Sun Drives Internet Computing Vision into Workgroup

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At a time when virtually all other UNIX vendors have adopted strategic roles for Windows NT, Sun relentlessly maintains its focus on UNIX, extending its role as a leading UNIX visionary. Some observers have criticized Sun for its position, predicting that Windows NT would sweep UNIX out of many key low-end server markets targeted by Sun's Solaris. In an adroit and remarkably successful response, Sun has embraced and extended the very characteristics of PC servers and Windows NT networks in its SPARC-based workgroup server hardware and Solaris software products.

By delivering the superior reliability and scalability of Solaris at competitive price-performance, Sun's low-end server packages highly effectively extend Sun's growing presence in the datacenter to outlying departments and workgroups. In addition, Sun correctly recognized that the proliferation of Windows desktops and Windows NT servers was rapidly establishing Windows NT's Domain mechanism as the de facto standard for managing network resources. By responding with an aggressive program to support Windows NT's directory and security services on Solaris, Sun now credibly positions its platform as a superior foundation for existing Domain-based infrastructures – offering better reliability and scalability than the Windows NT operating system itself.

Having faced down the Microsoft juggernaut and held its ground for the present, Sun now turns to promoting its own vision of Internet computing. Sun hopes to secure critical mindshare during the window of opportunity remaining before Microsoft plays its next hand with the shipment of Windows 2000. After decades of presciently proclaiming that the network was in fact the computer, Sun now seeks to expand that definition to the Internet itself. Thus, Sun promotes an architecture that is oriented totally around Internet protocols, and stresses the role of Web sites for a vast and diverse array of services that follow a utility model. From an operational standpoint, Sun's vision represents a mighty argument in favor of outsourcing – encouraging IT design to think of all computational services as commodities that are simply tapped from Internet points-of-presence under optimal economic terms.

Traditionally, Sun's vision resonates most appealingly at the high end of the enterprise, where datacenter culture has shown no sign of diminishing, and administrators are comfortable with the concept of

strongly centralized services akin to utilities. With Solaris Easy Access Server 3.0, Sun now seeks to extend its model downwards into departments and smaller organizations. In its previous incarnation as Solaris for Intranets, this package effectively targeted workgroup server requirements traditionally addressed by NetWare and Windows NT. It stressed PC interoperability and optimizations for ease of use. Sun intends its new Solaris Easy Access Server package for deployment on low-end and workgroup servers (i.e. E 450, E 250, and workstations configured as servers). However, Sun's hardware group bundles Solaris Easy Access Server with all server systems, allowing all administrators to access its ease-of-use enhancements when needed.

Sun positions Solaris Easy Access Server as its latest server operating system specifically targeting support for Internet, Intranet, and Extranet infrastructures. Historically, Sun has maintained a strong orientation towards networking based on the TCP/IP protocol – the foundation for the Internet. The vendor optimized its networking technology for TCP/IP long before the Internet broke into mainstream usage. As a result, Sun was well positioned to deliver highly competitive Internet solutions when the overall industry began retooling to meet Internet requirements.

Solaris Easy Access Server capitalizes on Sun's long-standing Internet focus to optimize for deploying large numbers of geographically dispersed servers. Solaris Easy Access Server builds on the same operating system base used on all Sun's SPARC servers. It adds extensions for interoperating with PC clients via their native protocols, and simplifies system management with a Java-based, GUI-driven management utilities.

Of course, this positioning sustains the competition between Solaris Easy Access Server and Windows NT. While Windows NT has emerged as a very successful alternative for supporting file and print sharing in workgroup environments, this report will show that its functions continue to fall short of being able to support enterprise requirements. In particular, Sun derives a significant advantage from its ability to present its products as complete, unified systems. In contrast, Windows NT-based solutions typically represent assemblies of point products derived from third parties such as Intel and Microsoft. Intel and Microsoft optimize their components for the broadest possible base of requirements, so Windows NT system vendors must differentiate their products by assembling the basic, and immutable, "building blocks" in novel ways.

For users, the potential business value of deploying environments such as Solaris Easy Access Server derives from their superior ability to accommodate business processes that increasingly depend on

universal connectivity and smooth scalability. Microsoft has clearly stated that it match its competitors in targeting Internet connectivity in its products. However, users who embrace commodity building blocks such as Windows NT quickly find that the products have instead shifted the burden of optimizing for scalable network computing into the users' own organizations – requiring administrators to deal with a variety of unforeseen issues as they struggle to assemble effective solutions. Moreover, since everyone in the Windows NT domain ultimately works with the same building blocks, establishing meaningful differentiation leading to competitive advantage becomes difficult. Conversely, Sun's recommended approach delegates services to third parties as much as possible. As a result, system administrators can focus on those aspects of IT solutions that result in more leverage, rather than the most basic elements infrastructure – i.e. keeping systems up, connected at high throughput, and configured with the correct software.

METHODOLOGY

This study examines Windows NT Server 4.0 Enterprise Edition and Solaris Easy Access Server 3.0 in terms of their ability to meet enterprise computing requirements. In addition to assessing functions that target traditional Information Systems (IS) needs, this report examines how each environment accommodates the need for support of PC users, as well as emerging enterprise requirements introduced by the globalization of business and the connection of computers via the Internet.

The report considers six functional areas of enterprise computing environments:

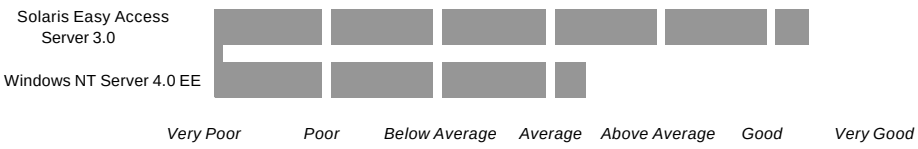
1. Platform Scalability;
2. Availability Functions;
3. Manageability Functions;
4. Internet Functions;
5. Web Application Services; and
6. Directory & Security Services.

