



Server Operating System

Comparing Sun Solaris 8 and Microsoft Windows 2000 Server Technologies

White Paper

Abstract

This paper compares the differences between the Microsoft® Windows® 2000 Server family and Solaris 8 from Sun Microsystems. The paper concentrates on four main areas: hardware device support, Internet services, reliability, and manageability.

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INTRODUCTION

Today, a modern operating system must be highly focused on providing applications—locally within a LAN or intranet, as well as globally over the Internet. These requirements demand specific features from the base operating system including the provision of Internet services, high reliability, availability and serviceability. And the OS must integrate with the hardware required to support these facilities.

Many of these features have previously been the preserve of UNIX platforms, dominated by Sun Microsystems' Solaris operating system. This is especially true in the Small to Medium Enterprise (SME) and the Datacenter. However, the Microsoft® Windows® 2000 platform offers many of the features offered by operating systems like Solaris but at a lower total cost of ownership. Windows 2000 includes Symmetric Multi-Processing (SMP), clustering, and advanced network and resource management tools and extends this to include an integrated service for providing Web and Internet applications.

Both operating systems support the Intel platform, which offers a much lower total cost of ownership (TCO) than traditional UNIX workstations and servers. Both platforms offer SMP and clustering using Intel hardware. The Solaris 8 OS is also supported on Sun SPARC and UltraSPARC systems.

The criteria to use when comparing the two operating systems include:

- **Hardware Support.** With the cost of hardware falling every day, a modern operating system must be able to take the best advantage of all the different hardware available. Support for system clustering, Symmetric Multi Processing (SMP) and Redundant Array of Inexpensive Disks (RAID) should be built into the OS.
- **Internet Services.** The ease with which companies can both deploy and manage their Internet presence affects how customers and clients perceive their company. Access times, availability, and feature-rich sites are all critical components of a company's Internet presence and the operating system should provide the best base on which to build Internet-enabled services.
- **Reliability.** Companies no longer work eight hours a day, five days a week. Services, especially on the Internet, must be available 24 hours a day. To support this, the operating system must be able to provide maximum reliability both through software-level services and hardware support.
- **Manageability.** With distributed servers over multiple networks and locations, administrators need tools that enable them to centrally manage their servers and provide a coherent service to their users.

The Solaris 8 Server product line is composed of:

- **Easy Access Server.** An SME-level solution that includes tools for ease of management, integration into existing networks and the Sun WebServer product for Internet services.
- **ISP Server.** Includes the iPlanet Server suite that provides a coherent directory, Web, email and group calendar and discussion group facilities. The iPlanet software is a replacement for the Netscape SuiteSpot server package

and has been produced by the Netscape/Sun alliance.

- **Enterprise Server.** Includes clustering and resource management features in addition to improved RAS and scalability tools. The Enterprise Server package also includes improved system/network-wide security and authentication features.

All Solaris 8 Server products include support for the main Internet protocols for e-mail, domain name services, and file transfer in addition to remote management capabilities and high RAS features.

The Windows 2000 product line includes:

- **Windows 2000 Server.** Includes four-way SMP capabilities and is optimized for the SME, incorporating Web publishing tools and high RAS features.
- **Windows 2000 Advanced Server.** Supports eight-way SMP and large memory configurations and is optimized for database intensive applications, integrating support for clustering and network load balancing.
- **Windows 2000 Datacenter Server.** Supports 32-way SMP hardware and up to 64 gigabytes (GB) of physical memory. In addition to clustering and network load balancing features, it is also tuned for data warehouses supporting On-Line Transaction Processing (OLTP).

All Windows 2000 Server products incorporate the Active Directory™ service for managing the services on the network, the Microsoft Management Console (MMC) for enterprise management and IntelliMirror™ management technologies for managing user files and configuration settings.

HARDWARE SUPPORT

As hardware costs fall almost daily, the specifications and requirements of the datacenter increase. Many systems now come with the ability to handle multiple CPUs and advanced storage facilities such as RAID arrays. To make the best use of this hardware, the OS must support the equipment at a system level, rather than relying on additional applications and device drivers.

For the modern datacenter, the ability to fit as much hardware as possible into a single room requires using either rack mountable hardware or specially designed systems. These hardware solutions often include built-in facilities for monitoring their environment and systems that make servicing the equipment as easy possible.

Some of these features are hardware, rather than software solutions, but the OS should be able to monitor the hardware and predict possible failures or handle acknowledged failures, such as when a UPS switches to battery, rather than on-line power. Supporting these features allows an OS to provide increased availability by reducing the amount of downtime when a failure occurs.

CPU, SMP and Clustering Support

Both Solaris 8 and the Windows 2000 Server product family support multiple-CPU configurations. Solaris is supported on both SPARC and Intel hardware. The SPARC processor standard is funded only by Sun, which also makes its own range of desktop and server solutions. The fourth generation of SPARC processor is the UltraSPARC II, now standard on all systems. Solaris 8 supports SMP solutions on both SPARC and Intel solutions.

Within the SPARC and Intel platforms it is possible to configure 64 CPUs within a single system. For datacenter applications, up to four nodes can be clustered together to provide the maximum performance or fault resilience within a single system. The clustering technology requires additional hardware to operate, which increases the overall cost of the clustering process. It also places extra reliance on a single piece of hardware for the cluster technology.

The distribution of the workload is automatically handled by the operating system to make best use of the available power or it can be controlled using the Sun Cluster Manager and the Solaris Resource Manager to allot individual tasks to each processor within a single node or cluster.

Windows 2000 supports the Intel Pentium processor family and will support the forthcoming Intel Itanium and other IA-64, 64-bit Intel processors when they become available. Windows 2000 supports up to 32-way SMP systems and clustering for up to 4 nodes when using the Windows 2000 Datacenter Server. The clustering technology is built into Windows 2000, instead of being a separate component.

Unlike Solaris, Windows 2000 clustering can be operated over the inexpensive SCSI bus standard. Additional SCSI cards can provide resilience for the cluster communication without the need for additional software. For resource management, Windows 2000 includes a tool for allocating individual resources for each application.

On Windows 2000 Server and Windows 2000 Advanced Server, this facility is handled by the Application Programming Interface (API) to the operating system, allowing software vendors to maximize the performance of their applications. On Windows 2000 Datacenter Server, the control is offered using the Process Control Manager, which can allot individual resources, including processors and memory, to each application.

A summary of the CPU, SMP, and Clustering support is shown in Table 1 below.

Table 1: CPU/SMP Support							
Feature	Solaris 8				Windows 2000	Windows 2000 AS	Windows 2000 DS
	SPARC		Intel		Intel	Intel	Intel
Processor Bit Width	32	64	32	64	32	32	32
Maximum CPUs per node	64	64	64	64	4	8	32
Maximum Nodes per cluster	4		4		0	2	4
Supports Processor Sets	Y	Y	Y	Y	API	API	Y
Maximum Addressable Physical Memory (GB)	4	64	4	64	4	8	64

Device Support

The support and management of devices within the modern server environment is a vital component of the operating system's feature set. In addition to supporting multiple CPU and node-clustering facilities, a modern OS should also provide support for enterprise devices including storage and monitoring technology.

