

Upcoming NETWARE Game Highlights

Linda Kennard

As a network administrator, you probably know what's in and what's out in the networking industry. For example, you may have noticed that client-server networking is becoming as passé as mainframes and dumb terminals. (And "retro" networks, unlike Austin Powers suits, are decidedly un-cool.) But if client-server networking is out, what's in?

What's in are n-tier networks. Based on three or more layers running separate processes or applications, n-tier identifies the type of architecture that commonly underlies networks providing intranet or Internet services. In an n-tier network built on three tiers, thin clients—workstations or laptops running web browsers and little client software—operate in the top tier. The bottom tier is predominately comprised of databases and data stores. All other servers—LAN and enterprise operating systems, communications, and, most important, application servers—run in the middle tier. (For more information about n-tier networks, see "Managing Multiple Databases," *NetWare Connection*, Oct. 1999, pp. 16–31. You can download this article from <http://www.nwconnection.com/past/>.)

Will upcoming versions of NetWare be in with this n-tier trend? Actually, upcoming versions of NetWare, specifically NetWare 5.1 and the version code-named 6 Pack, are well suited for n-tier networks. NetWare 5.1 will provide the application server platform you need to develop and run web- and java-based applications, which characterize the middle tier of an n-tier network. 6 Pack will provide the processing power your company's network needs to support these applications. In short, NetWare 5.1 and 6 Pack can help your company's network greet the 21st century sporting what is expected to be the networking style of the next generation.

THE NEXT PLATFORM FOR THE NEXT GENERATION

Novell announced NetWare 5.1 under the code name Cobra, which was presented as an Internet enhancement pack for NetWare 5.0. According to Dan Montieth, Novell product manager, however, NetWare 5.1 is a "big release"—certainly too big to be an enhancement pack and even bigger than a dot-one release would suggest. With NetWare 5.1, which will be released before the end of the year, Novell has migrated to the application server space. Montieth explains that this migration is as significant as the move from bindery to Novell Directory Services (NDS).

What exactly is an application server, and how can Novell claim to have migrated to the application server space? An



application server is typically defined as a platform on which one develops and deploys the business logic that provides the link between top and bottom tiers in n-tier networks. "Today," explains Bill Oakes, director of network applications marketing at Novell, business logic "generally means either Win32 or UNIX derivative-based code. Windows NT Server, Solaris, UnixWare, and Linux are good examples of application servers" on which you develop and run business logic of this type, Oakes adds. ("NetWare: The Application Platform of the Future," *NetWare Connection*, Aug. 1999, pp. 20–21. You can download this article from <http://www.nwconnection.com/past/>.)

However, there is a problem with today's application servers and, more specifically, with the type of business logic they use. Today's application servers "just don't account for the Internet," Oakes explains. Today's application server model, Oakes continues, "will migrate to a more open-standards-based environment called the *Open Application Server (OAS) model*."

Basically, the OAS model outlines the components that a next-generation application server platform needs to work effectively in an n-tier environment. (For a diagram of the OAS model, see Figure 1 on p. 8.) NetWare 5.1, Oakes implies, could be a prototype of the OAS model. In other words, NetWare 5.1 is a good example of the type of application server platform you need in an n-tier network.

NetWare 5.1 includes several new or enhanced features that help make it an application server platform, but Montieth believes the three most exciting features are listed below. (For a brief description of other new or enhanced features, see "NetWare 5.1 at a Glance" on p. 10.)

- IBM WebSphere Application Server 3.0 for NetWare, Standard Edition
- Native support for HTTP and NetWare Management Portal