Within each section, callouts note the functional advantages/ disadvantages for each competitor relative to the average competitive entry in the midrange server space. Each section begins with a summary chart that shows the average rating of all functional details for that particular area using the same metric. D.H. Brown Associates, Inc. (DHBA) rates capabilities according to the following nomenclature: Very Good, Good, Above Average, Average, Below Average, Poor, Very Poor.

Both Solaris and Windows NT draw significant strength from a large number of third-party add-on products. However, this study assessed only the vendors' base product offerings. In addition, both Windows NT and Solaris systems receive frequent updates and enhancements, including some that have been announced but not yet delivered. This comparative analysis concentrated on currently shipping functions and did not address any future capabilities.

PLATFORM SCALABILITY

FIGURE 1:
Platform Scalability



Enterprise computing environments are typically multi-site, multi-departmental operations whose disruption can significantly affect revenue or key business functions. Companies seeking enterprise solutions commonly face very large, or very fast-growing workloads. They cannot afford to have hardware or software act as limiting factors to business operations. Thus, the scalability of an operating system becomes one of its most important attributes.

Three functions determine the scalability of a system in enterprise environments:

- **64-bit support**: The ability to exploit processing, memory, and storage beyond the 4 GB limitation imposed by 32-bit systems. Several levels of 64-bit capabilities exist, including 64-bit processor support, large file systems, large files, large physical memories, and large process address spaces (where "large" means greater than 4 GB).
- **Shared-memory multiprocessing (SMP) support**: The ability to take advantage of multiple processors in a server. Criteria include kernel locking granularity, kernel thread mechanisms, and evidence of scalability based on industry-standard benchmarks.
- **Performance clustering options**: The ability to grow system capacity, including performance and storage, by lashing together multiple servers using high-speed interconnects. Typically, a system's ability to handle technical applications and commercial applications (e.g., database or Web) classifies its performance clustering capabilities.

64-BIT CAPABILITIES

64-BIT CAPABILITIES

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
ABOVE AVERAGE

Full 64-bit compliance requires that an operating system be capable of scaling its code and data support beyond the 2 or 4 GB limits common to 32-bit systems. The ability to handle larger disk file systems, file sizes, physical RAM, and process address space forms a key part of the technology required. In addition to adding 64-bit capabilities in both hardware and software, vendors must also ensure that the migration from 32- to 64-bit systems is as painless as possible.

The rapid reduction in memory pricing over the last three years has far outpaced Moore's Law – making very large memory systems configured with 4GB or more memory increasingly affordable. Some vendors have reduced the list price of 4GB of server-grade RAM from half a million dollars down to a relatively affordable $50,000. Street pricing for 4GB of desktop RAM has dropped to under $5,000.

The biggest payoff for 64-bit capabilities has been for large databases that can cache complete database indexes (or the database contents themselves) in physical memory, offering a roughly 10x improvement in access time over disk. Performance improvements in real-world situations with real workloads are substantially more modest – as demonstrated by TPC-C results for various 64-bit vendors that are moderately higher, closer to a factor of 10%-100%.

Solaris Easy Access Server 3.0 is hosted on Solaris 7, a fully 64-bit environment, providing applications with a full 64-bit virtual address space, and supporting up to 64 GB of physical memory and up to 1 TB of storage. Although Sun's servers have now turned over completely to the 64-bit UltraSPARC CPU, Solaris 7 still comes in both 32-bit and 64-bit flavors, chosen at install time[1].

NT has supported 64-bit files and file systems since it first shipped in 1993. Windows NT also runs on Alpha's 64-bit hardware today. However, as a fundamentally 32-bit system, Windows NT 4.0 currently supports a maximum of 4 GB of physical memory (it ignores any additional memory configured in servers). Moreover, applications have access to only 32 bits (i.e., 4 GB) of virtual address space.

SHARED-MEMORY MULTIPROCESSING

SMP RANGE

Solaris Easy Access Server 3.0
VERY GOOD

Windows NT Server 4.0/EE
AVERAGE

The ability of an operating system to exploit shared-memory multiprocessing (SMP) systems continues to represent a critical differentiator in server environments. Relevant factors include:

- The degree to which the kernel has been optimized to exploit multiple processors. This influences the absolute range of processors that can effectively be supported – from two processors to more than 100 in advanced NUMA architectures.
- The availability of mechanisms to support SMP-optimized applications such as threads.

[1] On newer systems using Intel's Pentium II Xeon processors (which support up to 64 GB of physical memory) Solaris 7 can use the greater ranges for transparent, high-capacity disk caches – helping speed up I/O-intensive operations.

- The availability of industry-standard benchmark evidence on high-end systems. Results should be based on tests such as TPC-C and TPC-D, which stress I/O as well as computation.

Solaris provides excellent SMP scalability, with support for up to 64 processors. Indeed, Sun's server product line is virtually unmatched in terms of scalability. It offers one of the broadest performance ranges in the industry – from uni-processor systems to very large SMPs – without introducing gaps in terms of binary compatibility or operational requirements. As one of the first UNIX environments to optimize for kernel threads, Solaris pioneered the MxN thread model. This model has proven highly effective in allowing scalable network applications. In addition, Solaris has produced TPC-D results using all 64 processors, and has demonstrated strong performance on a broad range of TPC-C benchmarks between 16 and 24-processor systems.

