IBM has been a leader in the clustering world for some time—we clearly have technologies that scale very, very well in our other server offerings. We're in the process now of having IBM Research move some of these technologies to the PC Server space, and I've demonstrated the successful results to customers over the course of the summer.

These stable, proven technologies will work in multiple operating system environments such as OS/2 and NT. And we expect them to be very well received.

As we move into 1998, we'll begin rolling out Phase III of our strategy. We'll provide combinations of both middleware and scalable software and hardware. Using the proven technology built into other IBM platforms, we will be able to push scaling to a much larger degree than most of our competition, and we'll be able to do it in less time.

This is a place where we have a lot of added value to bring to the Intel x86 platform. The combination of IBM expertise and experience in large servers plus our ties to many providers in the PC marketplace puts us in an ideal position to lead the industry as PC Servers grow from SMPs to clusters. We have reviewed our plans with several customers in different forums, and they have told us that from their perspective, we're on the right track! I'm confident that they are right!

IBM PC Servers Clustering Strategy

	Phase I	Phase II	Phase III
Benefits	High availability	Increased high availability Limited scalability	Increased scalability
Technology	Shared disk/mirrored servers Some applications Systems management 2 nodes only	OS & middleware Some hardware Systems management More than 2 nodes	OS & middleware Complex hardware Systems management More than 4 nodes
Solutions	Standby server Active standby Twintailing Serial storage architecture Racks Database tuning NotesClusters NetFinity management	High speed interconnects Industry std. comms (ATM, 100MBit Ethernet) Switch-based clusters Fiber channel Database & NOS tuning TME 10 for clusters	Processor bus Shared workload
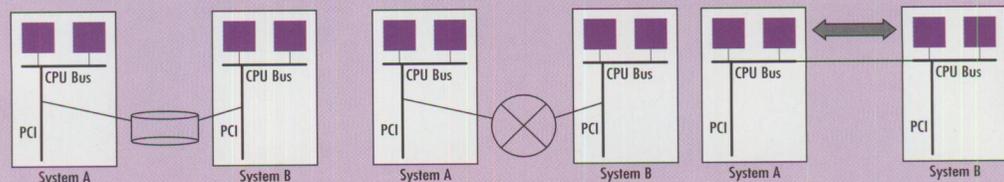
Interested in IBM PC Servers?

By Lisa Wikenczy

IBM's new PC Server line of products offers a wide choice of network-centric computing solutions—from industry-standard servers for stand-alone LANs with 12 or fewer users to super-servers supporting 1,000 or more users in sophisticated client/server environments. This article describes the compatibility, expandability, and reliability of IBM's PC Servers and offers helpful phone numbers and Internet addresses as resources.

If you purchase hardware for your organization, you know that a number of factors influence your decision. You must evaluate potential hardware solutions in terms of compatibility, expandability, and reliability in relation to your organization's specific criteria.

IBM PC Servers satisfy these essential requirements and can be configured to meet your specific needs. And, IBM's many service and support options will validate your purchase decision before, during, and after implementation. IBM makes it easy for you to find the information and support you need to make the best investment for your organization.

Compatibility

While evaluating hardware options, compatibility is an essential element to consider. Will the hardware coexist in your current environment? Will its inclusion in your environment result in additional hardware expenditures? Will your organization's software run on this platform? Your hardware solution must meet the needs of multiple functions across your organization to maximize shared maintenance, training, and long term growth, adding value and benefit without additional expense.

IBM PC Servers are compatible with the most popular network operating systems, including Microsoft Windows NT Server, Novell NetWare, OS/2 for SMP, OS/2 Warp Server, and SCO OpenServer. Detailed compatibility information for each PC Server model is available through the IBM PC Servers Web page (see sidebar). This Web page includes operating system certifications, memory and operating system matrices, comprehensive product compatibility reports for each server model, downloadable device drivers and
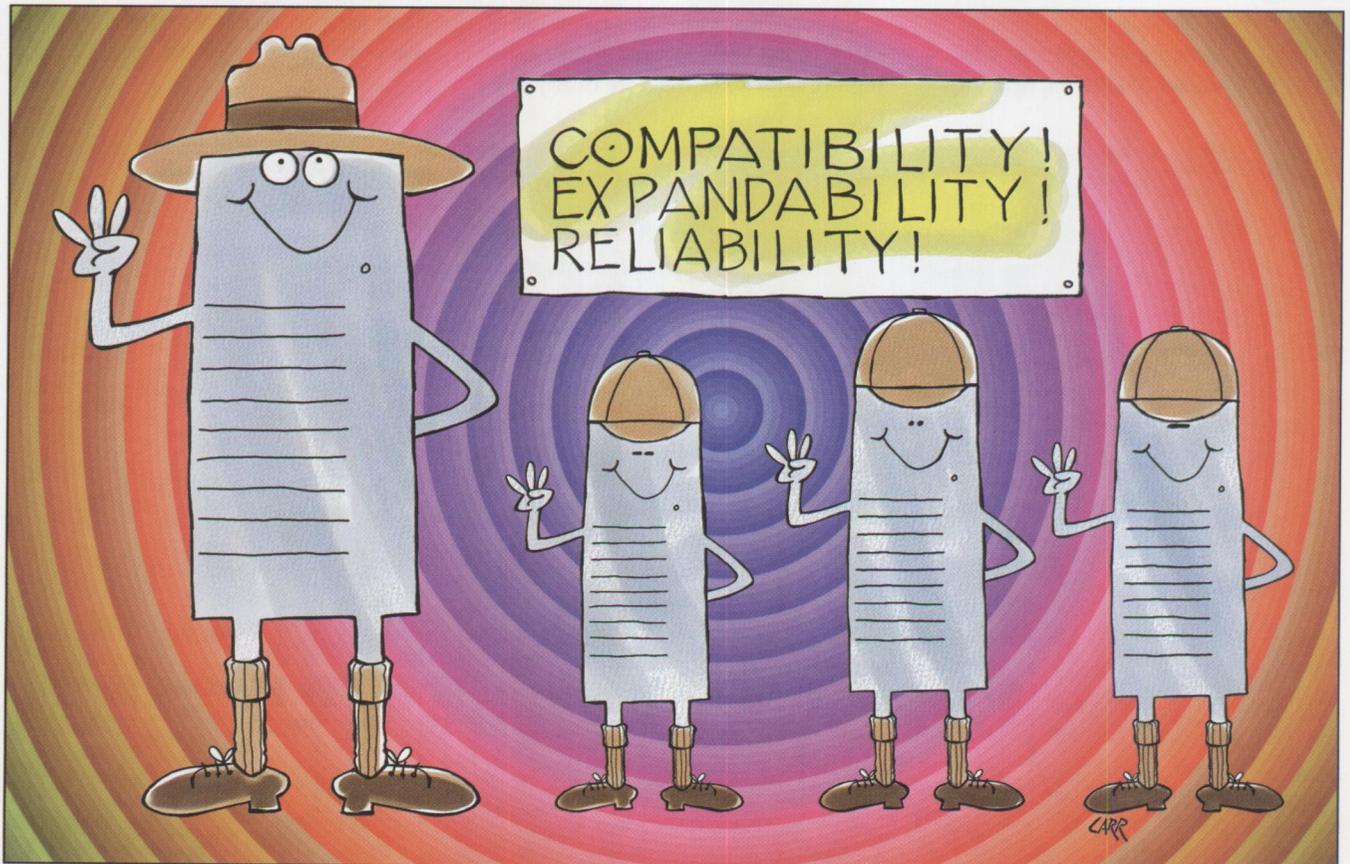
code, and information on IBM's solutions-focused compatibility testing methodology.

In addition to the Internet information, IBM offers a number of services to help you choose the right solution: system assurance, formal design reviews, product demonstrations, executive briefings, and proof of concept work. Contact your IBM PC Server specialist or local marketing representative for more information on the services and support tools available to assist you in understanding how IBM PC Servers will coexist with your current environment and meet its growth requirements.

Expandability

Once you are sure the system you are considering is compatible with your current environment, you must consider your organization's strategic direction, as well as industry trends. Your dynamic organizational structure, as well as the fast moving computer industry, dictate that the best investment will be a system that is easily upgraded and expanded to exploit future technologies. The length a system's life can be extended depends upon its ability to grow and add capacity and new features.

IBM is focused on creating scalable products and services to meet the needs of customers in varied environments and to accommodate those environments as they grow and change. "IBM is offering customers a wide range of our hardware with the latest technology from our alliances," said Michael Coleman, general manager, IBM PC Servers. "We are addressing the needs of our customers by providing them with a new clustering solution that will help them maximize network flexibility."

A number of PC Server solutions and options are available, including PC Server 320 Internet Series, PC Server 310 Small Business Solution, and PC Server 500 System 390. Each of these integrated bundles addresses specific business needs with one "all inclusive" package. Individual IBM PC Server models include PC Server 520, PC Server 720, and PC Server 704. PC Server options include Enterprise Expansion Enclosure, SCSI Multi-Storage Enclosure, Ethernet Quad PeerMaster Adapters, and PC Server 780W Redundant Power Option. All of these options expand PC Server capabilities.

Reliability

After evaluating your options and determining that systems are both compatible with your current environment and expandable within your organization, you must assess the systems' reliability. You must be confident that these servers will support your mission-critical LAN with little or no downtime, as well as maintain data integrity throughout the system. You need assurance that these systems have been implemented in similar customer environments.

PC Servers' proven hardware technology platform has been implemented by some of IBM's largest customers across all industries around the world. The PC Server Web page includes a section of news stories that may include details of customer implementations. Your PC Server specialist can also share with you details from other customers' experiences with this hardware platform.

IBM backs its proven technology with service and support options that include standard warranty support and free PC Server Startup. IBM also offers a number of value-added and fee-based services—from a certification program to a support tool that comes with the PC Server.

Pre-Sale Decision Support

How can you assess the compatibility, expandability, and reliability of IBM's PC Servers?

Proof of Concept

Depending upon your needs, your IBM PC Server specialist can coordinate the appropriate IBM resources from the Personal Systems Competency Center (PSCC) to prepare "proof of concept" environments, which may include testing, integration, migration, configuration, and interoperability. In addition, the PSCC can test your applications on-site for status reporting, recommend software versions for compatibility and coexistence, and supplement this support with a formal design review. These services will assist you in systems design, systems assurance, and validation.

Systems Assurance

To further validate systems assurance, the PSCC is available (through your IBM PC Server specialist) to complete any systems assurance checklist that might be

Helpful Information Sources

IBM General Information
(800) IBM-3333 (426-3333)

IBM PC Company Automated Fax System
(800) IBM-4FAX (426-4329)

IBM PC HelpCenter
(800) 772-2227

IBM Personal Systems Support Family Marketing Center
(800) 799-7765

IBM Personal Software Solutions Services (SupportLine)
(800) 992-4777

AssistLine
(To find your local PC Server Specialist/IBM Marketing Representative)
(800) 753-4426

IBM Corporation
http://www.ibm.com

IBM PC Company
http://www.pc.ibm.com

IBM PC Servers
http://www.pc.ibm.com/servers/index.html

IBM Personal Systems Competency Center
http://pscc.dfw.ibm.com

IBM Software
http://www.software.ibm.com

included with the product. The PSCC will sign off on the validity and success rate of the proposed solution. The PSCC has skills in both hardware and software and can assess complete end-to-end solutions.

Product Information
Technical flashes, compatibility reports, technical product information, and service and support information are available on the PC Servers Web page. Additional information can be obtained through your local PC Server specialist as well as directly from the PC Company Automated Fax System. This system includes document catalogs for each product type, as well as a catalog covering announcements made during the previous 30 days.

Executive Briefings and Product Demonstrations
If you need assistance validating your system design to your organization's executives, IBM PC Server specialists can coordinate executive briefings and product demonstrations; executive briefings often require travel, while product demonstrations can typically be made on-site. Another method of obtaining information on the technical benefits of using PC Servers is the IBM PC Company Automated Fax System, as mentioned in the previous paragraph.

Post-Sale Decision Support
Now that you've purchased IBM PC Servers, where can you find assistance?

IBM ServerGuide
The IBM ServerGuide, shipped with every IBM PC Server, provides a number of utilities that ensure a simple and hassle-free installation, provide guided configuration and performance tuning, and offer systems management features. This tool helps you quickly and easily install Windows NT Server 3.51, NetWare 3.12 and 4.1, OS/2 for SMP, OS/2 Warp, LAN Server 4.0 Entry and Advanced, SCO OpenServer Enterprise, and device drivers.

TME 10 NetFinity 4.0, included on most versions of the guide, lets you proactively monitor and manage server and client systems with automatic alerts. You can also manage American Power Conversion Uninterrupted Power Supply (APC UPS)

equipment remotely with APC Power-Chute. Additional utility programs let you control access to software for maintaining passwords and other system settings.

Additional features include a "diskette factory" function that generates copies of reference diskettes and device drivers, plus an online library of technical reference information and system documentation.

PC Server Start Up Support
For assistance with installation, configuration, and performance tuning, take advantage of your initial 90 days of extensive PC Server phone support from the IBM PC HelpCenter. This extension of the standard HelpWare support included with your PC Server covers support for not only the PC Server hardware, but also the network operating systems (NOSs), popular network interface cards and adapters, and network clients. Supported NOSs include Microsoft NT, Novell NetWare, IBM OS/2 Warp Server, IBM OS/2 LAN Server, SCO UNIX, and Banyan Vines.

HelpWare Standard Support
In the event you encounter a problem with IBM hardware after installation, IBM's PC HelpCenter is available 24 hours every day for assistance on installation, configuration, and problem determination.

Personal Systems SupportLine
Specific IBM Personal Systems software questions can best be answered through SupportLine services. Information on contract options is available through the Personal Systems Support Family Marketing Center. Additional information and the technical support services are available through IBM Software Solutions Services, also available 24 hours every day.

Complex Solutions Support
If your solution requires complex consulting support, the PSCC may be able to assist by providing configuration and installation support, as well as capacity planning and performance tuning. The PSCC supports the following software running on IBM PC Servers:

- OS/2 Warp, OS/2 Warp Connect, OS/2 Warp Server, and LAN Server 4.0
- Lotus Notes
- Novell NetWare

- Windows NT, Windows 95, Windows 3.x, and Windows for Workgroups
- Internet Server

Contact your local PC Server specialist for more information.

Product Futures
Information on product futures and additional support information is available through your IBM PC Server specialist, the executive briefing centers (obtain information about the executive briefing centers from your PC Server specialist), and the IBM PC Company Automated Fax System.

Complete Solution
IBM's PC Server hardware platform provides compatibility, expandability, and reliability. IBM PC Servers make up an essential part of proven customer solutions, made possible through the services provided by the IBM PC Company, the PSCC, and other IBM organizations. IBM is committed to providing a variety of pre-sale and post-sale options to assist you in validating and supporting your hardware and software purchases.

IBM has many years of experience in providing complete solutions for complex systems environments and has one of the largest networks of experts skilled in capacity planning, multiplatform integration, systems and application development, systems assurance, and performance tuning. Let us help you assess your system options and implement the best PC Server solution for your environment.

Lisa Wikenczy is a marketing support representative in IBM's Personal Systems Competency Center, Roanoke, Texas. She is currently the team leader for the Lab Advocate program. Previously, she spent two years working as a team leader for the IBM Software Solutions Services call center, Personal Software Products division, Austin, Texas. Lisa joined IBM in 1993 after earning a BS in Merchandising Management and a BA in English from Michigan State University. Her Internet ID is 1mw@vnet.ibm.com.

IBM PC Server Solutions for Today's Network Computing Environments

By Susan Davi

As network computing technology emerges at an ever increasing rate, new standards and options become available, and users face difficult choices in integrating complete client/server solutions to run their businesses. Customers and resellers are demanding total packages— complete solutions to simplify installation and reduce overall service and support costs. IBM's complete PC Server solutions meet this challenge.

For network computing solutions to be successful in today's dynamic technology environment, they must be:

■ *Easily available*—Solutions that are packaged with all the hardware and software components needed to install a complete, ready-to-use solution

■ *Easily installed*—Tested and approved components with software installation assistance (at a minimum, instructional road maps)

■ *Cost effective*—A solution where the total package is priced lower than the individual components

IBM currently offers five PC Server solutions centered around network computing. These packages are client/server-based and address the growing areas of the Internet, small business, and clustering:

■ PC Server Internet Series

■ PC Server Small Business Solution

■ PC Server High Availability Solution

■ Lotus Notes bundle

■ ServerGuide

Server Internet Series

The World-Wide Web brings network-centric computing to businesses and home consumers throughout the world. Users are flocking to the Internet in growing numbers, encouraged by the World-Wide Web's ease-of-use and ready access to all kinds of information. Because of this increased use, the number of Internet servers continues to grow.

Corporate and consumer users are demanding a Web presence from the companies with which they do business. Whether shopping for vehicles, evaluating insurers, or just browsing at their favorite snack-food's Web site, today's—and more importantly, tomorrow's—users will turn to the Web to reach companies they find interesting.

At the same time, corporations are finding that using Web browsers and servers within their organizations provide a simple and friendly way to share information such as text and graphics among "intranet" users on multiple platforms.

IBM's PC Server Internet Series provides small- to medium-sized businesses an easy, affordable, and secure Internet presence without needing to acquire, install, and integrate individual components. These bundles provide an entry-level Internet server solution with the potential for considerable growth and expansion. Each package comes with a PC Server 320, Web server software for the OS/2, SunSoft Solaris, or Windows NT platform, plus end-user documentation and integrator documentation—a ready-to-build solution for quick installation (Figure 1). All you need to add is your favorite connection to the Internet.

IBM has tested and supports each component and will serve as a single point of contact for service.

After an easy installation, you can quickly and efficiently create a World-Wide Web server as a base for customized solutions— one that fully supports key Internet and World-Wide Web standards such as hypertext transfer protocol (HTTP), hypertext markup language (HTML), Java, and secure sockets layer (SSL). Additionally, you can use the SunSoft solution to create a domain name server (DNS).

The Web presence you create with the PC Server Internet Series will be able to handle queries from Internet users anywhere in the world via industry-standard browsers such as IBM's OS/2 WebExplorer and Netscape's Navigator. The OS/2 package also allows HTML browser access to CICS and DB2 applications.

Operating System	Internet Software
OS/2 Warp Server (available as separate components outside the US and Canada)	IBM Internet Connection Secured Server (with CICS and DB2 Gateways)
SunSoft Solaris	Netscape Commerce Server
Microsoft Windows NT Server	Netscape Commerce Server

Figure 1. IBM PC Server Internet Series
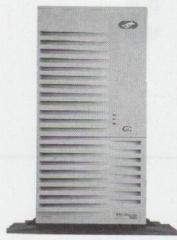
Figure 2.
PC Server 310
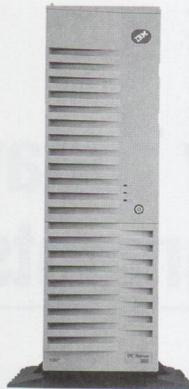
Figure 3.
PC Server 320

The flexible and powerful IBM PC Server 320 (8640-ODV) has an array of installation and support utilities, making it one of the industry's smartest server choices. Its components include:

- 133 MHz Pentium Processor and ZIF socket for symmetric multiprocessor (SMP) upgrade

- 16 KB L1 cache

- 256 KB write-back L2 cache (upgradable to 512 KB)

- 16 MB 70 ns parity memory (expandable to 256 MB)

- Error-correcting code (ECC-on-SIMM) memory options available

- Peripheral component interconnect (PCI) bus support

- Extended industry standard architecture (EISA) bus support

- Eight slots (two PCI, five EISA, and one combination)

- Nine bays (six half-high and three slim line)

- PCI fast/wide SCSI controller

- 2.25 GB 7200 rpm fast/wide SCSI hard disk drive

- Quad speed CD-ROM drive

The IBM PC Server 320 also comes with an easy installation option and access to IBM's HelpCenter, simplifying your implementation tasks and responsibilities. You'll receive 90 days of enhanced support for servers and some third-party elements, plus a three-year, on-site limited warranty on IBM's hardware components.

PC Server Small Business Solution

Technology is critical to help small businesses meet their internal needs as well as those of their customers. PC networks are emerging as one of the primary tools for increased productivity in small businesses. As network functions increase and costs continue to decrease, more small businesses are "getting connected." They do, however, face the challenge of selecting hardware and software solutions that are simple to use and maintain, support their current business requirements, and provide growth capability.

The small business client/server environment often consists of one PC as a centralized server, with other PCs as clients, linked through a network operating system such as Novell's NetWare and Artisoft's Lantastic. These networks are primarily used for sharing resources such as printers, storage devices, and files.

For years, large organizations have taken advantage of networks to share resources, which increases productivity and makes critical information readily available to those who need it. Now, small businesses can benefit from a networked computer environment that enables several end users to work simultaneously on the same data and still maintain data integrity.

IBM has teamed with Novell and Cheyenne to create two solutions that are just right for the small business market: the PC Server 310 (for five to 15 users) and the PC Server 320 (for businesses and departments with 15 to 100 users). Both solutions feature an easy-to-use, CD-ROM-based installation that consolidates all server network operating system software and desktop productivity applications. In addition, each package provides:

- Affordability—Less expense than separately purchasing each component

- Name brand hardware and software—IBM hardware with Novell and Cheyenne software

- Technical support—Industry-leading, 90-day Server Startup support

- Five languages—English, French, German, Italian, and Spanish

PC Server 310

This package (Figure 2) combines selected PC Server 310 models (8639-0ZT and --0DT) with a Novell network operating system and supporting network software. It includes:

Hardware:

- Pentium 100 or 133 MHz microprocessor

- 256 KB L2 adaptive write-back cache

- PCI SCSI-2 fast controller card

- Quad-speed CD-ROM drive

- 1.44 MB diskette drive

- 1.08 GB (5400 rpm) SCSI fast hard drive

- Ethernet LAN card

- ServerGuide

Software:

- Customization/installation utility diskette

- Quick and easy installation instructions

- CD-ROM library of network software (by language)

  - Novell NetWare 4.1

  - Novell GroupWise (e-mail, scheduling, and messaging)

  - Cheyenne FaxServe (server controlled fax service)

  - PerfectOffice suite of desktop productivity tools (WordPerfect, QuattroPro, Presentations, Envoy, InfoCentral, and GroupWise client)

  - TME 10 NetFinity (systems management software)

There is an optional 6- to 15-user Additive License for NetWare, GroupWise, and FaxServe.

PC Server 320

This solution (Figure 3) provides the logical step for small and general businesses supporting from 15 to 99 users. It has all the functionality plus the same ease of use and installation as the PC Server 310 solution but contains a richer set of functions, including:

Hardware:

- Pentium 66 or 133 MHz microprocessor

- 256 KB L2 adaptive write-back cache

- 32 MB EOS memory, upgradable to 256 MB

- Optional PCI and EISA slots
- PCI SCSI-2 fast controller card
- Quad-speed CD-ROM drive
- 1.44 MB diskette drive
- 2.25 GB hard drive

Software:

- GroupWise to support both local and remote e-mail
- NetWare Connect Server for remote network access
- NetWare Connect Services Client for complete Internet access with Netscape Navigator
- Cheyenne's ARCServe tape backup software
- Cheyenne's InocuLAN Server anti-virus software
- Lotus SmartSuite (Freelance, Word Pro, 1-2-3, Approach, Organizer)

Note: Exact specifications of the IBM PC Server 320 Small Business Solution may have changed since publication of this article; please see the IBM PC Server Web page at http://www.pc.ibm.com for current information.

PC Server High Availability Solution for OS/2 Warp, Windows NT, and Novell NetWare

As companies rely more and more on PC servers for mission-critical applications, they want servers that are *scalable* (i.e., capable of handling increasing workloads) and can guarantee high availability (a minimum of downtime). Clustering very often can provide these functions.

The term clustering can describe different types of server arrangements. A *cluster* may be defined as a two-server setup where one server provides backup for a primary server. Servers also can be clustered to share workload by sharing system resources such as memory, storage, I/O devices, and communication adapters, allowing the workload to be balanced between the servers. As more servers are added to the cluster, the clustered systems can handle more capacity, growing incrementally.
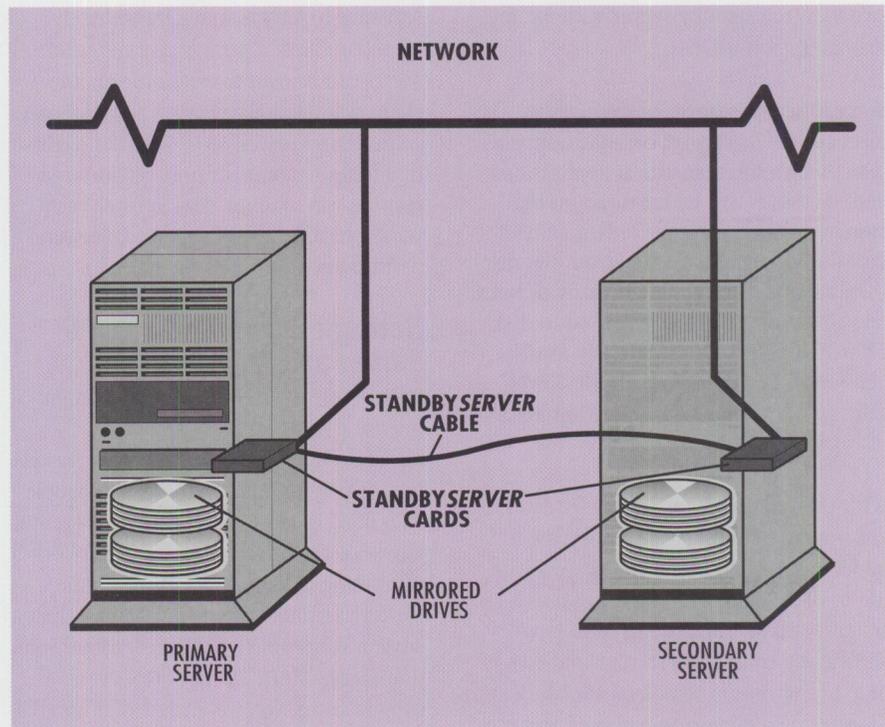
Figure 4. Mirroring with Vinca's StandbyServer

During the next few years, IBM is delivering clustering technology in three distinct phases:

- *Phase I* provides "clustering for high availability"—clustering two or more servers to work together to provide a system in which a secondary or backup server takes over the processing for a primary server that fails (failover). This type of clustering eliminates loss of end-user productivity caused by server downtime.