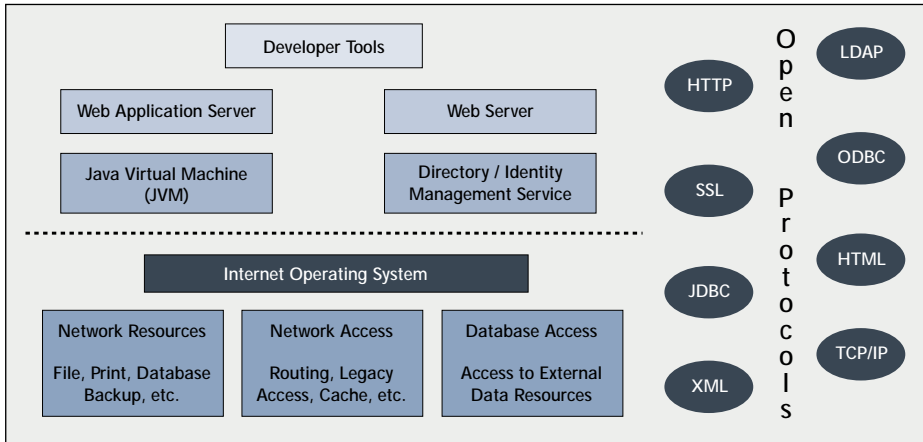


Figure 1. The Open Application Server model—the application server of the future

- Support for Microsoft's next-generation productivity applications and tools

WEBSHERE IS THE KEY

WebSphere Application Server 3.0 for NetWare, Standard Edition is IBM's Java-based web application server—and the key to securing Novell's position in the application server space. As a web application server, WebSphere is quintessential middleware that sits between top-tier and bottom-tier devices, ensuring that the correct data from a variety of applications gets to the right users. As you may expect, WebSphere is integrated with NDS 8. (For information about how NetWare 5.1 simplifies upgrading NDS, see "Need to Upgrade NDS? NetWare 5.1 Can Help" on p. 12.) In fact, WebSphere consults NDS 8 for information regarding access rights.

To understand WebSphere, you need a clear picture of how this server functions in an n-tier environment: In an n-tier environment, users frequently use their browsers to request information that requires a server, usually a web server, to access legacy and other databases. For example, when visiting a company's web site, a user may need to know whether or not a particular product is currently in stock. Using his or her browser, the user can request this information, which is stored in a bottom-tier database. Requests for information that requires the web server to access another application—whether that application is on the same server or a different server—can bog down a web server and slow network performance to a crawl.

To avoid this performance hit, you can configure the web server to offload such requests to an application server. Using this application server, you can develop the business logic designed to retrieve in-

ventory information from the database and then return that information to the web server. The web server, in turn, presents the information in HTML format to the user's browser.

If you offload these application-generation requests from the web server to an application server, the web server can continue processing other requests (for static web data, for example). As a result, the network can perform more efficiently.

In NetWare 5.1, for example, Novell has configured NetWare Enterprise Web Server to forward application-generation requests to WebSphere. This configuration ensures that your company's network performs as efficiently as possible. (For more information about NetWare Enterprise Web Server, which is integrated with the NetWare 5.1 installation program, see "NetWare 5.1 at a Glance" on p. 10.)

Theoretically, you could offload application-generation requests to any application server. According to Oakes, however, "WebSphere is arguably the best web application server available." WebSphere, unlike many application servers, provides an open, Java-based solution for developing, deploying, and managing web applications ranging from simple web sites to powerful e-business solutions.

Bean Babies

The Standard Edition of WebSphere, which is integrated with the NetWare 5.1 installation program, uses a servlet runtime engine to process requests for information on legacy and other databases. Servlets are an improvement over the Common Gateway Interface (CGI) scripts commonly used for processing application-generation requests. Servlets are more efficient than CGI scripts and are indifferent to the

platform running the databases and data stores these servlets access. (WebSphere supports most Java Database Connectivity [JDBC] compliant databases, including Oracle, SQL Integrator, and InstantDB.)

The Standard Edition of WebSphere also includes WebSphere Studio (Entry Edition), which is a collection of Java development tools, including the following:

- NetObjects's ScriptBuilder for creating HTML and Java Server Pages (JSPs)
- NetObjects's Fusion for developing interfaces
- NetObjects's BeanBuilder for building JavaBeans
- IBM's VisualAge for Java for building java applications

Eventually, you will have the option of upgrading to WebSphere Application Server 3.0 for NetWare, Advanced Edition, which will be available from both Novell and IBM. In addition to using the servlet engine, the Advanced Edition uses an Enterprise JavaBean (EJB) engine, enabling you to develop business logic using EJB components. (EJB components are commonly used to develop distributed, transaction-processing applications.) The Advanced Edition also supports Common Object Request Broker Agent (CORBA) and enables you to connect web applications to existing host-based transaction systems. (For more information about WebSphere, visit <http://www.software.ibm.com/webserver/appserv>.)