For storage, support should include online storage facilities such as RAID hardware, near-line storage facilities offered by high-capacity removable media and the off-line storage supported by tape backup systems. Monitoring facilities should include the ability to track the temperature—to ensure it is within working limits—and the power supply to avoid the normal effects of imminent power failures.

Solaris 8 includes the ability to monitor the core components of any UltraSPARC-based system. This relies on special hardware solutions and the expensive Ultra server line. Individual failures are monitored, and where possible the OS takes appropriate action automatically. For example, if the temperature of a CPU module exceeds the defined range, Solaris can allocate the processing to another CPU and power it down.

The Enterprise Server 10000 (Starfire) goes one stage further by allowing an SMP server to be configured as one or more physical machines. The configuration, via the Solaris Domain Manager, is dynamic, allocating CPUs to individual pools as necessary. Although normally used to provide multiple services from a single fault-tolerant hardware platform, the system can also be used to provide redundancy to all the components within the system including processors, RAM and I/O cards, and devices.

Support on Intel hardware is limited. Disk storage solutions can be supported in software using the supplied Solaris DiskSuite. Solaris 8 provides built-in support for hardware RAID devices from Compaq, Digital, Dell, HP, and others. However, many of these systems require not only a separate configuration tool but also additional settings to be made in other parts of the OS for the RAID device to be usable. Support is limited to the major players, and many common and inexpensive RAID solutions are not supported at all.

There is no built-in support for the advanced storage solutions such as removable storage or near-line storage libraries. Nor is there any extensive support for anything but the most basic of tape systems for backups. Although there are basic tools for monitoring the network and network performance, these are OS tools rather than tools for monitoring the entire network.

Windows 2000 includes extensive support for many RAID systems from those incorporated into server systems from companies like Compaq and Hewlett-Packard, as well as RAID systems built into off-the-shelf motherboards and many RAID PCI card solutions. You can also use the Windows 2000 Disk Manager to create software-based RAID solutions.

Removable storage—including Zip, Jaz, and Magneto-Optical libraries—are controlled using the same management console as other storage facilities and become a part of the standard storage facilities. You can monitor and track the storage on multiple removable devices and share these devices remotely over the network.

Using the Distributed File System (Dfs), all storage on the Windows 2000-based servers within a network can be made available under a single structure. The system is available irrespective of whether the servers are configured as a cluster. Plus the system enables a variety of storage mediums, from single disk drives to RAID arrays and removable storage to be made available across the entire network.

You can use the Windows 2000 Backup software to backup a machine without requiring any additional software, and support for a wide range of tape devices, including multi-tape libraries is built into the OS. You can also use the Windows 2000 Backup system with removable storage for archiving and hot-backups to reduce the downtime when backing up active databases and other services.

Windows 2000 includes technology for monitoring the internal systems of many standard hardware configurations. This allows Windows 2000-based systems to be monitored from a central console and problems such as overheating and device failures to be identified.

For power management, Windows 2000 can monitor the power supply on suitable systems as well as integrate into Uninterruptible Power Supply (UPS) solutions. A Windows 2000-based system can be configured to lower the power usage of systems running on backup battery power. In the event of imminent power failure, the system can be put to sleep, ready to awake when power is restored or shutdown. A summary of device support is shown in Table 2 below.

Table 2: Device Support			
Feature	Solaris 8		Windows 2000
	SPARC	Intel	
Platform	SPARC	Intel	Intel
RAID Storage (Software)	Y	Y	Y
RAID Storage (Hardware)	N	Limited	Y
Removable Storage	N	N	Y
Near-line Library Storage	N	N	Y
Distributed Storage	N	N	Y
Backup Device Support	Limited	Limited	Y
Tape Library Support	N	N	Y
Environmental Monitoring	Y	N	Y
Power Management	N	N	Y
UPS Monitoring	N	N	Y

Hardware Summary

Intel hardware provides the best price/performance and both Windows 2000 and Solaris 8 provide SMP capability on Intel hardware to extend performance and reliability. However, the clustering solution for Solaris 8 requires special hardware and software to operate, a burden that increases the cost and provides a less coherent solution. Windows 2000 includes support for clustering in the Advanced and Datacenter Server versions as standard, using off-the-shelf hardware. The control and management of the cluster is offered using the standard resource management tools.

Although Solaris 8 includes a RAID solution, it does not provide facilities for extended storage service. Solaris is also limited to the monitoring capabilities of specific UltraSPARC hardware solutions. There is no integration between the operating system and the monitoring of either the environment or power supply on Intel hardware.

To ensure maximum availability, Windows 2000 provides a coherent solution—both for storage support and for the monitoring of datacenter services. The ability to share different storage devices across the network, including online and near-line storage using standard tools is a clear advantage. By incorporating backup software into the OS you provide complete resilience.

The monitoring facilities also ensure that a Windows 2000-based server will be aware of any imminent failures. By monitoring temperature, power, and other environmental factors, a Windows 2000-based system can ensure maximum availability by changing its configuration, and even powering down to guarantee systems resilience to unscheduled system failures.

INTERNET SERVICES

The future of the Internet is in the e-commerce marketplace, an environment that requires interactivity and demands high-performance and developer friendly applications.

Modern operating systems must be able to provide a suitable environment to host an Internet application. At the basic level this requires support for the core Internet protocols, a range of suitable application development tools, and mechanisms for controlling access and authentication.

For high-traffic sites, the OS should be able to manage the connectivity and ensure the best performance for individual users—either through intelligent management of the resources on a single machine, or by using clustering and network load balancing techniques to spread the load over a server farm.

Internet Standards Support

Both Windows 2000 and Solaris 8 have strong Internet standard support, although the level of integration between the services and the operating system vary. Solaris 8 does not provide native solutions for the HTTP or NNTP Internet protocols, although it does support the SMTP and FTP protocols. A summary of Internet services is shown in Table 3 below.

Internet Service	Solaris 8	Windows 2000
HTTP (Web)	Via iPlanet Web Server	Built-in/IIS 5.0
Secure HTTP (SSL)	Via iPlanet Web Server	Built-in/IIS 5.0
SMTP (Mail)	Built-in	Built-in/IIS 5.0
FTP (File transfer)	Built-in	Built-in/IIS 5.0
NNTP (Usenet/Discussion)	N/A	Built-in/IIS 5.0
POP (Client E-mail)	Via iPlanet Messaging Server	Via Exchange Server
IMAP (Client E-mail)	Via iPlanet Messaging Server	Via Exchange Server

The Solaris 8 operating system does not support the primary protocols used for providing Web-based applications. Using the base Solaris 8 operating environment it is therefore difficult to provide a coherent Internet solution across the different services that would normally make up your Internet service. For example, using the built-in e-mail services and a third party Web server solution requires two different authentication systems. Although this requirement is not an issue for public Web services such as e-commerce, it is a significant omission for intranet and extranet applications.