- *Phase II* will focus on "scalable clusters" and include technologies such as high-speed I/O interconnects for fast, flexible access to storage devices. It will also include software for cluster management and workload distribution among multiple nodes in a cluster. These scalable clusters will let you run programs with larger databases on PC Servers and provide an easier incremental growth path.

- *Phase III* will focus on "high-performance clusters" and include improvements in both interconnect and management technologies such as high-speed transports and seamless cluster management. Through these hardware and software improvements, you will be able to migrate LAN-based clusters to the world of parallel processing.

IBM's PC Server High Availability Solution for OS/2 Warp Server, Windows NT, and Novell NetWare addresses Phase I clustering. The solution consists of Vinca Corporation's StandbyServer 32 software, IBM's PCI 100/10 Ethernet adapters, and connecting cable. With this solution, you can achieve maximum availability for your business-critical applications and data quickly, easily, and cost-effectively. This solution lets you implement an online standby server that takes over—without rebooting—if your primary server experiences a hardware or software failure. In virtually all circumstances, you will experience only a momentary delay. What's more, in most cases, you can maintain your network connections without having to log on again. This means you can achieve a high level of fault tolerance for networks with more flexibility than other solutions on the market today.

IBM's PC Server High Availability Solution provides real-time, transaction-based data mirroring via a dedicated link between the primary server and the standby server (Figure 4). Since the mirrored data travels over a dedicated Ethernet connection, the system adds no traffic load to your network. If the primary server fails, the IBM PC Server High Availability Solution will automatically

switch to the standby server without any manual intervention.

You can set switchover parameters to meet the needs of your organization and select which mission-critical applications and databases will be mirrored on the system. Users experience only a momentary delay during the switchover. Because the data is written simultaneously to both machines, any information saved to disk prior to a failure is immediately available–including data in open files. Typically, users will lose only a few minutes of work, if any.

With this solution, your primary server and your standby server do not have to be identical. Many companies extend the life of older equipment by using it as a standby server. You only need to have sufficiently configured storage and compute power on the standby server to handle your data mirroring and performance requirements. The IBM PC Server High Availability Solution runs on all PC Server 320, 520, and 720 models. And with support for three major operating systems (OS/2 Warp Server, Windows NT, and Novell NetWare), you can standardize on the IBM PC Server High Availability Solution as your maximum availability solution, even in multiplatform environments.

You can set up your standby server to act only as a passive backup machine that monitors your primary server and receives data continuously but performs no other functions on your network. Or you can implement your solution with a utility server running functions such as printer, database, or communications services while in the standby mode. In the event of a failure, the standby server automatically takes over the functions of the primary server in addition to its utility services. This option allows you to implement network services load balancing and maximum availability on the same secondary server.

A comprehensive LAN management system that lets LAN or systems administrators know exactly what's happening on each server, both primary and backup, as well as on all attached PCs is essential to integrating failover solutions. The IBM PC Server High Availability Solution works with TME 10 NetFinity management

software to let you know immediately when you have a primary server failure. Alerts can be sent to a local or remote client workstation–even over an Internet connection–as well as to a digital pager. In addition, administrators of clustered systems can monitor the status of each server, balance workloads, and fine-tune performance.

Network Computing with PC Server and Lotus Notes

Businesses involved in network computing use connected LANs and WANs anchored by powerful and reliable servers that distribute information to the people who need it. Most enterprises will eventually base their operations upon network computing. To take advantage of this exciting technology, you need more than advanced hardware, you need a total solution–Lotus Notes on IBM PC Servers. A copy of Lotus Notes is included at no additional charge with every IBM PC Server.

By combining client/server messaging and global access and distribution on the World-Wide Web, Lotus Notes provides an ideal communications infrastructure. Users can communicate with colleagues, collaborate in teams, and coordinate strategic business processes within and beyond their organizational boundaries to achieve dramatically improved business results. With Notes, organizations can integrate, analyze, and apply information– whether it comes from e-mail, a relational database, a desktop application, or on the Web–to become more efficient, effective, and competitive.

Lotus Notes 4.1 provides built-in Internet integration. End users can browse the Web and seamlessly incorporate HTML documents into Notes documents using the InterNotes Web Navigator. And InterNotes Web Publisher enables businesses to create, manage, and administer their intranets and public Web sites by using application development facilities to easily build and host Internet home pages and applications.

The new Domino server technology transforms Lotus Notes into an Internet application server, allowing any Web client to securely participate in Notes applications. By bridging the open networking environment of Internet standards and protocols with Notes' powerful application

development facilities, Domino lets you rapidly develop a broad range of business applications for the Internet as well as intranets.

Domino works with existing Notes 4.x Servers, including Notes 4.1. The Notes 4.1 Server includes capabilities and services that, when combined with the Domino technology, transform the Notes server running on IBM PC Servers into an integrated Internet application server. The Notes server reduces the cost of managing a Web site with a high volume of pages; gives developers a full breadth of application development facilities to create high value Web applications; and acts as a reliable infrastructure for corporate intranets by seamlessly integrating with other information system resources. Notes also extends mature functionality to standard Web browsers through its robust application services, broadening the reach of IBM PC Servers to more users within and beyond the enterprise.

Together, IBM PC Servers and Lotus Notes provide a powerful combination of hardware and software–a single solution for messaging and groupware–that integrates easily with the Internet. This combination provides outstanding scalability in number of users supported, integrating multiple platforms, applications supported, and much more, all built on proven IBM and Lotus technology.

The PC Server 720, tested using the recently introduced Lotus NotesBench benchmarking tool (which provides a methodology and tools for measuring Notes server performance), demonstrated the ability to support 1,500 active mail users on a 4-way SMP system running Notes 4.1 for Windows NT and configured with two Intel Pentium 133 MHz processors, two Intel Pentium 166 MHz processors, 640 MB memory, and 10 GB disk storage.

This test demonstrates the capability of the PC Server 720 to support heterogeneous processor speeds and achieve optimal performance while protecting your investment. NotesBench testing is ongoing with additional workloads, server hardware platforms, and hardware/software optimization.

ServerGuide 3.0

How long did it take you to set up your last server? First, you tried installing the operating system; then, you determined what level of hardware you had so you could find the correct device drivers, BIOS levels, and patches; and finally, you were able to install the network software and more device drivers. Not a simple task!

IBM's ServerGuide provides you with hassle-free setup by taking the guesswork out of installing a server. Advanced hardware detection determines what disk controllers and network cards you have and installs the operating system with the necessary drivers. Not only does ServerGuide save you time and money during setup, it also helps reduce the cost of system ownership by giving you consistent installations across all your network servers.

Everything you need for getting started with your server is accessible in one package: a CD-ROM library with your choice of operating systems, network software, network management software, plus a complete set of online documentation for assistance and reference.

Activities for which you might use ServerGuide include:

- Install operating systems from the CD-ROM library

- Install operating system software that you already own

- Use utility programs directly from the CDs

- Build diskettes with the latest device drivers, BIOS, or service fixes for your hardware or operating systems

- Use the latest set of online documentation, which includes the latest revision of Server Integration Guides to assist you with tuning tips, problem solving, or configuration questions

- Install TME 10 NetFinity to manage your server and clients

Currently, the IBM ServerGuide CD-ROM library includes the following operating systems and application software:

- OS/2 Warp with WIN-OS/2 and the following programs:

  –CompuServe Information Manager for OS/2

  –IBM Works and Personal Information Manager

  –FaxWorks for OS/2

  – HyperACCESS Lite for OS/2

  – IBM Internet Connection for OS/2

  – IBM Multimedia Viewer

  – Video IN for OS/2

  – IBM Person to Person for OS/2

  – System Information Tool

- OS/2 2.11 SMP (1 to 2 CPUs and 1 to 7 CPUs)

- LAN Server 4.0 Entry and Advanced

- TME 10 NetFinity 4.0 Manager for OS/2, Windows 95, Windows 3.1, and Windows NT

- TME 10 NetFinity 4.0 Services for OS/2, Windows 95, Windows 3.1, Windows NT, and NetWare

- Novell NetWare 3.12, 4.1, and 4.1 SMP

- Windows NT Server 3.51

- SCO OpenServer Enterprise 3.0 and SCO Multi-Processing Support

- Utilities that simplify SCO OpenServer 5.0 installation

- APC Powerchute Plus

This list is continually growing to provide the latest operating systems and applications that can enhance your server environment. For instance, the next release of ServerGuide will contain Lotus Notes Server, unencrypted—no activation key required—to give you one of the hottest applications for groupware and the Internet. We are also working to include the latest releases of OS/2, NetWare, and Windows NT, in addition to improving the ServerGuide's design so it will be easier to use and provide user requested functions.

In this vein, the next version of Server-Guide will be a complete product rewrite focused on usability features and simplifying your server setup. The areas on which we are concentrating include:

- Guided hardware installation that automatically detects the hardware setup in your server, then takes you step-by-step through the installation process to ensure that the hardware installation is completed quickly, accurately, and without guesswork. The new process will give you complete control over installation.

- New flexible software setup that lets you install all network operating products by either using a ServerGuide activation key or installing a previously purchased license (e.g., shrink-wrap, site license, etc.).

- New, faster, easier to use diskette factory with a graphical front end, organized into categories to make it easy to locate the latest device driver or utility. The diskettes will also be built much faster.

- ServerGuide Application Installer, a CD-ROM used after the NOS is installed, will provide you with applications to enhance your server with more complete solutions.

These enhancements will ensure that your server installations are trouble-free and provide you with more consistency across your network to help reduce the total cost of ownership of your IBM PC Servers. Combined with the robust server management you get with TME 10 NetFinity, you will have everything you need to keep your IBM PC Servers up, running, and under control in today's network-centric environments.

For the latest updates on IBM PC Servers and other IBM products, visit our Internet site at http://www.pc.ibm.com.

Susan Davi, a member of the IBM PC Server Solutions team, is the product administrator for solutions involving small businesses, Lotus, and networking. Before joining the Solutions team, she was with Networking Systems, providing technical planning and marketing support for NetFinity, SystemView for AIX, and Systems Monitor for AIX. Prior to that, she was a systems engineer with Federal Systems Division supporting NASA and government projects. Susan was also a communications-electronics officer in the United States Air Force.

Kirkland Programming Center– IBM's Link to Microsoft

By Avalyn Pace

As director of IBM's Kirkland Programming Center (KPC) located outside of Redmond, Washington, Roy Clauson developed the center from initial concept to its present role–ensuring the compatibility of IBM hardware with Microsoft software. Avalyn Pace, IBM Personal Systems Competency Center interface to KPC, talks with Clauson about the center's objectives and development.

Pace: *Roy, let me first thank you for agreeing to this interview. Our audience for this issue of* Personal Systems *includes current and prospective PC Server customers. With the increased focus on implementing Windows NT as a network operating system (NOS) platform, our relationship with Microsoft and, more importantly, the added value we gain from that relationship becomes a crucial point. Would you give us a general overview of your mission at the Kirkland Programming Center?*

Clauson: Our responsibility in Kirkland is to ensure that all Microsoft software works well on IBM's hardware platforms. This means early involvement in the design cycle, timely adaptation and porting, development of complementary software and drivers, extensive testing, and performance optimization.

Pace: *I was surprised to learn that Kirkland was established several years ago. Give us a little history on the center's origins and some of your accomplishments.*

Clauson: The Kirkland team was initially formed to work on porting NT to the PowerPC. The work started in January 1993, using Windows NT 3.1. We successfully shipped Windows NT 3.51 on IBM's PowerPC-based machines last June [1995]. We also ported Microsoft's Word, Excel, and Visual C++ products to the PowerPC architecture.
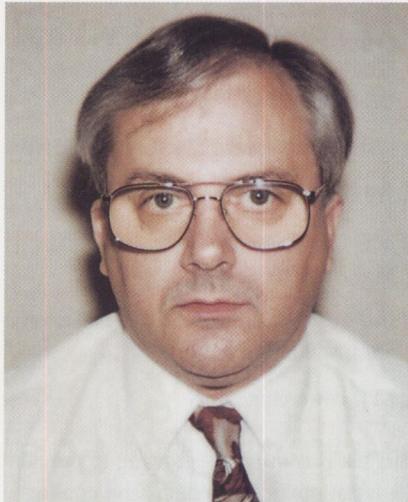
Roy Clauson, Director of IBM's Kirkland Programming Center

Pace: *That doesn't sound like a small effort. Please describe your organization for us.*

Clauson: The organization comprises six functional units: planning, business operations, development, testing, customer technical support, and defect support. The planning group is responsible for interlocking Kirkland's software plans with IBM's hardware groups' plans. The operations unit keeps the physical facility running in a cost efficient manner and manages my budgets.

The development and test teams are responsible for the porting efforts, as well as developing and testing new software, drivers, and HALs [hardware abstraction layers]. Our technical support people help IBM's marketing and sales teams "win"

NT–no pun intended–business for IBM, and our defect support team provides Level 3 support to IBM's HelpCenters around the world.

Approximately 120 people worked on our PowerPC team last year. With the addition of the PC Server mission, we are currently hiring and should be at 190 people by the third quarter this year.

Pace: *What about the facilities to house and support Kirkland personnel?*

Clauson: The Kirkland facility is located five miles from Microsoft's Redmond campus, allowing quick access to the Microsoft team. This is important, since many of my team members are on the Microsoft campus daily attending "bug fix" meetings, diagnosing problems, writing code, etc.

KPC's facility currently covers 30,000 square feet and is expanding to 50,000 square feet by year end. It houses offices, test labs, porting labs available to independent software vendors and customers, and customer briefing facilities.

We have intentionally tried to recreate the Microsoft work environment at our facility, and we have direct, high-speed data links between Microsoft and our facility that allow for instant access to key databases residing on Microsoft servers. I believe that because of this, we have been able to build a strong team that is well integrated with Microsoft.

Pace: *Let's talk about how you work with Microsoft. Can you describe the relationship?*

Clauson: Overall, the relationship between Microsoft and Kirkland is very strong. As I mentioned earlier, we are very much a part of the Microsoft team.

We attend and receive work from the daily "bug" meetings. Microsoft relies heavily on the testing that we do—the results are recorded in Microsoft's databases by KPC people. We have key contacts in their organization who help keep the communications channels between our companies open and information flowing.

Pace: *Do you view your relationship with Kirkland as a competitive advantage?*

Clauson: Absolutely, there is no question about it. Good systems are made up of good software and good hardware. Each component has to know what the other is doing in order for the system to perform well and appear integrated to our customers. Without the relationship we have here with Microsoft, our systems would never perform as well as they could.

Pace: *Can you share some of your current plans/efforts?*

Clauson: We have spent the last few months heavily engaged with the PC Company development teams to synchronize Microsoft's Windows NT plans with the future PC Company product plans. We are developing driver support and new HALs. We are working on easier install procedures. We are also looking outside

Kirkland Programming Center, Redmond, Washington

for software value-add packages that will make our systems more attractive to our customers.

Pace: *Is there anything else you would like to share with our readers?*

Clauson: Establishing the Kirkland Programming Center has been one of the best assignments I've ever had in IBM. The team members are great people and among the best I've ever had the opportunity to work with. We are committed to the concept that "the marketplace is the driving force behind everything we do," and we are here to provide what IBM's customers want.

Our motto is "just do it," and our team members exercise this kind of spirit daily. We are fully committed to making IBM a success by making our customers totally satisfied with our work products.

Avalyn Pace is an advisory marketing support representative in IBM's Personal Systems Competency Center, Roanoke, Texas. She is currently part of the PSCC PC Server team providing pre-sales technical support and assistance. Avalyn also serves as interface to the Kirkland Programming Center for the PSCC and is responsible for information sharing.

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Going Mobile: Part Deux

By Bob Angell

Bob Angell, consultant with Applied Information and Management Systems (AIMS) in Salt Lake City, continues his mobile computing journey, sharing his experiences with using TCP/IP to connect his mobile computer to his office docking station and RS/6000.

When I first pursued my "going mobile" project (see part one of "Going Mobile" in *Personal Systems'* July/August 1996 issue), I thought it was going to be an easy, "slam-dunk" process. However, implementing the appropriate solutions has provided me with quite an education when it comes to transmission control protocol/internet protocol (TCP/IP), network file system (NFS), point-to-point protocol (PPP), network printing, and other related obstacles.

Let me recap my office setup. I eliminated a single desktop workstation and purchased a RISC System/6000 (to be an interactive development platform/server running AIX) and a ThinkPad 755CE/Dock Station II combination. I put the docking station's 4.3 GB small computer system interface (SCSI) drive into the RS/6000, put a 1 GB SCSI drive on the docking station for local storage (to get around an annoying problem with extended attributes that I will discuss

later), then networked the RS/6000 and the docking station together. I also set up this configuration so that all print jobs are routed to the printer connected to the RS/6000.

All these services (except the docking station storage and data) are available when I telephone the office while on the road (without the ThinkPad, there is no CPU to facilitate this).

TCP/IP is a networking strategy for connecting computers running like or different operating systems (DOS, OS/2, UNIX, MacOS, etc.) to each other. It was developed many years ago to connect
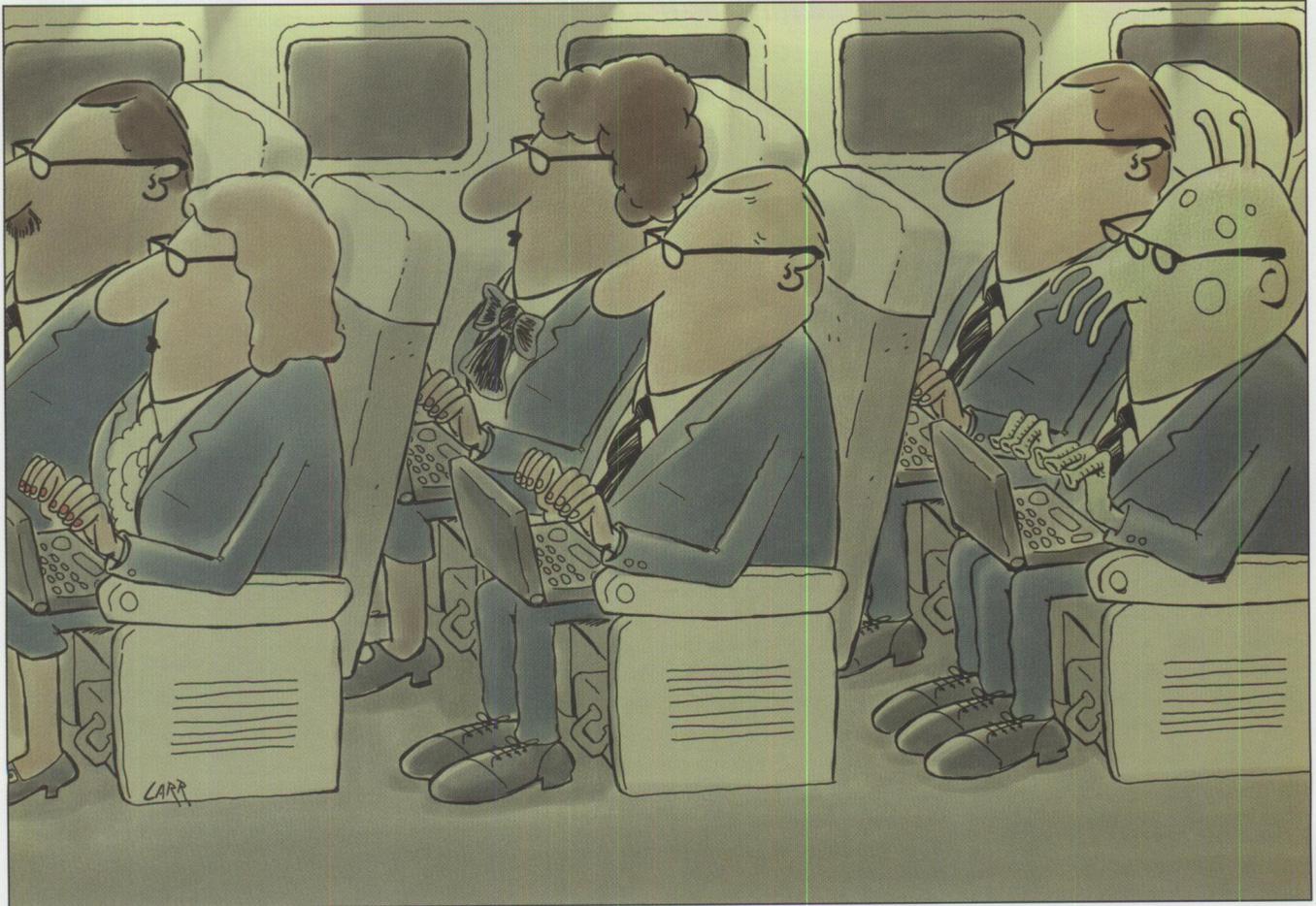
different computers and operating systems on the Internet.

Note: This is just a brief discussion on TCP/IP—there are many books written on this subject at your local library or bookstore, as well as numerous articles on the World-Wide Web. In addition, *Personal Systems'* March/April 1995 issue includes an in-depth article by Phil Lieberman: "TCP/IP: How it Works."

Computers using TCP/IP networks are known as *hosts* (or *nodes* in other networking lexicons), and all take on specific names as well as special internet protocol (IP) addresses. IP addresses consist of four groups of numbers separated by periods and are used to route messages, work, and other necessary information from machine to machine. For example, in my case, the RS/6000's name is Denali, the ThinkPad's name is Everest, and another server is called Hood. Denali's IP address might be 192.178.16.1.

TCP/IP is the "software glue" that connects these machines so that I have access to my data while I'm in the office or when I'm on the road. I use the built-in PPP and TCP/IP that comes bundled with OS/2 Warp Connect to dial into the office. This would be sufficient for the in-office network except that I need the NFS piece that is found only in the full TCP/IP 2.0+ package. (NFS is now included with OS/2 Warp Server—a less expensive alternative.) Once connected via modem, I can use my data loaded on the ThinkPad and RS/6000 simultaneously.

With TCP/IP connecting everything, I can be working at a customer site, use a word processing application installed on my ThinkPad, load my word processing file from the RS/6000, make changes, then print locally at the customer site and/or remotely back at the office—it doesn't matter whether I am in the office or across the world. This capability makes TCP/IP and its related tools (PPP, NFS, etc.) my "friends."

As I make the RS/6000 a full-time member of the Internet community in the next few months, I will have even more ways to access, use, and disseminate my data. Part of AIMS' expertise is designing, developing, and implementing database systems for clients, potential customers, and internal use. With my "going mobile" project thus far, AIMS can access basic data (word processing, spreadsheet, utility files, etc.); however, we don't yet have the ability to retrieve information from our databases. The next part of this project will focus on remotely accessing the RS/6000 database.

As I mentioned earlier, although OS/2 Warp Connect on my laptop allows me to remotely access most of what I need, extended attributes (EAs) do create some limitations. When a file is written to the hard disk, OS/2 creates an EA, a special index OS/2 uses to quickly find a file on the hard disk. DOS, UNIX, and other operating systems do not use EAs; thus sharing data from one operating system to another becomes a problem.

With TCP/IP connecting everything. . .it doesn't matter whether I am in the office or across the world.

The NFS I am currently using to store data on the RS/6000 does *not* support EAs. If I were using OS/2 Warp Server or another network solution, the EA problem would not exist. Because some of the software I use daily depends heavily upon OS/2's EAs, it is a bit tricky to use this information remotely (or in the office when connected to the network).

To get around this EA problem, I am going to implement local storage in the docking station. Having local storage in the docking station provides the flexibility for the office, but I am still limited remotely. In the future, I will use OS/2 Warp Server on a new machine (probably a small, compact-sized server) and place

all the necessary OS/2 storage there, thus eliminating the EA problem.

Another possible way around the NFS/EA limitations is a Distributed Computing Environment/Distributed File System (DCE/DFS) solution. This is an advantage OS/2 Warp Server's file system has over AIX/NFS. I will talk about this in my next article.

My phone system was also an obstacle to going mobile. I had to devise a way for the telephone (data line) to determine whether my ThinkPad had dialed into the office or a fax was arriving. After some research, I found an inexpensive electronic device for analog telephone lines that intercepts calls placed to the fax machine or to the modem. This device is about the size of a small modem. It plugs into the outgoing phone line, then the modems and fax devices are plugged into it. The device "listens" for the sounds that fax machines and modems make on incoming calls and routes them to the proper machine.

In my next "Going Mobile" article, I will continue to discuss the advantages and pitfalls of accessing data from the road, talking about DCE/DFS, DB2/6000, DB2/2, and other successes and failures I've had with this setup.

Bob Angell is a principal with Applied Information and Management Systems (AIMS) in Salt Lake City, Utah. A management consulting firm, AIMS specializes in management information systems integration, OS/2 and RS/6000 development and integration, total quality improvement engineering, and other related services. Bob's specialties include multiplatform data integration, database design and development, simulation and modeling of complex environments (neural networks), and cross-platform software development. Bob can be reached through the Internet at bangell@cs.utah.edu.

Lotus Notes Training from IBM

If you're interested in learning Lotus Notes Release 4, take advantage of the educational opportunities offered by IBM Education and Training (E&T), which are specifically designed for end users, application developers, and system administrators. E&T offers courses (open either to the public or as privately scheduled classes) on Notes Release 3 to Release 4 migration, Notes Release 4 application development, and Notes Release 4 system administration.

For those of you who prefer to train at your own pace and convenience, IBM E&T also offers Computer-Based Training (CBT) courses developed by CBT Systems under the direction of Lotus Corporation. These courses simulate the Notes environment and include practice questions. Please note that although only a few CBT courses are listed with their corresponding classroom courses, many more are currently under development and will be available at the time of this printing.

Additional courses are scheduled for release during the fourth quarter of this year.

To enroll in the courses listed or to purchase CBT courses (as well as receive current information on their availiability), call (800) IBM-TEACh (426-8322). To receive current class schedules and locations via fax, call (800) IBM-4FAX (426-4329) and request document 0007.