Of course, the WebSphere Java-based "development environment will not completely replace the traditional environment," says Montierth. Because developers today use both the traditional and the new Java-based development environments, Novell supports—and will continue to support—both. "But as time goes on," Montierth believes, "more and more developers will be moving over to the WebSphere environment."

A PORTAL TO BROWSER-BASED MANAGEMENT

Although finding an ideal platform for developing and deploying web applications is important, you also need a utility to manage a platform that provides Internet and intranet services. NetWare 5.1 includes NetWare Management Portal which, when coupled with NetWare 5.1's support for HTTP as a core protocol, enables you to manage

NetWare 5.1 at a Glance

The following is a list of many (but not all) of the products and features included in NetWare 5.1.

Feature	Description
IBM WebSphere Application Server 3.0 for NetWare, Standard Edition	Java-based web application server that enables you to develop, deploy, and manage web applications ranging from simple web sites to powerful e-business solutions.
HTTP as core protocol and NetWare Management Portal	Enables you to complete server and file-system management tasks for IP-based servers from a browser. Provides proxy services for IPX-based NetWare 4.x and 5.x servers. Includes a diagnostic utility that enables you to track the health of NetWare 4.x and 5.x servers. When queried, this utility displays a green light, a red light, or a yellow light, reflecting good health, bad health, or questionable health, respectively.
Web Distributed Authoring and Versioning (WebDAV)	Enables users to save files of any format to a web server just as if users are saving files to a local hard drive or to a network. Also enables users to access and collaborate on those files as easily as they collaborate on network files.
Support for Microsoft's next-generation productivity and authoring tools	Supports Microsoft Office 2000 and FrontPage 2000. Also includes FrontPage server extensions, which make it easier to collaborate on creating and maintaining web sites.
NetWare Enterprise Web Server	Enables you to develop web applications for NetWare using any number of popular programming interfaces, including Common Gateway Interface (CGI), NetBasic (which is compatible with Visual Basic Script), Netscape Server Application Programming Interface (NSAPI), Java Script, and Perl 5. Supports Open Database Connectivity (ODBC) and Java Database Connectivity (JDBC), enabling this web server to interact with ODBC- and JDBC-compliant databases, including Oracle8i. Supports Microsoft Active Directory Objects (ADO) and Microsoft Active Server Pages (ASP). Also includes Web Publisher, which enables users to publish web pages from their desktops, and is fully integrated with NDS 8. (For more information about NetWare Enterprise Web Server, visit http://www.novell.com/catalog/bg/bge34420.html .)
NetWare FTP Server	Supports all leading FTP clients, including Netscape Communicator, Internet Explorer, and FrontPage. Enables users to download FTP files from Internet and intranet servers. Fast, functional, and fully integrated with NDS 8.
NetWare News Server	Enables you to create internal news groups and to define external ones. Users with the necessary NDS rights can read and post messages to news groups using a standard news reader.
NetWare Web Search Server	Enables you to make corporate web information searchable from a central location. Using a browser, users can search all of the web servers on your corporate intranet for information (regardless of its file format). Supports up to 30 file formats, including web files (.html), WordPerfect files (.wpd), Word files (.doc), PowerPoint files (.ppt), and Adobe files (.pdf).
Oracle8i	Touted as "The Database for Internet Computing." Includes several features that simplify the development and deployment of web-based applications. For example, includes built-in Java Virtual Machine (JVM), enabling you to safely write, store, and execute Java code within the database itself for faster, more secure, and more reliable applications.* Also includes OracleDB, an Internet-ready development tool that enables users to create and publish dynamic web sites from their browsers. (NetWare 5.1 ships with a 5-user version of Oracle8i.)
Universal Component System	Is a development environment that facilitates development of server-side applications which provide the business logic that ties three-tier networks together. Applications developed using Novell Script, Perl script, serverside JavaScript, servlets, Java Beans, or Enterprise Java Beans can access NetWare services or link dynamic HTML pages to any ODBC-compliant database running on NetWare, Windows NT, or UNIX.