NT's relatively limited SMP range remains one of its greatest scalability barriers. Although vendors have tested and demonstrated Windows NT systems with up to 32 processors, evidence of Windows NT's ability to fully exploit systems with more than four processors is still inconclusive. Over the past few years, TPC-C results have emerged showing that Windows NT 4.0 can achieve moderate performance gains on systems with up to eight processors – with somewhat limited linearity. TPC-C tests have also been run on 12-way Windows NT systems, putting it in the same league as UNIX systems such as AIX or even Digital UNIX. However, TPC-C benchmarks run by NEC show that on otherwise identically configured 4, 6, and 8-way servers, Windows NT 4.0 delivers linearity of about 35% – i.e., doubling the number of processors produces 35% more performance. A major constraint, however, may derive from Windows NT's current 4 GB memory ceiling, rather than any inherent flaw in the design of its SMP support. Windows NT supports kernel threads using the 1-1 model.

PERFORMANCE CLUSTERING OPTIONS

PERFORMANCE CLUSTERING OPTIONS

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
AVERAGE

Clusters can sometimes increase a system's capacity, including performance and storage. To scale performance on a cluster, applications work in concert with clustering software to partition their workloads into subtasks, which the clustering software then distributes across the clustered servers. Since even the fastest cluster interconnects usually have lower bandwidth and greater latency than the bus in an SMP (in some cases by several orders of magnitude), synchronization between the subtasks becomes a critical bottleneck that systems must minimize. Identifying opportunities for coarse-grained parallelism, therefore, proves key to effective scalability on clusters. A variety of parallel programming tools and techniques have

emerged to assist in partitioning applications for clusters. Their use requires considerable expertise, however, and some classes of applications fundamentally cannot be adapted at all. If sufficiently partitioned, applications can exploit clustered systems containing hundreds or even thousands of nodes, resulting in monumental levels of performance.

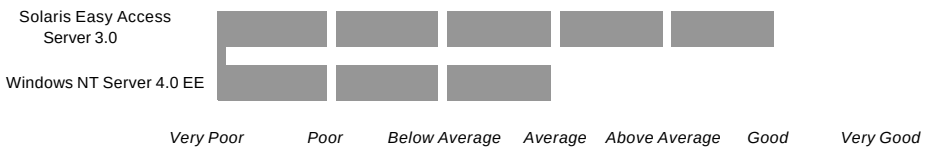
Several commercial database systems, including Oracle Parallel Server (OPS), IBM DB2 Universal Database (UDB), and Informix XPS, have been extended to work on clusters of servers connected by high-speed interconnects. All of these systems are available for both Solaris and Windows NT.

The credibility of Sun's commercial clustering performance has been validated with 2-node, 22-way TPC-C results, and a TPC-D result on a 4-node, 24-way cluster/SMP combination.

Windows NT has proven its ability to support scalable data warehousing with a TPC-D result for a 32-node, 4-way cluster. Somewhat less TPC-C evidence exists validating the performance of OLTP clusters on Windows NT. However, Windows NT recently gained an advantage for supporting Web server "farms" (clusters of Web servers). It achieved this capability by introducing the Windows NT Load Balancing Services – based on the Convoy Cluster software Microsoft acquired from Valence Research, Inc. The function enables TCP/IP load balancing and clustering of Windows NT servers by routing traffic coming into a single IP address to as many as 32 servers. Administrators can statically assign higher traffic loads to more powerful servers in the cluster, and can dynamically "drain" servers for purposes of planned downtime.

AVAILABILITY FUNCTIONS

FIGURE 2: Availability Functions



The reliability of a system depends on a variety of factors involving both hardware and software. On average, though, hardware has become more reliable over time. Server designs increasingly build on highly integrated components, reducing complexity and hence the points of failure. Hardware areas that are vulnerable to mechanical failure, such as storage, can be protected through techniques such as RAID, while components such as fans are now routinely replicated for reliability.

Still, some failures remain virtually unavoidable. Operating systems can protect against these failures in hardware and software through high availability (HA) techniques. Single-system HA functions allow an operating system to contain failures or planned outages within a server, in some cases drawing on technology long available in mainframe environments enables. Such "self-healing" features potentially include the ability to:

- Adapt to processor failure by isolating failed CPU components;
- Dynamically cordon off memory that has suffered single-bit errors – so that software no longer risks using potentially unreliable areas; or
- Support dynamic addition and removal of I/O adapters, CPUs, and memory modules for purposes of repair or upgrade.

Multi-system, i.e. clustering, functions can be used to maintain the availability of system services by failing over to a back-up system in the event of system outage – planned or unplanned. By allowing one or more servers to take over for a server that has crashed due to hardware or software failure, clustering enables processing to continue. Sometimes, clusters can also respond to the failure of individual components – such as disks or adapters, or individual applications. By isolating faults on a failed node, the remaining nodes can continue functioning. The overall clustered system, therefore, keeps functioning (albeit at reduced capacity).

In addition to addressing cases of system failure, clustering can also help with some management tasks by absorbing planned downtime. For example, a cluster could allow new software or hardware to be tested in the working system, while still protecting the rest of the system from any resulting failures.

SINGLE-SYSTEM AVAILABILITY FUNCTIONS

SINGLE-SYSTEM AVAILABILITY FUNCTIONS

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
AVERAGE

Solaris is at the forefront of dynamic reconfiguration functions. Solaris supports dynamic I/O reconfiguration and Alternate Pathing on most of Sun's server product line, providing a unique differentiation relative to both Windows NT and UNIX competitors. These functions enable on-line repair and reconfiguration of CPUs, memory, and I/O as follows:

- Dynamic reconfiguration enables HA by allowing a system administrator to "dry up" defective server components – such as CPUs, memory, and I/O – without application interruption by off-loading processes. Sun's hot-plug hardware capability then allows the defective component to be replaced without creating any electrical problems. As a result, both planned (e.g., for upgrades) and unplanned (e.g., for component failures) down time is reduced.
- Alternate pathing allows an I/O path to be redirected transparently to applications, allowing a server to adapt to I/O device failure.

Windows NT supports virtually none of the single-system high availability features offered by Solaris.