Release 4 Application Development	Course Number	Duration (days)	Corresponding CBT Courses
Lotus Notes Release 4 Application Development 1 Through hands-on labs, this course presents basic principles, concepts, and tasks of Notes application development. Learn how to design, build, and test a single database Notes application, then enhance and modify it to incorporate advanced Notes features and functions.	LD410	3	**CLD41A0B**–Creating a Notes Database **CLD41BOB**–Form Design Techniques
Lotus Notes Release 4 Application Development 2 This course builds upon the principles of Notes application development presented in Application Development 1. Through hands-on labs and lectures, learn to build a multi-database Notes application that automates workflow between departments. The course focuses on applicationwide implementation versus database-centric implementation.	LD420	4	
Lotus Notes Release 4 Introduction to the Notes Object Model This course provides an overview of the Notes object environment and explores the Notes classes and objects. Through lectures and hands-on experience, learn to extend application functionality using Notes objects.	LD450	2	
Lotus Notes Release 4 Application Development 3 This course builds upon the application development skills taught in Application Development 1 & 2 and Introduction to the Notes Object Model courses. Through lectures and hands-on experience, learn to add programming language functionality to enhance applications. You will build an enterprise-wide Notes application that encompasses multiple databases, departments, and tasks within and outside of Notes.	LD430	3	
Lotus Notes Release 4 LotusScript Language Fundamentals This course introduces the structures and syntax of LotusScript. Using a neutral environment, you will practice using a structured programming language to create simple programs. (This course does not teach programming concepts, object-oriented programming, or product-specific objects, methods, or properties.)	LD440	2	

Release 4 System Administration	Course Number	Duration (days)	Corresponding CBT Courses
Lotus Notes Release 4 System Administration 1 This course provides, through lectures and hands-on exercises, a solid foundation for the Notes system administrator. You'll gain in-depth experience in setting up, operating, and maintaining Notes servers and client workstations.	LA410	4	
Lotus Notes Release 4 System Administration 2 This course provides hands-on experience in server monitoring and statistics, database management, cross certification, multiple domain management, and extending Notes communications.	LA420	3	

Release 4 End User	Course Number	Duration (days)	Corresponding CBT Courses
Lotus Notes Release 4 Fundamentals Through hands-on experience and lectures, this course introduces you to Lotus Notes. You will learn to navigate Notes, use Notes documents and Notes Mail, as well as customize your mail environment. (This course is offered by Catapult. Call [800] 257-2079 for details.)	None Needed	1	**CLN4700B**–Moving to Notes Release 4: Basic User 1 **CLN4710B**–Moving to Notes Release 4: Basic User 2 **CLN4200B**–Moving to Notes Release 4: The Mobile User
Lotus Notes Release 4 Intermediate You will learn, through hands-on experience and lectures, to do Notes database searches, share information between databases, and administer and automate basic Notes tasks. (This course is offered by Catapult. Call [800] 257-2079 for details.)	None Needed	1	**CLN42B0B**–Moving to Notes Release 4: The Power User **CLN42C0B**–Lotus Notes Release 4 and the Net **CLN4800B**–Moving to Notes Release 4: Using Notes Mail

Release 3 to Release 4 Migration	Course Number	Duration (days)	Corresponding CBT Courses
Lotus Notes Application Development Update 1 Through lectures and hands-on exercises, learn how to build a single-database application using the new Notes Release 4 features. This course focuses on new design elements that don't require high level programming skills and teaches you to use features such as actions, agents, and navigators.	LN430	1	**CLN43A0B**–Creating a Notes Release 4 Database **CLN43B0B**–Enhancing a Notes Release 4 Database
Lotus Notes Application Development Update 2 You will learn to design and enhance a multi-database application using new Notes Release 4 features and functions. Lectures and hands-on exercises teach you how to apply Notes Release 4 design elements introduced in the Application Development Update 1 course and add new Release 4 features to create more complex workflow in your applications.	LN440	1	
Lotus Notes System Administration Update Lectures and hands-on exercises will introduce you to Notes Release 4's new features and functionality, with emphasis on system administration tasks. Learn about Notes Mail, replication, security, installation, and configuration of Notes Release 4 servers and clients, statistics monitoring and reporting, multiple domains, and database management.	LN450	2	
Lotus Notes Release 3 to Release 4 Migration This course guides Release 3 system and database administrators in planning and deploying Release 4 on their existing Release 3 networks. Through lectures and hands-on experience, you'll learn to implement the key migration tasks. (This workshop does not cover converting Release 3 databases to Release 4 databases.)	LN460	3	

The IBM PC Server 704

This article presents an architectural and functional view of the IBM PC Server 704. Topics include Pentium Pro technology and implementation, ECC memory subsystem, disk subsystem, and systems management.

Different applications and environments require PC servers with varying levels of performance, scalability, and fault tolerance. IBM markets a complete family of PC Servers (shown in Figure 1) to address the spectrum of system requirements, ranging from small, entry-level systems to enterprisewide systems supporting thousands of users.

Kazunao Teraoka
IBM Japan
Tokyo, Japan

Mike Snell
IBM Canada
Calgary, Alberta, Canada

Newest Member of the Family

The PC Server 704, the newest model in IBM's PC Server family, brings IBM's latest server technology to the marketplace. It is one of the first server products to support 4-way symmetric multiprocessing (SMP) using Pentium Pro technology.

The PC Server 704 is a high-end server that incorporates high performance, extensive scalability, and a high degree of fault tolerance. These features position the PC Server 704 at the top of IBM's product line and rank it among the top performers in the marketplace.

Providing high performance through its "balanced" system design, the PC Server 704 ensures that each of its subsystems (processor, memory, disk, I/O) is designed to support the others, thus reducing bottlenecks within the system. This "balanced" performance gives the PC Server 704 the power to drive today's many resource-demanding applications.

As applications mature and their demands on the system increase, it is important that the hardware platform be able to grow to meet the new demands. The PC Server 704 provides scalability across all subsystems, enabling the system to grow while (even more important) maintaining balanced performance.

Fault tolerance is becoming increasingly important as more mission-critical applications are deployed on PC server platforms. High reliability, fault tolerance, and quick recovery features are designed into the PC Server 704 to provide required stability.

Advanced Enterprise

Enterprise

Independent LAN

PC Server 704 (PCI/EISA)
PC Server 720 (PCI/MC)
PC Server 500/390 (MC)
PC Server 520 (PCI/EISA & PCI/MC)
PC Server 500 (MC)
PC Server 320 (PCI/EISA & PCI/MC)
PC Server 310 (PCI/ISA)
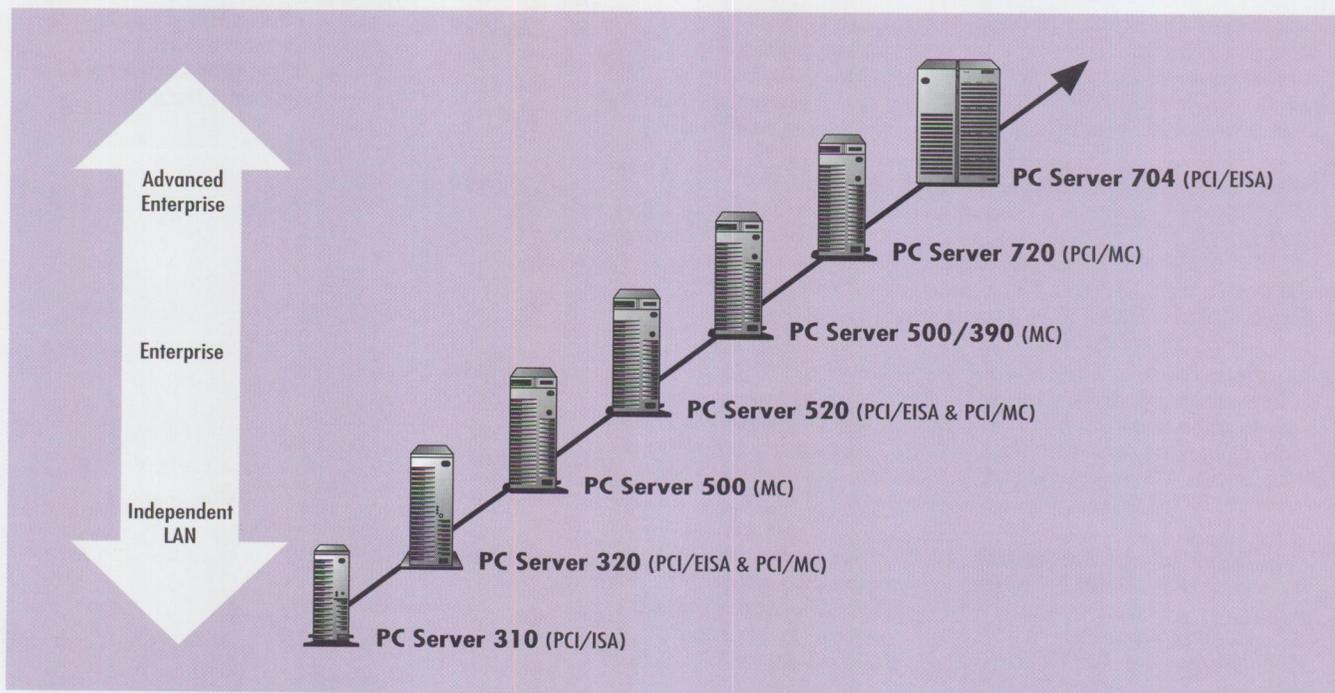
Figure 1. IBM PC Server Family
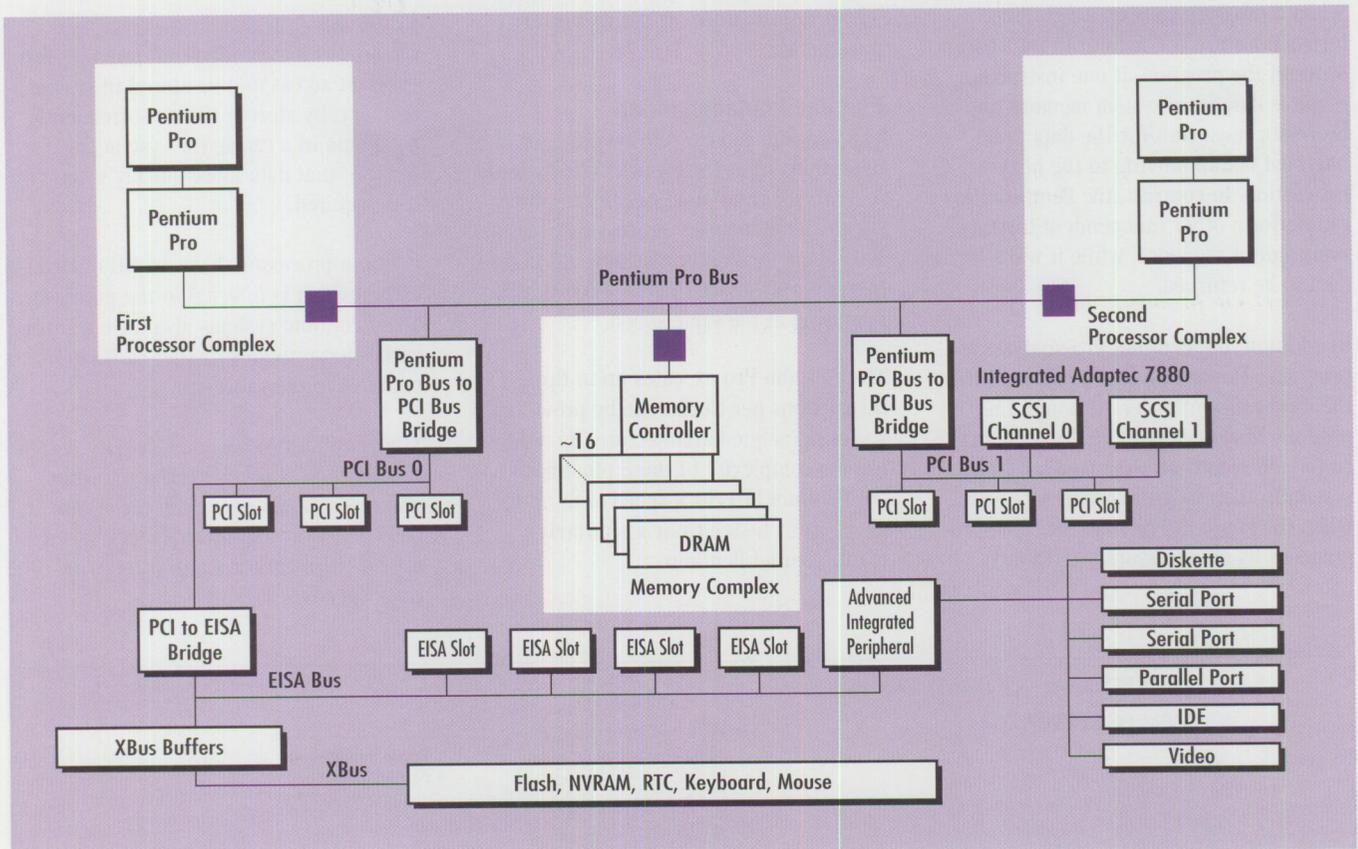
Figure 2. PC Server 704 Architecture

Major Features

The PC Server 704's main features include:

- *Processor performance and scalability*–The architecture of the Pentium Pro raises processor performance to unprecedented heights, particularly with today's advanced 32-bit operating systems and applications.

- *Memory capacity and performance*– The use of 60 ns memory SIMMs and 4-way interleaving help keep the processor busy with data. The memory system can grow to 1 GB and provide error checking and correcting (ECC) reliability to ensure data integrity.

- *Flexible, high-performance disk subsystem*–Using the integrated PCI SCSI controllers (in all models) or the PCI RAID adapter (in array models), the system provides flexible drive configurations to achieve the desired balance between performance and reliability. The system's 12 internal hot-swap drive bays support more than 25 GB of internal storage, with the ability to support further expansion outside of the system.

- *I/O bus performance and flexibility*– Up to 10 adapter slots are available for expansion cards. Using dual PCI buses, the system provides an increased number of native PCI slots and improved bandwidth to the six PCI expansion slots. The additional four slots provide compatibility for EISA- and ISA-based legacy adapters.

- *Reliability*–Fault tolerance can be configured for most major subsystems within the PC Server 704. This fault tolerance covers data integrity within the various subsystems as well as redundancy for protection or quick recovery in the event of component failures.

System Overview

The PC Server 704 is currently offered in two models. The non-array model starts with a single Pentium Pro processor and has two hot-swap disk drives connected to the standard SCSI-2 fast/wide controllers. The array model is configured with dual 166 MHz Pentium Pro processors and adds a PCI RAID adapter connected to four hot-swap disk drives.

To really understand the power of the PC Server 704, it is important to understand all of its subsystems. It is not the design or performance of any one of these subsystems that dictates the performance of the system as a whole. Rather, it is the balance between these components that creates a high-performance system free of bottlenecks.

Figure 2 shows an architectural view of the PC Server 704 design, while Figure 3 offers an exploded view of the system components.

Pentium Pro Architecture

As new processors are developed and manufactured, the chips get smaller and faster. Pentium processors have matured from speeds of 60 MHz to today's 166 MHz. The Pentium Pro was designed using the same manufacturing process as its Pentium predecessor, but new, innovative architectural designs were incorporated to enhance the chip's performance.

Dynamic Execution

One of the Pentium Pro's most notable enhancements is its ability to run programs in non-sequential order.

When a program runs on a Pentium, instructions are carried out in the strict order of the program. If one instruction requires data from system memory, the processor must wait for the data to be obtained before moving to the next instruction. In contrast, the Pentium Pro can perform other independent instructions, out of sequence, while it waits for data to be returned.

In addition, the Pentium Pro analyzes a program's flow to execute commands in the most efficient order. Although the program may be "decoupled" during execution, all results are reported back to the system in their original order. As a result, when the Pentium Pro runs the same programs as its predecessors, particularly 32-bit applications, it yields better performance.

Pipeline Implementation

The Pentium can execute two integer operations in a single clock cycle by building two separate pipelines in the processor to simultaneously process instructions. This helps the Pentium achieve 50 percent better performance than a 486 processor operating at the same speed.

The Pentium Pro executes up to three instructions per clock cycle by providing a super-pipelined architecture. By reducing the complexity of these pipelines, the Pentium Pro clock speeds run up to 33 percent faster than a similarly manufactured Pentium.

L2 Cache

Caching is a technique that provides fast, efficient access to data stored in system memory. By storing the most frequently used data in a cache, the system can retrieve that data more quickly when it is required.

Pentium processors have 16 KB of Level 1 cache, which is internal to the processor. Many Pentium systems also have a Level 2 cache that provides further caching resource to the processor.

The Pentium Pro has a dual-cavity design that integrates Level 2 cache into the processor. By doing so, the cache can be accessed at the internal clock speeds of the chip, rather than at external clock speeds.

IBM PC Servers Clustering Strategy
IBM PC SERVER 704

- Room for Optional 420 Watt Redundant Power Supply
- Two 420 Watt Power Supplies with Cooling Fans
- 1.44MB Diskette Drive
- 4x SCSI Bootable CD-ROM Drive
- Power, Coding and Drive Status Lights
- Server Operations LED Display
- 64MB or 128MB Standard ECC Memory Expandable to 1GB
- 10 Adapter Slots: 6 PCI (132MB/sec), 4 EISA
- Processor Complex Card: Up to 2 166MHz Pentium Pro Processors per Card, each with 512KB Dedicated L2 Cache (2 Cards per System Standard)
- SCSI Drive Status Lights
- 100/10Mbps PCI Ethernet Adapter
- PCI SCSI-2 Fast/Wide RAID Adapter (Standard on RAID Model; Optional on nonRAID Model)
- 3 Fans for Cooling Redundancy
- Access Door
- Room for up to 12 Half-High Internal Hot-Swappable Hard-Disk Drives
- Dual PCI SCSI-2 Fast/Wide Controllers
- Access Door
- Lock
- 3 Open Bays for Optional 5.25" SCSI Devices

Figure 3. Exploded View of PC Server 704 Processor

In the PC Server 704, the Pentium Pro 166 provides 16 KB of Level 1 cache and 512 KB of Level 2 cache. Both caches can be accessed at the 166 MHz internal clock speed, rather than the 66 MHz external clock speed. The L2 cache can operate in write-back mode for peak performance or write-through mode for improved data protection.

Figure 4 contrasts the Pentium Pro and Pentium chips.

SMP Implementation

The multiprocessor bus in the PC Server 704 supports from one to four Pentium Pro processors. The processors are interconnected using a gunning transistor logic (GTL) multiprocessor bus that supports up to 528 megabytes per second (MBps) of data.

The processors reside on one of the two processor complex cards and are seated in one of the two zero insertion force (ZIF) sockets on each card (see Figure 5). Because both processor cards are provided in all PC Server 704 models, adding more processors requires no complementary parts, and no parts end up on the floor. In contrast, some competitive offerings use one processor card plus a terminator card; to upgrade to the third and fourth processors, a second processor card must be purchased, and the terminator card is thrown away.

Memory Subsystem

The PC Server 704 has an ECC memory system that supports up to 1 GB of memory. By combining the fast access times of 60 ns memory and 4-way memory interleaving, the PC Server 704 gives its processors fast, efficient access to system memory.

This section covers several aspects of memory architecture.

SIMMs and DIMMs

In a Pentium or Pentium Pro system, information is retrieved from memory in 64-bit units. Most systems today use Single In-Line Memory Modules (SIMMs) to store data in memory. These SIMMs provide 32 bits of information at each memory location. To accommodate the 64 bits required by the processor, memory SIMMs must be added in pairs. The emergence of Dual In-Line Memory Module (DIMM) technology will eventually eliminate the requirement for adding memory in pairs, because

	Pentium Pro	Pentium
Integrated Cache	L1 Internal (16 KB) L2 Internal (256 KB or 512 KB)	L1 Internal (16 KB)
Transistors	5.5 million	3.2 million
Execution	Dynamic execution	Strict order of program
Pipeline	Super-pipelined (12 stages per pipe)	Pipelined (5 stages per pipe)
Instructions per clock cycle	3	2

Figure 4. Pentium Pro Versus Pentium
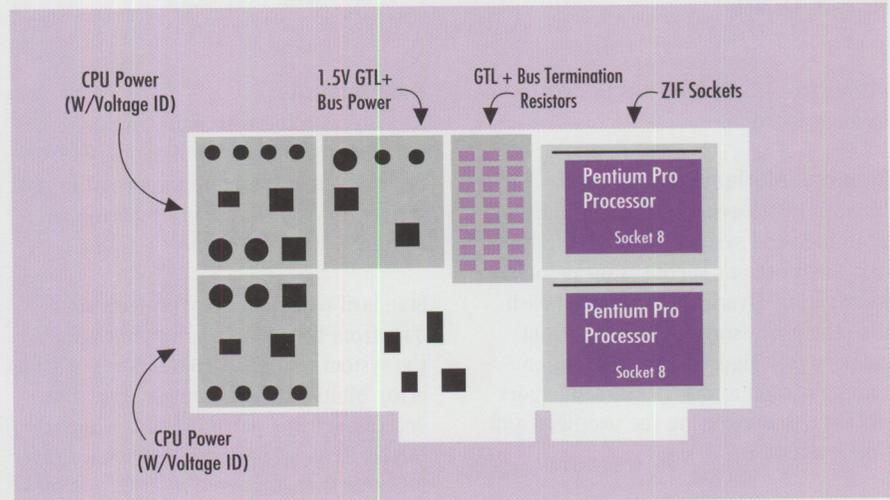
Figure 5. Processor Complex Card
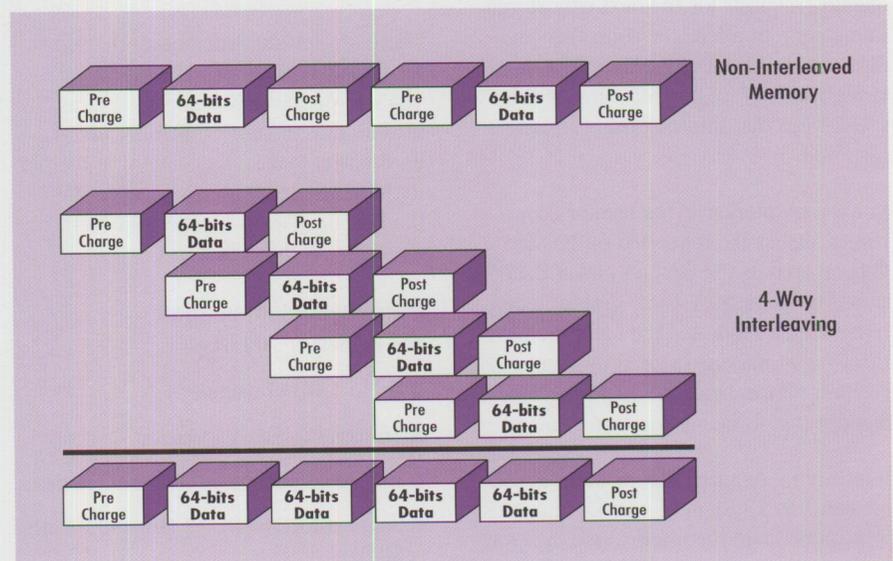
Figure 6. Memory Interleaving

Bank 0	Bank 1	Total Memory	Memory Interleaving
16 MB x 4	–	64 MB	2-way
16 MB x 8	–	128 MB	4-way
16 MB x 8	16 MB x 8	256 MB	4-way
16 MB x 8	32 MB x 8	384 MB	4-way
32 MB x 4	–	128 MB	2-way
32 MB x 8	–	256 MB	4-way
32 MB x 8	32 MB x 8	512 MB	4-way
64 MB x 4	–	256 MB	2-way
64 MB x 8	–	512 MB	4-way
64 MB x 8	64 MB x 8	1024 MB	4-way

Figure 7. Memory

DIMM stores the full 64 bits of data in one memory location.

Memory Interleaving

Memory interleaving, a common technology in high-end systems, reduces the time that the processor spends waiting for information. Overhead is involved each time the processor requests data from memory (see Figure 6). Memory interleaving is used to overlap these memory requests, thus reducing the overhead and time wasted.

In an interleaved memory system, the memory controller fetches the 64 bits of data requested by the processor, while queuing requests for the next data stored in memory. In effect, the controller predicts which information the processor will request next. If it is correct, time will be saved since that information is already retrieved.

In a 2-way interleave, the memory controller fetches the requested 64 bits of data, as well as the next 64 bits of data stored in memory. A 4-way design retrieves the requested data and the next three 64-bit packages stored in memory. For best performance, we highly recommend using 4-way memory interleaving.

Interleaving requires that memory SIMMs be added to a system in specific multiples to accommodate the interleaving. A 2-way system requires memory SIMMs to be added in multiples of four, while a 4-way system requires adding SIMMs in multiples of eight.

Data Integrity

As systems come with more and more memory, the likelihood of memory errors increases. It is therefore important to protect your system's memory by using an error-detection technique.

Standard parity memory protects your data from becoming corrupt, but it halts the system when it encounters a single-bit error. Multi-bit errors are generally not detectable using parity. ECC provides a further layer of protection. When a single-bit error is encountered in ECC, that bit is corrected without interrupting the system. Many multi-bit errors can also be detected using ECC techniques.

There are several different mechanisms for implementing ECC. The PC Server 704's error correction implementation uses an ECC memory controller and standard parity SIMMs. By combining the parity bits included with each parity SIMM, the ECC memory controller can correct the error on the data.

Memory Implementation

The PC Server 704 has:

- Up to 1 GB of memory
- 16 memory SIMM sockets
- Industry-standard 60 ns parity SIMMs
- Support for 16 MB, 32 MB, and 64 MB SIMMs
- 64 MB of memory (16 MB x 4) standard in the uni-processor, non-array model

- 128 MB of memory (16 MB x 8) standard in the dual-processor, array model

Memory Upgrades

When adding memory, several rules must be followed to ensure compatibility and the highest level of performance.

- The system supports only 4, 8, or 16 physical SIMM combinations.
- All SIMMs in one bank must be of equal size.
- Bank 0 must be fully populated before Bank 1 can be used.
- When Bank 0 is populated with 16 MB SIMMs, Bank 1 must use 16 MB or 32 MB SIMMs.
- When Bank 0 is populated with 64 MB SIMMs, Bank 1 must use 64 MB SIMMs.

