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Full Text:

LAN **Server** and NT **Server** are vastly improved, and NetWare 4.1 is what 4.0x should have been in the first place. At long last, network administrators no longer have to live in a one-NOS town.

If they were computers, goes the popular analogy, cars would go faster, cost next to nothing, and get hundreds of miles to the gallon. Fortunately for commuters, cars are not computers. If they were, they would crash every day. If you wanted to change a flat tire, you would discover that the owner's **manual** contained a treatise on lug-nut design but no instructions on where to find the jack. Perhaps worst of all, you would always need a skilled mechanic (Certified Driving Engineer) riding shotgun.

Networking PCs is becoming an inevitable headache for more and more businesses. What's truly exciting about the three network operating systems reviewed here is that for the first time the right folks have the headache: the vendors. This is the only reasonable division of labor: NOS vendors figure out how to build a faster, more reliable engine, while network administrators spend more time on the information highway and less in the shop.

The defining milestone in this new era is NetWare 3.x's passage from default choice to only one of several viable products. The reigning network operating system for years despite considerable flaws, NetWare 3.x is no longer the only NOS worth considering, or even the fastest, which is one of the reasons we didn't include Version 3.12 in this comparison except as a baseline for speed. Deciding on a NOS will be harder now that there are more choices, but we don't think users are going to complain too much. From installation to administration, these NOSes are simply better and easier than ever before.

WHAT KIND OF TOOL AM I? The fundamental architecture and design goals of these products remain much as they were in previous versions. Novell Inc. built NetWare 3.x from the ground up to provide file and print services to large numbers of users, based on a small, fast kernel. The company added a sophisticated directory-services layer to NetWare 4.01 for enhanced administration capabilities, which it finally brings up to full speed in Version 4.1.

IBM and Microsoft Corp. designed LAN **Server** and **Windows NT Server** to be more things to more people, providing not only file and print services, but also including the sorts of features -- such as symmetric multiprocessing (SMP) support, pre-emptively scheduled threads, process protection, interprocess communication, and virtual memory -- that are the hallmarks of good application **servers**. We were impressed by how fast these products' file and print services have become.

Despite their inherent differences, each of the new versions of the products under review here has implemented a common set of features and functionality important to most users. Together, the improvements define a baseline for NOS success in contemporary business environments.

\* Easier installation. Whether an administrator has years of experience managing hundreds of **servers** or is a newcomer building a departmental LAN, fast and simple installation saves the company money. LAN **Server** 4.0 Advanced and **Windows NT Server** 3.5 have both come close to the ideal of unattended installation. Even Novell, which in the past has seemed philosophically wedded to the notion of difficult installations, has reformed.

\* Easier administration. In 1844, Ralph Waldo Emerson jotted down some thoughts that seem pertinent in a world still dominated by NetWare 3.12. "Expecting nothing," he wrote, "I am always full of thanks for moderate goods." In that spirit, administrators have something to be thankful for, because the administrative tools in these new products show a marked improvement over past offerings and are often easy to learn and use. (This is particularly true of NetWare 4.1's NWADMIN utility and LAN Server's use of OS/2 objects.)

Plenty of room for improvement remains, however. With a few exceptions, the tools are not very well integrated, and some of them are amateurishly designed, lacking the interface features that have become commonplace in other commercial applications (such as default settings in dialog boxes), to say nothing of more sophisticated interface elements such as wizardlike helpers.

On the architectural side, administrative capabilities have improved noticeably.

Domain-based architecture is not exactly the wave of the future, but LAN **Server** and NT **Server** have beefed it up - - in different ways -- to a level approaching shouting distance of centralized administration. NetWare 4.1, which actually does provide centralized administration, looks more like what we can expect to see of future NOS designs.

\* Better security. User authentication with Version 3.x and earlier of NetWare was less than adequate. Although Version 3.12 now has a password-encryption option, the other products employ RSA-style authentication, in which a random-value key is sent by the **server**, encrypted on the client side by the password, and sent back to the **server** for verification, so the password itself never travels over the wire.

Both NetWare 4.1 and NT **Server** 3.5 implement C2-level security, a specification designed by the Department of Defense for military computers (see story, page 76). It is questionable whether anyone will ever actually sit behind an officially C2-certified system, because the rating applies only to specific combinations of hardware and NOS, and the certification period -- two years -- is just long enough to constitute a form of planned obsolescence. Moreover, C2 is designed with specifically military needs in mind and, although these are not necessarily incompatible with business needs, neither are they identical. For instance, C2 is not especially strong in addressing the security problems of enterprisewide networks.

\* Enterprise capability. Transport protocols have always been a defining aspect of NOSes. This year all three vendors appear to be aware of that fact and are shipping more of what their customers actually want and less of what they want them to want. The three new products all provide a form of multiple-protocol support.

Closely related to this is the fact that, except for NetWare 3.12, vendors are positioning NOSes not as LAN products anymore but as enterprise products. In this context, enterprise has one meaning: routing -- the task of herding data reliably from point A to point B irrespective of physical location. In order that their products can be more easily adopted by large companies with PCs in disparate locations, all three vendors now provide a routable protocol stack (chiefly TCP/IP).

BEST-LAID PLANS. Companies that need to expand their networks have several choices: they can remain a NetWare 3.12 shop; standardize on a different NOS and migrate their **servers**; or create a mixed network in which the original **servers** remain unchanged, but additional **servers** run one or more of the new products compared here.

We based the test plan for this comparison on the scenario of expanding a NetWare 3.12-based network with other NOSes, with interesting results (see the NetWare integration scoring category on page 74).

To evaluate the speed of these NOSes, we let the vendors make reasonable tuning adjustments before running our tests on 20 and 40 clients. Surprisingly, those tweaks, described on page 76, didn't always significantly improve performance over the "out-of-the-box" tests we ran.

Hot off the dupe machine, NetWare 4.1 barely made our deadline; it formally shipped only two weeks ago, just as we were finishing testing. The copy we reviewed was one of the last gold versions of the product. No changes were made to the core code before the product shipped, according to the vendor.

## Product Overview

### LAN **Server** 4.0 Advanced

IBM's LAN **Server** 4.0 Advanced is so much improved over previous versions that IBM should simply give it a new name. Its easy installation option equals Microsoft Corp. **Windows NT** Server's analogous express installation



for speed and simplicity, and the system takes advantage of OS/2's object-oriented capabilities to provide a strong new set of graphical administration tools.

For moderate file-and-print service loads, LAN **Server** has revved its performance considerably. Its support of the new symmetric multiprocessing version of OS/2 2.11 allows it to handle CPU-intensive applications better than ever, assuming you're using a multiprocessor system.

IBM has enhanced LAN Server's enterprisewide networking capabilities by including an improved TCP/IP protocol stack (easily configurable as the default) and aliasing features that allow easier management of resources across workgroups and domains. LAN **Server** is unique among the network operating systems here for including a scripting language, the powerful Rexx.

We tested the Advanced version of LAN **Server**, which comes with the High Performance File System (HPFS). LAN **Server** also comes in a less expensive Entry version, which lacks HPFS and is intended for smaller networks where performance is of less concern than price.