HIGH AVAILABILITY CLUSTERING OPTIONS

HIGH AVAILABILITY CLUSTERING OPTIONS

Solaris Easy Access Server 3.0
GOOD

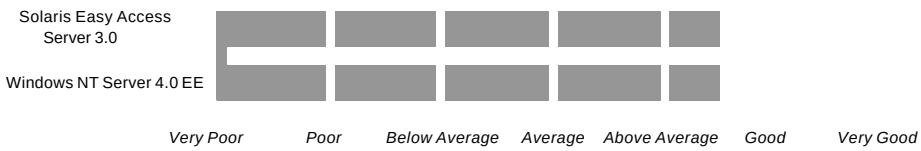
Windows NT Server 4.0/EE
AVERAGE

Sun's clustering option for Solaris, called Sun Clusters 2.2, offers a competitive set of HA functions. While not industry-leading by UNIX standards, Sun Clusters 2.2 supports up to four nodes, enabling important HA cluster functions such as multidirectional and cascading failover. Multidirectional failover allows a failed node's workload to be split and failed over to multiple backup nodes. Cascading failover allows failover to continue when a backup node fails. Sun provides monitoring agents for both its own and third-party applications.

Windows NT 4.0 EE includes a native clustering solution called Microsoft Cluster Server (MSCS – formerly code-named "Wolfpack"). Compared with UNIX-based HA clustering products such as Sun Clusters 2.2, MSCS delivers minimum HA capabilities. Clusters remain limited to two nodes, which prohibits multidirectional and cascading failover. Third-party options such as NCR's LifeKeeper and IBM's recently announced "Cornhusker" technology can provide higher-end capabilities. Standard, real promotion to the next class will arrive some time after Windows 2000 ships, through full 4-node MSCS ("Wolfpack") capabilities.

MANAGEABILITY FUNCTIONS

FIGURE 3:
Manageability Functions



GUI-BASED ADMINISTRATION TOOLS

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
VERY GOOD

Historically serving highly technical users on its workstations, Sun has only recently begun to address ease-of-use criteria in system management. This new emphasis represents part of its move to focus more on commercial user requirements. Although all versions of Solaris include a GUI-based system management tool, `admintool`, it lacks the breadth of SMIT in AIX, or SAM in HP-UX. It only covers the basics of adding and deleting user profiles, printers, host names, serial ports, and software.

With Solaris Easy Access Server 3.0, Sun introduces Solaris Management Console 2.0. The company based this update to its point-and-click administration tool for Solaris on the Web-Based Enterprise Management (WBEM) and the Desktop Management Task Force (DMTF) Common Information Model (CIM) standards. Solaris Management Console provides a centralized integration point for Solaris system administration and management tools. The console is configurable and extensible, allowing integration of system management applications based on a variety of development methods – including the X Window System, scripts, Java, and HTML.

Another Solaris Easy Access Server tool, WebStart, provides a Java-based GUI for installing system software and software add-ons, providing both ease of use and remote manageability. Solaris Easy Access Server 3.0 also introduces Configuration Wizards based on the popular InstallShield tool for Windows, which extends simplified installation to third-party Solaris applications. Finally, Solaris Easy Access Server includes AdminSuite, a central console which provides a unifying framework for grouping Sun's unbundled system management tools.

NT has long enjoyed an intuitive user interface for managing single systems, largely benefiting from the exceptional familiarity of the Windows look-and-feel adopted by the Windows NT GUI. Microsoft strengthened Windows NT 4.0 system management with the Microsoft Management Console (MMC), currently used by IIS and other system components. MMC is a general-purpose management display framework for hosting administration tools, built as MMC Snap-Ins by Microsoft and third parties. MMC can be

used from within an existing enterprise console, or to launch enterprise consoles. Unlike enterprise consoles, MMC imposes no protocol dependencies or object repositories: these remain the responsibility of each Snap-In. Working within the MMC or a Web browser, the administrator can use a series of Snap-Ins to create task-oriented administrative displays customized to provide the appropriate management functions. Snap-Ins can work independently or act to extend functionality of other Snap-Ins. By allowing administrators to create their own views and by removing technology discipline boundaries, MMC enables the creation of appropriate displays of network, systems, and user information – providing a single point of management which is integrated, comprehensive, and easy to use.

In Windows NT Service Pack 4, Microsoft also introduced its Windows Management Instrumentation (WMI) framework, an implementation of the WBEM standard. WMI provides an operating system interface through which instrumented components can provide information and notification to remote systems. A bidirectional instrumentation access mechanism brings together management data from the hardware platform, drivers, and applications. It then passes the consolidated data into a consistent management schema. This schema was developed to conform to the requirements of the WBEM standard, and uses CIM as the basis for exposing and interacting with the information. Currently, Windows NT's registry, performance monitor, Win32 subsystem, and even SNMP and DMI all provide data for WMI – making it the only place an application needs to go to get management information.

REMOTE MANAGEABILITY

REMOTE MANAGEABILITY

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
AVERAGE

As enterprises increasingly depend on the network, the IT infrastructure becomes more distributed, dramatically growing the number of deployed servers. Large enterprises routinely disperse servers geographically, in some cases across different continents and time-zones. Thus, effective remote management of operating systems becomes increasingly important. If an enterprise depends on a thousand servers, it is simply not feasible to maintain a thousand system administrators locally. A more methodical procedure is required.

A number of techniques have emerged to help manage servers remotely, including:

- **Server hardware features**: A number of server hardware vendors offer service processors for their systems. These independent processing units monitor server activity and allow

remote diagnostic access in the event of failures that disable the main system processor.