Figure 7 summarizes memory configurations and interleaving.

Storage Subsystem

The PC Server 704 has a high-speed, high-capacity disk subsystem to meet the demands of disk-intensive applications. Both PC Server 704 models ship with all the cabling and trays required to fully populate the system with drives and storage devices, plus its storage bays hold more than 25 GB of drive space using today's drive technology. External storage can be provided using the IBM SCSI Multi-Storage Tower or the IBM Enterprise Expansion Tower.

Physical Storage

The PC Server 704 comes with:

Drive Bays

- 17 drive bays
- Capacity for more than 25 GB of storage
- 12 hot-swap bays (3.5-inch, half-height), with all 12 hot-swap trays included
- Four front-accessible, removable media bays (5.25-inch, half-height)
- One 3.25-inch slimline bay for a 1.44 MB diskette drive

Storage Devices

- Support for 2.14 GB SCSI-2 fast/wide drives (9.0 ms/7200 rpm)
- Quad-speed CD-ROM drive

- One 24/48 GB DAT AutoLoader, supported by bridging two front-accessible bays

Cabling (Non-Array Model)

- Two internal SCSI-2 fast/wide cables (SCSI controllers to backplanes)
- 3-drop, SCSI-2 fast cable (daisy chain from upper backplane to CD-ROM and removable media bays)

Cabling (Array Model)

- Two internal SCSI-2 fast/wide cables (RAID adapter to backplanes)
- 4-drop, SCSI-2 fast cable (SCSI controller A to CD-ROM and removable media bays)

SCSI Adapter

All PC Server 704 models come with two integrated SCSI-2 fast/wide controllers. These busmaster PCI controllers, located on PCI Bus 1, use RISC-based Adaptec AIC-7880 controller chips. Each controller supports up to 15 physical devices.

Because the system provides two separate SCSI controllers and two independent backplanes, the components can provide mirroring or duplexing through a network operating system. Mirroring and duplexing are software-based techniques similar to RAID-1 striping. Mirroring provides protection in the event of a drive failure, while duplexing gives additional protection in the event that a SCSI controller fails. When failures occur, the system continues to operate uninterrupted.

RAID Adapter

In the RAID model of the PC Server 704, the RAID adapter features:

- Two SCSI-2 fast/wide channels (20 Mbps each), internal or external
- Up to seven devices per channel
- Up to four arrays (packs) and a total of eight logical drives (system drives) per adapter
- RAID-0, RAID-1, and RAID-5 striping on any logical drives
- 4 MB cache and i960 processor

The PC Server 704 RAID model includes a Mylex DAC960 RAID adapter. The standard 4 MB of cache increases disk performance, while the adapter's i960 processor and busmastering relieve some of the
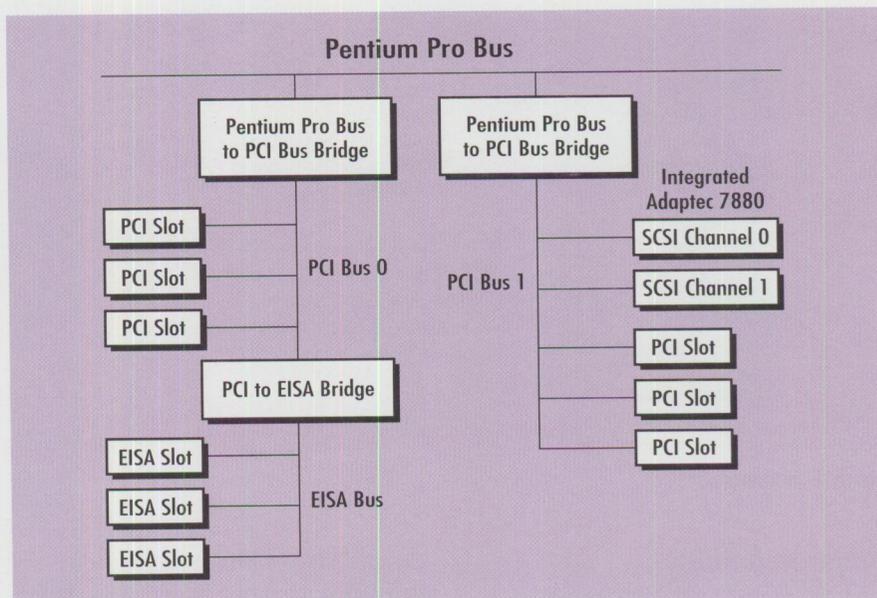
Figure 8. PCI Buses

burden on the main processor. The cache and processor perform better than a software-based RAID implementation.

I/O Bus

The IBM PC Server 704 provides six PCI expansion slots and four EISA slots, for a total of 10 expansion slots. With this design, the system can support a large number of today's high-performance PCI cards, as well as legacy EISA- and ISA-based cards.

PCI Bus

Due to electrical load limitations on a PCI bus, a single bus traditionally does not support more than three expansion slots. By implementing dual PCI buses, as shown in Figure 8, the PC Server 704 provides support for up to six PCI expansion adapters in addition to its integrated PCI SCSI fast/wide adapter. This dual-bus design also improves bandwidth, because each bus provides up to a full 132 Mbps to the system.

PCI Bus 0 supports three expansion slots and a bridge to the EISA slots provided for legacy cards. Because of these legacy cards, we recommend that any high-performance PCI adapters, such as RAID adapters or network cards, be placed on PCI Bus 1. PCI Bus 1 also supports three physical slots and carries the traffic for the integrated SCSI controllers.

All PCI slots are busmaster-enabled to provide direct memory access (DMA) to adapters without processor intervention.

EISA Bus

To provide support for legacy EISA and ISA adapters, the EISA bus supports up to four adapters, all of which can be busmaster adapters. The maximum bus speed supported by this EISA bus is 33 MBps. It is important to note that traffic on this bus is not parity-protected as it is on a PCI bus. For this reason, as well as performance reasons, we recommend that these EISA slots not be used unless necessary.

Video Subsystem

The integrated system video controller is a Cirrus Logic GD5424 with 512 KB (upgradable to 1 MB) of video memory. This adapter supports standard VGA resolutions, as well as many SVGA resolutions up to 1024 lines. (Since graphics chipsets change frequently, this implementation is also subject to change without notice.)

Network Card

The standard IBM 100/10 PCI Ethernet adapter attaches to a 10BaseT or 100Base-TX using a single RJ-45 connector. This busmaster adapter resides in one of the six PCI slots. The busmastering feature enables this card to access the system memory directly, without the main processor's intervention.

Power

All PC Server 704 models ship with two 420-watt power supplies that provide power to the entire system. An optional third power supply can be added to provide fault tolerance in the event that one of the primary power supplies fails.

Front Panel Indicator Lights
- Power (green)
- Power Failure (yellow)
- Cooling Failure (yellow)
- Drive Failed (yellow)

SCSI Drive Indicator Lights, Three for Each Drive
- Drive Power (green)
- Drive Activity (green)
- Drive Failure (yellow)
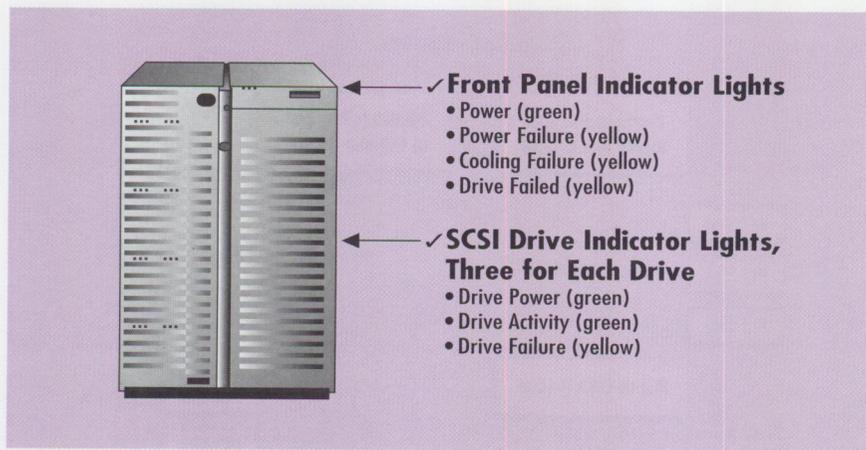
Figure 9. Indicators

Server Reliability

The importance of reliability in a PC server warrants special focus. Although some of these points have been discussed previously, it's important to discuss them together to emphasize the PC Server 704's high degree of reliability.

Processor

A system equipped with more than one processor is protected in the event of a processor failure. Although it is likely that the operating system will require a reboot to recover from this error, the system simply disables the failed processor during the reboot process.

Memory

ECC automatically corrects single-bit failures without service interruption. When most multi-bit errors are encountered, the system halts so that the corrupted data is not further propagated. If an entire memory SIMM fails, the system must be restarted to recover. If the failure occurs in Bank 1, the system will reconfigure to operate using Bank 0 only. If the failure occurs in Bank 0, it may be necessary to replace that SIMM with one from Bank 1 before rebooting.

Disk Subsystem

PC Server 704 array models provide RAID-1 and RAID-5 protection against single-disk failures. Failed drives can be removed, replaced, and rebuilt without bringing the system down. Hot standby drives can also be defined to automatically rebuild failed drives. Drives can be rebuilt via the operating system-specific utilities provided with the system or through the RAID Manager in TME 10 NetFinity.

The dual SCSI controllers permit software-based mirroring or duplexing. In a mirrored system, redundancy is provided in the event of a drive failure, while duplexing also provides protection in the event of a SCSI controller failure.

Bus Traffic

Parity checking is provided on the SCSI, PCI, keyboard, and serial transmission lines. The parity protection will detect and retransmit any data that has experienced a single-bit error during transmission. As outlined in the specifications for EISA, there is no parity protection provided on the EISA bus.

Power

In the standard dual-power supply system, no redundancy is provided. When a third power supply is added to the system, the power load is shared across all three 420-watt sources. If one of these independent power supplies fails, the system continues to run on the remaining two power supplies without interruption. When a power supply is lost, however, a scheduled downtime is required to replace the failed power supply.

System Utilities and Management

When installing the operating system on the PC Server, you must use a few important DOS-based utilities to configure the system. Most of these disks are not bootable, so you may need a DOS boot diskette.

System Configuration Utility

The System Configuration Utility (SCU) alters the system settings stored in CMOS and other NV-RAM. Many of the settings available through this utility are also available through the standard setup program stored in CMOS. We recommend that you use the SCU instead of the Setup program, because it provides additional functions and better conflict resolution.

Whenever you change the hardware configuration on the system, you should run SCU. It ensures that hardware changes are recognized and appropriately set.

RAID Utility Disk

This utility defines and prepares the system's RAID arrays (packs) and logical drives (system drives); you must run it before installing the operating system.

Operating System Support

Operating system support for the PC Server 704 is currently available for OS/2 SMP v2.11, Windows NT v3.51, and NetWare. Additional operating systems are being tested, with results available via the World-Wide Web at http://www.pc.ibm.com/servers.

If you are installing OS/2 SMP, be sure to use a CD-ROM with CSD 630. Use the SCU diskette to set the MP Spec version to 1.1 for OS/2 SMP and 1.4 for Windows NT.

Controls and Indicators

The four LEDs on the system's front panel show the status of the power system, cooling systems, and hard drives (see Figure 9). A front-panel LCD displays system messages. These indicator lights are controlled by the I2C management bus built into the PC Server 704.

Security

Both physical and system security features are available on the PC Server 704. Physical security includes loopholes to secure the server and all covers with a padlock and cable. A door lock prevents the front access door from being opened.

System security is available to prevent unauthorized use or access to the system. Some optional system security settings include:

- User password, which locks the keyboard, mouse, and display during start-up or upon system timer expiration (1 to 128 minutes)

- Administrative password, which accesses setup utilities

- Secure mode, which disables the power switch, reset button, and writing to a diskette drive

TME 10 NetFinity

Included with the purchase of a PC Server 704 is a licensed copy of the TME 10 NetFinity systems management product. This program currently supports OS/2, NetWare, Windows NT, Windows 95, Windows for Workgroups, and Windows 3.1.

Some key features of TME 10 NetFinity on the PC Server 704 are:

- *Hardware management*—Collect hardware configuration (adapter, disk, processor, etc.) and asset information using automated remote functions

- *Software management*—Collect software inventory and monitor critical files and processes

- *System monitors*—View usage statistics about system resources to identify bottlenecks and problematic behavior

- *RAID adapter*—Provide notification of drive failure (using pager, network messages, etc.) and functionality to rebuild data when a drive has been replaced (RAID-1 and RAID-5 only)

- *PFA alerts*—Provide notification of impending drive failures up to 40 hours in advance using PFA-enabled drives

- *Remote management*—Provide utilities for file transfer, screen capture, and remote session

Resources

IBM maintains extensive, timely information on the World-Wide Web. Visit the following sites for product information, performance data, and technical literature about IBM PC Servers and other IBM products.

- **IBM PC Server Home Page**
  `http://www.pc.ibm.com/servers`

- **IBM Home Page**
  `http://www.ibm.com`

- **IBM PC Company Home Page**
  `http://www.pc.ibm.com`

- **IBM PC Company Support**
  `http://www.pc.ibm.com/support.html`

- **TechConnect Program**
  `http://www.pc.ibm.com/techlink/tcpage1.html`

- **File Repositories**
  `http://www.pc.ibm.com/files.html` or `ftp://ftp.pcco.ibm.com`

More detailed information and performance information about Pentium Pro processors is available from Intel's Web site at `http://www.intel.com`.

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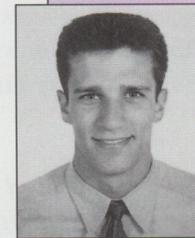
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TECHNICAL

PC Server High-Availability Techniques

Most companies today are concerned about system availability, or uptime, of their local area networks. With mission-critical applications now commonplace on PC servers, companies cannot afford to incur unplanned outages of LAN resources. In many instances, companies traditionally used mainframes to host these critical applications, and executive management expects from LANs the same availability levels associated with mainframe systems. For these reasons, many systems administrators have the mission to significantly improve LAN availability.

In this article, you'll be introduced to ways to increase system availability in a LAN environment using high-availability solutions on the market today. You'll also read several scenarios that incorporate these solutions to provide high availability in various environments.

Simply stated, *availability* is the percentage of time that a system is up, running, and available for users to do productive work. Availability is calculated only for the hours during which a system is supposed to be available. For example, if your business requires a system to be up from 7 a.m. until 11 p.m., then system maintenance downtime between the hours of 2 a.m. and 4 a.m. does not count against availability.

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High availability is a target that means a system will be available a higher percentage of time than if no special system features or operational procedures were employed.

As a point of reference, normal system availability in a mainframe environment has traditionally been measured at 99 percent to 99.5 percent. High-availability percentages are more often around 99.95 percent. You can reach this level only by eliminating or masking unplanned outages during scheduled periods of operation using techniques such as advanced system design, fault tolerance methods, and fast restart.

Advanced system design uses highly reliable hardware and software components in a system. These components can often anticipate failures and employ preventive measures to avoid failures or at least prevent these failures from affecting normal system operation.

Fault tolerance is a system's ability to deliver acceptable service in the event of a component failure. Obviously, the proper system features and/or operational procedures have to be in place to keep critical system resources up, even if a piece of hardware fails.

The most common method of providing fault tolerance is through redundancy of critical resources—either in the same machine or elsewhere on the network—so a backup is available if a primary resource fails.

Fast restart is the ability to quickly detect and recover from a failure in a way that minimizes service disruption. This key concept must be exploited to achieve the high level of availability in the LAN environment that exists in the mainframe environment.

Mainframe administrators know that to achieve high availability, you must recover from a failure as quickly as possible. The first priority is to restore service. There is no time to waste in determining the proper recovery technique. Recovery plans must have been decided upon, and procedures must be in place long before the failure occurs.

A key method for achieving a fast recovery is *offline diagnosis*. When a failure occurs, there is no time to diagnose mishaps. Diagnosis must be done only after service has been restored. Stopping to analyze what went wrong before restoring service can significantly hurt availability.

Suppose the required system operation hours are between 7 a.m. and 11 p.m., Monday through Friday. This means your system must be available 90 hours per week or 387 hours per month. If your availability target is 99.5 percent, then downtime cannot exceed 1.9 hours per month during normal operating hours.

Designing a High-Availability Solution

To design a high-availability solution for your environment, determine the required availability level by answering two key questions:

- What percentage of time must my systems be available?

- How quickly must I recover from an unplanned outage?

Although businesses answer these questions differently, generally unplanned outages of several hours or days are the most costly to a business. Unfortunately, lengthy outages have been common historically in LAN environments.

Once you set your goals, you must design a solution that meets them using the choices on the market today. Your first consideration has to be the basic engineering of the system itself. Solid system engineering uses more reliable components, which help to avoid failures.

Your next step is to examine individual subsystems inside the machine and look for ways to increase the single-system availability of the stand-alone machine.

Your final step is to consider the entire LAN environment and look for areas that may need complete system redundancy, such as a hot backup system. One hot topic today addressing redundancy is *clustering*. We discuss it later, as well as system engineering and single-system availability.

System Engineering
IBM PC Servers were designed with high availability in mind. They include many state-of-the-art technologies important for availability; therefore, we now briefly discuss some of these.

Power
If you mention fault tolerance, relative to power, to systems administrators, they start talking about redundant power supplies and concepts such as triplicated majority redundancy!

Before we discuss ways to avoid power supply failures, keep in mind that the vast majority of power problems have nothing to do with power supply failure. According to a contingency planning study quoted by American Power Conversion, more than 45 percent of data losses result from power failure and line surges. This compares to only 8 percent due to hardware or software error and 3 percent due to human errors. One IBM study estimated that as many as 120 power problems occur per month in a typical installation. American Power Conversion has grouped these problems into five categories:

- Sags
- Blackout
- Spikes
- Surges
- Noise

The impact of these events can be measured both in terms of lost productivity when a system is unavailable and the replacement costs for damaged equipment. A good uninterruptible power supply (UPS) is the most cost-effective first step toward increasing availability.

A well-designed power supply should protect against many types of line problems, but a good UPS can protect against line problems and permit an ordered shutdown in case of a prolonged power failure. By using a UPS to filter your A/C power line, you are protecting all the system and disk caches and giving the operating system time to finish its final processing before power is removed.

Once you have protected and conditioned the power reaching the system, the next component to consider is the power supply itself. Because power supplies have a lower mean time between failure (MTBF) than digital electronic circuits, building in redundancy is a good idea. In the standard method, called *triplicated majority redundancy*, the power supply is split into three components, any two of which are sufficient to power the machine. If one component fails, the system continues to function, and an alert is sent to a systems management console so that the failed component can be replaced.

IBM offers a redundant power supply option for a wide range of its PC Server systems.

Cooling
The proper cooling of PC components received considerable attention when Pentium-based systems started shipping. The focus at that time was on ways to keep the processor chip within acceptable heat limits. In an effort to keep the temperatures down, some vendors even mounted fans aimed at the chip assembly; however, from an overall system viewpoint, extracting the heat from the CPU is

only part of the solution. If the heat is removed from any one chip but not adequately forced out of the machine, your reliability problems can increase. Effective dissipation means extracting the heat from *all* sources, thereby reducing the machine's overall operating temperature.

Reducing the temperature is key to extending the life of the components inside. Statistics from the U.S. Department of Defense show that the MTBF is halved for every 20 degrees Celsius increase in operating temperature.

IBM has implemented a design approach called FloThru cooling, which maximizes the air flow through the server box while keeping that flow primarily front to back. This front-to-back flow avoids problems created by vents that are blocked when multiple servers are stacked side-by-side or on top of each other.

The ambient temperature of the machine is also important for system reliability. For example, if you put a server into a rack that has inadequate cooling, your machine's reliability will be compromised. IBM's PC Server racks are designed

with an extra level of cooling that permits a server to actually run cooler in the rack than it would if it were a stand-alone machine.

Disk Drive Design
As one of the few remaining mechanical devices within the server, disk drives are among the first components to consider when increasing availability. While a complete discussion of hard-disk technology is beyond the scope of this article, a few points regarding disk-drive design are mentioned here, along with examples that illustrate why IBM leads the field in disk-drive reliability.

- *Storage density*–Open any large-capacity disk drive and you'll find a number of platters or magnetic disks. The fewer the disks, the fewer the read/write heads, and the lower the probability of failure. IBM Ultrastar XP hard disks use specially developed technologies that increase the density of each platter, thereby reducing the number of platters required.

- *Air filters*–Dust can easily cause disk failures. Because disk drives generate heat, they cannot be made airtight and, therefore, must employ air filters. IBM

disk drives have chemical filters that stop not only dust, but also harmful gases that might damage the disk surface.

- *Head technology*–Head crashes on disk drives occur when a read/write head comes into contact with a disk surface. As a result, the drive fails, and data is usually lost. IBM has pioneered methods to ensure that the head's flying height is correctly set to a level that minimizes the chances of a head crash.

These are just a few important technologies enabling the IBM Ultrastar line of hard-disk drives to be rated at an MTBF as high as one million hours.

While this seems like a minuscule failure rate, it is still too large for high-availability environments. For this reason, IBM developed disk-drive *predictive failure analysis* (PFA). PFA monitors key device performance statistics for trends that ultimately lead to device failure. The disk drive then notifies systems management software, such as IBM's TME 10 NetFinity, of imminent failure. When combined with RAID technology (see the next section), PFA can provide the basis for a high-availability solution.

Other PC server vendors have realized the advantage of these techniques and are working to develop a similar technique called SMART, which stands for self-monitoring, analysis, and reporting technology.

Improved Subsystem Availability
Before we focus on the popular topic of clustering multiple systems to provide system-level fault tolerance, keep in mind that a full system failover—the switchover to a hot-spare system—should be a last-resort option.

Beyond the previously discussed features that provide the base level of availability, other technologies implemented in a modern PC server can aid in achieving even higher availability of that single system. Most of these technologies concern eliminating single points of failure inside the machine. These approaches can protect against the majority of typical failures, as well as prevent full system failures. Many of these techniques are also cost-effective, since a good deal of protection can be provided for a comparatively
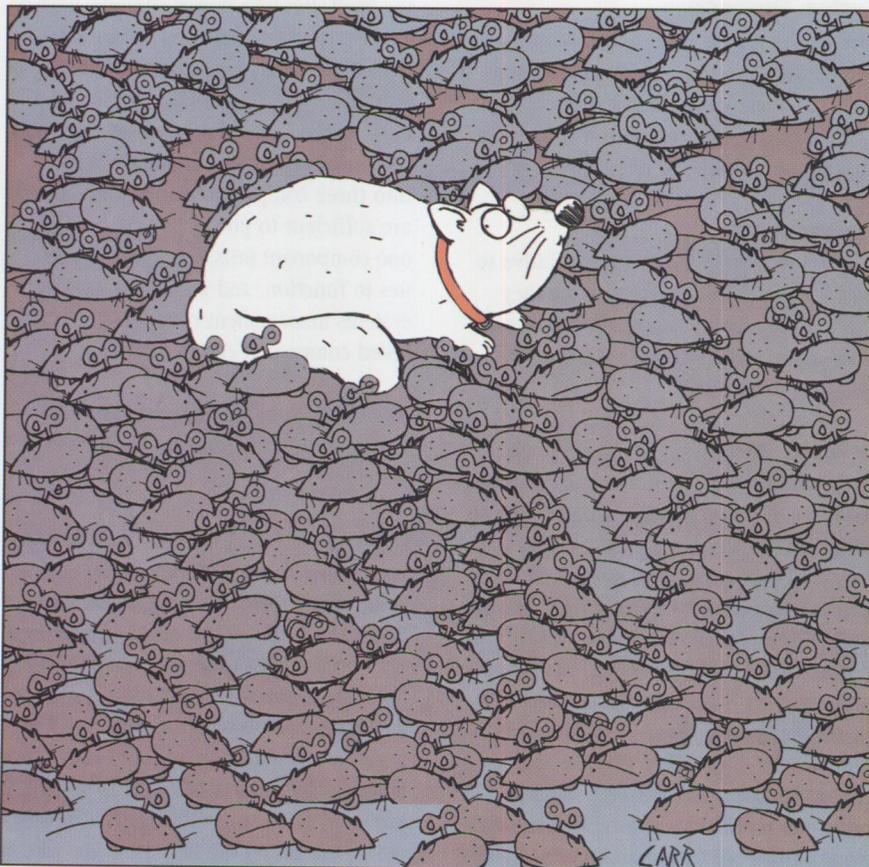
small investment. The more important of these technologies are discussed next.

Redundant Disk Subsystems

Even with advances in technology, hard disks are still mechanical devices that fail more often than integrated circuits. Because of this, redundancy within a disk subsystem is often the easiest and cheapest way to increase a server's availability. The RAID technology, which stands for "redundant array of independent disks," has been developed to address these requirements.

RAID defines different *levels* of redundancy in the disk subsystem. For example, RAID 1 defines the most common method of providing disk redundancy, which is disk mirroring and/or duplexing. With this method, the amount of disk space required is doubled, since every piece of data is duplicated on separate drives. If one drive fails, data is still available on the other drive, and the system continues to operate without downtime.

For servers requiring a relatively small data space, this method provides good performance at a minimal cost. But as data spaces grow larger, this method becomes increasingly expensive, and eventually the cost of having twice the number of drives becomes prohibitive.

Higher levels of RAID, such as RAID 5, also protect against drive failure and avoid system downtime but require only a single additional drive to record redundancy data. This requirement for only one additional drive keeps the overall disk cost lower than with duplexing. Most RAID implementations also provide for hot-spare drives and the ability to rebuild a failed drive using the hot spare, so that a failed drive can be automatically replaced without downtime. Even more effective is the use of hot-plug drives, which allow you to physically unplug a failed drive and plug in a new drive without bringing the system down.

A key factor in choosing an approach for disk redundancy is whether to implement it in hardware or software. For example, NetWare, Windows NT, and OS/2 Warp Server all provide a facility within the network operating system that manages a mirrored or duplexed environment. SCO UNIX even offers the ability to implement a RAID array within the operating system.

Most server manufacturers offer RAID controller cards that offload redundant disk management to specialized processors on the adapter. This not only increases the efficiency of the system CPUs, it also greatly improves the speed of RAID operations over software RAID.