*The JVM that Oracle8i includes is separate from the JVM that runs on NetWare 5.1. ●

Number of Processors	Scale Factor
1	1
2	1.8
4	3.5
6	5.2
8	6.1

Figure 2. The more processors an SMP server has, the more processing power you get. The increase in power relative to the number of processors is not a one-to-one ratio, but the increase is significant.

IP-based NetWare servers over the web.

NetWare Management Portal requires no additional software on your workstation or laptop and is simple to use. From your browser, you enter the URL for the NetWare 5.1 server you want to manage. (Novell has tested NetWare Management Portal using Internet Explorer 5 and Netscape Communicator 4.5, but any browser should work.) Next, you enter your NDS username and password to be authenticated to the server over a Secure Sockets Layer (SSL) connection. After you've been authenticated, you will see the console for this NetWare 5.1 server.

From this console, you can manage this NetWare 5.1 server, assuming it uses IP, and you can also manage its file system. From your browser and by way of NetWare Management Portal, you can complete most server management tasks including the following:

- Modify and view server Set parameters
- Load and unload NetWare Loadable Modules (NLMs)
- Start and stop multiple processes
- Configure the memory system
- Check server memory status
- View and edit the registry settings
- View and clear server connections
- Set parameters for LAN and disk drivers
- View the status of various processes
- Manage volume information
- Compress files
- Change file and volume attributes

- Manage file system, including changing file system rights

NetWare Management Portal also enables you to upload or download files between your workstation and a NetWare server's DOS partition.

volume on any IP-based NetWare 5.1 server's DOS partition.

You can also configure NetWare Management Portal to act as a proxy for NetWare 4.x or 5.x servers that still use IPX. In this case, "acting as proxy" means that NetWare Management Portal acts on behalf of IPX servers, enabling you to manage the file systems on these servers. That is, NetWare Management Portal translates your browser-based requests into NetWare Core Protocol (NCP) requests and forwards those requests to the IPX servers for which it has been configured to act as proxy. When these IPX servers reply, NetWare Management Portal translates their NCP responses into HTTP and forwards their replies to your browser.

NetWare Management Portal enables you to manage IP-based NetWare 5.1 servers and the file system on IPX-based NetWare 5.1 and NetWare 4.x servers even when the server you are accessing via NetWare Management Portal is "in a less-than-healthy state," Montierth says. "You don't even have to have CLIB [C-library] up for the portal server to work," Montierth explains. In other words, NetWare Management Portal enables you "to do whatever management you need to do" even when the server you are accessing via NetWare Management Portal is experiencing difficulties. Furthermore, despite such difficulties, you will not have to reboot a server to manage it by way of NetWare Management Portal.

SUPPORT FOR WEB COLLABORATION

In addition to WebSphere and NetWare Management Portal, support for Web Distributed Authoring and Versioning (WebDAV) plays a critical role in making NetWare 5.1 an ideal platform for n-tier networks. WebDAV is an Internet Engineering Task Force (IETF) standard that Novell, Netscape, Xerox, Microsoft, and other vendors worked together to develop. A set of extensions to HTTP 1.1, WebDAV enables users to edit and post documents on the web in a consistent way—regardless of the software or Internet service provider (ISP) they are using.

For example, NetWare 5.1 supports Microsoft Office 2000, which is WebDAV-compliant software. This news may surprise you because Microsoft and press members have led many people to believe that Windows NT alone supports the new Office 2000.