- **Remote operating system access**: Since the operating system controls all server functions, administrators must be able to communicate with it remotely. Ideally, a remote administrator should be able to use the system as if he or she were physically next to the hardware. Remote interaction might occur over character-oriented sessions – as if the administrator were using a local ASCII terminal – or via a distributed GUI – with graphics and keyboard/mouse events being passed back and forth based on the native look-and-feel of the environment being managed.
- **Web-based system management**: By using a Java-based system management GUI, systems can be managed remotely across networks from any Java-enabled Web browser. Java's user interface widgets closely match those of mainstream Windows widgets, enabling management tools that are relatively intuitive to inexperienced users.
- **Template-based installation**: The template approach involves a "cookie cutter" method, in which a template server is created and tested, and then replicated across multiple servers using some distribution mechanism. The cost of this technique is that the template is installed on a server that is not, in fact, used. However, by using this approach, if a critical server crashes, administrators can take an idle standard server, or one being used for low priority tasks, and change its configuration to make it into a replacement for the critical server. This approach provides tremendous flexibility for managing systems. The next step is to automate the update of common parts so that administrators can ensure that all servers remain identical – guaranteeing the backup server can substitute for the critical server once reconfigured. In addition, if a critical server behaves in a problematic fashion, administrators can use an identical server to replicate the problem, rather than having to take the critical server out of service.

Solaris Easy Access Server natively supports all classes of remote management. A number of Sun's SPARC servers offer service processor options, which support the ability for administrators to dial in remotely and perform diagnostics without involvement of the host processor. Through this capability, maintenance can occur whether or not the system is up and running. Sun's SPARC servers derive an additional advantage from OpenBoot, a low-level PROM-based mechanism for managing information related to devices and boot sequences. Since OpenBoot relies on an independent processor, it can be accessed even when a server is disabled. Also, an OpenBoot session can be set up over serial lines, allowing a server to be accessed even when the network is not operational.

Because Solaris has a multiuser design like most UNIX implementations, it fully supports remote interaction via network or serial line connections. In other words, the Solaris kernel can manage the processes associated with remote system administrators, while simultaneously running processes associated with server tasks and local users – appropriately tracking security privileges and processor usage. Based on this basic scheduling ability, remote administrators have several choices for communicating with an active Solaris environment, including:

- Logging in via an ASCII terminal over a serial port. Solaris inherently has the ability to manage many serial ports to which ASCII terminals are attached. This option is typically useful in campus environments, where infrastructures may include RS-232 serial line configurations. It provides access to Solaris via the UNIX command shell, which in turn provides access to all files and system configuration settings – stored by UNIX in traditional files that can be edited in character-based sessions.
- Logging in over `telnet`, the traditional UNIX network terminal tool. `Telnet` allows administrators to access Solaris over a network as if they were connected locally through an ASCII terminal. As with any character-based session, administrators using `telnet` have total access to all files and UNIX system settings.
- Using X Window System distributed graphics to run Solaris GUI system management utilities such as admintool remotely. The X Window System used by Solaris inherently has the ability to support remote interaction. Users on remote systems that are also configured with the X Window System can, therefore, run graphical applications as if they were local. Administrators can use admintool to graphically configure any server on the network.
- Using WebStart, Sun's Java-based system management tool. WebStart's Java implementation allows administrators to perform software installation and configuration from any Java-enabled Web browser.
- Using JumpStart for template-based installation. This function allows operators to create a master of a Solaris environment, including all necessary patch updates, which can then be rolled out to many distributed systems.
- Using Solaris Management Console. Introduced in Solaris Easy Access Server 3.0, it allows administrators to take advantage of remote access functions supported in its underlying WBEM and CIM standards.

Some Windows NT server suppliers have introduced service processors akin to those found in Sun's SPARC systems, allowing

remote management at the hardware level. In terms of remote operating system management, though, architectural shortcomings in Windows NT have become apparent. These derive primarily from its design as a single-user system. Unlike UNIX, Windows NT was fundamentally designed as a single-user environment, meaning that its kernel does not have the ability to arbitrate resources between multiple users – i.e. simultaneously performing processes with different security and resource privileges.

Some of Windows NT's built-in management tools have the ability to configure remote servers. But without add-ons, Windows NT does not support in-bound `telnet` sessions, or even character-oriented sessions through ASCII terminals. Even with such tools, administrators would gain only limited control over Windows NT's configuration: Windows NT maintains configuration information in the Registry, a proprietary database that requires a GUI tool to fully maintain. Windows NT also requires add-ons to support distributed graphics akin to the X Window System.

Microsoft has taken several steps to address these limitations. For example, the Windows NT Resource Kit includes a `telnet` implementation. Microsoft has also introduced the Microsoft Terminal Server to enable remote access to Windows NT servers. This special-purpose, multi-user version of Windows NT is based on the older Windows NT 3.51 kernel. In addition, the WMI extension introduced in Service Pack 4 allows administrators to take advantage of remote access functions supported in its underlying WBEM and CIM standards. While the delivery of WMI has shed some light on Microsoft's vision for distributed systems management, complete implementation awaits the delivery of Windows 2000.

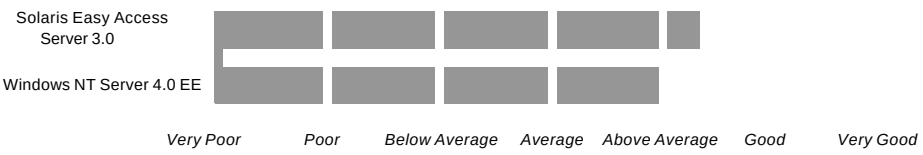
Meanwhile, Windows NT administrators typically rely on one of two options:

1. Local management involving the installation of a local expert – which they hope will be easier due to Windows NT's larger volumes and similarity to mainstream Windows versions; or
2. Layered system management products from Microsoft and third parties.

Neither of these options, however, quite matches the inherent efficiency of managing distributed Solaris systems.