IBM PC Servers employ the hardware approach. Several PC Server models offer the RAID controller as a standard feature, while in other models it is optional. These high-performance adapters can implement multiple levels of RAID (0, 1, and 5)—even on the same set of hard disks.

IBM's latest RAID card, called the ServeRAID Adapter, offers additional protection by allowing arrays to be spread across up to three SCSI channels. It also permits adding disks to the array, thereby increasing the size of the logical drive without bringing the system down.

> *. . . a typical server-class machine using ECC memory will fail only once every four thousand years due to memory bit errors.*

The ServeRAID adapter allows you to create high level protection by implementing three-drive RAID 5 arrays, with each disk of the array residing on a separate ServeRAID SCSI channel in a separate external storage enclosure. Using this configuration, an entire storage enclosure can fail and the system will still function.

Memory

The need to increase data integrity within the memory subsystem has received significant attention. Certainly, as we drive more mission-critical applications onto PC servers, it is imperative that data be protected from soft errors that can occur in memory systems.

To combat this problem, IBM PC Servers employ schemes called *error-correcting code* (or sometimes *error checking and correction* but more commonly just ECC) to detect and correct single-bit memory errors, detect double-bit memory errors, and detect some triple-bit memory errors.

ECC works like parity by generating extra check bits from the data and storing these extra bits with the data in memory; however, while parity uses only one check bit per byte of data, ECC uses seven check bits for a 32-bit word and eight check bits for a 64-bit word. Extra check bits, along with a special hardware algorithm, enable the detection and correction of single-bit errors in real time as data is read from memory.

Statistical analysis estimates that a typical server-class machine with 64 to 128 MB of parity memory will fail about once every two years due to random memory bit errors. This may not seem like much risk, but a modest-sized installation of 24 servers will sustain a monthly failure due to memory bit errors. On the other hand, a typical server-class machine using ECC memory will fail only once every four thousand years due to memory bit errors. In addition, since ECC memory can detect multiple bit errors, data integrity of the machine is also improved.

IBM provides ECC memory as standard on most of its servers. For models that come with parity as standard, IBM provides ECC on SIMM or EOS upgrades.

I/O Bus

Data integrity across the system I/O bus merits attention even though it's not specifically an availability issue.

Servers continuously check for errors and data corruption in memory using parity or ECC, on the disks using RAID and Predictive Failure Analysis, and on the processor and the cache using parity. Since the I/O bus is used to transfer data between these subsystems, it is equally important in ensuring reliability and availability.

ISA and EISA buses do not employ bus parity checking. That is, they have no logic to ensure that data put onto the bus by the sender is the same as data removed by the receiver. PCI and Micro Channel buses have parity checking that allows a receiving device to request that corrupted data be re-sent. This reduces data corruption, and most important, it stops the propagation of these errors across your business.

IBM implements bus parity checking on the PCI bus and the MCA bus in all of its
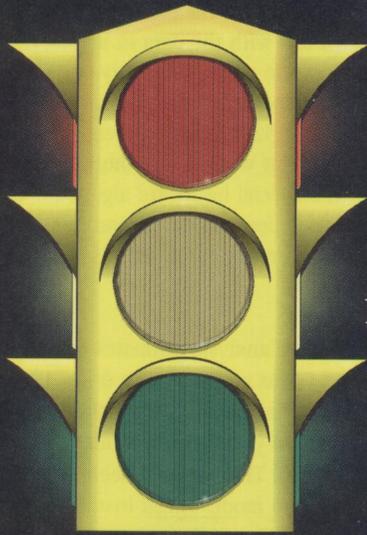
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NO? Caution.

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Kroy	10	12
Lieberman and Associates	12	5
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Network Telesystems	17	Cover 3
Oracle	19	Cover 2
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Pinnacle Technology	2	3 & 8
Repository Technologies Inc.	6	10
SofTouch Systems	7	11 & Cover 4
Spitfire Software	14	10
Tangible Vision, Inc.	9	12
Telegenisys Inc.	4	9
XcelleNet, Inc.	1	8

servers. The PC Server 720 implements parity protection on both the PCI and Micro Channel buses, as well as ECC protection on the internal SMP bus.

Network Interface Card

The server's network "on-ramp" is its network interface card (NIC). In many implementations, this adapter card remains a single point of failure; however, the task of implementing multiple NICs that access the same network is often easily supported by the network operating system without further hardware assistance.

IBM's OS/2 Warp Server, for example, supports multiple NICs that are active within the same server on the network. During normal operation, the network load is distributed among the active cards. This is a distinct advantage over other hardware-based approaches that implement a "standby" card, which provides no value until a primary adapter card fails. In either case, if one card fails, the remaining card(s) is available to pick up the load. Additional protection against network component failures can be provided by attaching these cards via different physical paths to the network (separate hubs, for example).

CPU

Machines that offer multiple processors are becoming commonplace. Typically, these machines are designed for high-performance applications that require more CPU power than is currently available from a single chip.

In some cases, such as the IBM PC Server 720, hardware watchdog timers are implemented to identify a failed CPU and initiate a system restart. In most cases, however, neither the operating system nor the hardware engineering can accommodate management of fault conditions. (Such management would enable continued operation if one CPU suddenly fails.) In these instances, the operating system halts, and users on the network lose their connections. In some cases, the system must be manually reconfigured to take a failed CPU offline. Once offline, the server can be restarted, and users can reestablish their connections.

Some industry offerings incorporate spare processors that take over in case of failure. These solutions are the exception, not
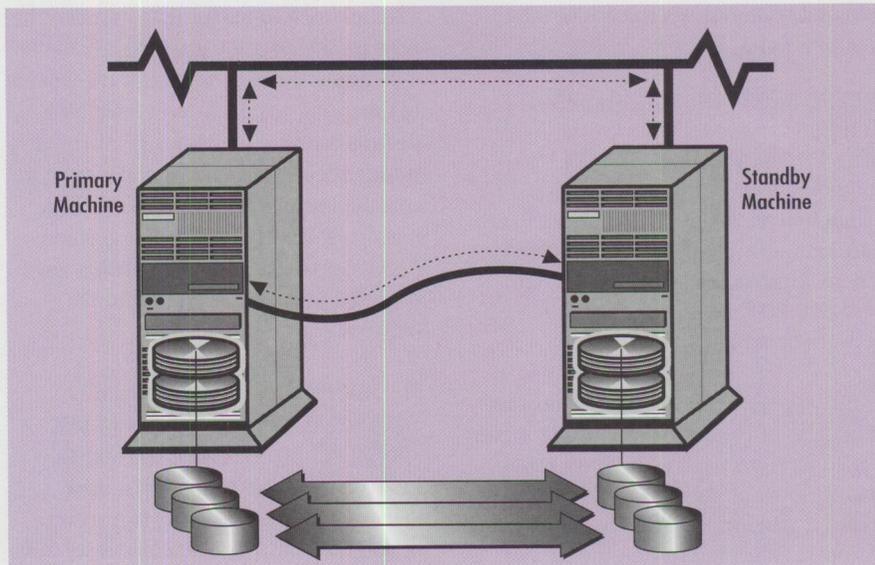

Figure 1. IBM PC Server High-Availability Solution

the rule, of SMP implementations, and typically carry a significantly higher price.

If CPU failures are a concern, there are a number of other ways to protect the installation. The section on clustering multiple systems to improve fault tolerance gives more detail.

Systems Management

Another important aspect of improving availability is *systems management*. Regardless of how well availability is designed into the final system solution, it is critical to be able to manage that solution, predict problems before they occur, react to faults as they happen, and take appropriate recovery actions. The choice of an integrated management tool, not just for the PC server itself, but for all components of the chosen solution, is crucial.

IBM PC Servers come standard with TME 10 NetFinity, an award-winning systems management product with a great deal of function designed to keep the system up and running.

Clustering for Fault Tolerance

While single-system availability is important, it is not the sole factor in producing a highly available LAN. Many factors outside the scope of hardware reliability can cause unplanned system outages, including:

- Software bugs
- System configuration changes

- Computer viruses
- Environmental problems
- Human error

You need to plan for these failures and design the appropriate recovery techniques if your LAN is going to meet or beat the availability numbers of the mainframe environment.

Recently, the idea of clustering multiple PC servers to achieve fault-tolerant solutions has become popular. A word of caution: the word *cluster* (as with many terms in our industry) can mean different things to different people. Here, we are not clustering machines in order to build a high-performance computer engine, as is the case with the IBM RS/6000 SP2 design. (Certainly this high-performance model is in the future for PC servers also, but for the present, the maturity of the operating systems and their associated system interconnects preclude vast progress.)

In the context of this discussion, clustering means linking two or more machines to provide system-level fault tolerance. A wide range of solutions in the marketplace provide such function, and for the most part, each solution works well in certain situations.

In the following sections, we review three popular solutions. After that, we consider (from a requirements point of view)

different scenarios where each of these solutions apply.

IBM PC Server High-Availability Solution

IBM's PC Server High-Availability Solution, illustrated in Figure 1, uses Standby*Server* software from Vinca Corporation and a dedicated 100 Mbps Ethernet link in conjunction with standard IBM PC Servers and a standard network operating system.

In this approach, Vinca software mirrors data in real time from a production server (called a primary server in Vinca terminology) to an online backup machine (called a standby server). Depending upon the operating environment, the backup server can be either dedicated to its standby function or can be an independent, active server on the network.

Systems management for this environment is crucial to successful operation. In the OS/2 Warp Server environment, for example, IBM's TME 10 NetFinity systems management software is configured to monitor the primary machine during normal operation via NetFinity's presence detect feature.

If the primary server fails, NetFinity signals the standby system to take over the primary role. This requires a slight change in the standby machine's configuration, followed by restarting the failed applications from standby. This automated sequence requires no operator intervention.

After the standby machine takes over the primary's role, the failed machine can be diagnosed offline, repaired, then brought back online. The two systems are then re-mirrored to bring the disks back in sync. Depending upon the size of the mirrors, you may need to perform this operation after hours, because the mirroring operation can degrade performance.

It should be stressed that this is a high-availability solution rather than a continuous-availability solution, since there will be a short gap in service while the standby machine is brought online in the primary role. In most cases, users will not have to log off and then log on. The client code for Windows NT, OS/2, and the latest 32-bit requester code for NetWare will automatically reconnect.

The link used to mirror data between the primary and standby machines should be a dedicated connection, unless the amount of mirroring activity is very small. If a dedicated link is used, data is mirrored through separate adapters and a separate communications link. This removes the mirroring activity from the production LAN transport, thereby eliminating any potential performance impact to the network.

The IBM PC Server High Availability Solution ships standard with two IBM 100/10 PCI Ethernet Adapters and an interconnect cable to support a direct, dedicated link between the two servers. In addition, the Vinca Standby*Server* software offers other options for linking the two systems. Under NetWare, for example, Vinca Standby*Server* 2.0 supports link communications over any NetWare-supported NIC, including fiber, which offers additional advantages in speed and distance between the link servers.

The IBM PC Server High Availability Solution is available for the OS/2 Warp Server, NetWare, and Windows NT environments. Its benefits are:

- *Full-server fault tolerance*—Because data is mirrored to a completely separate computer, all server components are redundant. RAID can protect disk drives, and redundant power supplies can ensure continuous power, but the Vinca solution replicates all hardware components. In addition, since data is mirrored to a separate computer, the Vinca solution can even recover from a software failure on the primary server.

- *Primary server and standby machine do not need to be identical*—A systems administrator can configure a less expensive computer as the standby machine (perhaps using last year's 486 server) and a more expensive Pentium-based system as a primary server. When the primary server fails and the users are switched to the slower standby machine, they might notice a performance difference between the two servers, but they can continue to access their data.

- *Full automation of server failover*—When the primary server fails and the standby machine is initialized as the main machine, no manual intervention

is required. This is advantageous when the support staff is unavailable, or even nonexistent, such as at remote sites.

- *Remote notification*—Using IBM's TME 10 NetFinity, alerts and other system notifications can be sent to a management console or to a digital pager. This makes it convenient to monitor system status in environments where the administrator is off site or is responsible for several networks at different locations.

- *Offline diagnosis and problem resolution*—Implementation of a hot-spare server allows an administrator to recover quickly from a system failure by using the standby machine to restore service to users. Then, the failing machine can be taken offline and diagnosed without affecting users' level of service. After that, the support staff will have time to analyze why the server failed and determine how to prevent the problem in the future.

NetWare SFT III

Like the Vinca solution, NetWare SFT III is a mirrored server solution that automatically takes information from one server and duplicates its disk and memory image to a standby server connected by a mirrored server link (MSL).

The Novell solution, however, has one important distinction; it is a continuous-availability solution. If the active server has a hardware failure, the second server begins serving clients immediately, without losing a connection to any client.

The faulty server can then be shut down and serviced. When service is completed, the server is returned online, and the two machines are re-mirrored to bring their disks back in sync. As is the case with the Vinca solution, the re-mirroring operation can degrade performance, so if you have large, mirrored disks, you may want to do it after hours.

This solution permits complete redundancy of all server components. Because each file transaction is duplicated on each server, both machines have complete, up-to-the-second versions of all the data necessary, in case they have to operate independently.

While this solution can provide higher reliability, it can be more expensive to implement, because all server hardware must be completely duplicated in an identical configuration. As application environments grow larger, the cost of duplicating the disk alone could make this solution prohibitively expensive. Also, as a NetWare-only solution, it does not work in OS/2 Warp Server or Windows NT environments. IBM provides support for NetWare SFT III across its server line in conjunction with OEM fiber adapters.

Shared External Disk

With this solution, each primary server uses external direct access storage devices (DASD) to store end-user applications and data. The external disks can be taken over by a standby machine if the primary machine fails.

One advantage of this solution is that multiple primary servers can be backed up with one standby machine. This solution requires a method of connecting the external disks to the primary machine in such a way that it can be easily switched to the backup machine when a failure occurs. There are several ways to do this:

- Manually disconnect the SCSI cables from the primary, then reconnect them to the backup machine

- Use an A/B switch box for SCSI interfaces

- Use the IBM ServeRAID Adapter

- Use serial storage architecture (SSA)

Manual Reconfiguration

Manual reconfiguration requires the support staff to disconnect the SCSI cables from the primary server and reconnect them to the backup machine in the event of a failure. The problem with this approach is obvious—it requires a systems administrator to be available immediately to reconfigure the system. In situations where every second counts, this is an unrealistic expectation. At remote locations, there may be no support personnel who can make the switch.

Another manual method is to remove the disk drives from the failing machine and place them in a spare server set aside for this purpose. With this method, one spare server could potentially back up many other servers. This can be accomplished
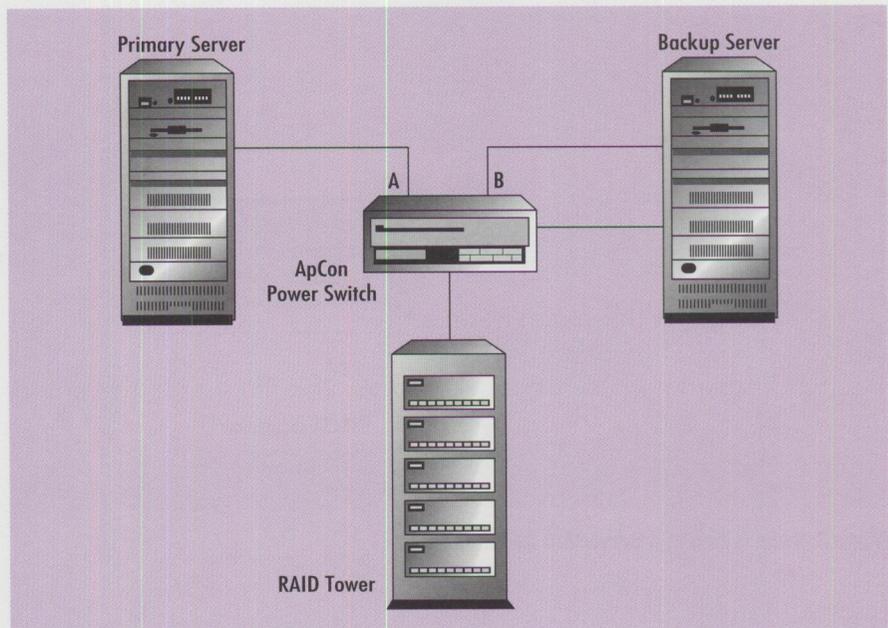

Figure 2. ApCon PowerSwitch

without using external disks, although using a hot-swap chassis and disk drives would make this solution more feasible. This method has the same inherent problems as the previous method, but it is a low-cost solution if you have the personnel to make it happen.

ApCon PowerSwitch

The PowerSwitch is a high-performance, electronic, cross-point SCSI switch manufactured by ApCon, Inc. (formerly Applied Concepts). It enables multiple, independent SCSI buses to be electronically selected and connected via internal switching circuits. This setup allows two computers to access external SCSI devices in much the same way that a printer A/B switch allows two computers to share a single printer; therefore, the need to manually swap and reconfigure SCSI cables and bus terminators is eliminated.

Figure 2 shows an example of an ApCon solution. During normal operations, the primary server accesses data on the external SCSI enclosure through the "A" port connection. If a failure occurs, the switch is reconfigured to connect the standby machine to the disks through the "B" port on the switch.

Like the Vinca solution, IBM's TME 10 NetFinity systems management software is configured to monitor the primary machine via NetFinity's presence detect feature. If the primary server fails,

NetFinity sends simple ASCII commands out through the serial port to the Power-Switch, telling it to switch the SCSI devices from the primary to the backup server. Next, NetFinity sends an alert to the backup machine, which has been configured to execute a reboot sequence upon receiving this alert. This sequence is automated and requires no operator intervention.

The backup server has a different boot configuration when it functions as a standby, versus when it switches roles to become the primary. When it boots as the backup machine, it boots from its internal hard disk. When it boots as the primary, it boots from the external disk. This switch is accomplished by changing the machine's startup sequence to boot first from the external disk, then from the internal drive.

As in the Vinca solution, service is disrupted slightly while the standby machine is brought online in the primary role; however, in most cases, users do not have to log off and then log on. The client code for Windows NT, OS/2, and the latest 32-bit requester code for NetWare will automatically reconnect to the backup when it comes online.

This approach has a few limitations. One is the physical distance that can be supported between the servers and the external SCSI devices. This distance is limited
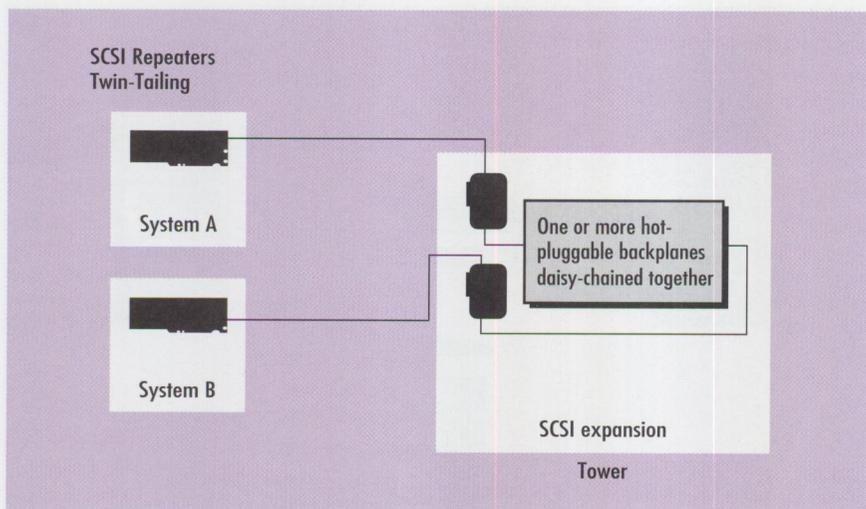
**Figure 3. Twin-Tailing IBM ServeRAID Adapters**
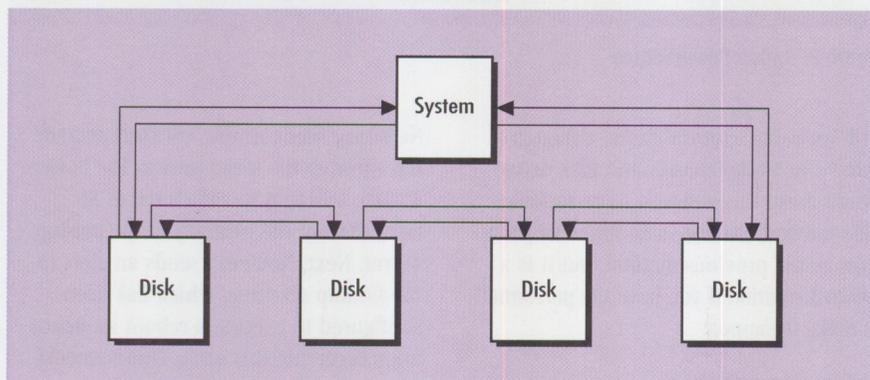
Figure 4. Serial Storage Architecture

by the ability of the SCSI adapters to drive the SCSI bus signals. The supported cable length depends upon several factors, including the speed of the interface (e.g., 5 MBps or 10 MBps) and whether it is a single-ended or differential-ended SCSI. Always check the product specifications.

If you need greater distances between the two servers than what is supported, SCSI extenders are available from several vendors. This solution works best if both the primary and backup machines have identical hardware configurations, because each server boots from the 3518 external DASD when acting as the primary. This means that the network operating system image on the 3518 must see the same hardware configuration, regardless of whether the primary or the backup server is in control of the disks.

IBM ServeRAID Adapter

The IBM ServeRAID Adapter is IBM's newest RAID controller. It is a 32-bit PCI

adapter that can burst data across the PCI bus at 132 MBps. On the SCSI side, it implements the UltraSCSI interface and is capable of a 40 MBps peak data-transfer rate between the SCSI device and the adapter. With three such independent SCSI channels, it can attach up to 45 devices on one adapter.

The RAID controller on the adapter is based upon the RISC POWER PC 403 chip and supports RAID levels 0, 1, and 5 at a configurable interleave depth of 8, 16, 32, or 64 KB. The RAID support also includes several features suitable for use in high-availability situations, one of which is the ability of the adapter to read RAID configuration data from the array itself. It can also detect any changes to the array configuration and can automatically update the configuration data.

An example of where this adapter might be used is in the event of a drive failure. If a hot-spare drive exists in the array, the

controller maps it into the array, then automatically rebuilds the array. When the failed drive is replaced, the new drive becomes the hot spare, and the array information is updated while the machine is up and running. (In contrast, on previous IBM RAID controllers, this information was stored on the adapter in erasable programmable read-only memory [EPROM] and had to be updated each time the RAID configuration was changed. This involved bringing the machine down and then booting a configuration utility to reconfigure the array.)

As for fault tolerance, the IBM ServeRAID adapter allows you to twin-tail two IBM ServeRAID adapters from different machines to the same external SCSI expansion tower. (Figure 3 shows this type of configuration.) Using this method, if the primary machine fails, the backup dynamically takes control of the DASD and updates the array configuration without requiring a reboot operation. Of course, the operating system must be able to dynamically mount new drives; NT and NetWare already do that.

Serial Storage Architecture

Serial storage architecture (SSA) is already being used in the RS/6000 environment and is an emerging technology in the PC server arena. As Figure 4 shows, this architecture is based upon a two-way serial communication loop that interconnects controllers and devices over an 80 Mbps daisy-chained link.

Because of the bi-directional nature of the links, fault tolerance is built into the architecture. If one device in the chain breaks, the data simply circumvents the loop to get to its destination. This works much the same way as the backup path on a token-ring network.

Since the architecture permits multiple controllers to participate in the loop, the implementation of a shared-disk approach using SSA is quite feasible. Figure 5 illustrates an SSA domain where all systems can access not only their own disks but the disks on the other systems as well.

Sample Scenarios Using High-Availability Solutions

The preceding section discussed a few methods available for clustering multiple servers into a fault-tolerant configuration.

These methods were highlighted here due to their richness of function and general-purpose application; however, a vast number of other approaches can produce viable high-availability implementations in the PC server environment. These solutions range from basic alert notification provided by systems management tools to application-specific, fault-tolerant features integrated into database and groupware applications.

With so many possibilities to choose from, the systems administrator faces the daunting task of sorting through the choices and selecting the right solution. Ultimately, there is no single best option, such as the best file server approach or the best database solution. Instead, you must evaluate the trade-offs, which depend upon the application and the environment that you want to protect.

This section presents several realistic scenarios that call for a range of approaches to fault tolerance. In each case, we outline the requirements and discuss the reasons for choosing the indicated solution. Our scenarios provide examples of how you can implement high availability. The solutions we present may or may not match your needs.

Scenario 1: The Establishment File Server

Requirements—400 Windows-based clients attached to an IBM PC Server 520 running Windows NT 3.51 share access to data and to personal productivity applications (Lotus 1-2-3, WordPerfect, and Microsoft Project). The corresponding end-user data files associated with these products are stored on the server in both public and private areas. The server contains 6 GB of disk storage.

If the server is unavailable, users' productivity is immediately impacted; however, as long as access to the applications and shared data areas is returned within minutes of an outage, the productivity loss is minimized. Also, in this environment, it is quite acceptable to perform machine maintenance after normal working hours.

Solution—This situation is appropriate for the IBM PC Server High-Availability Solution for these reasons:

- Recovery time from a failed server is minutes rather than hours. When 400

users are down, you need a recovery procedure that lets you restore service as quickly as possible. The cost of the additional hardware is justified when compared to the cost of lost productivity due to an inoperative file server.

- The standby machine does not need the same configuration as the primary. In this case, a lower-cost IBM PC Server 320 serves as the backup. Both machines, however, have the same disk configuration.

- With the Vinca software, the end-user data is mirrored in real time to the standby machine. This means if a failure does occur and the standby is activated, users still have access to their latest work. Contrast this to an approach that requires data to be reloaded from tape; the end users would lose any data they had saved since the last tape backup.

- 6 GB is an acceptable amount of data to be mirrored. It might matter more if there were 60 GB, because the cost of providing 60 GB of mirrored data is substantial. Also, the time it takes to re-mirror 6 GB is not long, and it can be done after hours during the reintroduction of the primary machine.

Scenario 2: The Mission-Critical Application Server

Requirements—A NetWare 4.1 server provides file and application service for 500 OS/2-based clients. The application is a mission-critical, LAN-based, commodities-tracking system. Any outages could result in lost opportunities and lost business. Downtime can be scheduled during off-hours, but 100 percent availability during business hours is required. The disk-storage requirement is 10 GB.