Arguably the most interesting new feature in Office 2000 is Web Folders, which make files and folders that are physically stored on a web server look like files and folders that are stored on a local hard drive or on a network server. To create Web Folders, you use the My Computer icon on a Windows NT, 98, or 95 desktop: You choose the "Web Folders" selection, and then you double-click "Add Web Folders." A wizard walks you through the creation of the Web Folder (during which you specify a URL for a web server).

After you've created a Web Folder, saving files to that folder—and consequently posting them on the web—is as simple as saving a file to any desktop folder. You can also drag file icons to the Web Folder to move any file from a local hard drive or network server to a Web Folder and vice versa.

After you create a Web Folder, you can use collaboration tools in Internet Explorer 5 to work on the files in that folder. For example, you can select the Discussions tool to insert comments in a file.

Need to Upgrade NDS? NetWare 5.1 Can Help

If you're like most network administrators, upgrading Novell Directory Services (NDS) sounds like a hassle. However, NetWare 5.1 includes several options that make upgrading NDS easier:

1. When installing NetWare 5.1, you can choose to implement NDS 7 or NDS 8.
2. If you choose NDS 8, the NetWare 5.1 installation program checks the NDS tree to ensure that it is prepared for NDS 8.
3. If the NDS tree is not prepared for NDS 8, the NetWare 5.1 installation program will prepare the NDS tree and install NDS 8, assuming that is possible. (See number 4.)
4. If the NDS tree is too old to prepare for and install NDS 8, the NetWare 5.1 installation program will prepare the NDS tree for and install NDS 7. (The NetWare 5.1 installation program can prepare trees stemming from NDS versions as old as the version included with NetWare 4.1.)
5. When you are ready for and decide to install NDS 8, you can use a post-installation option included with NetWare 5.1. ●

6 Pack MP-Enabled Components

In NetWare 5.0, Novell made the NetWare kernel multiprocessor (MP) enabled. In 6 Pack, Novell will make the core services upon which the kernel depends MP enabled. These MP-enabled components will include (but will not be limited to) the following:

Protocol Stacks and Services

- IP stack
- Service Location Protocol (SLP) 2
- Gigabit Ethernet/100 Megabit Ethernet/10 Megabit Ethernet
- Token Ring 16

Security-Related Features

- Authentication
- Novell International Cryptographic Infrastructure (NICI)

- GUI Audit (a ConsoleOne snap-in module)

Storage-to-Wire-and-Back Services

- Event bus
- Novell Storage Services (NSS)
- Fibre Channel disk support
- Transport service request dispatcher
- Protocol service request dispatcher

NetWare 5.1 Components

- HTTP
- WebDAV
- Search engine
- Web engine
- NetWare News Server
- Servlet interface (part of NetWare Enterprise Web Server)

Miscellaneous Components

- Novell Directory Services (NDS) 8 (including LDAP support)
- Novell Java Virtual Machine (JVM) ●

You can also use the Subscribe tool to subscribe to the files on which you are collaborating. You can set up subscriptions in a variety of ways. For example, you can set up a subscription so that you receive an e-mail message once a week to notify you of changes that your collaborative group has made to the file in the Web Folder.

To use Web Folders, you must have a web server that has either FrontPage server extensions or WebDAV support. NetWare 5.1 has both. FrontPage is Microsoft's authoring tool that now owns about 80 percent of the web authoring market. NetWare 5.1 supports FrontPage 2000 and includes FrontPage 2000 server extensions on NetWare Enterprise Web Server. These server extensions make it easy for users using FrontPage 2000 to collaborate on creating and maintaining web sites.

In NetWare 5.1, Novell not only supports Microsoft's productivity and authoring tools, in many respects, it improves upon them. For example, Microsoft stores information for Web Folders in the registry of the PC on which the Web Folder was first created. Consider the consequences of this client-centric approach: If you are away on business or sitting temporarily at a different desk, when you open Microsoft Word or another Office 2000 product, the computer you have logged in to will have no knowledge of your Web Folder. Therefore, you will be unable to open and save files in that Web Folder through Office 2000 products.

Novell, in contrast, stores information about Web Folders in NDS. Consequently, no matter where you go, information about your Web Folders (including access rights) goes with you. Hence, if you create a web folder on a desktop in Provo and then you log in to the network from your laptop in San Jose, you can use any Office 2000 product to open, edit, and save files in that Web Folder.