#### NetWare 4.1

NetWare's primary design goal remains fast file-and-print services for large LANs, and as our file-and-print services benchmark shows, it succeeds admirably in NetWare 4.1. To this, Novell Inc. has added a second major design goal: easier administration. This is partly the result of a Novell customer survey that showed that 70 percent of the cost of ownership of NetWare 3.x was administrative.

Novell's solution consists of a network structure based on a set of X.500 conventions called NetWare Directory Services (NDS), which made its debut in Version 4.00 to a less-than-enthusiastic reception, even among confirmed NetWare users. Although widely acknowledged to be a potentially powerful and sophisticated means of administering large networks, NDS lacked a crucial feature: the capability to make significant changes to the directory structure once it had been defined.

Version 4.1 remedies this oversight; NDS now delivers the most robust administration scheme of the NOSes we tested. Novell significantly augments this administrative power with a new utility called NetSynch, which allows a NetWare 4.1 **server** to administer as many as 12 NetWare 3.x **servers** by adding them to the NDS context. Users can access this functionality through a new GUI-based utility called NWADMIN, which presents the whole network visually.

After you use NWADMIN, the **server** operator's console comes as a shock. Mysterious bulletins that you cannot pause or capture (until well into the start-up process) scroll up the screen. This is probably for the best, because the uninitiated will never be able to discern bland informational lines from critical error messages. For aging computer operators, it's a heady draft of nostalgia. Turn up the air conditioning, add a clacking teletype, and you'll find yourself transported back 20 years to the console of an old mainframe.

For wide-area connectivity, Novell suggests using its IPX protocol with NetWare Link Services Protocol; Novell includes a coupon for NetWare Internet Protocol (IP) as well.

Though it doesn't offer them in a tightly integrated suite, Version 4.1 also introduces a number of tools for configuring and monitoring the network, such as INETCFG and SERVMAN.

NetWare 4.1 continues to support RAID Levels 0 and 1 in both mirrored and duplexed configurations, and now bundles Novell's own System Fault Tolerance III software, though you must pay an extra activation fee.

#### **Windows NT Server 3.5**

It is faster and simpler to create a functioning network with Microsoft's **Windows NT Server 3.5** than with any of the other products we tested in this comparison.

NT **Server** also holds the title of most improved. It performed our file-and-print services benchmark nearly twice as fast as the disappointing NT **Server** 3.1 did.

Microsoft bundles an improved IPX stack as NT Server's default protocol and offers an improved version of TCP/IP.

NT **Server** has also taken a giant step by providing an automated IP-address pooling service that automatically allocates IP addresses to clients without user intervention, regardless of the user's location on the network.

Also new is a migration utility that copies the bindery information and data volumes from a NetWare 3.12 **server** onto an NT **Server** 3.5 machine. If you don't want to go that far, you can plug into an existing NetWare **server** directly from a client machine or via a NetWare gateway located on the NT **Server server**.

NT Server's network administrative scheme revolves around domain directory services. In order to avoid the administrative nightmare of maintaining separate user accounts on different **servers**, you can establish trust relationships between domain directories to allow users a single networkwide log-in.

New to this version is the capability to administer the network either from a 16-bit or 32-bit client workstation or from a remote workstation, independent of the protocol running on the client.

#### Installation and client configuration

LAN **Server** 4.0 Advanced: Very Good

LAN **Server** provides two installation options: easy and tailored. The easy option really is; it's quick and simple. The tailored option allows you greater flexibility in specifying the configuration but requires low-level knowledge of your hardware that may mean some homework. (Quick! Does your server's disk drive use 24-bit direct memory access?)

LAN **Server** does not support the NE3200 network interface card (NIC), which prompted us to switch to Compaq NetFlex II EISA Ethernet cards for all the NOSes. (IBM's stated aim is to support 90 percent of Token Ring cards but only 70 percent of Ethernet cards.)

IBM continues its obsession with acronyms. In the course of the installation we found help screens littered with references to MPTS, NIF, DASD, and other product-specific acronyms, which are seldom explained in context and often are not to be found in the on-line glossary. (MPTS, by the way, stands for multiprotocol transport service; NIF is network information file; and DASD, a mainframe term for hard disks that apparently no one but IBM uses, stands for data access storage device.)

During benchmark testing, we discovered that a bug in the DOS requester prevented two of our DOS applications -- Paradox 3.5 and Harvard Graphics 3.0 -- from launching. IBM supplied us with a new, compatible version that worked with our applications and is available to users through IBM's usual problem-solving channels.

The interface that LAN **Server** provides for setting up client machines is only slightly worse than NT Server's. Administrators must purchase a separate product to be able to install requester software across the wire, but the option that creates installation disks works easily, detects hardware accurately, and creates a handy log-on screen. The client requester installation for Windows assumes Windows 3.1; if you're running Windows for Workgroups 3.11, you must rename some DLLs and make some other simple but obscure changes (all of which you can automate with a simple batch file). You can use the requester that comes with Windows for Workgroups 3.11, but you must use the LAN **Server** requester if you want to use aliasing or public applications, two of the NOS' stronger features.

NetWare 4.1: Good



Novell has somewhat improved NetWare 4.1's installation over that of Version 3.12. A "simple" CD-ROM installation assumes an existing DOS partition with at least 15MB of space and a working CD-ROM drive. It chooses a default volume name and IPX network number, then uses the remaining free disk space to create a single NetWare partition with a SYS volume that has a single-organization NetWare Directory Services tree.

According to Novell, most administrators want total control of **server** configuration, so NetWare 4.1 offers limited hardware detection and the administrator must confirm every choice. Both the simple and custom installations require detailed knowledge of the hardware, including I/O port and interrupt request values for the disk controllers and NICs.

By contrast, installing Version 4.1's client software was a snap. We still had to use the downloaded EtherExpress driver, but otherwise the installation took little effort. Users can now configure CD-ROM-equipped client machines directly from the installation CD.

### **Windows NT Server 3.5:** Excellent

Like any Microsoft product, NT **Server** offers both custom and express installation options; we found both to be fast, simple, and straightforward. The system had no problem recognizing our hardware, which included Adaptec 7770 and 1542 cards, a Mylex DAC960 redundant array of inexpensive drives controller, and four NE3200 NICs (and later -- when we switched NICs -- four Compaq NetFlex II EISA Ethernet cards). We completed the express installation successfully simply by accepting the defaults. The custom option allowed us to select and configure many of the services we review in subsequent tasks.

A utility new to Version 3.5 is the Network Client Administrator (NCA), which provides several ways to install client-requester software. Unfortunately, NCA's interface and help screens are ambiguous. It also presented us with a surprising number of error messages when we accepted defaults.

The handiest option has you specify the client-side NIC, then creates a boot disk that connects the client machine to the **server** and performs an across-the-wire installation of Windows for Workgroups or Microsoft Network Client for MS-DOS.

Redirector choices include real- and protected-mode DOS requesters in full and basic versions (posing a tastes-great, less-filling trade-off), and a 32-bit TCP/IP stack originally developed for Chicago, as well as for the DOS and OS/2 versions of LAN Manager. The system supports a broad range of NICs. Microsoft's SMC Elite 16 Combo driver, however, would not work over IPX. We had to use the driver that SMC ships with the card until Microsoft could provide us with a fix.