It is possible with Solaris 8 to use the Sun Directory Service, which uses LDAP technology to store user and directory information. This can be used to provide unified authentication and security across the main Internet services. However, by doing this, the entire Internet service sits above the operating system and actually supercedes, rather than replaces the standard UNIX authentication systems.

As a replacement to the built-in SMTP support, Solaris 8 can be used in combination with the iPlanet Messaging Server to provide an advanced Internet-standards-based messaging server. The iPlanet server supports not only SMTP, but also POP and IMAP for client connectivity and the MIME standard for data exchange. You can also use iPlanet as a secure messaging solution, because it also supports message transfer using SSL encryption. The iPlanet mail service can be scaled across multiple servers without having to resort to clustering technology.

For HTTP support, you need to acquire additional software. The Sun recommended solution is to use the iPlanet Web Server, Enterprise Edition 4.0 (formerly Netscape Enterprise Server). The iPlanet Web Server supports the HTTP protocol, virtual servers, and SSL for secure connectivity. For authentication, the iPlanet Web Server can integrate with Solaris Directory Service or with the iPlanet Directory Server, which also uses LDAP for storing directory and authentication information.

The iPlanet server suite also includes servers for SMTP and NNTP and group calendar facilities using a proprietary protocol. As with the Web Server, any LDAP-compatible directory server (including Active Directory) can provide authentication for all these systems.

Windows 2000 Server includes Microsoft's Internet Information Services (IIS) 5.0. This provides native support for SMTP, FTP, NNTP, and HTTP protocols. IIS 5.0 integrates closely with the operating system providing a unified authentication and security system linked to Active Directory. This allows for singlesign-on (SSO) authentication to e-mail, FTP, NNTP, and Web services.

The IIS SMTP service allows for secure message sending and SMTP routing and forwarding while also providing secure e-mail forwarding using the SSL protocol. For client-based messaging, the Microsoft Exchange Server must be installed. This provides both native Exchange e-mail services and Internet-based protocols for supporting POP and IMAP connections. Because Exchange Server is integrated into Active Directory users require only a single login to the Windows network to access file, Web and e-mail services.

Web Application Development Environment

Solaris 8 does not include native support for Web protocols, instead Solaris relies on the Sun WebServer 2.1 or the iPlanet Web Server components. These two platforms include support for Java, JavaScript, Common Gateway Interface (CGI) technology, Perl, C, C++, and other scripted and compiled languages.

Windows 2000 includes Internet Information Services (IIS) 5.0. IIS builds on Windows NT® 4.0 and the IIS 4.0 solution provided by the Windows NT Option Pack. In addition to common CGI languages such as C/C++, Perl, and the Visual Basic® software development system, IIS 5.0 also supports Active Server Page (ASP) components. ASP allows scripts to be embedded into Web pages in a language similar to HTML. ASP can be used to embed interactive elements such as forms and database query engines or to embed "static" information extracted from a database.

Windows 2000 also includes support for the Common Object Model (COM). COM allows individual components to be developed and then shared among all the applications on the machine. The ASP system provides the interface supporting COM-based applications on the Web. The use of ASP and COM technologies decreases the development time, as objects can be re-used. The Distributed COM (DCOM) model expands on this by allowing individual COM components to be shared across a server farm to provide maximum scalability.

Solaris 8 includes a Java Virtual Machine (JVM) as a built-in component of the operating system's kernel. The kernel level support also allows for the development of server-based Java applications, called servlets, allowing complex interactive applications to be deployed with two-way communication between the client's browser and the Web server. The servlets themselves are loaded dynamically, allowing for the best use of system resources. Because of their dynamic nature, servlets can also be modified without interrupting the user application, helping to improve Web service availability.

The Solaris Java implementation also includes extensions to the Java language including JDBC, the Java interface to Open Database Connectivity (ODBC)-aware database engines. For applications not based on Java, the Sun WebServer also supports ODBC connectivity. However, the Solaris 8 platform does not include any form of native data storage. Separate applications and tools must be supplied to support data storage.

Windows 2000 includes the Microsoft Java Virtual Machine for Java support. By combining Java components, ASP and transaction server features, a Java developer can easily build enterprise-wide Java-driven Web applications. Under Solaris 8, integration between the supported languages and data sources is entirely language dependent, requiring additional libraries and code to access database systems either natively or through the use of the Open Database Connectivity (ODBC) system. Support for other database types is dependent on the scripting language used. The lack of a coherent data interface system means that Solaris 8 is limited to the external applications and languages supported by the system.

Windows 2000 provides native database connectivity through the ASP development environment. Using ASP you can connect to traditional ODBC resources such as Microsoft SQL Server™ or Oracle and through the use of the ActiveX® Data Objects (ADO) and the OLE DB system to a wide variety of non-relational sources. The OLE DB component provides access to non-relational sources such as mainframe databases, hierarchical storage systems, e-mail databases, and traditional file systems.

To further extend the features for developing Web applications, especially in the realm of e-commerce, Windows 2000 incorporates Microsoft Transaction Services and Microsoft Message Queuing Services (MSMQ). The Microsoft Transaction Services system allows for Web applications to perform multiple actions on a transactional basis, allowing all or none of the actions to complete. This ensures that operations like database updates happen consistently.

For distributed systems, the MSMQ system provides a reliable method for individual machines to send and receive messages. For e-commerce and other secure transactions, the MSMQ service allows public Internet servers and internal operational servers to remain separate, while still allowing transaction operations to be conducted over a secure connection.

Solaris 8 does not provide any built-in transaction or message queuing services. Although there are products available that will support each service, none of these are integrated either with each other, or the Web server and operating system.

A summary of the Web application features can be seen in Table 4 below.

Table 4: Internet Languages on Solaris 8 and Windows 2000

Language/Application Environment	Solaris 8	Windows 2000
C/C++	Y	Y
Perl	Y	Y
Python	Y	Y
Visual Basic	N	Y
Java	Y	Y
Java Servlets	Y	N
Server hosted Scripts	Y	Y
JavaScript	Y	Y
Active Server Pages	N	Y
Supports FrontPage® Extensions	Y	Y
Message Queuing Services	N	Y
Transaction Services	N	Y
ODBC Interface	Y	Y
JDBC Interface	Y	Y
OLE DB	N	Y
ActiveX Data Objects	N	Y

Scalability

As the Internet grows so does the size of the infrastructure and servers required to support Internet-based services. To be able to scale Internet services successfully, the operating system must grow, both within the confines of the hardware and through the use of distributed computing technology such as clustering, network load balancing, and transaction services.