6 PACK PUNCH

As your company's n-tier network grows and you increase the number of distributed applications and services running in the middle tier, the processing power required to run those applications and services also increases. By upgrading to Intel-based, symmetric multiprocessor (SMP) hardware, you can increase processing power without having to buy an inordinate number of new computers and without increasing server management overhead (and costs). However, SMP hardware alone won't give you the processing power you need. To reap the rewards of SMP hardware, you need an operating system (and also applications) that are multiprocessor (MP) enabled.

When running MP-enabled software, SMP hardware can concurrently process several threads from one program, a practice called multithreading. In NetWare 5.0, Novell multithreaded the NetWare kernel—a big step toward increasing the performance level of NetWare, already renowned for its high-performance levels.

However, the performance increase that the NetWare 5.0 MP-enabled kernel offers is limited because the protocol stacks and other network services that kernel depends upon are not MP enabled.

For example, the IP stack in NetWare 5.0 operates in a single-threaded environment: Only one thread from within the IP protocol stack can be processed at a time. Although this IP stack is "the fastest IP stack on the planet," according to Allen Tietjen, director of Novell product management, the IP stack cannot take advantage of any additional processors that may be available to it—not yet anyway. Novell will soon enable the IP stack to use additional processors with the release of 6 Pack.

2, 4, 6, 8—Power Up!

Scheduled to be released in September 2000, 6 Pack will essentially be an MP-enabled version of NetWare 5.0. For example, in 6 Pack Novell will multithread core NetWare services, including the IP stack, the NetWare Core Protocol (NCP) engine, and Novell Storage Services (NSS). In addition, several of the features that ship with NetWare 5.1 will be MP enabled in 6 Pack, including HTTP and WebDAV. (For a list of features that will be MP enabled in the 6 Pack release, see "6 Pack MP-Enabled Components.")

In addition, Novell has made its development environment MP enabled. Beginning with the release of NetWare 5.1, the Novell Java Virtual Machine (JVM) will be MP enabled. This MP-enabled JVM will be included in the Novell Developer Kit (NDK) for NetWare 5.x, beginning with the first version of the NDK that ships after the NetWare 5.1 release. (For more information about the NDK, visit <http://developer.novell.com/ndk>.)

6 Pack will support hardware from all major SMP hardware vendors, and its MP-enabled components will be able to scale up to eight processors. When you install 6 Pack, it will automatically detect the number of processors available on that server and then distribute its program threads and components accordingly.

As you would expect, the more processors you have, the more processing power you get. However, the relative increase is not at a one-to-one ratio. For example, adding a second processor to a server does not yield the same processing power that two single-processor computers would yield.

Nevertheless, the second processor does significantly increase the processing power. As a general guide, Novell suggests that you can expect a server with two processors to offer 1.8 times as much processing power as a single-processor server. (For a list of Novell's suggested scale factors for SMP servers, see Figure 2 on p. 12.)

MACK TRUCKS AND SPORTS CARS—THE BEST OF BOTH

Contrary to what you may think, the effect of increasing processing power has little to do with increasing performance and everything to do with increasing scalability, that is, the ability to run more services on one server. Brad Young, Novell product manager, offers this example: "Suppose you have an MP-enabled database running on one CPU [and] that [database] commits 25 transactions per second at 80 percent CPU utilization." Increased scalability, Young continues, means that if you add more CPUs to the server, the utilization per CPU will drop.

For example, if this MP-enabled database had four CPUs at its disposal, the utilization per CPU could drop to as little as 20 percent utilization on each of the four processors. Performance, on the other hand, "may be unaffected," Young notes, adding that "the database [is] still committing only 25 transactions per second." The difference is that this database is now committing 25 transactions at 20 percent CPU utilization instead of 80 percent, enabling you to run more services on a single server.

All versions of NetWare run very fast on one processor. NetWare is and always has been a high-performance operating system. As Young explains, however, 6 Pack isn't about performance, "it's all about scalability—running more services on one box."