Administration: establishing users

### LAN **Server** 4.0 Advanced: Very Good

Because virtually all aspects of the network appear as objects to LAN **Server**, creating and managing them is a quick and flexible process. If the OS/2 desktop is new to you, it may take some time to learn but will be worth the effort. Its drag-and-drop functionality makes for very fast and easy user-account management and resource sharing. This use of OS/2 objects and templates is one of LAN Server's greatest strengths. In addition, LAN **Server** satisfies power users who prefer a command line over a mouse and icons by granting the Rexx scripting language access to the LAN **Server** API.

IBM supplies an adequate number of privilege levels in addition to user and administrator, though none is customizable and administrative control over password use is minimal at best. The system also lacks a way to restrict log-on hours from the graphical administration tools, but you can do so from the command line.

We particularly liked the capability to specify limits to disk usage in users' home directories. When the limit is reached, both administrator and user are notified (the system continues to allow further writes to the disk, so data is not at risk).

LAN **Server** gives administrators user-access profiles to grant access to and restrict usage of system resources. Just when administrators were getting used to objects, IBM throws them a form to fill out; fortunately, it's fairly simple.

Just as we were about to give the Stupidest Error Message of the Whole Comparison award to NT **Server**, we tried saving some changes we made to a user account on LAN **Server**, and got this message: "The parameter is incorrect." Dozens of parameters for a user account are scattered through a number of pages in the tabbed dialog. This help screen is also worth noting: "Cause unknown; consult the **documentation**." As we were pondering how to look up an unnamed problem with an unknown cause, we suddenly realized that, contrary to myth, software developers do have a sense of humor.

You can create a single networkwide log-on for a user, as well as centralized administration, though the process involves more steps than with NetWare or NT **Server**. A single log-on for a domain is simple to generate, but then you must create an identical log-on for each additional domain; this isn't ideal, but it's a big improvement on the one **server**, one log-on scenario. Separate log-ons are not necessary for each domain as long as the password and user ID are consistent. (An optional application, Net Signon, lets you synchronize IDs and passwords across domains.) LAN Server's aliasing scheme has networkwidescope, allowing **servers** on one domain to see resources on others.

There are limits to your ability to perform centralized administration. From the graphical interface, you can administer a maximum of six domains; from the command line, however, you can administer all domains.

#### NetWare 4.1: Excellent

NetWare 4.1's new capabilities and GUI-based administration tools are a boon to administrators of both large and small networks. Full-time administrators receive the power they need to keep up with organizational changes, and part-time administrators don't have to master a plethora of obscure commands.

Versions 2.x and 3.x of NetWare relied on the system's bindery database to keep track of network objects such as file **servers**, printers, routers, gateways, groups, and users. In Version 4.0, the NetWare Directory Services (NDS) database replaced the bindery. In its simplest form, NDS can act as a flat database, such as the bindery, or it can take the form of a complex tree incorporating multiple **servers**, locations, and even countries.

You can partition the NDS database across multiple **servers** for fault tolerance and manageability. This means that different locations can administer their own areas, and the network database scales up without becoming unwieldy.

One of the drawbacks in the 4.0x NDS was the incapability to move or rename subtrees or merge two separate trees. This meant that changing a group such as Marketing to Mktg or moving it to a different location required deleting and then re-creating it. Because changes were so difficult to implement, administrators had to plan the NDS structure carefully and limit subsequent alterations. NetWare 4.1 removes these restrictions. For administrators of large networks, changing the network to reflect the corporate organization is now a quick and easy task.

NWADMIN, a Windows tool, displays the NDS database as a tree, with every object type represented as a descriptive icon, allowing you to create and delete objects, move them, and change their properties. Double-clicking on an object brings up a properties dialog box. To insert a new user, for example, just highlight the new user's group and select the Create button. It brings up a dialog box in which you can enter the appropriate information about the new user.

You can also define a template that defines groupwide properties. Each user created under the template automatically receives the properties. From the template, you can define passwords and password restrictions, hours of use, printers, home directories, and log-in scripts. Although the administrator can change any user's properties and rights to objects, the templates and NDS' inherited-rights structure simplify the task of creating consistent user accounts.

Multiple log-in scripts let administrators tailor each department's and each user's environment. Every organizational unit can have a log-in script, so a user belonging to a hierarchy of organizational units will execute all of the scripts. Each script can be edited from NWADMIN.



To move a user to a different group with NWADMIN, just highlight the user's icon and pick the Move menu, or drag and drop the icon. A dialog box appears listing permissible moves. Moving a whole group, a **server**, or any other object is also easy. NWADMIN allows you to combine two separate trees using DSMERGE, a separate **server** console utility.

Novell has made the process of configuring network protocols, network interface cards, and interfaces significantly easier in NetWare 4.1 by combining the operations into a single utility, INETCFG. The company has also added other network monitoring and testing utilities to make the administrator's life more bearable.

### **Windows NT Server 3.5:** Good

NT **Server** 3.5's User Manager provides quick and relatively painless access to most user account tasks. You can specify a home directory on the user's machine or map a drive letter to a **server** directory, although the inexplicable absence of a Browse button makes this an error-prone chore.

We encountered warnings that the **server** could not create new directories that we specified for user home directories when we failed to set up the user account in precisely the (undocumented) correct order. The "invalid path name" error message we got when we specified "c:\users\paula" as a home directory on the **server** struck us as just plain weird. The directory of that name showed up in the File Manager, but the User Manager insisted we use the \\servername\path convention. It's just as easy to tell the user what convention to use as it is to say, "Sorry, you can't do that," so why the secrecy? (The Help button in the user-environment profile screen under the User Manager does state that users need to follow the Universal Naming Convention pathname.)

We also experienced difficulties with root mapping. We mapped \\...\subdir to drive X; on the client machine, drive X appeared as X:\subdir rather than just X:. The remedy to this problem was simple: We just established a share first on the parent directory, then we could map any number of directories under that share. Microsoft could make the interface much clearer about the order in which to proceed.

The User Administrator provides an impressive number of predefined access types beyond the traditional administrator, user, and guest, and you can also create custom types. Administrators can easily restrict hours of access, limit the number of machines a user can log on from, and manage log-in scripts and user profiles. Passwords are also easily managed. You can specify policies such as length of a password, uniqueness, aging, how often users must change passwords, and the number of log-on attempts to allow. Microsoft does not, however, offer more advanced password administration, such as disallowing the use of a user's own name, as NetWare 4.1 does.

NT Server's access scheme lets you define a share name for a set of files and directories. You can define shares with various names and access levels and apply them to different individuals and groups. Setting shares and permissions is reasonably easy, though not quite as straightforward as it is with LAN **Server** 4.0; integrating this functionality into the User Administrator would further simplify administration. Microsoft could also better integrate **server**- and domain-level administration, which, though easy to carry out, resides in four separate places in the interface.

Once we had created accounts, we experienced a surprising amount of trouble connecting to the **server** from our NT workstation. We got "Could not locate domain controller" messages on some accounts, logged on successfully with another account, and then successfully logged on with the original account. We saw similar behavior with an erroneous message that the log-on service was missing.

As before, NT **Server** 3.5 includes the capability for administrators to establish trust relations between domain directories. Though it lacks the power of NDS, this capability nonetheless permits users to have a single user account with one password across domain directories and, just as important, allows centralized administration of the network. You can set the trust to be mutual or one way. For networks with many domain directories, managing the trust relations themselves is not trivial, but the added power this capability affords administrators is part of what makes this version of NT **Server** such a compelling product.