To manage the network resources for an individual server you can use the Solaris Bandwidth Manager, which allows you to configure the available network bandwidth on Wide Area Network (WAN) connectivity on an application and/or user basis. For example, you could allocate a significant proportion of the bandwidth on an Internet link to the HTTP protocol, ensuring maximum throughput when supporting Web applications. However, the settings are fixed according to individual protocols and machines—there is no load balancing between multiple machines

In addition, a single server can be configured to provide performance and services

to specific applications. Using Processor Sets, a multi-processor server can assign groups of processors to handle individual applications. This ensures that mission-critical applications gain the maximum performance without sacrificing individual CPU performance to non-critical tasks.

Using Solaris Domains, a SPARC-based SMP server such as the Sun Enterprise 10000 (Starfire) can be configured to appear as one or more physical machines. Configuring each of the Solaris Domains is dynamic. For example, during the day the system can be configured to provide maximum performance to the client-facing e-commerce application, but during the night the system is reconfigured to provide the best support for batched jobs or to the replication and backup systems, without entirely disabling the e-commerce site.

For performance-intensive or mission-critical sites, you can use Sun Cluster Manager to support a 4-node cluster using Solaris 8 Enterprise Server. The cluster can be configured either to ensure scalability and availability or reliability. When used in combination with the Solaris Resource Manager, the cluster can be configured to maximize the available resources on all servers. For resilience, any individual server within a cluster can replace a failed server with no determinable loss in availability.

Windows 2000 Server supports advanced resource planning either through the API used to build the applications or, in the case of Windows 2000 Datacenter Server you can use the Process Control Manager. The Process Control Manager allows you to distribute individual applications to specific processors in a similar method to the Solaris Processor Sets. This can be used to give the individual Internet service applications one or more processors and therefore control the resources given to each service.

Windows 2000 also supports multi-processor systems and clustering of individual systems up to a maximum of four nodes. Each cluster can be configured for either availability or performance. Using other facilities of the operating system it is also possible to control the performance of multiple machines and clusters.

Windows 2000 supports the Network Load Balancing Service (NLBS). NLBS allows Windows 2000 to distribute TCP/IP requests to any of up to 32 servers or clusters within a network. Rather than restricting the choice to a simple round-robin system of distribution, or throttling bandwidth to individual protocols on each server, NLBS monitors the load on each server and automatically allots new requests to the most appropriate machine.

Using NLBS it is possible to handle multiple requests across an entire server farm whether you are using individual machines or multiple clusters. In each case, NLBS will make the best use of the available resources across the entire server network without resorting to controlling servers on an individual or protocol basis.

Although Solaris 8 provides tools for controlling the network bandwidth and resource use within a server farm, there is no way of managing application performance across a network for Internet services. Windows 2000 supports all of

the resource management features offered by Solaris 8, as well as the ability to control the performance of the network as a whole.

Internet Service Management

Management of Sun WebServer services on Solaris 8 are handled through a Web-based management tool called the Sun WebServer Administration Console. Although the interface may be practical for remote management, it has significant limitations.

Because there is no integration between individual Internet services on Solaris, each service can have its own administration interface. For most services, the only interface provided is through a command line interface. Although this is compatible with a remote connection, it is less than ideal for most services. To further complicate matters, because the different services use different management tools the administrator needs to be an expert on a number of different systems.

The lack of integration also means that the effects of managing one service do not automatically notify the other services. For modern Internet applications these can have serious ramifications, including loss of service and even data corruption.

Windows 2000 Server uses the new Internet Information Services (IIS) 5.0, which provides operating system level functionality for the main Internet services. IIS 5.0 can be managed using the Microsoft Management Console (MMC), a unified management tool that supports remote management of all services across both local and remote instances of IIS.

Because Internet service support is built into the operating system using IIS, all aspects of your Internet service can be managed from a single console, either locally or remotely. This includes HTTP, FTP, SMTP, and NNTP services. For remote management, you can also use an HTML-based administration tool allowing control of services from any frame and script-capable browser. By using a combination of wizards and traditional property dialogs, Windows 2000 and IIS make it possible for any computer-literate user to set-up and manage Internet services. Table 5 below compares Internet Management Services.

Table 5: Comparing Internet Management Services

Service	Solaris 8 Easy Access Server	Solaris 8 ISP Server	Windows 2000/IS 5.0
GUI Website Management	N	N	Y
GUI Mail Server Management	N	N	Y
GUI Directory Management	N	N	Y
Web-based Web site Management	Y	Y	Y
Web-based Mail Server Management	N	Y	Y
Web-based Directory Management	N	Y	Y
Command-line management tools	Y	Y	Y

Security

In order to support e-commerce applications, the operating system and the Web application environment that it supports must be able to support secure communication. Security for Web applications centers on the following areas:

- **Access Control.** Used for controlling which files clients can access.
- **IP Security.** Used to restrict access to specific IP addresses or domains.
- **Authentication Methods.** Used for identifying individual users.
- **Encryption.** Used to support for the encryption of information across a network.

Because Solaris 8 does not provide an integrated solution for Internet services, the available security options rely on the capabilities of the Web server software used. When using Sun WebServer or the iPlanet Web Server, Solaris provides very good all-round security. Authentication on both systems is either via a local registration database or integrated into the Solaris Directory Server product using the Lightweight Directory Access Protocol (LDAP).

The authentication systems in both optional products provide basic and encrypted authentication, in addition to certificate-based authentication. The iPlanet suite also includes a certificate server and management system for deploying and controlling authentication using the certificate system.

Solaris 8 access control either uses built-in authorization tables or can be integrated into an LDAP service. However, the configuration of the access control system is in addition to the permissions configured for each file and directory on the physical file system. The lack of integration complicates the process and risks rendering entire Web sites unavailable if the file system permissions are modified.

Solaris 8 includes support for both 40-bit and 128-bit Secure Socket Layer (SSL) encryption and is included in both the WebServer and iPlanet applications. Solaris 8 supports integration with the operating system but only if you also choose to use the Sun Directory Server as the authentication system for user logins. In addition, both

SDS and the iPlanet Directory Server offer unified authentication across Internet services, allowing for a single login/password combination for e-mail, Web, and group collaboration.

Windows 2000 uses Active Directory as the core for all authentication and control when supporting Internet services. Active Directory is an integrated part of the operating system, recording not only information about users and accounts, but also directory information for services and resources across the entire network. For compatibility, Active Directory can also be accessed using LDAP protocols.

A user can be configured with a single account that provides access both to Internet services and other services hosted by the network including shared files and printers. This means that users can have a single login that grants them access to all of the facilities provided on the network.

The same Access Control Lists (ACLs) as the underlying file system handle access control to individual Internet services. Modifying file access within the file system modifies access to the file over the Internet and the use of a single access control mechanism reduces the need for duplication of the information across both the internal and external systems.