Solution—This scenario is a good match for NetWare SFT III, for these reasons:

- With the requirement for 100 percent uptime during operating hours, you need a fully redundant solution. SFT III provides continuous availability in the NetWare environment.

- As in the first example, 10 GB is feasible for a mirroring solution. Again, the re-mirroring can be done after hours.

Scenario 3: A Customer Service Voice-Response Application

Requirements—A customer service
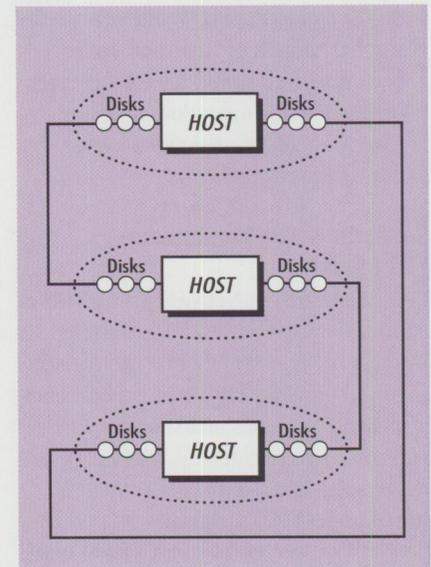
Figure 5. SSA Domain Concept

database running on OS/2 Warp Server is connected to a voice-response unit that customers access over the phone. Customers can place orders, check the status of existing orders, verify account balances, and update information such as address and billing information. Service has to be available 24 hours per day, although short disruptions can be tolerated at a slight inconvenience to customers. The size of the database is 30 GB.

Solution—This scenario is a good match for an external shared disk, for these reasons:

- The 24x7 nature of the operation precludes server maintenance down time. With a shared-disk approach, the stand-by server can be used during maintenance of the primary machine.

- A 30 GB database is almost too large for a redundant solution. Complete redundancy requires twice the amount of disk space, so the main concern here is cost. Another concern is performance, because the server resources required to keep two databases of this size in sync can be substantial. With a shared-disk approach, the information can be stored in a RAID 5 array that protects the data but requires substantially less overhead than a mirrored approach.

- If a mirrored solution was implemented and a machine fails, the two databases have to be re-synchronized when the failed machine is reintroduced. With a

30 GB database, this would take a substantial amount of time, and either both machines would have to be taken offline for this operation or performance would significantly decrease during the re-mirroring.

Scenario 4: The Multimedia File Server

Requirements—A NetWare 3.12 platform multimedia server is used for training. Workers on an assembly line use the server to call up video clips that explain manufacturing processes and show how to perform corrective actions when parts are out of spec. The multimedia content is stored on a CD-ROM, which is shared from the NetWare server. The application needs high availability to keep the assembly line running smoothly.

Solution—Because the digital content is on a CD-ROM, the easiest method of providing fault tolerance is to have another NetWare server with a CD-ROM drive that can be accessed in the event of a server failure. This backup server could normally be used to provide service to another user group, but it could also serve as a backup if the primary machine fails.

Scenario 5: The Enterprise Information Base

Requirements—A Lotus Notes-based product information database is replicated to 850 auto dealerships for access by local personnel. Product data is updated once a week from the corporate office. Disruptions in service of 30 minutes or less are acceptable. Outages of more than two hours can severely impact the business. The size of the database is 15 GB.

Solution—In this example, fault-tolerance features are built into the application. In Lotus Notes, database replication is done between servers automatically. The servers are configured such that, when the master database is updated each week, it contacts the other servers and sends only the changed data.

In this case, any of the servers can be used to retrieve the information. If one database fails, users can simply dial into another location via a communication server that has been configured to access an alternate site.

Scenario 6: A Branch-Office Application Server

Requirements—IBM PC Server 320s running NetWare 4.1 are used as a platform for a mission-critical client/server application. The environment consists of 40 enterprise branch offices spread across a major metropolitan area. At each location, 10 OS/2 Warp-based clients access a server that is part of one NetWare NDS tree. The critical nature of the data requires each location to be backed up by another location that can provide processing and data access when necessary. The business leases FDDI links from the local telephone company to connect the branches.

Solution—The Vinca StandbyServer 2.0 for NetWare, with a fiber connection to link the servers would satisfy the requirements presented in this scenario.

> *Many of the business processes that used to run on mainframe systems have now been migrated to the client/server environment.*

Scenario 7: A Departmental Database Server

Requirements—IBM PC Server 720s running Windows NT provide support for a large customer service call center. A database holds customer account information, and the majority of the transactions retrieve current account balances and recent transaction histories. Account update transactions, such as address changes, are held until after hours and are executed in batch mode each night. In addition, the building has an annoying environmental problem that intermittently brings servers down while leaving the rest of the users' systems and network in the building operational.

Solution—This is another situation where the IBM PC Server High-Availability Solution could be used. A dedicated 100 Mbps Ethernet link between the primary and the standby will permit the backup server to be on a different floor with different environmental factors. Because the

database is used mainly for read operations, there would not be excessive traffic on the mirrored link.

Scenario 8: A Corporate LAN Environment

Requirements—This example illustrates how a combination of all of the preceding techniques can provide high availability for an entire corporate LAN environment.

In this scenario, a company uses OS/2 Warp Server to deliver file and print services, as well to provide a platform for communication, collaboration, software distribution, and database functions. Twelve servers participate in an OS/2 Warp Server domain that services 1,000 users in five different locations. The company also has an IBM mainframe and two LAN-attached AS/400s located at the corporate office.

Many of the business processes that used to run on mainframe systems have now been migrated to the client/server environment. The company's chief information officer has committed to senior management that the LAN environment will be no less reliable than the mainframe environment. This translates into a requirement that the overall availability of the LAN must be at least 99.5 percent during normal operating hours.

Solution—This situation calls for using a combination of techniques. Some of the fault-tolerant requirements are satisfied by built-in features of the hardware and software products. Others have to be designed as part of the overall LAN.

Let's look at the built-in features first. Both OS/2 Warp Server and Lotus Notes provide fault-tolerant features to help achieve high-availability goals. OS/2 Warp Server uses the domain concept, which presents the LAN as a single-system image. The domain comprises a primary domain controller and other servers. The primary domain controller maintains the master domain control database. It is automatically backed up by one or more backup domain controllers.

In this solution, the primary domain controller is located at corporate headquarters, while one of the servers at each location is configured as a backup domain controller. In this way, the backup

domain controller can provide logon authentication for all users at that location, which increases logon speed.

As the domain database is updated, the changes are automatically replicated to all servers that are members of the domain. If the primary domain controller fails, the backup domain controllers continue to provide authentication and security functions for the domain. The role of one backup controller is temporarily changed to the primary role, so that a master domain control database is still available to handle changes to the domain.

Lotus Notes provides the collaboration functions. As in a previous example, Notes database replication is handled automatically between all Notes servers. One server in each location is loaded with Notes, and it participates in the database replication with the other servers. If a machine fails, the clients have a backup Notes server they can access over the network.

The communication server is located on the corporate backbone and provides a gateway to the host. It is backed up via a hot-spare machine dedicated to this purpose. The backup server is an older machine previously used as a file server at one of the remote locations.

The backup gateway can be implemented in several ways. In the first way, all client machines are configured to use the primary communication server at a specific token-ring address. If the primary machine fails, the backup machine is brought online with the same token-ring address. This automated process uses TME 10 NetFinity to monitor the primary server. If the primary server fails, NetFinity alerts the backup machine, instructing it to reboot with the configuration of the primary communication server. Users will have to reestablish their host sessions, but the change to the backup server is otherwise transparent.

Another, more sophisticated way is to use the high performance routing (HPR) function within the IBM Communications Server for OS/2 Warp. HPR is a feature of APPN that dynamically reroutes connections around network failures. In this case, both "gateways" are configured as APPN network nodes. The clients use the Communications Server's dependent LU requester (DLUR) feature to allow the 3270 sessions to use HPR. If one of the network nodes fails, HPR reroutes the sessions in a non-disruptive manner.

To meet the requirements for the file, print, and database functions, the shared-disk approach is implemented. At each location, two IBM PC Server models 310 in production are backed up by an additional PC Server 310. Each production server is attached to an IBM 3518 SCSI expansion tower with a redundant power supply and 40 GB of disks configured as RAID 5 arrays.

All servers and 3518s are connected through an ApCon PowerSwitch such that, if a primary machine fails, the backup machine takes control of its 3518 and temporarily assumes the primary machine's role. This gives the support staff time to diagnose the problem and correct it.

The RAID 5 arrays in the 3518 provide ample data protection. If a drive fails, the server continues to operate by recreating the data from the failed drive on the fly from check bits that have been stored on the other drives. While this is totally transparent to users, the system is configured to send an alert to a NetFinity systems management console at the corporate support center to notify the staff that a drive has failed.

Overall, the techniques applied in this scenario cost-effectively provide the appropriate level of protection. Each functional service provided by a PC Server has been analyzed, and the appropriate techniques have been employed to protect it.

The PC Server model 310 is a low-priced server that offers high performance but more limited expansion capabilities; however, when used in conjunction with the external 3518s, the DASD expansion capabilities are more than adequate to handle file, print, and database services.

In this scenario, to further reduce costs, the machine redeployment technique is also used. As new hardware is purchased, existing machines can be redeployed to provide redundancy of network resources.

Managing LAN Availability

This article has presented some concepts and techniques that you can use to increase your LAN's availability. Many companies already use these techniques.

As the technology for availability management rapidly advances, the future will no doubt deliver many new and exciting techniques that will help satisfy your critical requirements for LAN availability.

Resources

Portions of this article come from the new IBM redbook *PC Server High Availability Techniques*, SG24-4858. This book can be ordered via the PUBORDER application on IBMLink or by calling (800) 879-2755. The redbook covers all of the concepts presented in this article in greater detail.

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TECHNICAL

Managing PC Servers Using TME 10 NetFinity

Ensuring that your PC servers are operating efficiently is very important to the client/server architecture. TME 10 NetFinity enables you to ensure efficient operation by monitoring key indicators such as CPU and memory utilization, system temperature and voltage, and disk usage. Additionally, you can monitor the system itself, as well its critical applications.

In the move toward client/server architecture, availability of the PC environment and local area networks becomes increasingly critical. Maintaining a high availability network requires using the best components—the servers, network devices such as routers, and even the network itself. Using reliable hardware such as IBM PC Servers can minimize unexpected outages. And implementing TME 10 NetFinity's extensive management capabilities further enhances your system's availability, enabling you to move from a reactive into a proactive systems management mode.

Craig Elliott
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Roanoke, Texas

Overview

Does the name NetFinity sound familiar? Perhaps, because it was originally released as IBM NetFinity. Developed by the IBM PC Company to manage IBM hardware, NetFinity performed extensive asset management (of hardware and software inventory) as well as other tasks such as monitoring critical system resources and automating responses to alerts. As IBM began renaming its products to be consistent with the SystemView brand, NetFinity became PC SystemView. After IBM's acquisition of Tivoli, the product has again become NetFinity, but now it is TME 10 NetFinity to align with the new TME 10 brand.

NetFinity supports a variety of platforms, enabling systems management in the majority of customer environments. There are Clients (called Services in NetFinity terminology) for Windows 3.x, Windows 95, Windows NT, OS/2, and Novell NetWare servers. There are also Managers on the Windows 3.x, Windows 95, Windows NT, and OS/2 platforms. This flexibility lets you implement NetFinity on your existing platform, rather than switch platforms to accommodate your management application.
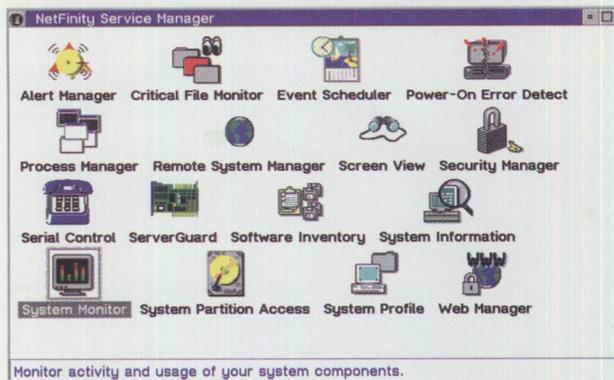
Figure 1. NetFinity Service Manager

Figure 2. System Groups

Another bonus is NetFinity's consistent functionality across all platforms, which means you have the same management capabilities in a Windows 3.x system as you have in an OS/2 system. The consistent user interface eliminates the learning curve for multiple platforms.

When installing NetFinity, the installation program queries the hardware and installs only the components that apply to your system; therefore, not all systems have the same program icons in the graphical user interface. Because some tools apply only to a Manager system, the icons present on the Client system may differ from those on the Manager system (see Figure 1).

TME 10 NetFinity 4.0 includes support for new IBM hardware, including PC Servers and LAN adapters, and it adds an interface to enable management via the World-Wide Web.

Common Management Tools

Although originally designed for IBM PCs, NetFinity can provide valuable management tools for any hardware or operating system. These tools allow you to monitor your remote systems to ensure they are operating satisfactorily. Some of the common management tools and their benefits are discussed next.

Remote System Manager

Manage the systems in your environment with the Remote System Manager. It allows you to group systems into logical collections that are similarly managed. For example, you may have one group for all servers, one for all workstations, and another for all systems within a specific department. These groups are created
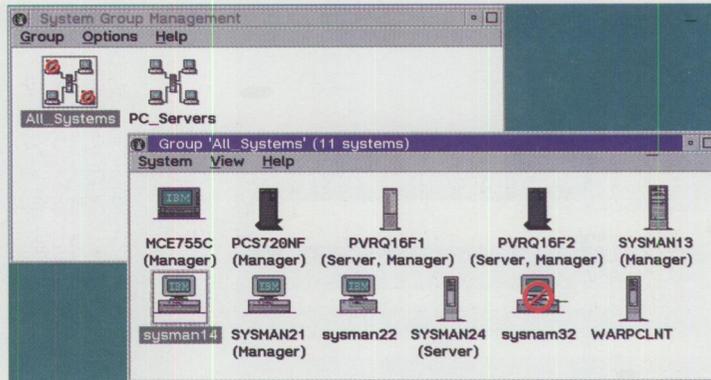
based upon combinations of eight system keywords specified during configuration.

You can also limit the systems added to each group based upon the operating system and/or communications protocol being used. This gives you the capability to create a group not just of systems in a specific department, but of only those systems running a specific operating system and communicating via a specific protocol.

A system's availability can be determined simply by viewing the group within the System Group Management window. (System Group Management is the title of the window, shown in Figure 2, that opens when you double-click on the Remote System Manager icon.)

Systems that have gone offline (because they were stopped) are represented by a grayed-out icon. Operational systems have a normal icon that represents the system type. Optionally, using the Alert Manager, you can add an overlay to the system's icon to indicate an operational problem or another condition that requires your attention.

In addition to changing the icon, you can configure the Remote System Manager to generate an alert whenever a system comes online or goes offline. You can specify how often you want to check the operational status, on either a per-system or per-group basis. Also, the Remote System Manager lets you reboot or power-on a remote system using the Wake On LAN feature of the new IBM adapters.

Critical File Monitor

Regardless of the application or operating system, certain files must be specially configured. For critical applications, including

network operating systems, changes to these configuration files can cause system outages.

The Critical File Monitor, illustrated in Figure 3, monitors these critical system files for changes, then generates an alert when a change is detected. Since these critical files are selected by the user, any file on any system can be monitored for changes. For example, on an IBM LAN Server system, you can select to monitor the CONFIG.SYS, IBMLAN.INI, PROTOCOL.INI, or any other file and receive a notification when it is changed. You are warned before the system is rebooted and have the opportunity to verify the changes and prevent the system from becoming unusable.

File Transfer

Once you are notified that a critical file has been changed, what then? How can you replace it or correct it? The File Transfer utility provides a graphical interface that you can use to copy a file from the Manager system to the remote system. You can use this interface, for example, to copy a backup of the changed configuration file from the Manager to the Client, thereby preventing an inoperable Client system upon reboot.

In addition to transferring any file between the NetFinity Manager and NetFinity Client, the File Transfer utility can transfer entire directories or delete files from the local or remote system. This utility is a useful tool to back up configuration files.

Event Scheduler

If you use the File Transfer tool to replace changed files, how do you get the backup copy of the file to the Manager system? One way is to use File Transfer to copy it
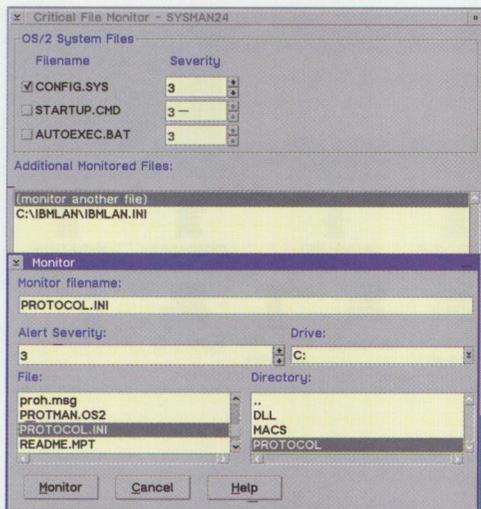
Figure 3. Critical File Monitor

Figure 4. Remote Session

from the Client to the Manager; however, this way requires that you connect to each system and manually copy the desired files. Since you typically want to back up these files periodically, you may want to automate this process. Unattended, the Event Scheduler can periodically perform the file transfer to ensure that you have the latest copies of the configuration files.

In addition to transferring files, you can use the Event Scheduler to schedule other NetFinity services such as rebooting the system, executing a command, or collecting software and hardware information. You can schedule these services for a single system, multiple systems, or a group of systems concurrently.

Remote Session

Instead of replacing the changed file, you may want to view the changes or even edit the file to correct the changes. The Remote Session tool enables you to perform those functions remotely.

The Remote Session tool (see Figure 4) establishes a remote command-line session with any Client system, regardless of the operating system. From this session, you can issue operating system commands such as TYPE to view the file's contents. Additionally, you can execute a text-based application such as EDIT or TEDIT to make corrections to the files.

Applications other than editors can be executed as well, as long as they are text-based. On OS/2 systems, Presentation Manager applications can be remotely launched in a separate session using the
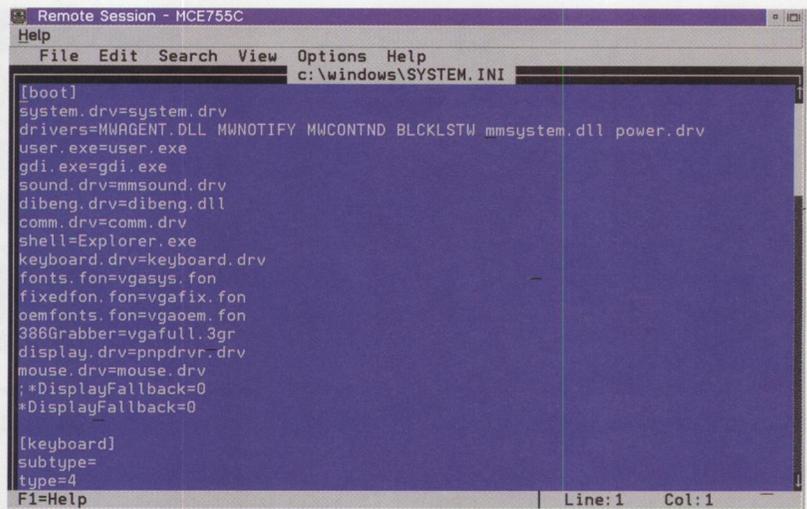
START command. Since they are launched in a separate window, and since they are graphical rather than text-based, you cannot interact with them. When opening a Remote Session on a NetWare server, you are actually establishing a Remote Console session with that server. From there, you can perform any function as though you were sitting at the console.

Screen View

Sometimes executing text-based commands is not enough. You may find it necessary to view the screen on the remote system, especially when a graphical application is being executed. Using the Screen View tool (shown in Figure 5), you can take a snapshot of a desktop to view exactly what is on the screen. This tool is very useful for remote problem determination.

For example, suppose a user calls a help desk and asks how to execute a program. The help-desk staff can take a snapshot of the user's screen and tell the user which commands to type or icons to execute. After the user completes those tasks, an updated screen shot can be captured to ensure that the tasks completed successfully. This sequence of giving task instruction and updating the screen capture can be repeated until the application is successfully executing.

Another way to use the Screen View tool is to capture error information. If a user calls a help desk to report an error, the help-desk personnel can capture the screen containing the user's error information and optionally save it as a bitmap for future reference.

Process Manager

Just because a system is running doesn't mean that it can perform its intended function, as in the case where the operating system is running, but a critical application has failed.

The Process Manager lets you monitor processes to ensure that they are executing and to optionally generate an alert if they are not. For example, you may want to monitor a LAN Server service, such as LSSERVER, to verify that it is running and to generate an alert when it stops.

Critical application processes such as those within LAN Server typically start automatically when the system is restarted. Process Manager (see Figure 6) can also monitor these processes to ensure that they start within a user-specified time after the system restarts.

Finally, you can monitor processes that you *do not* want to execute. You can use the Process Manager to monitor a system for specific processes, such as games that run over a network and generate a lot of traffic, and have alerts generated when these processes start running.

System Information

An important function in managing your systems is tracking the location of all hardware. This information is critical when installing new software that has specific hardware requirements; when adding new users to a network, which causes the server to use more disk space or memory; or at the end of the year

when assets must be counted for tax purposes. In any of these cases, having an updated list of your assets is invaluable.

The System Information tool collects and graphically displays detailed information about your hardware. It collects information such as the amount, size, and speed of SIMMs; the number and sizes of disk drives; and adapters in expansion slots. Optionally, you can export this information to a Lotus Notes or DATABASE 2 for OS/2 (DB2/2) database for future reporting. If you don't have Lotus Notes or DB2/2, you can save the hardware information to an ASCII file or formatted file for importing into another database.

Software Inventory
Having a complete software inventory is as important as your hardware inventory, especially when planning to roll out new software. The Software Inventory tool uses a list of applications registered in a database to scan your system to see what software is installed.

The Software Inventory tool can detect more than 2,000 applications. If desired, you can import software dictionaries from the Software Publishers' Association SPAudit or from Qsoft (in IBM's NetWork Door/2 product) to use during the search. You can also add your own software to the dictionary, giving you the capability to search for custom-written applications.

Applications are identified by a file name (or group of files), date, and size. You can group the software based upon application type, search for a specific type of application, and export the results of the

system scan to a Lotus Notes database, DB2/2 database, or an ASCII file. You can also format and import the search results into another database.

System Profile
To make the information collected about your system even more useful, NetFinity provides the System Profile tool for recording user- and hardware-specific information. The System Profile tool records data such as user name, department, and hours worked, as well as hardware make, model, and serial number.

Additionally, the System Profile tool provides space for entering miscellaneous information about the system such as NetBIOS names, locally administered addresses, TCP/IP host names, and more. You can also export this information to a Lotus Notes or DB2/2 database for future reporting.

System Monitor
Just because your system is running doesn't mean that it is operating optimally. The System Monitor tool, shown in Figure 7, enables you to monitor critical system resources for potential problems. You can monitor CPU utilization, memory usage, and disk usage. By configuring thresholds and having alerts generated when those thresholds are exceeded, you can be notified of exceptions such as excessive CPU utilization or insufficient available disk space. You can collect and export this data to a Lotus Notes or DB2/2 database.

Alert Manager
Monitoring system operation and receiving alerts isn't sufficient for maintaining

system availability. You must also be able to automate responses to the alerts.

The Alert Manager can process alerts when they are received and proactively respond by automatically executing a variety of actions that include logging the alert, executing commands, dialing a pager, or forwarding the alert to another NetFinity Manager or a Simple Network Management Protocol (SNMP) Manager. Taking these actions permits error-correction activities to begin before users call the help desk.

Alert processing is very specific. You can configure actions based upon several qualifying factors, including:

- Alert type
- Severity
- NetFinity application that generated the alert
- Application alert type
- Sender ID

Using these factors, you can configure a specific action for each system, alert type, or severity. For example, if Server A has a performance problem, you may want to dial the administrator's pager. If Server B has the same performance problem, you can send an e-mail message to the back-up administrator.

Web Manager
Some organizations may need to remotely perform some systems management activities. Other organizations may need to give
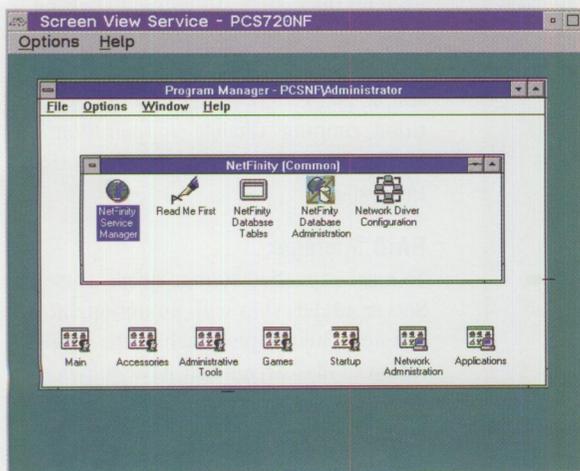
Figure 5. Screen View Service
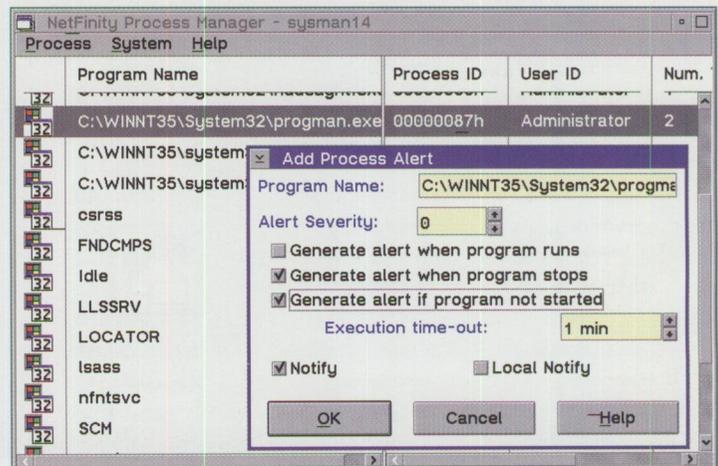
Figure 6. NetFinity Process Manager
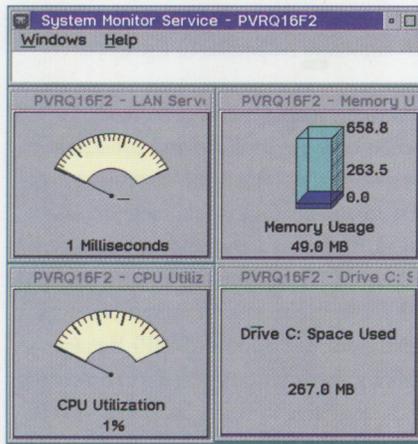
Figure 7. System Monitor Service

management capabilities to people who don't need or want the NetFinity Manager code installed on their system.