Administration: other tasks

## LAN **Server** 4.0 Advanced: Good

Unlike NT **Server**, which forces you to choose between the faster file allocation table (FAT) and the more secure NT File System (NTFS), LAN Server's High Performance File System (HPFS) gives you the best of both worlds; it's fast and provides fine file and directory security. HPFS runs at the Intel CPU's so-called Ring 0 and attempts to process I/O requests within a single interrupt. HPFS is also necessary in order to perform the full range of administrative tasks, such as protecting files from unauthorized access at the **server** itself (an important feature because LAN **Server** runs on top of an operating system without log-on protection).

LAN **Server**, unlike NT **Server** and NetWare 4.1, does not implement C2-level security. It does use an encrypted key to authenticate users, though, just as the other two NOSes do.

LAN **Server** logs system errors and warnings and provides quick help with them. The audit log utility, however, is limited to events on the **server**. There is no auditing facility, nor does it provide transaction logging or automatic reboot.

LAN **Server** adds a second meaning to the term "application **server**." Administrators can define DOS, Windows, or OS/2 applications to LAN **Server**; users and groups with rights can access applications without having to know their actual locations, allowing administrators to make changes to **servers** that are transparent to users. You can administer the **server** from a client workstation, though not a remote workstation.

LAN **Server** 4.0 does not implement dynamic performance tuning. However, it does come with a utility called LS 4.0 Tuning Assistant that gives administrators extensive access to system parameters. Using it requires a lot of LAN **Server** savvy, though, as well as expert knowledge of networking at a low level.

IBM equips LAN **Server** with a number of utilities, including LAN Specialist, which helps track errors (client software is required), and a file-synchronizing utility for remote users (who must be running OS/2). An action folder called LAN **Server** Productivity Aids contains some in-house utilities included on the installation CD. They're worth the separate installation required, especially the Access Control Manager, which further simplifies resource sharing.

LAN **Server** supports only RAID Level 1, though third-party software is available to implement other levels. LAN **Server** offers uninterruptible power supply (UPS) support as well.

## NetWare 4.1: Very Good

NetWare 4.1 offers a wealth of features in both the host and client areas that provide fine basic security and allow network managers to decide how they want to balance security against user-friendliness. Novell has applied for C2 security certification -- the so-called Department of Defense Red Book standard -- with the National Computer Security Center for the entire network environment -- **server** and client hardware and software.

At the **server**, you can remove DOS after installing NetWare to deter tampering. Novell provides various options to prevent the use of unauthorized NetWare Loadable Modules. Password encryption, log-in restrictions, and automatic intruder lockout (multiple unsuccessful log-in attempts cause a user to be locked out) help prevent unauthorized log-ins. At the client, RSA encryption provides log-in security, and NetWare Core Protocol Packet Signature checking prevents a user from assuming unauthorized privileges.

Novell relies on NetWare Directory Service (NDS) access-control rights and inheritance-rights filtering to limit access to objects in the NetWare database. This also allows the administrator to create subgroup administrators who have control over only part of the NDS tree.

A separate auditing function and a utility, AUDITCON, monitor both security and resource usage.

NetWare has long offered a brace of system fault tolerance (SFT) features known as SFT I and II. They include duplication of FATs and directory entries, read-after-write input and output, and disk duplexing and mirroring.



Novell's hot-fix feature automatically remaps bad disk blocks. NetWare's transaction tracking system protects database files from corruption by backing out incomplete transactions.

SFT III, which was an add-on to NetWare 3.x, mirrors two **servers** across a high-speed link. Novell includes SFT III as an option on the installation CD-ROM (but you must still buy a license).

Although Novell touts the NDS database as a scalability feature, you can partition it and make replicas on other **servers**. If a **server** goes down, users on that **server** can still log in to the network using a replica. In addition, NetWare 4.1 print **servers** automatically reconnect after going down.

The High Capacity Storage System migrates older files to optical jukeboxes, thus maximizing hard disk space. NetWare 4.1 also provides an integrated system, Storage Management Services (SMS), to back up files across the network for both **servers** and workstations. SMS backs up workstation files independent of client operating systems. The NetWare Message Handling Service is now an integral part of the OS and provides enhanced internetwork routing. It comes with a simple E-mail package, First Mail, as well as APIs for industry-standard messaging protocols.

NDS enhances NetWare 4.1's utility as an application **server**. By defining an object that points to an application, such as a word processor, users can access the application without knowing details about its location. The administrator can move the application to a different directory or file **server** without affecting users.

### **Windows NT Server 3.5:** Excellent

Although NT **Server** sports an improved FAT, you must use NTFS to achieve the Defense Department's C2-level security for both Orange Book and Red Book classification (a fact Microsoft should highlight during the installation procedure).

As a transaction-based file system, NTFS helps Version 3.5 achieve a measure of protection against system crashes and power failures; the file system automatically specifies what information to log and then re-creates the state of the machine prior to the crash.

Transaction logging can take a lot of administration and eat up an enormous amount of disk space, so it comes at a price, but for certain client/**server** applications, it's well worth it. You can set a **server** to reboot automatically after a crash -- an essential feature for many mission-critical and line-of-business applications.

In addition, like the other NOSes in this comparison, you can administer the **server** from a 16-bit or 32-bit client workstation, or from a remote workstation, independent of the protocol the client is running.

NT **Server** self-tunes to optimize performance, but administrators can also use some modest tools to improve performance. The best of these is a performance monitor that keeps an eye on a large number of system goings-on (it reads a dynamic registry rather than hooking the system, so it adds little overhead of its own). You can specify in advance if the **server** is to act as an application **server**. You can also specify that the **server** not participate in domain control.

NT Server's administrative utilities include a disk administrator that helps with partitioning and fault tolerance; an obtuse but informative event viewer; a diagnostics tool that is actually a system information utility; and a backup utility.

NT **Server** also provides built-in uninterruptible power supply support and offers the most extensive RAID support, for Levels 0,1,2, and 5. In addition, NT Server's client software will attempt to reconnect when a connection is lost.

File and print speed: moderate and heavy loads

Once you've determined that a NOS contains all the functional pieces necessary to support your needs, your next

step is to learn how fast and reliable the system is. It's difficult, if not impossible, to choose or add a NOS to your existing infrastructure without knowing how the system performs. In prior comparisons, NOS file and print performance varied considerably, often with enormous gaps between products. With these NOSes, the gap has tightened at moderate loads. We still found considerable differences in scalability, however.

#### MODERATE WORKLOAD

LAN **Server** 4.0 Advanced: Excellent

LAN **Server** blazed across the finish line on 20 workstations, leaving behind all the competition, including NetWare 3.12, over which it had an 11 percent lead. No client workstations dropped out.

NetWare 4.1: Very Good

The results here were similar to the results of our heavy workload: NetWare 4.1 ran only 3 percent slower than NetWare 3.12. The system did not drop any clients.

**Windows NT Server** 3.5: Very Good

NT **Server** 3.5 acquitted itself well under our moderate workload. The system was 4 percent faster than NetWare 3.12, earning second place.

#### HEAVY WORKLOAD

LAN **Server** 4.0: Satisfactory

LAN **Server** ran our heavy workload 47 percent slower than it ran the moderate load. It handled the 40 workstations fairly well in terms of speed.