For e-commerce, Windows 2000 supports the 40-bit and 128-bit SSL protocols in addition to Server Gated Cryptography, a common standard used for online transactions with financial institutions. To further restrict access, IIS 5.0 supports IP level security for restricting access by IP address, domain name, or a combination of the two.

Both the Windows Active Directory service and the Solaris and iPlanet Directory services support multiple databases allowing for authentication to be spread across multiple domains. However, in Solaris the partitions are physically separate. Windows 2000 uses the same unified directory structure for all the domains that it controls.

For network-wide searches, Solaris uses a referral system to forward an individual search across each physical partition. This increases the time to search for authentication information across individual LDAP directories and servers. Because Active Directory uses a single database, searches across multiple domains occur concurrently.

Solaris 8 supports replication of the LDAP database using a master/slave model. For each database there is one master directory which can be replicated onto multiple slaves. Synchronization takes place either on a manual basis or at specific intervals. Because there is only one master server, Solaris relies on the integrity of one machine in the network to provide authentication services.

With Active Directory all servers are peers of each other. There is no single Active Directory-based server that is responsible for holding the core information for the entire network. In the event of a security breach or hardware failure, a server can be taken off-line and immediately replaced with a new server that duplicates the Active Directory information from its peers.

Because the synchronization process for Active Directory is automatic and two-way, updates on a local server will also update the security records on the other servers sharing the same Active Directory service. Since all the machines within the network use the same unified directory, they can all individually authenticate requests. This is especially useful in a distributed environment because it ensures that authentication provides access to the entire network.

A summary of the security features offered by each operating system is shown in Table 6 below.

Table 6: Internet Security Comparison		
Service	Solaris 8	Windows 2000
Authentication Services	Y	Y
Encrypted Authentication	Y	Y
Certificate-Based Authentication	Y	Y
SSL Encryption (40-bit)	Y	Y
SSL Encryption (128-bit)	Y	Y
Access Control	Y	Y
IP-based Security	Y	Y
LDAP Authentication/Integration	Y	Y
OS Authentication Integration	N	Y
Unified OS/Internet Access Control	N	Y

Internet Service Summary

By providing a solid base of Internet services, especially in the realm of e-commerce and Web applications, Windows 2000 provides an advanced and more developer friendly solution than Solaris 8.

Solaris 8 has strong Java features, including support for Java servlets, but its lack of message queue services, transaction processing and all-round integration between the OS and Internet service means that it falls short of the requirements of a modern Internet-aware operating system.

One of the greatest strengths in Windows 2000 is the integration of the OS and the IIS 5.0 Internet Service component. The OS also provides the best reliability and scalability across an Internet server farm because Windows 2000 can distribute requests based on the resource load of individual servers. Using Windows 2000 it's possible to maximize performance both in terms of servicing a client's request and internally through the use of distributed development tools such as DCOM, Microsoft Transaction Services and MSMQ.

RELIABILITY

In order to ensure the maximum reliability of a system, features must be incorporated into every component of the operating system. The OS should be able to tolerate faults and monitor the situation on a server so that it can predict when faults may occur and take action to rectify the problem.

At a core level, the operating system must be able to protect itself from the effects of the applications it supports. When an application crashes it should not cause the entire system to fail. This requires the OS to employ techniques to ensure that individual applications cannot affect each other or the OS itself.

For top reliability, the operating system must be able to support fault tolerant devices to allow automatic fail-over when a piece of hardware fails. This includes support for RAID systems to allow for recovery from disk failures, and clustering to provide resilience in the event of a complete hardware failure. Other fault tolerant services include uninterruptible power supply (UPS) support, which must be monitored so that a system can be safely shutdown in the event of a power failure to prevent data corruption.

To ensure minimum downtime, various mechanisms help improve the recovery time once a fault has been identified or after faults have been rectified. These include tools for file system recovery and the backup and recovery systems. For diagnosis, the system also needs to be able to log its current status and provide the tools to examine the logs so that the origin of the fault can be traced.

Although unplanned outages present the most serious problems to providing high reliability, planned downtime can also be a factor. The ability to dynamically reconfigure the OS without needing to reboot the system will help to improve the availability and therefore the perceived reliability of the system.

System Reliability

Both Solaris 8 and Windows 2000 provide extended facilities for ensuring that individual applications do not affect the operation of the operating system. Both operating systems support protected kernels and protected memory areas for individual applications. If an application fails due to a memory access failure, the crash will only affect the allotted area and not the entire operating system.

Fault Tolerant Device Support

Solaris 8 incorporates a monitoring capability tailored for the SPARC hardware platform, but not for Intel hardware. In supported systems this allows for components to be swapped while the machine is running.

For greater resilience, the Sun Cluster Manager allows up to four machines to be configured as a single cluster. If one machine within the cluster fails, the other machines within the cluster automatically take over the processes and services previously supported by the failed device. The clustering facility is provided by Solaris on both SPARC and Intel-based hardware but requires specialized hardware to link individual nodes.

More Information

See the **Hardware Support** section earlier in this document for more details on the fault-tolerant support offered by Solaris 8 and Windows 2000.

Solaris 8 includes Solaris DiskSuite—a software-based solution for disk management that provides RAID features in software without the need for special RAID hardware. Configuration of the disks is handled in real time and for most operations does not require a reboot for changes to take affect.

Windows 2000 Advanced Server and Datacenter Server support clustering of up to four nodes to provide system-wide redundancy for an individual cluster. Unlike Solaris, which requires using special hardware to enable the clustering technology, Windows 2000 supports clustering with any SCSI equipped PC. This helps lower the cost for providing fault tolerant clusters.

Windows 2000 includes built-in support for software-level RAID solutions and extensive support for many RAID controllers and RAID systems including those built into many datacenter servers. All disks and RAID systems are configured using the same Disk Administrator tool, providing a consistent interface to managing data storage.

In addition, Windows 2000 incorporates support for monitoring the system environment on suitable hardware and integrates with many UPS systems to support advanced reliability in the event of power failure.

Failure Recovery

Solaris 8 includes the UNIX *fsck* utility, which enables the OS to repair a file system during a system reboot. However, recovery is not always perfect and it is possible to lose files and data. For fault-tolerant file systems it's possible to use the third party Veritas file system. The Veritas file system supports journaling, which writes file system changes to a log that can then be recovered during a reboot. This is similar functionality to that available natively with the Windows 2000 NTFS file system. Unlike NTFS, the Veritas system is only supported for data storage volumes; it cannot be used with the OS boot volume.

The Windows 2000 NTFS file system is highly tolerant of disk failures. It employs a transaction logging technique to ensure that all requests are recorded on the disk. In the event of a system failure, the file system can process the pending changes recorded in the log to bring the file system back to the state it was in when the machine failed.