Tietjen, who admits to having a penchant for analogies, explains what 6 Pack's MP-enabled components do for NetWare by way of analogy: Suppose you have a sports car that purrs at 100 miles per hour, Tietjen begins. Now suppose on that sporty car you put a load that would tax a Mack truck. What happens? "Your sports car just doesn't perform like it used to," Tietjen says. With 6 Pack, Tietjen continues, Novell has made core NetWare services MP enabled, delivering an operating system that can be compared to a sleek auto-

mobile that performs like a sports car but can carry the weight of a Mack truck.

IT'S SAFE TO BE SINGLE

Although MP-enabled components tend to attract the most attention, 6 Pack will have several other new and enhanced features that are equally exciting, in many respects. For example, 6 Pack will include several enhancements to Novell Storage Services (NSS), including improved support for NDS and support for the transaction tracking systems (TTSS) of NetWare applications, including Btrieve, Novell Distributed Print Services (NDPS), and ManageWise.

Not all 6 Pack components will be MP-enabled—and some of them never will be. Tietjen says that Novell carefully analyzed NetWare products and services and determined that some of them "just don't have scale or performance issues" and, therefore, would not improve by being MP enabled. For example, Tietjen explains, "I don't expect printing will ever be MP-enabled. Printing services just don't invite the need for speed." In addition, products and services for which Novell plans to provide backward compatibility (but does not plan to enhance) will not be MP enabled. For example, the IPX stack will not be MP enabled.

However, NetWare components that are not MP enabled will be MP safe. MP-safe components are single-threaded components that pose no threat to the system's stability, even when running on SMP hardware. MP-safe components use the MPKXDC Application Program Interface (API) to interact with other system components. Similarly, MP-enabled components use the MPKXDC API to access MP-safe components. In 6 Pack, the IPX stack, legacy file system components, and WAN connection protocols such as Serial Link Internet Protocol (SLIP) and Point-to-Point Protocol (PPP) will all be MP safe.

For optimal performance, you should make sure that all system components, including third-party components, are either MP enabled or MP safe. Components that are not MP enabled or MP safe do not use the MPKXDC API and, as a result, do not perform as well as components that do use this API.

More important, components that do not use the MPKXDC API pose a potential threat to system stability. To ensure

that these MP-unsafe components do not jeopardize system stability, the operating system checks these components regularly. Consequently, the performance of the operating system suffers when burdened with components that are neither MP enabled nor MP safe. (If you are a developer and want more information about how to use the MPKXDC API, see http://developer.novell.com/ndk/doc/docui/index.htm#..nlmnlwlib/ndev_enu/data/hdvx1sto.htm.)

GREET THE 21ST CENTURY IN STYLE

In some senses, n-tier networks, for which NetWare 5.1 and the upcoming 6 Pack are so well suited, combine the best of their predecessors, client-server and mainframe networks. Like client-server networks, n-tier networks don't use Intel-based hardware that is relatively inexpensive (compared to mainframes). Like mainframe networks, n-tier networks run virtually all of their resources on the server or, rather, several second-tier and third-tier servers. By running all of the resources on the servers, you can outfit clients with as little as web browsers to access the network's resources.

As with any paradigm shift, the new paradigm introduces new advantages. For example, n-tier networks enable you to use thin, browser-based clients, sparing you the expense and hassle of deploying and managing specialized client software on users' workstations. N-tier networks also enable you to distribute applications and services across several servers—a fact that users need never learn. Because n-tier networks enable browser-based network management, you can manage the network whether you log in from a computer within the building or from across the globe. Finally, n-tier networks enable dispersed users to save files easily to web servers and to read and collaborate on those files over the web.

If you are ready to sport the networking style of the next generation but are stuck with outdated tools, NetWare 5.1 and 6 Pack can help. With NetWare 5.1, you'll have the tools you need to model a network on the n-tier networking paradigm with ease. With 6 Pack, you'll have the processing power the network needs to support the Java and web applications that make this paradigm possible.

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