However, like NT **Server** 3.5, LAN **Server** dropped a couple of workstations when we moved to the heavier load, indicating engine trouble.

Turning in a time of 27 minutes, 33 seconds for the heavy load, LAN **Server** was 16 percent slower than NetWare 3.12 (which dropped no clients), but it performed considerably faster than NT **Server** 3.5.

NetWare 4.1: Very Good

Although Novell may not consider Version 3.12 a competitor to Version 4.1, users should be comforted to know they will experience minimal performance degradation in moving from Version 3.12 to Version 4.1. NetWare 4.1 was only 5 percent slower than NetWare 3.12 at running our application scripts on 40 workstations, and it far outpaced NT **Server** 3.5 and LAN **Server** 4.0.

Neither version of NetWare degraded much between 20 and 40 clients (only 14 percent for Version 3.12 and 16 percent for Version 4.1), indicating similarities in the core operating systems. They handled the heavier load far better than LAN **Server** and NT **Server**.

Moreover, Version 4.1 earns our "no baby-sitter required" award; it ran our heavy load flawlessly, without dropping any clients.

**Windows NT Server** 3.5: Satisfactory

Compared to its predecessor, NT **Server** 3.1, Version 3.5 is a competitive NOS. Version 3.5 runs significantly faster over its new native IPX than Version 3.1 ran over NetBEUI.



Compared to the NOSes here, however, NetWare 3.5 is still a tortoise when the network load climbs. A fine performer under lighter loads, NT **Server** showed the most dramatic degradation of all the products -- 56 percent -- at 40 workstations.

Moreover, like LAN **Server**, NT **Server** typically dropped two client workstations during our multiple runs of the benchmark test.

NetWare integration

LAN **Server** 4.0 Advanced: Satisfactory

LAN **Server** does not deliver support for direct NetWare connectivity (that is, it does not ship with an IPX protocol stack). This is partially an architectural issue: LAN **Server** runs as an application on top of OS/2, for which users can purchase a separate NetWare requester. Although the result is more limited than NT Server's NetWare interconnectivity, users can employ the **server**-atop-base-OS scheme to roll their own gateways. Running the NetWare requester from the LAN **Server** machine, for instance, allows you to map directories on the NetWare machine and then set shares to them from LAN **Server**. Like NT Server's gateway, this is not a high-performance link, so you should use it with some caution. In addition, the connections aren't free.

NetWare 4.1: Excellent

Novell, realizing that NetWare 3.1x systems predominate among current networks, has made it possible for earlier versions of NetWare not only to connect to Version 4.1, but also gain greater functionality in the bargain.

A coupon is included for another tool, DSSTANDARD, which reads Version 3.x bindery information, allows you to manipulate it as if it were a NetWare Directory Services (NDS) database, and writes the resulting data in NDS format.

The product's NetSynch utility lets you cluster as many as 12 NetWare 3.1x systems with a NetWare 4.1 system that manages the NetWare 3.1x users and grants them access to its printing services. If you change a user's account with NWADMIN, the program will automatically propagate those changes to the other systems. This allows a leisurely migration to NetWare 4.1 and simplifies networkwide administration.

**Windows NT Server** 3.5: Very Good

Version 3.1 of NT **Server** was conspicuous in its failure to relate well to NetWare **servers**. Version 3.5 remedies that oversight with a vengeance. IPX now operates as the default stack, and the product now supplies Gateway services for NetWare. In addition, a new NetWare Gateway service provides transparent, protocol-independent access to NetWare files and directories from a client machine via the NT **server**. Be aware that a toll booth guards this gateway, however.

Although the NT **server** only needs to have a single account on the NetWare **server** for the service to work, individuals using the gateway must all possess NetWare licenses, just as they normally would. Performance also takes a hit; because a single connection can handle only so much traffic, users will achieve faster results accessing the NetWare **server** directly rather than going through the NT intermediary.

With Version 3.5, Microsoft has made it quite easy to abandon NetWare 3.x altogether by including a utility called Migration Tool for NetWare, which reads bindery information on the NetWare **server**. It then creates NT versions of the user accounts on a second machine, copying over whatever files, directories, and associated permissions you select.

Enterprise capabilities

LAN **Server** 4.0 Advanced: Good

LAN **Server** 4.0 now ships with TCP/IP within its Multiprotocol Transport Services package, which helps manage the use of protocol stacks. IBM has rewritten this version of TCP/IP; it performed well in our recent TCP/IP comparison, coming within 1 second of the fastest product in executing File Transfer Protocol (FTP) transfers.

IBM's moniker for the product, TCP/IP over NetBIOS, can be confusing, but it does refer to a native protocol stack and not a NetBIOS-to-TCP/IP translation. (IBM also uses the terms NetBIOS and NetBEUI interchangeably.)

Unlike NT **Server**, LAN **Server** does not implement the Dynamic Host Configuration Program (DHCP) specification of the Internet Engineering Task Force; IBM plans to include it in a future release. LAN **Server** provides Internet-access utilities through the Internet Access Kit that ships with OS/2 Warp 3.0. Alone, the Warp utilities provide only modem connectivity, but LAN **Server** is actively aware of these utilities and automatically makes them network enabled.

NetWare 4.1: Good

NetWare 4.1 allows multiple protocols -- including IPX, TCP/IP, and AppleTalk -- to run simultaneously on a **server**. Novell's preferred internetworking protocol is its own IPX, along with NetWare Link Services Protocol (NLSP); for installations that use Internet Protocol (IP) as their base, Novell includes a coupon for IP in 4.1.

NLSP provides internetwork routing functions for the network. One of its biggest advantages is that it dramatically cuts down on the broadcasting of Routing Information Protocol and Service Advertising Protocol, protocols that the system uses to communicate internetwork configuration information.

Version 4.1 introduces some new tools, such as INETCFG, SERVMAN, and TCPCON, among others, that help in network configuration, maintenance, and monitoring.

INETCFG is a one-stop configuration utility that handles boards, protocols, interfaces, and bindings. SERVMAN handles set variables and provides resource-usage information, and TCPCON provides information about TCP/IP connections.

NetWare provides support at both the host and client level for TCP/IP. You can configure client access to use SLIP or Point-to-Point Protocol (PPP).

Two separate products, NetWare Connect and LAN Workgroup, enhance NetWare's connectivity. NetWare Connect allows dial-in and dial-out access to the NetWare network and provides administration tools for remote user management. LAN Workgroup, which administrators receive when they redeem their coupon for NetWare IP, gives users at NetWare workstations access to Unix and other IP platforms.

**Windows NT Server** 3.5: Very Good

In our tests, the speed of NT **Server** 3.5's out-of-the-box TCP/IP stack rivals that of the fastest product in our Sept. 12 TCP/IP comparison (FTP Software Inc.'s PC/TCP 1.3 for OS/2 2.0). The product also boasts a new facility called DHCP, a **server** that pools and dynamically allocates IP addresses across the enterprise. A facility called Windows Internet Name Service handles the mapping and resolution of NetBIOS host names to the pooled IP addresses.

All in all, the DHCP **server** was easy to set up, though you'll still need lots of IP savvy. Adding a TCP/IP stack to our client workstation was fast -- the DHCP **server** handled everything.