If the operating system fails, Solaris 8 automatically writes a log of the failure to disk for later study. The machine then automatically reboots to its normal operating state. On Sun's Enterprise Server systems, Solaris 8 also supports Automatic System Recovery (ASR). ASR monitors the components within a Sun server and when a component failure occurs, it automatically reboots the system. During the reboot process, the failed component is then ignored or disabled by the operating system, which then continues to boot up as normal. This allows for completely unattended operation—the machine will restart even if a critical component within the machine is faulty.

For more serious problems, Solaris also supports an interactive environment for

repairing the operating system. However, effective repair requires extensive knowledge of the underlying file system and the tools available for repair. For non-technical users this is a daunting interface and without UNIX experience competent repair is impossible.

Windows 2000 also supports an automatic restart option with the ability to save the memory contents to disk so that the problem can be traced. To aid in the recovery process, Windows 2000 includes the Repair Command Console (RCC) which allows you to manage NTFS volumes from floppy disks, or from a bootable CD-ROM. The RCC allows recovery of the system even in the event of file system failure on the boot disk using the familiar Windows Scandisk and management tools. In addition, you can boot a server running Windows 2000 into “Safe Mode” to allow for system reconfiguration without loading additional drivers and services.

For ensuring the active status of a system, Windows 2000 allows you to store the current configuration for the entire server in a separate location. The configuration can then be recovered to reset the system back to its original state. This is useful not only in the event of system failure, but also when installing new device drivers and hardware that may upset the system. Solaris 8 does not offer this capability. And it would be impossible to implement such a system because the configuration information is spread across a number of files and locations.

Solaris 8 includes a basic tape backup system, but is neither reliable nor practical for most server installations. The *ufsdump* utility requires experience of the command line to be able to use it effectively and is not guaranteed to restore your system perfectly. To recover a system after failure you must boot from CD and re-install the base operating system before restoring the files stored on tape. This increases the recovery time significantly.

There are other solutions available for Solaris 8 backups, such as Legato NetWorker, but this is yet another application that sits on top of the operating system. Although Legato provides certain levels of integration with other application software (Oracle, Sybase, Veritas), and facilities for backing up entire networks and many different operating systems, it remains a separate component, with a separate management interface that serves to increase costs—both in software and staff time.

Windows 2000 includes a powerful backup application that can backup files to tape based on a number of different criteria. Windows Backup also supports powerful scheduling features. For recovery you can create a recovery boot disk that can be used to boot the system and then recover files from tape to recover your system in the shortest possible time. The backup is also integrated into the rest of the operating system allowing for safe backup and recovery of Active Directory and Microsoft Exchange.

A summary of the standard system recovery features offered by each operating system is shown in Table 7 below.

Table 7: System Recovery Features

Feature	Solaris 8	Windows 2000
File System Recovery Tools	Y	Y
Fault-Tolerant File System	N	Y
Crash Logs	Y	Y
Kernel Dumps	Y	Y
Automatic System Recovery	Y	N
Interactive System Recovery	Y	Y
CD/Floppy Book Recovery	Y	Y
Configuration Backup/Recovery	N	Y
Simple Tape Backup System	Y	Y
Enterprise Tape Backup System	N	Y

Dynamic Configuration

Solaris 8 supports a dynamic configuration system allowing all aspects of the operating system to be modified without the need to reboot or reset the system. The dynamic capabilities extend to all aspects of the operating system, from configuring devices and services to installing new device drivers. This enables Solaris to support very high availability installations and it is not uncommon to have live Solaris servers with availability quoted in days, or even months.

Solaris 8 also introduces a new Live Upgrade feature, which allows new versions of the operating system to be installed while the machine is still running. When the machine is next rebooted the new OS version replaces the previous version. In case of problems, you can also fallback to the previous version in order to get the equipment back on line as quickly as possible.

Windows 2000 also supports a dynamic configuration system. This enables the most common operations such as adding Plug and Play devices, virtual memory configuration, and modifying network settings on the fly. In addition, Windows 2000 also supports installation of Microsoft SQL Server™ 7.0 and Microsoft Exchange 6.0 without requiring a reboot. By using the clustering capabilities in Windows 2000 Advanced Server and Datacenter Server, customers can do rolling upgrades. By using this technique, customers can take one machine in a cluster off-line, upgrade that machine, bring it back online to rejoin the cluster and then progressively update each machine in the cluster. This allows an organization to upgrade a server environment without any downtime during the upgrade.

Reliability Summary

Solaris 8 provides some good reliability features, but the support is limited to a very small range of systems, especially on Intel hardware. Using additional software, Solaris also supports RAID via software and some hardware-based solutions. There is limited support for hot-swap devices on UltraSPARC hardware, and no solution for Intel hardware. There is also no UPS integration on any Solaris platform.

Windows 2000 provides the best all-round support for the reliability features built into the majority of modern hardware platforms. Clustering is supported using the inexpensive SCSI interface and support for RAID is built into the operating system on a hardware and software level using the same tools required when managing all disk storage.

When a failure does occur, Solaris, again via additional software, provides automatic reboot facilities when an individual component fails. This is only supported on the high-end datacenter UltraSPARC servers; support is not offered for Intel-based systems. Solaris offers little in the event of complete system failure, with no standard reliable Backup/Restore service and only limited system recovery features.

Windows 2000 includes NTFS, a highly resilient file system that can recover and repair itself automatically—even after a complete power failure. With built-in backup software and advanced system recovery tools, including the ability to save configurations and repair the operating system from floppy disk or CD-ROM, Windows 2000 is the most resilient of the two operating systems to software or file system failures.

MANAGEABILITY

The modern network is no longer controlled from a central location. Entire networks are not supported from a single server, furthermore, they are often not supported by multiple servers in the same location. The distributed network with multiple servers spread over different floors, buildings, and even continents is now considered to be normal practice. To manage these disparate services you need a simple way of controlling and monitoring your network without needing to visit each machine individually.

Managing server resources is one problem, the other is managing the resources provided to the desktops of your users. You need to be able to control user's access to applications and to shared resources and ensure that they cannot upset the configuration of their desktop machines which increases support times and therefore increases the Total Cost of Ownership.

Management Interface

Windows 2000 uses the Microsoft Management Console (MMC), an application originally included in the Windows NT Option Pack. MMC provides a simple unified interface for configuring all aspects of the operating system. Using a combination of wizards and property dialogs it is possible for any experienced user of Windows to control all aspects of the Windows 2000 operating system.

The MMC uses the same interface for controlling all aspects of the operating system. Each subsystem and service is available through a series of extensions called snap-ins, which provide the template for controlling the service. Individual sets of extensions can be configured within the MMC, allowing an administrator to set up different management extension collections. For example, it's possible to create an extension set purely for controlling security and another for managing network-based services such as printers and shared folders.

The MMC is completely network capable. Individual snap-ins can provide the facility to manage the services of a remote machine over a network. This means that you can use the same MMC interface and application from a single desktop machine to control the services and facilities of remote machines. The MMC is optimized to use the minimum of network bandwidth that makes it perfectly suited to managing services over Wide Area Networks and remote access services.