INTERNET FUNCTIONS

FIGURE 4:
Internet Functions



INTERNET PROTOCOL SUPPORT

INTERNET PROTOCOL SUPPORT

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
AVERAGE

Both Solaris and Windows NT fully support the most common Internet protocols – including standard SLIP and PPP functionality, as well as multilink PPP to aggregate bandwidth across multiple dial-up connections for improved bandwidth. Solaris gains an advantage from several performance enhancements to its TCP/IP implementation that Windows NT lacks, including TCP Large Windows, Zero Copy TCP/Hardware Checksum, and TCP selective acknowledgement (SACK). Also, unlike Windows NT, Solaris supports the Resource Reservation Protocol (RSVP), an extension that assigns varying priority levels to IPv4 packets. With RSVP, networks can promise varying quality-of-service guarantees across networks in which the intervening routers also support RSVP.

MESSAGING SUPPORT

MESSAGING SUPPORT

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
ABOVE AVERAGE

Electronic mail remains one of the most frequently used Internet functions. Both Sun and Microsoft have aggressively targeted delivery of full-function and scalable e-mail solutions. To meet low-end e-mail and "workflow" messaging requirements, Sun resells a Solaris version of Lotus Notes through its workgroup server hardware division. For high-end requirements, Solaris Easy Access Server includes Sun Internet Mail Server (SIMS), an Internet mail solution supporting Internet messaging standards as POP3, IMAP4, and LDAP. SIMS features include:

- A committed transactions model to prevent lost or corrupted mail messages;
- Encryption between client and server using Secure Sockets Layer (SSL) and X.509 certificates;
- Enhanced anti-spamming capabilities; and
- Simplified administration through a Java-based interface.

To help maintain SIMS availability, Sun offers an option to integrate SIMS with its Sun Cluster software. Sun also offers the Messaging Connectivity Services option to provide connectivity to proprietary mail environments.

Although Windows NT 4.0 EE includes the sendmail tool, users need to install unbundled options such as Microsoft Exchange Server to gain full messaging capabilities. At the low-end of the market, Exchange competes effectively with Lotus Notes. It has proven surprisingly scalable: some large enterprises report deploying Exchange with more than 40,000 users at acceptable levels of reliability.

VPN SUPPORT

VPN SUPPORT

Solaris Easy Access Server 3.0
ABOVE AVERAGE

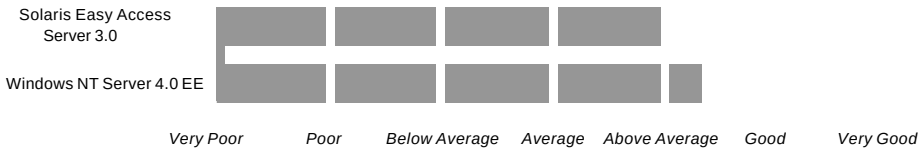
Windows NT Server 4.0/EE
VERY GOOD

Virtual Private Networks (VPNs) allow remote users to access an internal corporate network using standard TCP/IP services rather than a dialup modem. Historically, corporations have used either dedicated – and expensive – leased lines, or dialup remote access servers. However, these traditional approaches potentially incur problems, such as limitation of simultaneous users by the available bank of modems, security problems due to trivial passwords and insecure gateway software, and costly long-distance calls. VPNs overcome these barriers by allowing users to dial their local service provider and connect company systems over the Internet, as if they were just another node on the local area network. Secure VPN access requires overcoming two barriers: authenticating users before allowing them to access corporate internal resources; and securing all traffic that passes over the public Internet to prevent interception.

Solaris Easy Access Server requires installation of an optional component, such as the i-Planet software from the Sun-Netscape Alliance, to obtain most VPN benefits. Windows NT Server 4.0 EE builds in the necessary functions for users to deploy VPNs.

WEB APPLICATION SERVICES

FIGURE 5:
Web Application Services



As networks based on Internet protocols become the norm, a growing need emerges to support applications that can be deployed reliably and scalably on Internet infrastructures. This support must meet the requirements for Internet-based electronic commerce, corporate applications based on enterprise networks ("Intranets"), and applications spanning disparate networks across supplier chains ("Extranets"). Two technology areas serve as a foundation for Web-based applications:

- **Online Transaction Processing (OLTP) functions**: The traditional tools used to process many short transactions for many users, while maintaining ACID (Atomic/Consistent/Isolated/Durable) properties on affected databases. A well-understood practice, OLTP has historically been addressed by proven products such as CICS (IBM), Tuxedo, and TopEnd. (Both Tuxedo and TopEnd are now maintained by BEA Systems.)
- **Web-based application servers**: An emerging functional area in which a Web server is extended with OLTP capabilities so that users can initiate full-fledged transactions from their browsers.

Traditionally, layered products have addressed OLTP and application server functions. However, the importance of OLTP in enterprise infrastructures has grown strong enough to rationalize closer integration with the operating system itself. The benefits from close integration of OLTP and application server functions emerge at several levels: the meshing of directory, security, and application infrastructures simplifies system management; and creating platform-standard APIs for distributed services results in more straightforward application development. Also, system reliability becomes easier to maintain when an operating system vendor supports the entire network infrastructure, rather than just the individual system environments.

TRADITIONAL TRANSACTION PROCESSING FUNCTIONS

TRADITIONAL TRANSACTION PROCESSING FUNCTIONS

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
AVERAGE

Solaris has built a solid track record in supporting business-critical OLTP at the enterprise level. Users routinely deploy the top traditional OLTP tools on Solaris, along with leading OLTP-oriented database systems such as Oracle, Informix, and Sybase.

Although some users – particularly those in large enterprises – deploy traditional OLTP tools on Windows NT, most tend to gravitate to Microsoft's SQL Server database, a part of BackOffice that is tied fairly closely to Microsoft's emerging Microsoft Transaction Server (MTS) standard. (See "Web-based Transaction Processing Functions," below.) MTS primarily targets emerging Web-based transaction applications, and has not yet built a proven track record in traditional OLTP environments.