NT **Server** 3.5 Remote Access **Server** (RAS) now offers transparent dial-in access that makes the remote machine appear to be a network node and allows 256 simultaneous connections. Combined with properly administered trusted domains, RAS provides remote users with a single log-on irrespective of locale. RAS, which supports SLIP and PPP clients, can use IPX, TCP/IP, NetBEUI, or any other transport for remote NetWare interconnectivity, and it offers the identical authentication security as NT **Server**. RAS also supports ISDN and x.25.



NT **Server** comes with FTP, Telnet, and about 15 standard IP utilities, such as finger, lpr, and rexec.

Report Card: Network operating systems

LAN **Server** 4.0 Advanced

IBM

Austin, Texas

(800) 342-6672; fax: (800) 426-4329

(Weighting) Performance

Installation and client configuration (75) Very Good 56.25 The easy option really is. If you can answer all the questions in the tailored option without resorting to your computer **documentation**, you automatically qualify for a degree in computer science. Separate installation required for OS/2.

Administration: establishing users (150) Very Good 112.50 Object-oriented administration tools allow quick and easy user account creation and resource sharing. Centralized administration and single network log-on are achievable with a bit of extra work. The public-applications feature and enforced disk-space limits are especially strong.

Administration: other tasks (150) Good 93.75 LAN Server's security is weaker than NT Server's or NetWare 4.1's -- OS/2 lacks a log-on capability but it offers file access protection via High Performance File System. You must tune performance manually, but IBM supplies a very complete tool. Basic bundled tools are helpful for administrative tasks. LAN **Server** does basic event logging.

File and print speed: moderate load (150) Excellent 150.00 At 20 clients, LAN **Server** posted the fastest time of all the NOSes we tested -- including NetWare 3.12.

File and print speed: heavy load (150) Satisfactory 75.00 Although it didn't suffer quite the hit that NT **Server** took when moving to 40 clients, LAN Server's performance still degraded 47 percent.

NetWare integration (75) Satisfactory 37.50 LAN **Server** doesn't ship an IPX stack and doesn't directly address NetWare connectivity; you must use the OS/2 NetWare requester instead. You can use the system's Net Signon product to coordinate a user log-on with both NetWare 3.x and 4.x **servers**, as well as LAN **Server servers**.

Enterprise capabilities (75) Good 46.87 LAN Server's rewritten TCP/IP is faster and is now a part of its Multiple Protocol Transport Services, which makes managing it easier. OS/2 Warp 3.0 comes with a strong suite of stand-alone Internet-access applications, which LAN **Server** can leverage to provide Internet capabilities to networked clients.

Support and pricing

**Documentation** (50) Good 31.25 **Documentation** is provided both in hard copy and on-line (on the installation CD). It is easy to use and reasonably complete. You can view on-line **manuals** from both Windows and OS/2 clients. On-line help, however, is too often more didactic than tutorial.

Support (75) Excellent 75.00 IBM is the only vendor here that provides any free telephone support (on a toll-free line to boot). The vendor also offers a wide variety of paid-support options.

Price (50) Good 31.25 LAN **Server** lists for \$2,295 per **server** and \$45 per user license. Based on IBM's estimated retail discount of 40 percent, our one-**server**, 100-user network is \$4,077. Our calls put the price at about \$700 to \$1,000 higher.

Final Score 7.0

NetWare 4.1  
Novell Inc.  
Provo, Utah  
(800) NETWARE, (801) 429-7000

Installation and client configuration (75) Good 46.87 CD-ROM and reasonable defaults make installation easier than ever. But you still have to know your I/O addresses and IRQs to get through the process. You must specify disk and network interface card drivers. Client installation is a snap.

Administration: establishing users (150) Excellent 150.00 Administration tools are so intuitive and comprehensive, you won't think it's NetWare -- until you look at the console. NetWare Directory Services' (NDS) edit and merge limitations are gone. You can configure a single network log-on. Consolidated network configuration.

Administration: other tasks (150) Very Good 112.50 Provides C2-level security and independent auditing function to monitor usage and security. Performance tuning is dynamic. NDS replicas allow log-ons even if main **server** is down. Transaction tracking and file backup add reliability. SFT III allows duplexing of two separate **servers** for mission-critical applications.

File and print speed: moderate load (150) Very Good 112.50 NetWare 4.1 handled our moderate load almost as well as NetWare 3.12, but neither could match LAN **Server**.

File and print speed: heavy load (150) Very Good 112.50 Like NetWare 3.12, Version 4.1 did a superb job of shouldering the heavy LAN load in our 40-client tests. After NetWare 3.12, it degraded the least and had no problems with workstations dropping out.

NetWare integration (75) Excellent 75.00 Novell has done what it takes to make a leisurely migration from 3.1x to 4.1 not only possible but desirable. Stand-alone tools let you read and edit the 3.12 bindery and turn it into a 4.1 NDS database. With the NetSynch tool, 3.12 **servers** not only connect but can be administered from 4.1.

Enterprise capabilities (75) Good 46.87 IPX, TCP/IP, and AppleTalk can run simultaneously. NetWare Link Services Protocol eases internetwork routing and reduces overhead network traffic. Coupon for IP and LAN Workgroup included in 4.1. New tools help configure, maintain, and monitor networks.

#### Support and pricing

**Documentation** (50) Good 31.25 A separate CD (from the installation CD) contains the **documentation**; printed **manuals** cost extra. On the bright side, the on-line **documentation** is faster to search than before and is fairly comprehensive. On-line help is straightforward and useful.

Support (75) Good 46.87 Novell offers some fee-based plans and adequate on-line support, but NetWare users are expected to rely primarily on their dealers and NetWare's huge third-party market of consultants and training centers for help.

Price (50) Very Good 37.50 NetWare 4.1 is too new for us to estimate a street price, but it will be on par with 3.12, according to Novell. List prices range from \$4,995 for 50 users to \$47,995 for 1,000 users. Based on 3.12 street prices, our estimated 100-user street price is \$3,300.

Final Score 7.7

#### Windows NT Server 3.5

Microsoft Corp.  
Redmond, Wash.  
(800) 426-9400, (206) 882-8080



Installation and client configuration (75) Excellent 75.00 Couldn't be easier. A new Network Client Administrator provides several ways to install client-requester software.

Administration: establishing users (150) Good 93.75 Main user-account administration tool is functional and fairly simple to use. Resource sharing and domain management are poorly integrated with user administration and somewhat prone to minor errors. Trusted domain directories allow easy centralized administration and a single network log-on -- a major enhancement over the previous version.

Administration: other tasks (150) Excellent 150.00 Provides C2-level security. Dynamic performance tuning requires little input from administrator. NT File System supports transaction logging, as well as a new automatic reboot feature that helps keep client/**server** applications on-line and aids in troubleshooting.

File and print speed: moderate load (150) Very Good 112.50 NT **Server** beat our baseline of NetWare 3.12's performance by a modest margin.

File and print speed: heavy load (150) Satisfactory 75.00 Despite its new IPX stack, NT Server's performance degraded 56 percent in going from our moderate to heavy workloads.

NetWare integration (75) Very Good 56.25 Ships with fast IPX stack and provides separate gateway service for clients not running a NetWare requester.

Enterprise capabilities (75) Very Good 56.25 DHCP for pooled IP addresses. TCP/IP is fast and easy to install, and Remote Access Service is well integrated into the product.