For ease in remote configuration, Windows 2000 also supports a Web-based interface to certain parts of the operating system to allow better control of remote systems. For example, the printer queues on a Windows 2000-based server can be monitored from a Browser and individual jobs paused or re-assigned.

In addition to the support offered natively by Windows 2000 for operating system configuration, the MMC also allows third parties to provide snap-ins that control the applications and systems they support. For example, it's possible to control Microsoft Exchange server using the MMC either locally or remotely. This further simplifies the management process because the system administrator only needs to be familiar with one management system.

The base Solaris 8 package does not come with a unified interface for managing different aspects of the operating system. Instead, the bulk of systems management is handled by the manual modification of various text files to control different elements. There is an administration tool supported by the X Windows GUI that allows for easier modification of certain databases but it is limited to modifying the user, group, host, and printer configuration.

For more extensive management tools, the Solaris 8 Easy Access Server comes with a Web-based management tool that provides browser-based management of most of the facilities of the system, including user and groups, DNS configuration and even some aspects of the security of the individual machine. However, the interface is very non-intuitive and slow to use. In addition, because the management interface sits on top of the operating system, it is possible to make modifications to the system configuration files without changes being reflected in the information available from the browser.

Both Solaris 8 and Windows 2000 support Web Based Enterprise Management (WBEM), a system designed by the Desktop Management Task Force (DMTF) to make the management and monitoring of individual machines accessible over the network. Integrating the access rights and group policies into Active Directory further enhances support on Windows.

The summary of management features for each operating system is given in Table 8 below.

Table 8: Management Interface Features		
Feature	Solaris 8	Windows 2000
Command-Line Based Management	Y	Y
GUI-Based User/Group Tool	Y	Y
GUI-Based Network Tool	Y	Y
GUI-Based Printer Tool	Y	Y
GUI-Based File Sharing Tool	N	Y
GUI-Based Service Tool	N	Y
Extensible Management Tool	N	Y
Remote GUI Management Tools	Y (partial)	Y
Unified Management Tool	N	Y
Web Based Management Interface	Y (with EAS)	Y
WBEM/DMTF Compliant	Y	Y

Directories and User Authentication

Centralized management requires a service that stores information about the network and also provides a coherent interface for recording user and resource information on an enterprise basis. To ensure the usability of this system it must use standard Internet protocols and be integrated into other areas of the services provided by the server network. In addition, it should also be resilient to failures. The reliance on a single server for authentication and directory information leads to potential problems, as it means there is a potential single point of failure relying on a

single server.

Windows 2000 uses Active Directory. This supercedes the old Windows NT Domain system and provides a central resource for all the information about the network, from individual machines and the services they provide to user and group authentication. In place of the old Windows NT 4 Domain model, Active Directory uses Internet Domain Name Service (DNS) as the partitioning scheme.

By using standard Internet domain names to identify objects within the directory the Active Directory service can provide a directory to internal, external, and public services—all within the same database. When querying the directory the Active Directory system supports the Internet standard Lightweight Directory Access Protocol (LDAP). However, Active Directory does not use the LDAP system for storing information in the database and is therefore not subject to the same limitations that apply to the referral system offered by traditional LDAP implementations.

The Active Directory system supports the authentication of users across the entire network. There is no longer a Primary/Secondary domain controller system as supported by Windows NT 4. Windows 2000 uses a single directory for the entire network; multiple domains are supported within the single directory. The domains become logical, rather than physical boundaries between machines. Each user is provided with access to the resources within each domain and therefore only needs to log in to the network once. There is no need to connect to multiple individual domains.

All servers within a Windows 2000 network are peers of each other and synchronization of the authorization is automatic in both directions across the entire server network. This has the advantage that all servers within the network are aware of the authority available to each user, while also being capable of modifying that authorization information and having it replicated across the network.

Active Directory is also used and made available to other applications including the Web services supported by IIS, Microsoft Exchange and Microsoft SQL Server. The same authentication information is shared by all applications and also controls access to the files and folders on each server. There is no need for a separate authorization scheme under Windows 2000.

Solaris 8 provides a centralized authentication ability through the traditional Network Information Service (NIS/NIS+). The NIS/NIS+ system uses a central server that propagates information to other servers within the network at specific intervals. Authorization to a local machine is therefore controlled from a central server, although for speed, servers cache the information. The main disadvantage to the client of this system is that it does not provide a single point of authorization, the user must authorize their connection to each server, even if they all use the NIS/NIS+ system.

For more extensive integration under Solaris 8 you can also use the Sun Directory Service (SDS), which builds on the LDAP standard to provide a centralized directory

for user login and contact information. The SDS system supports authentication both at the user login level and also through integration with the Solaris Internet Mail Server and the iPlanet suite for e-mail, Web service, and group collaboration projects.

However, SDS is not an integrated solution to the problem. Users must still log in to servers individually even though they may be using the same LDAP database for authorization. Furthermore, because the Sun Directory Service uses LDAP for its storage mechanism, integration across multiple directories is complex. Each LDAP server must forward requests that it cannot handle to a pre-configured alternative server. There is no automatic referral to another directory.

For individual authentication, both Solaris 8 and Windows 2000 support a variety of systems, from the basic login and password through to smart cards. More extensive authentication is supported under Solaris 8 and Windows 2000 through Kerberos and X.509 certificates as used in many Internet-based authentication systems. Windows 2000 also supports the LAN Manager system, as used by Windows 95/98 and Windows NT. The Active Directory system supports further authentication systems through a modular extension system, providing a method for future support of new technologies such as finger print identification.

A summary of the directory and authentication systems is shown in Table 9 below.

Table 9: Directory and Authentication Comparison		
Feature	Solaris 8	Windows 2000
Integrated Directory/Authentication Service	Y	Y
Integrated Directory/DNS Service	N	Y
Integrated Directory/File Security Service	N	Y
LDAP Compatibility	Y	Y
Distributed Directory	N	Y
Smart Card Authentication	Y	Y
Kerberos Authentication	Y	Y
X.509 Certificate Authentication	Y	Y
Single Sign-On Capability	N	Y

Managing the Desktop

Solaris 8 is not a client-oriented operating system. Solaris supports client machines in terms of providing services such as file and printer sharing and through the Solaris Internet Mail Server or iPlanet Suites mail and group collaboration services. But it does not grant any facilities for managing client machines or managing the information and individual resources that each machine has access to.

Windows 2000 builds on the features provided by the Zero Administration Kit (ZAK) technology. The Windows 2000 system, called IntelliMirror™ management technologies, allows the administrator to set up a user profile that defines the data to which they have access, where the information they use should be stored, and what applications they have access to—either published or through a subscription.