WEB-BASED TRANSACTION PROCESSING FUNCTIONS

WEB-BASED TRANSACTION PROCESSING FUNCTIONS

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
GOOD

In 1997, Sun responded to the requirement for closely integrated Web-based application services by acquiring NetDynamics, the developer of a Java-based application server. More recently, Sun engaged in an alliance with AOL-Netscape to co-develop and integrate the Web application services provided by the Netscape product line. While Sun's embrace of Netscape's highly regarded products will clearly strengthen the Solaris platform over time, the alliance remains a work-in-progress – several technology paths from the Sun and Netscape portfolio must still converge before Solaris can match the richness of Microsoft's platform.

Microsoft took a bold step to redefine standard operating system functions by building transaction processing capabilities directly into Windows NT Server 4.0 EE with MTS. MTS uses Microsoft's COM distributed object protocol to create robust links between Windows NT's Internet Information Server (IIS) Web server and database servers. As a relatively new technology, MTS has only begun the long and tortuous path to building credibility as an enterprise alternative, and its limits are not yet fully understood. Moreover, since MTS runs only on Windows NT, its deployment range remains limited by the same barriers currently affecting the underlying platform. However, MTS does earn Windows NT an advantage for delivering a comprehensive Web-based application architecture that is closely integrated with directory and security infrastructures. (See "Electronic Commerce Services," below.)

ELECTRONIC COMMERCE SERVICES

ELECTRONIC COMMERCE SERVICES

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
GOOD

As the first medium to automate both marketing-on-demand and sales-on-demand functions on the same platform without requiring human intervention for each customer, the Internet offers a compelling and unique promise of enabling electronic commerce. Despite e-commerce's promises of a low variable cost per customer, the startup expertise and integration required to develop a full e-commerce solution suitable for businesses remains relatively high. Assessing e-commerce, therefore, requires examining the degree to which vendors and their platforms can provide comprehensive solutions for their customers.

Central to these middleware products are software tools which work with Web servers, bundled or unbundled, in a packaged offering from the vendor. These tools perform a variety of tasks – ranging from user interface templates to site management – while focusing on bolstering security for the safe passage of critical information. In the absence of these applications, companies would not be able to manage transactions efficiently, performance and reliability would be severely dented, and, above all, Net buying would become a text book example of the unsafe nature of the Internet. Some vendors innovate their own application-level solutions, others provide a combination of layered software and ISV products, and still others depend almost entirely on ISVs.

Rather than presenting a solutions-oriented approach, Sun has adopted an ISV-centric and infrastructure-centric strategy for its electronic commerce offerings. Developing an e-commerce site on Solaris may, therefore, require a fair amount of development work. Still, Solaris's e-commerce offerings remain marginally broader than other UNIX vendors with similar strategies. Some of Sun's technologies, such as Java Wallet, provide developers with a framework for e-commerce – spanning from the user-interface through public-key technology infrastructures to back-end Java frameworks. However, real applications leveraging the JavaWallet infrastructure have yet to make a significant impact.

Microsoft's Commercial Internet Systems (MCIS) is a commercial-grade, integrated suite of servers for providing Web-based electronic commerce services. MCIS offers value-added access, communication, and hosting services based on Windows NT Server 4.0 EE and the IIS Web server. MCIS has been tested to allow Windows NT servers to host up to 1,000 virtual electronic commerce Web servers. It includes features to provide complete, end-to-end order processing pipelines based on a mixture of open standards and various Microsoft applications.

Microsoft also offers the Site Server Commerce Edition package, which meets many of the functional requirements for a comprehensive electronic commerce platform. Site Server includes the Site Builder Wizard for building a Web site, as well as sample sites. Templates are provided that use Active Server Pages to create custom product catalog Web pages. Microsoft's GUI site administration tool, Commerce Host Administrator, allows remote administration and provides usage analysis and content management. Support for both SSL and SET standards enhances security. Database connectivity is offered through ADO objects. Microsoft Wallet, integrated with Site Server, provides functionality similar to IBM's Consumer Wallet and Sun's Java Wallet. Site Server is tightly integrated with the Windows NT operating system as well as Microsoft Transaction Server (MTS).

Additional software included in Microsoft's package include a set of APIs, the FrontPage Web site creation and management tool, and the Visual InterDev development system. Windows NT also supports some electronic commerce performance optimizations, with IIS offering the ability to allocate and throttle bandwidth for Internet services. On Solaris, this function requires an unbundled option from Sun.

SECURITY & DIRECTORY SERVICES

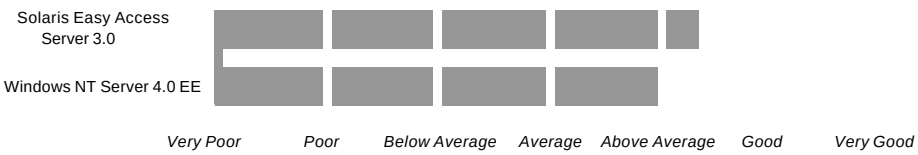


FIGURE 6:
Security & Directory Services

In large networks, it becomes increasingly tedious for users and administrators to securely and reliably track user IDs, passwords, server host IDs, and printers throughout the enterprise. System management itself presents a database problem. Operating systems supporting enterprise networks must therefore provide effective distributed network security functions, along with a special-purpose distributed database called a directory service that provides users and administrators with an up-to-date and global reference to all network resources. With fully distributed security and directory services, administrators can provide access to data and applications from anywhere on the network. Users can then log in from any client system, regardless of its geographic location, or the server through which it connects.