#### Support and pricing

**Documentation** (50) Good 31.25 A complete set of **documentation** comes on the installation CD, but only setup instructions are provided in hard-copy form (you can purchase the rest of the **manuals** for \$69.95). **Documentation** is generally comprehensive, with most information easy to locate.

Support (75) Very Good 56.25 Like NetWare, NT **Server** comes with no free telephone support, but Microsoft offers more support avenues overall than Novell, including a free quick-fix service that diagnoses and fixes problems remotely in real time.

Price (50) Very Good 37.50 Microsoft's estimated street price is \$699 per **server** and \$569 for a 20-user license pack. Upgrades from NetWare and NT **Server** clients are half price. Total price for our one **-server**, 100-user network: \$3,544.

Final Score 7.4

#### GUIDE

InfoWorld reviews only finished, production versions of products, never beta-test versions.

Products receive ratings ranging from unacceptable to excellent in various categories. Scores are derived by multiplying the weighting of each criterion by its rating, where:

Excellent = 1.0 - Outstanding in all areas.

Very Good = 0.75 - Meets all essential criteria and offers significant advantages.

Good = 0.625 - Meets essential criteria and includes some special features.

Satisfactory = 0.5 - Meets essential criteria.

Poor = 0.25 - Falls short in essential areas.

Unacceptable or N/A = 0.0 - Fails to meet minimum standards or lacks this feature.

Scores are summed, divided by 100, and rounded down to one decimal place to yield the final score out of a maximum possible score of 10 (plus bonus). Products rated within 0.2 points of one another differ little. Weightings represent average relative importance to InfoWorld readers involved in purchasing and using that product category. You can customize the report card to your company's needs by using your own weightings to calculate the final score.

The Test Center Hot Pick is InfoWorld's new award for outstanding products we have evaluated in scored stand-alone reviews or product comparisons. To receive the Test Center Hot Pick seal, a product has to offer what InfoWorld deems to be a standout feature or technology that is unusually valuable or revolutionary compared to competitors. The product must also score at least satisfactory in all report card categories and receive a final score of 7.0 or more.

Related Article: HOW WE TESTED

#### Installation

We installed each network operating system from CD-ROM and the necessary client-requester software from floppy disks. We awarded a satisfactory score to a largely **manual** installation process that an administrator could carry out with the aid of reasonably clear written **documentation**. Products that made the installation faster and easier -- by offering features such as automatic hardware detection, a well-designed interface, or **documentation** that helped us make informed configuration decisions -- received extra points. We deducted points for inadequate on-line or written **documentation**, lack of support for common brands of hardware, poorly designed interface elements, or run-time errors attributable to faulty installation.

Related Article: HOW WE TESTED

#### Administration: establishing users

For this task, we attempted to create user accounts that had home directories on the **server**, log-in script support, and various privilege levels. Products that allowed us to do this in a fairly straightforward manner received a satisfactory score. We awarded extra points if the NOS let us provide users with single networkwide log-in capabilities and gave administrators the ability to administer the network from a single location.

We also awarded extra points if we could administer and control user accounts in a detailed manner and if we could set password policies and restrict the hours of access to the **server**. Products that let us easily create local and global groups of users, create domains or their equivalent, and replicate and edit groups of users and individual accounts also received bonus points.

Related Article: HOW WE TESTED

#### Administration: other tasks

A product earned a score of satisfactory if it could implement reasonably robust user authentication and file access security; supported some form of data redundancy; could do performance tuning; and could do at least minimal event logging. We awarded extra points for any features that increased the product's capability to restrict access or extended administrative functionality.

#### Platform for speed tests

To eliminate bottlenecks on our network, we divided our twisted-pair Ethernet network into four segments, each



consisting of a rack of 10 clients. Each rack consisted of four Gateway 486/33 PCs with 8MB of RAM; four Hewlett-Packard 86/66 PCs (three of which had 16MB of RAM and one of which had 8MB of RAM); one Dell 386/33 PC with 8MB of RAM; and one Dell 486/25SX PC with 8MB of RAM. We used 3Com 3C509 network interface cards (NICs) for all the clients but the Dells, which used SMC Elite 16 Combo NICs.

Our **server** was a dual-processor 66-MHz HP NetServer 5/66 LM2 Pentium equipped with 64MB of RAM (see story, page 77). We configured the server's array of five 1-gigabyte drives at RAID Level 5. We used a Cabletron MMAC-M8FNB concentrator as our network hub.

Related Article: HOW WE TESTED

Applications for speed tests

We used four popular DOS applications (WordPerfect 5.1, Harvard Graphics 3.0, Paradox 3.5, and dBaseIV 1.5) and five Windows applications (cc:Mail 1.1, Lotus 1-2-3 1.0, Freelance Graphics 2.0, Excel 3.0, and Word 2.0) running from the **server**. Using either the native scripting language of the application or MS-Test, a software automation tool, each application performed common tasks, including opening, modifying, printing, and saving files. We timed each application for each workstation and averaged the results for all the workstations.

Moderate and heavy workloads

We tested each NOS' speed with three workloads -- single (one client), moderate (20 clients), and heavy (40 clients). We scored only the vendor's implementation of moderate and heavy workloads (see story, page 76).

Moderate load: We calculated how long it took on average for each NOS to complete our benchmark test and compared it to NetWare 3.12's performance.

NOSes that were faster than the NetWare 3.12 baseline earned scores of very good or excellent, depending on the percentage of improvement. (We used 10 percent increments to determine scoring categories.) NOSes slower than our baseline received lower scores.

Heavy load: We calculated scores for heavy workload on both the degree to which a NOS' performance degraded as the network expanded from 20 to 40 clients and its stability -- whether it dropped client workstations as the workload increased.

Related Article: HOW WE TESTED

NetWare integration

To test how well each product can be introduced into an existing NetWare 3.12 environment, we used InfoWorld's own production network as a test bed. We installed each NOS onto a machine and added it to the network (all **servers** were on the same cable segment). We defined satisfactory as the capability to add the new **server** to the network without creating additional administrative work, and the capability to allow clients to access files and directories on NetWare **servers** through the new **server**. We awarded additional points for the provision of an IPX protocol stack; a NetWare 3.12-to-product migration tool or capability; a product's administrative tools that were capable of managing a NetWare 3.12 **server**; and any other features that enhanced or extended the interconnectivity of the product with a NetWare 3.12 **server**.

Enterprise capabilities

In this task we wanted to see how well each product was suited to wider-area connectivity. We awarded a satisfactory score to products that shipped with a routable protocol stack. We awarded extra points for additional features that enhanced that capability or aided the administrator in carrying out the task. We also awarded bonuses to products that provided Internet access utilities.

Related Article: HOW WE TESTED

### Documentation

We looked for a well-laid-out **manual** that was informative and easy to use. At a minimum, we required that the **documentation** possess the following: a section that detailed how to set up and configure the **server** for different environments and that suggested operation and maintenance policies; accurate diagrams; a table of contents; an index; and a specification section.

### Price

We scored the estimated retail price of the network operating system plus 100 clients. Microsoft provided us with an estimated price for NT **Server** 3.5; we based the retail prices for LAN **Server** 4.0 and NetWare 4.1 on our own research. The three NOSes' prices are similar.