The IntelliMirror system uses the user profile information to set up a user's machine when the user logs on to the network. Any machine within the network can potentially be used by any user—IntelliMirror will automatically set up the machine according to the user's profile with exactly the same storage facilities and applications. This reduces the need for individual machines for each user within the network. Instead users can “hot-desk” and work at any machine without being restricted in their abilities.

For further resilience, and because most users do use the same machine each day, IntelliMirror keeps a copy of users' files on their current desktop machine as well as the server. Even in the event of a server failure, a user's files will still be accessible. If users move to a different machine then the information ‘follows’ them to the new desktop.

The IntelliMirror system also allows you to define applications for users. And IntelliMirror dynamically installs and configures the applications if the user moves to a new machine. If the user applies for access to another application while still logged on, that application will also be installed on the machine, in real-time, or loaded from the server. As administrator you can modify the application availability on a per-user, group, or machine-basis, allowing you to deploy a single application across the entire network without visiting each machine.

By centralizing the process of storing user-specific data and the applications required by each user, you eliminate many of the problems of supporting a user within a network. They are no longer restricted to which machine they use. Because the user cannot make changes to the configuration, it is impossible for them to break their machine and this helps reduce the number of help desk calls, lowering the total cost of ownership.

Table 10 below summarizes the Desktop Support offered by each platform.

Table 10: Desktop Support Comparison		
Feature	Solaris 8	Windows 2000
User Data Management	N	Y
Desktop Application Management	N	Y
User Settings Management	N	Y
Roaming User Support	N	Y

System Deployment

On SPARC hardware Solaris supports remote booting capabilities. This enables any SPARC-based machine to be booted from a central server without the need for any form of local storage. Supporting a centralized boot process makes software and driver installation easy—once installed onto the remote boot system all machines that reboot remotely use the new version of the operating system and any software supported by the server.

Under Solaris for Intel platforms, remote booting is not supported, but the platform does allow for the sharing of applications across the network using the normal file

sharing tools. Sharing can be supported for multiple platform types on a single server, allowing both SPARC and Intel versions to reside on the same central location.

Windows 2000 does not support remote booting, but it does support a system that allows for remote installation of the Windows 2000 Professional client software onto a machine over the network. An extension of IntelliMirror, the Remote Installation Service allows you to login to a Windows 2000-based server from a remote machine and have the operating system automatically installed.

Furthermore, IntelliMirror makes it easy to provide a core set of applications onto each desktop machine according to the user, rather than the machine needs. The installation, update, and control of the applications configured for each user is centrally managed. This reduces the management cost and time taken to install applications or install or upgrade a new machine to Windows 2000.

Manageability Summary

Solaris 8 provides few management tools. Most of the configuration of the Solaris system is done via the command line interface or a number of highly focused applications that are disparate and not integrated into the operating system. Although Solaris 8 does provide remote management abilities through a Telnet interface or various Web-based tools, it lacks a coherent system for managing the machine either locally or remotely. In its favor, Solaris 8 does provide remote booting capability for all SPARC-based Solaris clients.

Windows 2000 provides a simple and consistent management interface, both to the local machine and to remote services through the Microsoft Management Console. For authentication and directory management, Windows 2000 includes Active Directory, which provides a central location for all of the resources on the network. The information is shared, and therefore available to all servers enabling a user to log in once to the network and never have to enter a password to access a networked resource.

Through IntelliMirror, Windows 2000 provides the next best thing to remote booting; the ability to dynamically reproduce a user's environment on any machine in the network including desktop settings, file availability, and applications.

CONCLUSIONS

Solaris provides some advanced reliability and scalability facilities including SMP and clustering support. On Intel hardware, the requirements for hardware clusters under Solaris 8 are much higher than those for Windows 2000. Considering the lack of certain features in the Solaris 8 operating system, the Solaris solution is an expensive choice in terms of cost of ownership and management time.

Solaris 8 requires UNIX experts for management as well as additional software to provide even the basic functionality provided by Windows 2000. The Sun Directory Service and the iPlanet suite do go some way to solving the Internet solution for Solaris and the incorporation of Java into the Solaris 8 kernel shows that Sun is committed to supporting an Internet-focused operating system.

Solaris 8 concentrates its abilities on expensive, single-system solutions such as the E10000 Starfire server. Although this enforces a centralized solution, it also limits the effective reliability across the entire network. By concentrating on single-server solutions, rather than the distributed solution offered by Windows 2000, Solaris 8 is vulnerable to failures at multiple single points. There is no network-level resilience—a single machine failure within a Solaris 8 network could make the entire network unusable.

In contrast, the Active Directory service forms a core part of the Windows 2000 strategy. By controlling all aspects of the resource management process, Active Directory ensures consistency right across the network from access to the network as a whole and to the individual authorization of shared folders and other network resources. Sun's Directory Service addresses some of these problems but is restricted to authentication on a single, rather than network resource basis.

Windows 2000 supports many of the high-availability facilities offered by Solaris 8. Windows 2000 supports 32 processor SMP systems. Already, the advances in Intel hardware and the improvements supported by the Windows 2000 architecture mean that performance for many applications—particularly in the datacenter and e-Commerce arena—may exceed those offered by Solaris on either Intel or UltraSPARC hardware. The release later this year of the Intel Itanium processor will provide another significant advancement in performance and Microsoft has been working hard with Intel to ensure the maximum operating system performance from the new processor.

The wide range of Windows 2000-supported hardware enables you to deploy future-proof solutions across your network without worrying about the scalability of your existing hardware or software platforms. Clustering on Windows 2000 is handled using standard off-the-shelf components and is therefore possible on a much wider variety of hardware at a much lower cost.

For deploying applications to the public over the Internet, Windows 2000 also demonstrates a clear advantage. With built-in support for the major Internet protocols, Windows 2000 can be used out of the box for providing Web applications and services. By using Active Server Pages, COM, and Java, it is possible to deploy distributed Internet applications with ease.

The management support provided by Windows 2000 lowers the total cost of ownership for the entire network. By centralizing the management process, the normal overheads associated with supporting a distributed client-server network are reduced significantly.

In addition, because Windows 2000 provides a network-oriented solution, it inherently offers a much more resilient solution to the problem of providing network resources. By offering clustering, network load balancing, and distributed storage facilities built in to the operating system, you can safely deploy a Windows 2000 network without having to worry about the future scalability of the network.

**FOR MORE
INFORMATION**

For the latest information on Windows 2000 Server, check out our Web site at <http://www.microsoft.com/windows2000> and the Windows 2000/NT Forum at <http://computingcentral.msn.com/topics/windowsnt>.

For additional enterprise management services see:

<http://www.microsoft.com/smsmgmt/>

For more information about the technical differences between the two directory services, see “Microsoft Active Directory vs. Sun Microsystems’s Sun Directory Service 3.1” at <http://www.microsoft.com/WINDOWS2000/guide/server/compare/ADandSDS.asp>