NetFinity's Web Manager accomplishes these tasks. The Web Manager is a mini hypertext transfer protocol daemon (HTTPD) server that allows any NetFinity tools to be served remotely over the Internet or an intranet and executed by any system using a Web browser. (To execute the Remote Session tool, the Web browser must support Java.) This provides a way to create an administrator workstation without requiring the NetFinity manager code. A user who has a Web browser

(see Figure 8) can connect to the managing system's Web Manager and manage any Client on the network.

Serial Control

Some organizations might need remote management capabilities but lack a connection between two sites, as in small branch offices with stand-alone networks under the responsibility of the main office. In this environment, you can use NetFinity's serial protocol to connect from one NetFinity Manager system to another over an asynchronous line. The Manager at the main office connects to the Manager at the remote branch, then passes through to the Clients needing to be managed. The Serial Control tool lets you configure this connection, including phone numbers, userids, and passwords to be used for authentication.

Specific Management Tools

In addition to its general management capabilities for all systems, NetFinity provides specific management tools for systems like PC Servers, which implement enhanced architectural designs. NetFinity's capabilities include enhanced memory monitoring, monitoring reference partitions on hard disks, and collecting additional hardware information from systems with either a Micro Channel or PCI bus.

Power-On Error Detect

On the non-array models of PC Servers, hardware configuration is performed using utilities stored on a special partition on the hard disk, typically referred to as a *reference partition* or initial machine load (IML) partition. When the system restarts, it verifies the configuration by running a power-on self test (POST). If a configuration change is recognized or a failed component is discovered, a POST error displays on the screen. NetFinity provides a utility called Power-On Error Detect (POED), which generates an alert after receiving a POST error. This utility is loaded onto the hard disk's IML partition, and the alert is generated over NetBIOS.

The POED service also generates warnings when the IML partition is booted. These alerts are received by the POED service on the NetFinity Manager, which can generate other alerts to be processed by the Alert Manager.

System Partition Access

Maintaining the latest adapter definition files, either on the reference diskette or on the hard disk's IML partition, can greatly improve hardware performance.

Updating the IML partition on the PC Server non-array models with the latest version of these files typically requires you to shut down the system, boot into the IML partition, then manually copy the files from each diskette to the IML partition using the Copy Option Diskette utility.

The System Partition Access tool (see Figure 9) lets you access the IML partition, upgrade the adapter definition files, and back up the system, all without shutting down the system. Once you have updated these files, changing the configuration is a simple matter of booting into the IML partition, running "Change configuration," saving the configuration, then rebooting the system.

RAID Manager

To meet expanded storage needs, some PC Server models ship with an optional RAID adapter. This adapter enables the configuration of disk drives that have enhanced data integrity, providing the ability to dynamically recreate data if a drive fails. Along with this enhanced functionality is
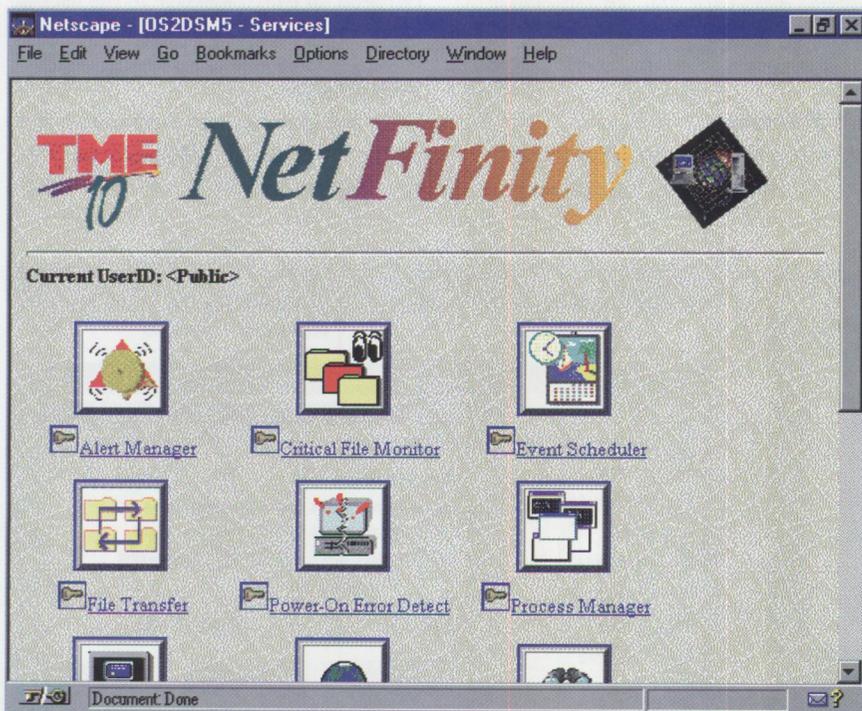
Figure 8. Netscape View of TME 10 NetFinity

the additional burden of managing the drive array configuration.

The RAID Manager, illustrated in Figure 10, lets you remotely configure the array on a Client system from the Manager system by stopping or starting a device, adding a device, or setting a hot-spare drive. The RAID Manager interface graphically displays the devices making up the array and the adapters connecting them. You can also use the System Monitor to monitor the RAID array to ensure that the devices are functioning. Optionally, alerts can be generated if a device stops or if the array configuration changes.

Predictive Failure Analysis

The ultimate way to prevent data loss is to know when a drive is going to fail before it actually fails. That is the function of the Predictive Failure Analysis (PFA) tool. It monitors IBM disk drives on the PC Server non-array models for potential failures and generates an alert 24 to 48 hours before the failure occurs. You can use this alert as the basis to place a service call to IBM and have the drive replaced before it fails, thus preventing critical data loss.

ECC Memory Manager

In addition to ensuring data integrity on a disk drive, you should monitor the data in memory to ensure its integrity. The ECC Memory Manager (see Figure 11) provides a way to count single-bit errors and correct those errors on PC Servers that have error checking and correction memory. The System Monitor tool can monitor these errors and generate an alert if a specific threshold is exceeded. Additionally, if a user-defined threshold is exceeded, the ECC Memory Manager can generate a non-mask interrupt (NMI). Use caution with this ECC Memory Manager feature, since an NMI causes most systems to halt.

Enhanced Management Functionality

Beyond its basic operating system and hardware management, NetFinity monitors specialized hardware such as the PC Server 720, as well as network operating systems, to ensure that they are operating satisfactorily. This section discusses some of NetFinity's enhanced management capabilities.
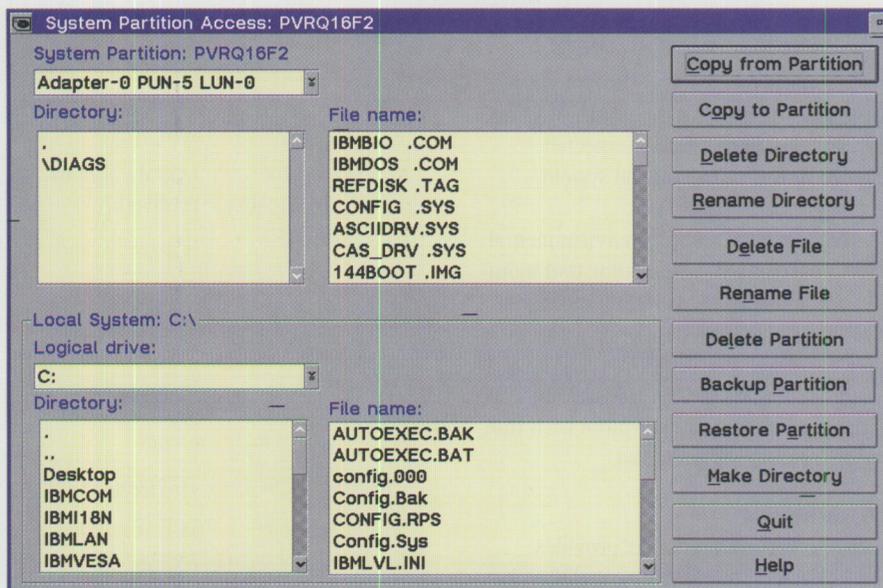
Figure 9. System Partition Access
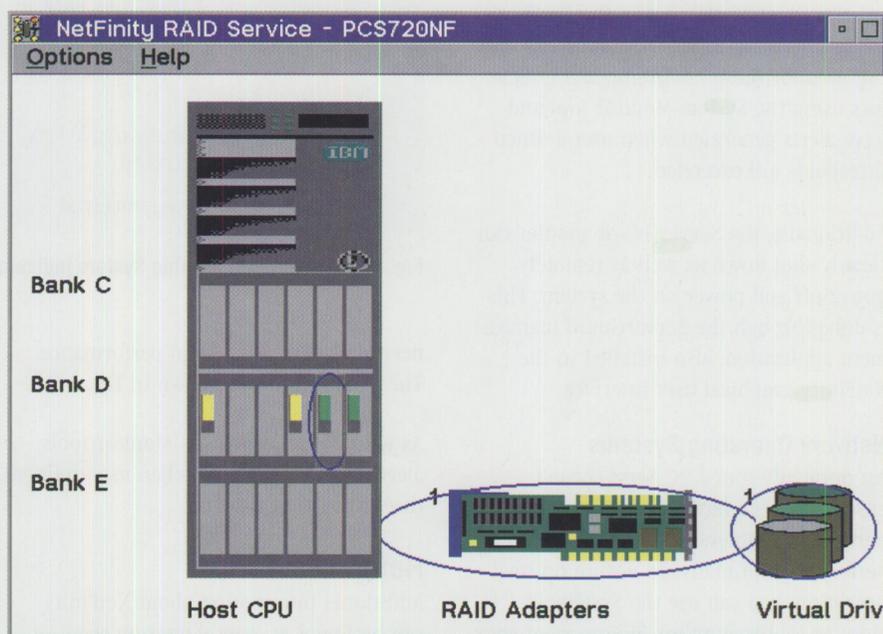
Figure 10. NetFinity RAID Service

PC Server 720

Because excessive heat or reduced voltage can result in system failure, environmental indicators have been engineered into the PC Server 720 hardware. Using the System Monitor tool, you can monitor environmental indicators, including:

- Power supply temperature
- System temperature
- Planar temperature
- Power supply voltage
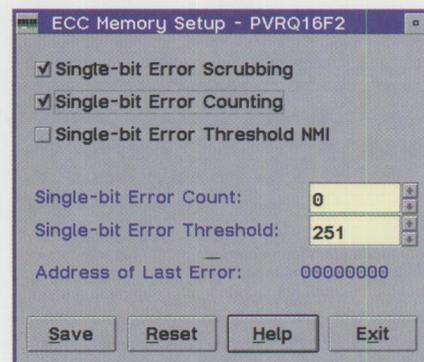
Figure 11. ECC Memory Setup

As with the other System Monitor tools, you can have alerts generated when thresholds are exceeded. You are notified when the operating temperature becomes excessive or there is an unexpected change in the voltage of the system.

In addition to monitoring environmental indicators, the System Monitor tool monitors individual processors; therefore, in addition to having one monitor presenting an average for all CPUs, you'll have a monitor for each CPU in the system. This setup enables you to determine each individual processor's workload.

ServerGuard

IBM's ServerGuard adapter provides environmental monitoring capability for the PC Server 500 and the Micro Channel versions of the PC Servers 310, 320, and 520. The ServerGuard management program seamlessly attaches to the NetFinity folder. Just as with the PC Server 720, you can monitor these environmental indicators using the System Monitor tool and have alerts generated when user-defined thresholds are exceeded.

Additionally, the ServerGuard adapter can cleanly shut down as well as remotely power off and power on the system. This is done through the ServerGuard management application, also installed in the NetFinity graphical user interface.

Network Operating Systems

An optimally tuned PC Server won't ensure that you have the best system performance unless the software is also performing optimally. To ensure optimal operation, you can use the System Monitor tool to monitor indicators of your

LAN Server	TCP/IP	Novell NetWare	Windows NT
Sessions	UDP datagrams sent	Number of connected users	Sessions
Connections	UDP datagrams received	Volume space used	Opens
Opens	IP packets sent	Volume space remaining	Bytes sent
Shares	IP packets received	Cache blocks in use	Bytes received
Bytes sent	IP packets received with errors	Percent of cache in use	
Bytes received	TCP connections		
Response time	TCP/IP sockets		
Requester buffer shortage	Unicast packets sent		
Big buffer shortage	Broadcast packets sent		
	Bytes sent		
	Unicast packets received		
	Broadcast packets received		
	Bytes received		

Figure 12. Network Operating System Indicators

network operating system performance. These indicators are shown in Figure 12.

As with the other System Monitor tools, alerts can be generated when user-defined thresholds are exceeded.

References

Additional information about NetFinity can be found at several sites on the World-Wide Web. Here are a few sites of interest:

```
http://www.pc.ibm.com/products/
    netf.html
http://www.tivoli.com/products/
    TME10/NetFinity/revgde40.html
http://www.tivoli.com/products/
    TME10/NetFinity/NetFinity.html
```

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PC Server High-Availability Techniques	❏	❏	❏	❏	❏
Managing PC Servers Using TME 10 NetFinity	❏	❏	❏	❏	❏
Specifying a PC Server for Lotus Notes	❏	❏	❏	❏	❏
Exploring IBM PC Servers in an ATM Environment	❏	❏	❏	❏	❏
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Corrective Service Information	❏	❏	❏	❏	❏

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Specifying a PC Server for Lotus Notes

Subsystems within your PC server can affect Lotus Notes performance. This article describes how to configure these subsystems for the best performance. It then presents ways to customize the operating system to better support your Notes environment. Finally, it mentions one parameter in the NOTES.INI file that can also affect the performance of your Lotus Notes environment.

The design of Notes applications, such as View and Formula, heavily influences Lotus Notes performance. (See *Personal Systems'* January/February 1996 issue for an article on how to design a Notes application.) But other factors—hardware, operating system, and Notes server—can also affect the performance of your Notes implementation.

When you choose a PC server as your Lotus Notes 4 server, you need to understand the capabilities of the hardware, as well as the operating system, to take full advantage of Release 4's new features.

Hardware

Today's PC consists of a central processing unit (CPU), several subsystems (memory, disk, network interface adapter), and input/output devices, plus a common bus. Every hardware vendor's objective is to provide not only a high-performance CPU complex, but also a well-balanced architecture that does not cause a bottleneck among subsystems.

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How can a specific bus architecture, memory subsystem design, or disk I/O subsystem affect Lotus Notes performance and capacity?

First, let's consider the potential hardware bottlenecks.

System Bus

The sole purpose of the system bus is to provide a path for different subsystems to communicate with each other. In a symmetric multiprocessing (SMP) system such as a PC server, which requires a very high communication bandwidth, a slow-speed system bus can be a bottleneck. Hardware vendors, therefore, design their high-performance PC servers with a high-speed bus, sometimes called a *system interconnect bus* or *local bus*.

In most cases, this bus is proprietary. For example, the (proprietary) system bus in the IBM PC Server 720 is the C-Bus II. It operates at 400 MB/sec and provides a high-speed connection for up to six CPU complexes and main memory. It also isolates the high-speed subsystem from the lower-speed subsystem by implementing a secondary bus that connects existing ISA, Micro Channel, EISA, and VESA adapters. This approach not only prevents the slower devices from causing bottlenecks, but also protects your investment in your existing technology.

Processor

We always talk about processor, or CPU, speed—100 MHz, 133 MHz, etc. CPU speed is the primary factor used to measure and compare system performance. But since the introduction of the system interconnect bus, a better measurement is the *CPU complex* (sometimes called a *processor card*). A CPU complex consists of a CPU, L2 cache, L3 cache, plus system bus interface and logic.

Lotus Notes 4 takes full advantage of symmetric multiprocessing support provided by the underlying operating system; therefore, the more CPU complexes your PC server and its operating system can support, the better Lotus Notes performs.

Memory

The redesigned, 32-bit Lotus Notes 4 provides larger structures to hold session information. Larger structures require more memory. Installing more memory may solve your I/O and processor problems. (As an example, the IBM PC Server 720 can support up to 1 GB of error correcting code [ECC] memory.)

Why does more memory help? Because most operating systems use virtual memory managers to emulate the amount of memory available to each process. When a new process is scheduled to execute, it will be loaded into main memory; if there is not enough main memory, the current process has to be paged out to disk. When the number of processes exceeds available memory, a condition called *thrashing* occurs, where the system constantly swaps processes between memory and disk and accomplishes little or no useful work.

Network Adapter

Under normal conditions, the network adapter is usually not a bottleneck. But some factors inherited from the network

operating system may cause your server to limit the number of active sessions available. For example, the NetBIOS transport support can accommodate only 120 active Notes sessions per adapter.

To increase the number of active sessions, use the TCP/IP protocol, which has no logical limit on the number of active Notes sessions per adapter.

Disk Subsystem

In a virtual storage system, generally the first place to look when evaluating performance is in the disk subsystem. Since the disk subsystem is so closely related to the file system, both systems should be discussed together. Because our discussion centers on how the hardware affects the Lotus Notes environment, let's start with the file system.

A file system organizes and manages files on a physical or logical mass-storage device such as a disk, diskette, or another file system in a distributed environment. For this article, I am limiting the discussion to physical mass-storage devices.

Why is one file system implementation superior to another? The answer often depends upon how the operating system designer implemented its search algorithm and where the information needed to locate a particular file is stored.

In OS/2, HPFS386 versus FAT is the most suitable file system for Lotus Notes, while in Windows NT, the choice is NTFS rather than FAT.

The performance of the disk subsystem depends upon how fast a piece of data can be made available to the CPU. The bottleneck for the disk subsystem is the disk drive's seeking mechanism. Seek time is the major factor when comparing two disk drives. The second factor is the rotational speed of the disk, sometimes referred to as *average latency*. The average seek time and average latency affect Lotus Notes performance.

Fortunately, there is almost no difference among the seek times and average latency of disk drives used in today's PC server disk subsystems. Many disk drives have a rotational speed of 7200 rpm and a seek time between 7 and 8 milliseconds.

Some disk controllers use disk cache memory for data writing and reading. With a disk cache, the disk drive can write data to and read data from the cache, then proceed with processing while the disk controller actually writes the data from cache to disk or reads more data from disk to cache. Because a cache minimizes CPU idle time, it can enhance Notes' performance.

Another disk subsystem component that affects Notes performance is the disk controller. The most popular disk controllers are small computer system interface (SCSI) and enhanced integrated drive electronics (EIDE). Using a disk controller to implement multiple small disks instead of one large disk provides one way to enhance a disk subsystem because multiple drives can provide faster access to the data requested by Notes. A SCSI disk controller provides connections for seven disk drives, and SCSI II increases that number to 15. The SCSI II fast/wide controller can provide an 80 MB/sec transfer rate between the disk subsystem and the system peripheral bus and a 20 MB/sec data-transfer rate between the disk drives and the controller.

An EIDE controller provides a maximum of four connections. It can achieve up to a 16.6 MB/sec data-transfer rate between disk drives and the controller.

For a small system that uses no more than four disks, EIDE can be a viable alternative; however, for a large Notes system, you should choose SCSI II fast/wide.

How about a RAID implementation? Obviously the best performance is RAID 0, disk striping, but RAID 0 sacrifices system reliability. In a mission-critical environment, RAID 0 is not feasible. RAID 5 seems good, because it is reliable and wastes less disk space. But RAID 5 also uses higher overhead to create the checksum. For combined reliability and performance, the best way to implement a RAID system is disk striping and disk mirroring, a configuration sometimes referred to as RAID 10 or enhanced RAID 1.

Operating System

Two ways to improve operating system performance include:

- Keeping all processes/threads at the same priority. In OS/2, set `PRIORITY=ABSOLUTE` and `PRIORITY_IO=NO` in the `CONFIG.SYS` file. In Windows NT, open the Control Panel icon, open the System icon, select Tasking, and set "Background Applications Equally Responsive."

- Optimizing file caching. In OS/2, set `USEALLMEM=YES` in the `/IBM386FS/HPFS386.INI` file. In Windows NT, open the Control Panel icon, open the Network icon, select "Configure," and set "Maximize Throughput for Network Application."

Notes Environment Variable

One environment variable for the Notes server on the PC server, `NSF_Buffer_Pool_Size`, affects Lotus Notes performance. Set this variable by editing the `NOTES.INI` file to create an entry `NSF_Buffer_Pool_Size= xxx` (where xxx is the maximum amount of buffer memory available to the Notes server). The value depends upon the memory available in the PC server. The maximum allowable size is 128 MB.

Although Notes performance relies heavily on the design of the Notes applications, remember that hardware can also have an impact. Properly specified system bus, memory, network, and disk subsystems can enhance the performance of your Notes application.

Benjamin P. Chang is an advisory marketing support representative in IBM's Personal Systems Competency Center, Roanoke, Texas, and a member of the Lotus Notes support team. He joined IBM in 1983. Benjamin has an MS in Industrial and System Engineering from the University of Florida, an MS in Computer Science from Southwest Texas State University, and a BE in Mechanical Engineering from Tamkang University in Taiwan. His Internet ID is benjaminc@vnet.ibm.com.

Exploring IBM PC Servers in an ATM Environment

Asynchronous Transfer Mode (ATM) is an emerging technology that affords greater throughput and support of diverse media for high demand networks and PCs. The IBM PC Server runs network operating systems that are not written to support native ATM networks. This article presents a solution, LAN Emulation over ATM, and tells how to implement it with some of the network operating systems supported by IBM PC Servers.

I have had to change my definition of "ATM." During a recent discussion, several of my peers said that ATM is the "hottest thing going." My reaction was that my co-workers must be out of touch—after all, ATMs have been around for a long time! I use my plastic ATM card on a regular basis. After that discussion, I felt I was the "hippest," most up-to-date person in the group.

During a technical planning session several days later, I suddenly realized that ATM now means more than just "automatic teller machine." The "hottest thing going" is instead the rapidly evolving networking concept of "Asynchronous Transfer Mode."

The first ATM products hit the market in 1994, and they have been proliferating since that time. The forces behind ATM include high-capacity, high-demand workstations and servers such as those in the IBM PC Server family.

IBM PC Servers in the Traditional LAN Environment

The IBM PC Server supports the following network operating systems (NOSs):

- IBM OS/2 Warp
- Novell NetWare

Franchesca Collins
IBM Corporation
Roanoke, Texas
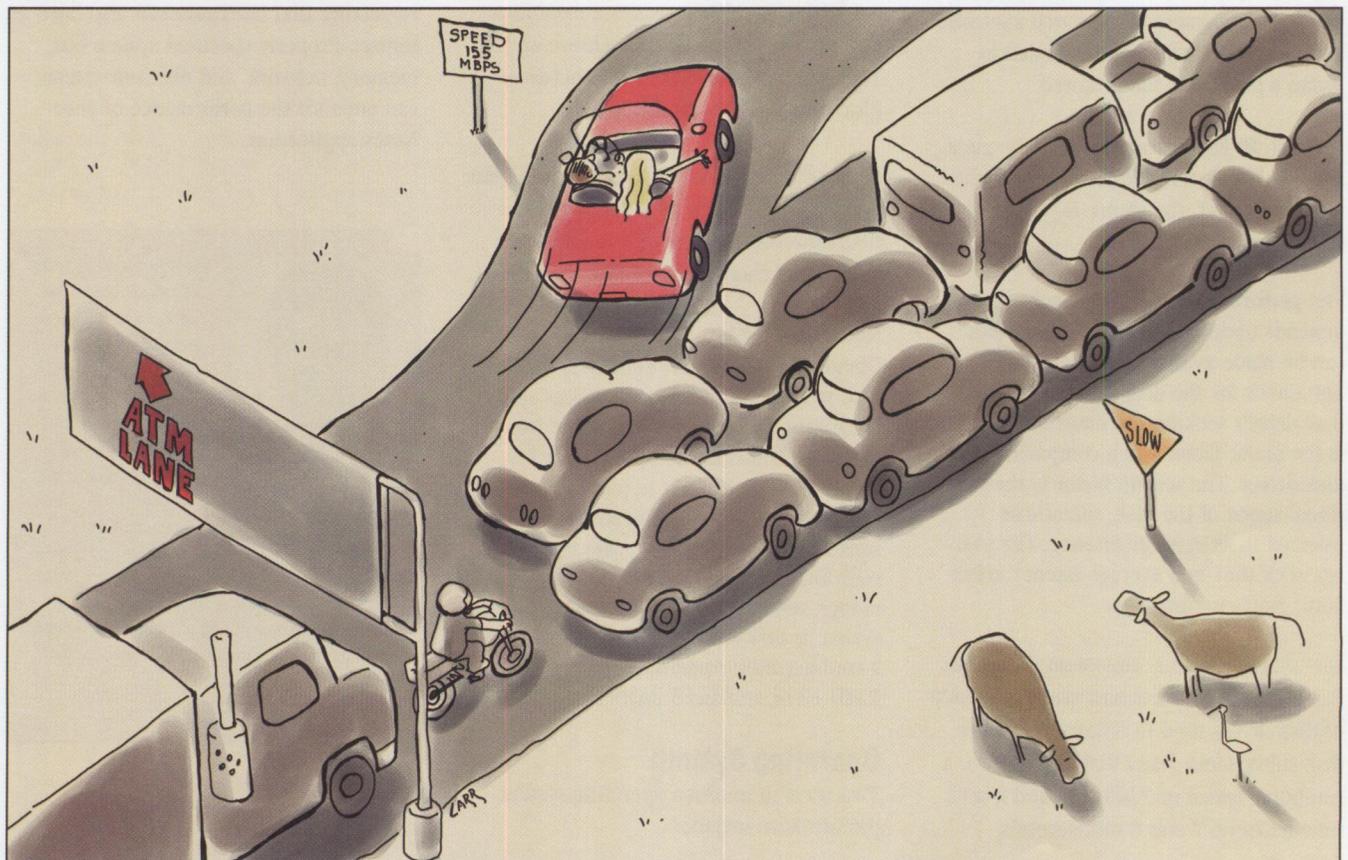
- Microsoft Windows NT
- SCO UNIX
- Banyan Vines

Each of these NOSs is a LAN application that conforms to traditional LAN topologies. That is, it assumes a LAN type of token-ring, Ethernet, fiber distributed data interface (FDDI), and so on. The protocols used by these physical media include TCP/IP, NetBIOS, NetBEUI, and IPX/SPX. Each of these protocols works well in the shared medium for which it was designed.