### Support

Because support for network operating systems is usually available from a wide variety of sources and the vendors themselves rarely provide free support, we did not test technical support for this comparison by calling the vendor. Instead, we scored the number of avenues of support and the cost. The more ways a user can get support and the less it costs, the better the score.

Related Article: HOW WE TESTED

### TESTING ADJUSTMENTS:

#### Capturing print activity

While running LAN **Server** 4.0 on the heaviest load, we noticed that the print queue continued processing print jobs after the last client had completed the test suite. In order to capture this additional print processing time, we measured the time from when the last workstation completed the suite until the print queue was empty. We then averaged this additional time into each workstation's recorded time.

Related Article: HOW WE TESTED

### WORKLOADS EXPLAINED:

#### Force-feeding NOSes

If you think testing a NOS with only 20 and 40 clients is unrealistic, you're right. Like most testing facilities, however, we don't have hundreds of PCs lying around. We make up for it with scripted benchmark tests that generate a much higher workload than the size of our test LAN suggests. We tune each network segment to push the NOS and CPU to the max with a constant onslaught of file and print requests. The result: a 40-client LAN that approximates several hundred users.

Related Article: In tune: How IBM, Microsoft, and Novell tweaked their NOSes for speed

To see what an expert could do to make these operating systems go faster, we gave IBM, Microsoft, and Novell the opportunity to tune their products for our file and print speed tests. For (unscored) comparison, we ran an untuned and unoptimized implementation of the tests (achieved primarily by using defaults) for all the NOSes except LAN **Server**. (We couldn't run LAN **Server** completely unoptimized because of the memory requirement of its DOS requester.)

The number and complexity of changes the vendors chose to make varied. Not all of them improved performance.



NT **Server** required the fewest and simplest changes. Microsoft changed the striping factor on our disk array from 8KB to 16KB. The company also increased the paging file for virtual memory from 75MB to 150MB during installation. In addition, it optimized client memory by running DOS' MemMaker program. As a result of the latter, Microsoft's implementation of the benchmark ran significantly faster than ours.

Novell tweaked its NetWare 3.12 and 4.1 products similarly. It optimized client memory and the NET.CFG file on each client. On the **server** side, the company made changes in both the start-up and AUTOEXEC command files. For example, Novell increased the number of packet-receive buffers and concurrent disk writes. Overall, the changes were easy to implement, but they resulted in a difference of less than 4 percent on both our heavy and moderate workloads.

LAN **Server** required the most changes, though they were fairly simple. IBM required the tailored (vs. the easy) installation in order to disable 24-bit direct memory access. To our surprise, the network interface card (NIC) driver IBM recommended we use for testing (Compaq Netflex II) was not included with the shipping product. After installing the driver from a floppy, IBM made several changes to the NIC parameters, including increasing the number of general requests, queued transmits, and receive buffers. IBM increased the **server** cache for HPFS386 and decreased the **server** cache for the file allocation table. As did the other NOS vendors, IBM optimized client memory.

Related Article: HP NetServer is a champ

If we ever need a dual-processor Pentium **server** again, we'll know where to go. The **server** for our network benchmark tests, Hewlett-Packard's NetServer 5/66 LM2, is a solid, flexible machine that takes frequent tweaking well.

Our system -- an EISA system that conforms to the symmetric multiprocessing (SMP) specification -- came configured with 64MB of RAM, dual Intel Pentium 66-MHz processors, a CD-ROM drive, and a 5-gigabyte disk array. We requested an additional single-processor CPU board, which we used to conduct our single-processor testing. The server's standard configuration is 16MB of memory, a 256KB write-back cache for each CPU, and 3.5-inch and 5.5-inch floppy drives. (Storage costs extra.)

The disk array we used consisted of five 1-gigabyte hot-swappable drives. The disk array employs an HP i960 EISA SCSI array controller, which supports RAID Levels 0, 1, 5, and 6. We used RAID Level 5 for our testing. In addition to the array, the LM2 provides a single 1-gigabyte drive connected to the internal SCSI controller.

In the course of testing NOSes, we made countless changes to the server's configuration, including changing the CPU board from the dual processor to the single processor and vice versa, changing the network interface cards (NICs), setting up RAID and partitioning the array, and modifying the EISA configuration numerous times. The HP passed these changes with flying colors.

The system was a dream to configure. Changing the CPU board required no tools and, believe it or not, no trips to the EISA configuration. We simply unplugged one board (there are no screws) and plugged in the other. JetSet, HP's menu-driven program for setting up the array, includes extensive help screens. We just booted off the custom JetSet configuration program disk to launch the configuration.

The NetServer's expandability capabilities made the system very flexible, perfect for our testing needs. You can expand memory to as much as 384MB, and processors range from 486DX2-66 to 66-MHz dual Pentiums. It features eight EISA bus-mastering expansion slots and eight front-accessible, half-height drive bays, as well as on-board SCSI and IDE controllers and several disk-array options. The system also incorporates fine security measures, including options for disabling serial and parallel ports, floppy drives, and write operations.

The NetServer 5/66 LM2 has a list price of \$20,478 for the configuration we used in our testing. The standard configuration costs \$8,757.

HP can be reached at (800) 322-4772.

Related Article: Symmetric multiprocessing may not always boost performance

The vendors have designed all the NOSes in this comparison to be scalable to some extent. For NetWare, this means designing the product to provide large numbers of users with file and print services without significantly affecting performance (see benchmark chart, above). Hosting an application with CPU-intensive tasks (as opposed to file and print services) on a NOS, however, calls for another strategy. One such strategy is symmetric multiprocessing (SMP). LAN **Server** 4.0 supports these via an SMP version of OS/2; NT **Server** 3.5 supports SMP via a second SMP-aware kernel. Novell is currently at work incorporating SMP capabilities into NetWare.

SMP allows multiple CPUs to share a server's memory, interrupts, and devices through a run-time algorithm. Such a scheme, however, does not automatically translate to improved performance or scalability. For I/O-intensive workloads, the additional overhead of SMP may actually decrease performance, as we found when we ran our file-and-print-intensive benchmark workload on the SMP versions of LAN **Server** and NT **Server** using two processors. As the accompanying table shows, multiprocessing proved slower than the uniprocessing environment for all our workloads. Apparently, the overhead of the multiprocessing kernel is significantly greater than that of the uniprocessing kernel, accounting for our single-user test taking longer on multiple CPUs.

It's possible that had we continued to add processors, we would have seen scalability within the multiprocessing kernel itself. It could be, however, that the increased complexity of the SMP environment may simply allow more room for unexpected and unwanted application behavior.

Abstract:

IBM's LAN **Server** 4.0 Advanced, Novell's NetWare 4.1 and Microsoft's **Windows NT Server** 3.5 network operating systems offer administrators three excellent choices, but NetWare 4.1 garners top honors. Despite differences, each of the three NOS versions employ a core set of common features. LAN **Server** 4.0 and **Windows NT Server** 3.5 offer users nearly unattended installation and NetWare is not far behind. Each NOS provides better administration capabilities through enhanced tools, especially NetWare 4.1. NetWare and **Windows NT** employ C2-level security features designed by the Dept of Defense for improved data security. All three NOSs offer multi-protocol support that improve enterprise capabilities. NetWare 4.1 won the top rating partly because of its flexibility and because of its improved administration capabilities.

**Source Citation** (MLA 7<sup>th</sup> Edition)

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