Client/server implementations that use any of the NOSs supported by IBM PC Servers fall into a local category, remote category, or both.

Figures 1 and 2 represent local and remote LAN implementations. Local LAN implementations usually accommodate intra-communication between clients and one or more servers; the servers can range from file servers to application servers, as shown in Figure 1. Remote LAN implementations accommodate communication between clients and servers in two different physical locations, as illustrated in Figure 2.

Regardless of which LAN implementation is applied, the problem of increasing throughput (that is, giving users better response time) is always present. With the increasing bandwidth required by servers, ATM is a solution.

Faster Than a Speeding Bullet

Token-ring, Ethernet, and sometimes FDDI networks reign supreme as the networking topologies of choice in today's client/server environments.

When token-ring was first introduced, it was considered fast at 4 Mbps; however, 16 Mbps soon became the standard for ring speed. Then early token release was added to speed things up even more.

Meanwhile, in the Ethernet world, 10 Mbps networks rapidly exploded to 100 Mbps networks.

Whether you are dealing with 4 Mbps or 100 Mbps, in a LAN environment the *n*Mbps must be shared among all devices connected to the LAN. Traditional LAN topologies have just about reached the
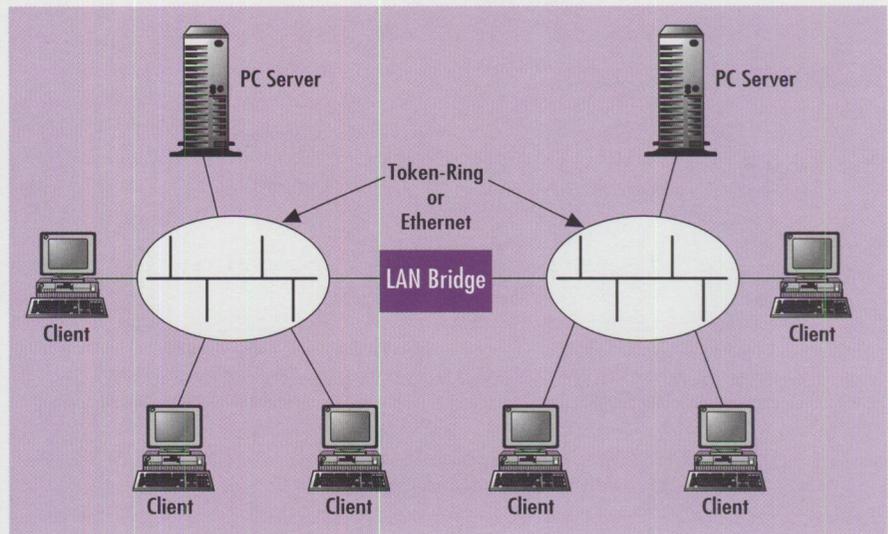
Figure 1. Local LAN Implementation
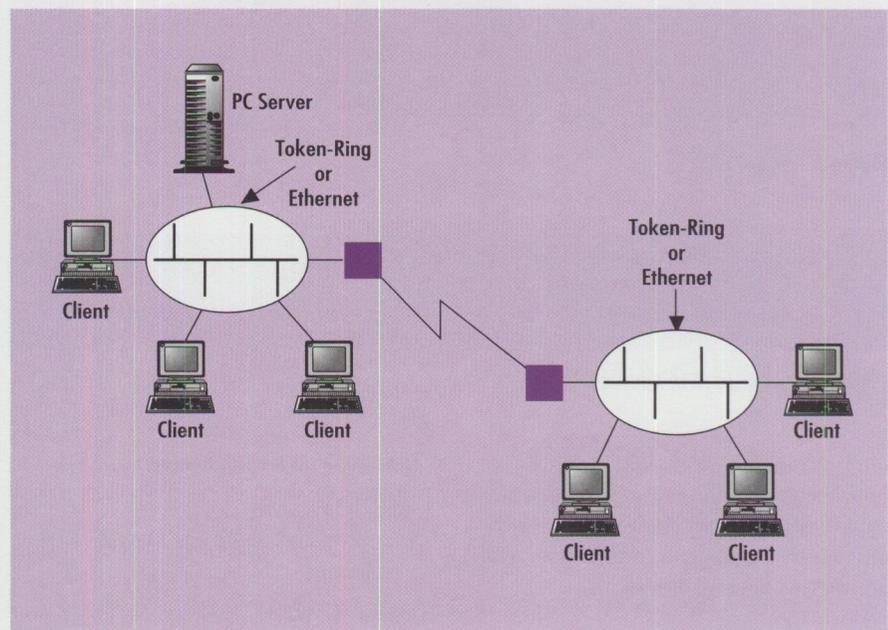
Figure 2. Remote LAN Implementation

maximum for transmission rates. In an attempt to maximize throughput, we have streamed, jetted, dualed, and quadded the adapters used in devices on the LAN.

ATM, being a high-speed switched network, nicely addresses the throughput issue. In theory, all devices installed with 155 Mbps adapters can concurrently transmit at 155 Mbps, yielding greater overall throughput. This is a slight stretch, but the point is that no single device must wait for another before transmitting data on an ATM network. (Switched Ethernet is another alternative but is beyond the scope of this article.)

Adding ATM to the Picture

Most environments are traditional LAN installations. The NOSs supported by IBM PC Servers are written for communication using traditional LAN protocols and technologies. To add ATM to the current LAN picture, you must have a "glue" known as ATM LAN Emulation (LANE). Although, in some cases another option is Classical IP, this article focuses on ATM LAN Emulation.

Components of ATM LAN Emulation

ATM LAN Emulation (more precisely, LAN Emulation over ATM) comes in proprietary implementations and ATM Forum

Figure 3. Virtual LAN

Switch prefix	MAC	Selector
3909851111111111111111110101.	700080009001.	00
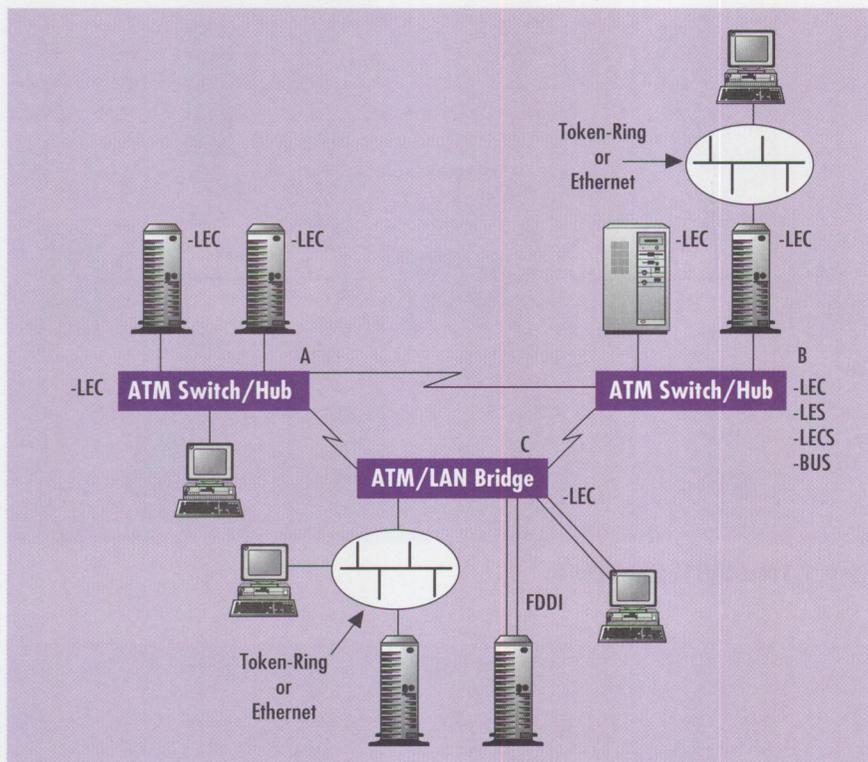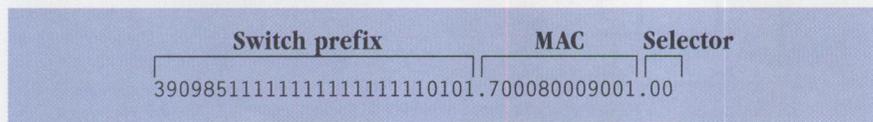
Figure 4. An Entire ATM Address

implementations. Regardless of which implementation, the goal is to enable LAN applications and protocols written for traditional LAN topologies to run on an ATM network without modifications.

IBM developed a proprietary implementation of LAN Emulation over ATM prior to the existence of the ATM Forum implementation. The proprietary implementation is now being phased out in favor of the ATM Forum's LAN Emulation over ATM, the standard to which most ATM vendors adhere.

The ATM Forum LAN Emulation consists of:

- LAN Emulation Client (LEC)
- LAN Emulation Server (LES)
- LAN Emulation Configuration Server (LECS)
- Broadcast and Unknown Server (BUS)

The emulated LAN components collectively:

- Resolve MAC addresses to ATM addresses
- Replace the connectionless operation of a traditional LAN with ATM's connection-oriented approach
- Mimic the broadcast and multicast characteristics of a traditional LAN in a connection-oriented ATM environment

An emulated, or virtual, LAN requires a LAN Emulation Client running on each device on the network. The remaining components (LES, LECS, and BUS) can be distributed over different physical devices or can exist collectively in one physical system. Either way, they are three distinct functions.

In Figure 3, a virtual LAN consists of IBM PC Servers, RISC/6000 systems, ATM switches, and a bridge. Each of the IBM PC Servers and RISC/6000 systems

(connected to ATM switches) is running LEC services. Switch B in this case runs the LEC, LECS, BUS, and LES services. The PC Server on switch B provides routing services for the PCs attached to the token-ring LAN. The bridge runs the LEC service and connects the token-ring, Ethernet, and FDDI LANs to the ATM emulated LAN.

ATM Addressing Versus LAN Addressing

An obvious distinction between a traditional LAN and ATM LANE is in the addressing. In traditional LAN environments, a six-byte media access control (MAC) address is used. The ATM address, on the other hand, is 20 bytes, six of which make up a MAC address. The ATM address is made up of the following components:

- 13-byte switch prefix
- 6-byte MAC address
- 1-byte selector

Figure 4 contains a sample of the entire ATM address, with periods separating the logical components.

ATM addressing is automatic if you use Interim Local Management Interface (ILMI) or another registration procedure service. In fact, only the six-byte MAC component is static. You can manually specify the ATM address for every LEC, LES, LECS, or BUS in an emulated LAN, but it will soon become an administrative nightmare. You also have the option of specifying the MAC portion of the ATM address, as you would have in a traditional LAN environment.

Installing ATM LANE for PC Server Support NOSs

Installing ATM LANE for PC Servers consists of installing the physical adapter, the NOS-specific device driver, and LAN emulation software. At a minimum, the LAN emulation software you install on the server should consist of the LAN emulation client services.

Installation Under OS/2 and OS/2 Warp

Installing ATM device drivers under OS/2 and OS/2 Warp requires modifications to the PROTOCOL.INI and CONFIG.SYS files. The Multi-Protocol Transport Services (MPTS) program automatically configures and installs LAN-based communications

adapters and protocols for the OS/2 and OS/2 Warp environments. You have the option of manually installing device drivers, but the task can be tedious, so use MPTS whenever possible.

ATM adapters do not appear in MPTS's default adapter list. Follow these steps to add the ATM adapter and desired protocols under MPTS.

1. Execute the MPTS program from the desktop or from the OS/2 folder.

2. When you see the Multi-Protocol Transport Services logo panel, select OK.

3. In the Multi-Protocol Transport Services panel, select the Install pushbutton.

4. When the Install Additional Network Device Drivers panel appears, insert the ATM adapter's OS/2 device drivers diskette for the adapter you have installed. (This disk should have come with the adapter.) Select OK.

5. Select OK in all the installation completion panels until the Multi-Protocol Transport Services panel reappears. Select Configure.

6. In the Configure panel, make sure that the LAN adapters and protocols (LAPS) radio button is selected, then select Configure.

7. In the LAPS Configure panel, select the newly added ATM adapter from the network adapter list, then select Add.

8. From the Protocols list, select the desired protocols to run over this adapter, then select Add.

9. Select OK to accept the configuration. All editing is complete.

10. When the Configure panel reappears, select Close.

11. In the Multi-Protocol Transport Services panel, select Exit.

12. In the Update CONFIG.SYS panel, ensure that the Update CONFIG.SYS box is checked, and select Exit.

13. When the CONFIG.SYS Updated information panel is displayed, select OK.

14. In the Exit MPTS panel, instructions are given for making the configuration active. Make note of the

instructions so that you can follow them later, then select Exit.

15. After you have followed the Exit instructions, the ATM Adapter device driver installation is complete.

Installation Under NetWare

Installing ATM device drivers under Novell NetWare requires modifications to the STARTUP.NCF and AUTOEXEC.NCF files. The NetWare INSTALL program automatically configures and installs LAN-based communications adapters and protocols for NetWare environments. You have the option of manually installing device drivers, but the task can be tedious, so use NetWare INSTALL whenever possible. (Some adapters provide an installation program that installs the device drivers independent of NetWare INSTALL.)

ATM adapters do not appear in the NetWare default list of adapters. Follow

these steps to add the ATM adapter and desired protocols under NetWare using Novell's INSTALL program. *Note:* Prior to the installation, you may be required to manually update the STARTUP.NCF file to increase buffers or receive packet sizes. Consult the manual provided with your adapter.

1. To start the NetWare installation program, type LOAD INSTALL and press Enter.

2. In the Installation options panel, select Driver options.

3. In the Driver options panel, select Configure network drivers. The Additional driver actions panel appears.

4. In the Additional driver actions panel, select a driver.

5. Insert the diskette containing the NetWare device drivers for the ATM

ATM Adapter	Part Number		NOS Drivers	LANE
Turboways 155 Micro Channel	MMF	38H6388	NetWare 3.1.2 NetWare 4.01 OS/2 2.11 OS/2 Warp 3.0	IBM IBM IBM/Forum IBM/Forum
Interphase 155 5515 PCI Adapters	UTP5 MMF	85H4041 85H4042	NetWare 3.x NetWare 4.x Windows NT 3.51	Forum Forum Forum
Interphase 155 4815 EISA Adapters	UTP5 MMF	85H4045 85H4046	NetWare 3.x NetWare 4.x Windows NT 3.51	Forum Forum Forum
Turboways 100 Micro Channel	single 5-pack FRU	04H7521 04H7522 04H7523	NetWare 3.1.2 NetWare 4.01 OS/2 2.0 or higher	IBM IBM IBM/Forum
Turboways 25 ISA short card UTP or STP	single 5-pack FRU	42H0525 42H0526 42H0532	OS/2 2.11 OS/2 Warp 3.0 Windows NT 3.51	IBM/Forum IBM/Forum IBM/Forum
Turboways 25 Micro Channel	single 5-pack FRU	25H3546 25H3547 41H8917	OS/2 2.11 OS/2 Warp 3.0	Forum * Forum *
Turboways 25 PCI	single 5-pack 30-pack FRU	25H3562 25H3563 42H0554 25H3569	OS/2 Warp 3.0 Windows NT 3.51	Forum Forum

* Ethernet only

Figure 5. IBM ATM Adapters

adapter that is installed in the PC Server.

6. Press the Insert key to install a new driver from the diskette in the diskette drive.

7. Press Enter to start the search on the diskette.

8. When the Select a driver to install panel reappears with a new window listing the driver that can be installed, select the driver for the ATM adapter you have installed, then press Enter.

9. You are asked whether or not you want to copy the driver. Respond with Yes.

10. Once all the drivers are copied, you may see more panels for configuring the adapter, depending upon the adapter BUS and the vendor implementation. In most cases, you specify the slot where the adapter is installed and its locally administered address.

11. After you have completed the installation and configuration, exit the installation program.

12. Check the AUTOEXEC.NCF file to verify that the installation program added LOAD statement(s) for the adapter drivers and BIND statement(s) for the protocols. If not, add them as described in the manuals provided with the adapter.

13. Shut down and restart the server.

Installation Under Windows NT

Installing ATM device drivers under Windows NT is supported only through the Network program in the Control Panel. This means that the diskette containing the ATM adapter drivers for Windows NT must also have an OEMSETUP.INF file.

ATM adapters do not appear in the Windows NT Network Installation Program's default list of adapters. Follow these steps to add the ATM adapter and desired protocols under Windows NT using the Network Installation Program.

1. Log on to Windows NT as an administrator.

2. In the Control panel, execute the Network program.

3. In the Network Settings panel, select "Add adapter."

4. In the Add Network Adapter panel, select "<Other> requires....", then select Continue.

5. When the Insert Disk dialog box appears, insert the ATM adapter's Windows NT driver diskette for the adapter you have installed, then select OK.

6. When the Select OEM Option dialog box appears, select the ATM adapter that you have installed, then select OK.

7. Depending upon which adapter you installed, you are presented with a series of panels in which you configure the ATM adapter. Follow instructions in the panels to finish installing the adapter.

8. Once you have completed the adapter installation, the Network Settings panel is displayed again. Select "Add software" to install the LAN emulation software provided with the ATM adapter.

9. In the Add Software panel, select "<Other> requires....", then select Continue.

10. When the Insert Disk dialog box appears, insert the ATM adapter's LAN emulation software diskette for the adapter you have installed, and select OK.

11. When the Select OEM Option dialog box appears, select the LAN emulation software for the ATM adapter that you have installed, then select OK.

12. Once the software is copied, follow the instructions in the subsequent panel to configure the software. Once the configuration is complete, save all changes.

13. To make the configuration active, restart the system.

General Installation Considerations

Regardless of the NOS installed on the PC Server, you should complete some basic steps prior to adding any communication adapter or driver:

- Upgrade the BIOS to the latest level available.

- On split BUS MCA/PCI servers, load the PFEE7.ADF file that corresponds to your installed communication adapters' BUS architecture.

IBM ATM Adapters for IBM PC Servers

Figure 5 lists the ATM adapters offered by IBM that conform to the Micro Channel, ISA, and PCI BUS architectures and support the NOSs that run on the IBM PC Servers.

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LITTLE SOLUTIONS

Corrective Service Information

Figure 1 shows maintenance release levels for the listed products. This information is effective as of August 1, 1996. CSDs may have been updated since press time.

To order all service packages—except for the OS/2 2.0, OS/2 2.1, OS/2 2.1 for Windows, and OS/2 2.0 Toolkit ServicePaks—call IBM Software Solution Services at (800) 992-4777. For the OS/2 2.0 ServicePak (XR06100), OS/2 2.1 ServicePak (XR06200), OS/2 2.1 for Windows ServicePak (XR06300), or the

IBM Developer's Toolkit for OS/2 2.0 ServicePak (XR06110) on diskettes or CD-ROM, call (800) 494-3044. Most OS/2 service packages are also available electronically from the following sources:

- **OS/2 Bulletin Board Service (BBS)**: In Software Library, select Option 2. (Corrective services are also listed under the General category on the IBMLink BBS.) To subscribe to the OS/2 BBS, call (800) 547-1283.
- **IBM Personal Computer Company (PCC) BBS**: Call (919) 517-0001.

Service packages are located in Directory 4.

- **CompuServe**: Download service packages from the IBM OS2 FORUM library (GO IBMOS2 IBM DF2).
- **Internet**: Do an anonymous FTP from ps.boulder.ibm.com at /ps/products/. TCP/IP packages are located at software.watson.ibm.com at pub/tcpip/os2.

*—Paul Washington,
IBM Corporation, Austin, Texas*

Product/Component	Release	CSD Level	PTF Number	Change Date	Comments
OS/2 Standard Edition	1.3	XR05150	XR05150	02-10-93	
OS/2 Extended Edition	1.3	WR05200	WR05200	05-12-93	WR05200 replaces WR05050, which can no longer be ordered on diskette
OS/2	2.0	XR06100	XR06100	09-01-93	XR06100 replaces XR06055.
OS/2 2.10 ServicePak	2.1	XR06200	XR06200	03-01-94	This package is not for OS/2 2.1 for Windows.
OS/2 2.11 for Windows ServicePak	2.11	XR06300	XR06300	05-24-94	
OS/2 Toolkit	2.0	XR06110	XR06110	09-01-93	
	1.3	XR05053	XR05053	03-23-92	
OS/2 LAN Server/Requester ServicePak	2.0	IP06030	IP06030	04-25-93	
OS/2 LAN Server/Requester ServicePak	3.0	IP07060	IP07060	05-10-95	Supersedes IP07045.
IBM LAN Server/Requester OS/2 Warp Connect LS 4.0 ServicePak	4.0	IP08222	IP08222	05-14-96	Supersedes IP08152.
IBM Peer for OS/2 Public FixPak	1.0	IP08185	IP08185	03-21-96	Available electronically only.
Service Bundle CD-ROM	1.0	IP08250	IP08250	05-30-96	Includes IP08222, WR08210, UN00067, WR08150, IP08205, IP06200, IP08185, and XR_W017
LAN Server for Warp Server Public FixPak	1.0	IP08260	IP08260		
OS/2 Extended Services Database Manager ServicePak	1.0	WR06035	WR06035	11-18-93	Supersedes WR06001, WR06002, WR06003, WR06004, WR06014, and WR06015.
DB2/2 ServicePak	1.0	WR07042	WR07042	06-08-95	
DB2/2 FixPak	2.1	WR08090	WR08090	05-06-96	
DDCS/2 ServicePak	2.2	WR07046	WR07046	06-06-95	
	2.0	WR07041	WR07041	02-06-95	

Figure 1. Maintenance Release Levels (continued on next page)

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LITTLE SOLUTIONS

Product/Component	Release	CSD Level	PTF Number	Change Date	Comments
Database Manager DB2/2	1.2	WR07047	WR07047	06-06-95	
Client Application Enabler/2 (CAE/2)	1.2	WR07043	WR07043	06-06-95	
Software Developers Kit/2 (SDK/2)	1.2	WR07048	WR07048	06-06-95	
SDK/Windows FixPak	2.1/2.1.1	WR08092	WR08092	05-06-96	
Extended Services Comm Mgr ServicePak	1.0	WR06025	WR06025	11-29-93	
System Performance Monitor (SPM/2) ServicePak	2.0	WR06075	WR06075	12-10-93	
OS/2 LAN Server Macintosh ServicePak	1.0	IP06200	IP06200	03-13-96	
LAN Distance ServicePak	1.1/1.11	IP08205	IP08205	04-17-96	Supersedes IP08175, which superseded IP07050.
OS/2 Network Transport Services/2 SelectPak	2.20.5/2.20.1 2.20.2	WR07060	WR07060	05-10-95	Must be LAPS 2.11 or above. If not, order WR07045 first.
LAN Server 4.0 MPTS ServicePak	4.0	WR08150	WR08150	10-18-95	
LS 4.0 MPTS Warp Connect/Server ServicePak	1.0	WR08210	WR08210	05-15-95	Supersedes WR08152. Requires UN00067 if using TCP/IP 3.0.
Communications Manager/2 Version 1.01 ServicePak	1.01	WR06050	WR06050	06-11-93	Available only on diskette.
CM/2 Version 1.11 ServicePak	1.11	WR06150	WR06150	05-31-94	Available on diskette and CD-ROM.
DOS	4.0/4.01	UR35284	UR35284	09-26-91	
	5.0	UR37387	UR37387	09-22-92	
C Set/2 Compiler	1.0	CS00050	XR06150	06-29-93	
C Set C++ Compiler	2.0/2.01	CTC0010	XR06190	09-15-94	
C Set C++ Utilities	2.01	CTM0006	XR06196	09-15-94	
	2.0	CTL0007	XR06197	09-15-94	
TCP/IP for OS/2 Warp Connect	3.0	UN00067	UN00067	05-15-96	Requires WR08210 for TCP/IP to function properly.
TCP/IP for OS/2 Base and Application Kit	2.0	UN64092	UN64092	08-24-94	
TCP/IP for OS/2 DOS Access	2.0	UN57546	UN57546	08-24-94	
TCP/IP for OS/2 Extended Networking	2.0	UN60005	UN60005	06-21-94	
TCP/IP for OS/2 Programmer's Toolkit	2.0	UN57887	UN57887	06-21-94	
TCP/IP for OS/2 Domain Name Server	2.0	UN60004	UN60004	08-24-94	
TCP/IP for OS/2 Network File System	2.0	UN57064	UN57064	06-21-94	
TCP/IP for OS/2 X-Windows Server	2.0	UN87312	UN87312	03-06-96	
TCP/IP for OS/2 X-Windows Client	2.0	UN59374	UN59374	08-24-94	

Figure 1. Maintenance Release Levels

CSD Naming Conventions

In the past, CSDs were known as ServicePaks and FixPaks. ServicePaks were more complete, cumulative, regression-tested packages. They were large in size and generally available both in diskette and electronically. FixPaks were smaller and more component-oriented than ServicePaks and were generally available electronically only.

All future LAN Server service will adopt the same naming convention for service that is used by OS/2, DB2/2, CM/2, and all the IBM Personal Software Product (PSP) line of products. *FixPak* will be used for all future LS and PSP service offerings; some will be Public FixPaks and some will be Controlled FixPaks. *Public FixPaks* may

be total cumulative service available both in diskette and electronically; or they may be available electronically only. *Controlled FixPaks* will not be generally available until they complete testing and will be available only by contacting Software Solutions Services.

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