Despite its relative scalability limitations, Windows NT's directory service, NT Directory Service (NTDS), is emerging as a de-facto directory service standard, simply due to the proliferation of Windows NT servers. NTDS has successfully enabled small networks to be set up quickly and simply, based on the Domain concept of aggregating users into workgroups. In large enterprise networks, however, the use of Domains requires administrators to deploy a matrix of trust relationships between multiple Domains – which quickly becomes expensive to manage. Domains also have only relatively primitive replication capabilities. Microsoft has recognized the limitations of NTDS, and plans to introduce an entirely new directory scheme in Windows 2000 called Active Directory, which will be compatible with the Lightweight Directory Access Protocol (LDAP).

LDAP provides an open standard for directory services based on a subset of X.500, the vast, comprehensive, and formal standard for information exchange. In addition to comprehensively addressing data interoperability, the LDAP functional specification is also broad enough to leave room for implementation of a variety of enhancements for boosting scalability and reliability in very large networks. As LDAP continues to gain implementations on a wide variety of operating systems, it promises to become both a de jure and de facto standard for managing resource information on enterprise networks.

Kerberos is a distributed security system developed at MIT that authenticates users across large networks. When integrated with applications, Kerberos allows the verification of the identity of an application user, without sending any data across the network that might allow an attacker to impersonate that user. Kerberos establishes a user's identity at logon and then attaches a "ticket" containing a session key to the user's client. This ticket can then be used to continuously verify the identity the client by applications throughout the network. Because the ticket is encrypted in the Kerberos server's key, a client cannot modify the ticket without detection. Windows 2000 will introduce Kerberos to take over the security functions of NTDS.

WINDOWS NT AUTHENTICATION & DIRECTORY SERVICES

WINDOWS NT AUTHENTICATION & DIRECTORY SERVICES

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
VERY GOOD

At the network protocol level, UNIX-Windows NT interoperability has become relatively straightforward, thanks in part to the dominance of the Internet, which is based on the TCP/IP protocol used by most UNIX systems. In the past, Windows-based systems required unwieldy extensions to connect to TCP/IP networks in addition to their native NetBEUI protocol. Today, virtually all versions of Windows support the TCP/IP protocol natively, and UNIX-Windows interoperability issues have largely shifted to the service level (i.e., the ability to share file, print, and application resources across both platforms).

Historically, accessing UNIX files and printers from PCs required each client to have extensions that worked on UNIX terms, such as Sun's PC-NFS software. This cumbersome arrangement incurred significant software costs and administration burdens. Now, a number of commercial and public-domain options exist that enable a UNIX server to act as a file and print server to Windows clients using Microsoft's native Server Message Block (SMB) protocol. When configured with these extensions, Windows clients can access UNIX files and printers transparently by their native protocols. UNIX servers simply appear in the Windows Network Neighborhood as virtual Windows NT servers.

Tools allowing Windows systems to access files and printers from UNIX systems have become somewhat commoditized by Open Source solutions such as Samba. However, differentiation remains in terms of the ability to integrate UNIX and Windows NT at the administrative level. PC NetLink, a component of Solaris Easy Access Server 3.0, introduces a critical new function for strengthening ties with Windows clients by allowing them to access Windows NT administrative services from Solaris systems. Other

Windows file- and printer-sharing options – such as Sun's earlier PC interoperability software, SunLink PC, or Samba, the Open Source alternative used to serve Windows clients from most Linux systems – primarily enable access to shared files and printers. PC NetLink also allows Solaris systems to perform security operations such as authentication for Windows clients using their native protocols.

Moreover, PC NetLink uses code licensed from Microsoft, instead of the reverse-engineered techniques used in most other alternatives. In fact, PC NetLink derives from the same networking code used by Windows NT itself. Windows NT's networking functions were originally transplanted from Microsoft's LAN Manager product – introduced during the 1980s as a file and print-sharing competitor to Novell NetWare. LAN Manager, along with a variant sold by IBM called LAN Server, was originally based on an OS/2 kernel. After developing the Windows NT kernel from the ground up as an alternative to OS/2, Microsoft rehosted LAN Manager's networking functions on Windows NT, and introduced the new product as Windows NT Advanced Server in 1993. Simultaneously, AT&T secured a license from Microsoft to port the same code to UNIX kernels and resell it to third-party OEMs. Currently, AT&T's package runs on a variety of UNIX platforms in addition to Solaris, including AIX, DG/UX, HP-UX, Tru64 UNIX, SCO UNIX, SCO UnixWare, Siemens-Nixdorf Reliant UNIX, and NCR MP-RAS.

PC NetLink's implementation allows Solaris systems to host Primary Domain Controllers (PDCs), which are used to maintain Windows NT's Directory Service (NTDS) and network authentication protocols. Through PDC, Solaris systems can take over NTDS functions by authenticating network logins by Windows clients using NT's native security protocols. PC NetLink, therefore, potentially enables Windows NT administrative infrastructures to be rehosted entirely on Solaris servers. (Without PDC support, users must continue to maintain Windows NT servers for managing user information.)

PC NetLink allows Sun to position its Solaris systems as a superior foundation for existing NTDS infrastructures, offering better reliability and scalability than the Windows NT operating system itself. The limited SMP scalability of Windows NT servers – typically ranging up to four processors – along with restrictions on the configuration of Windows NT-based PDCs – users often avoid deploying PDCs on servers that run critical applications due to their fluctuating resource consumption – has led to a proliferation of servers that are dedicated to simply maintaining the network. Sun offers to consolidate these servers into more robust Solaris systems, ranging as high as 64 CPUs, and offering industry-leading availability features such as Dynamic Reconfiguration, Alternate Pathing, and

Dynamic Domains. IT personnel can potentially manage these larger systems more efficiently.

LDAP DIRECTORY SERVICES

LDAP DIRECTORY SERVICES

Solaris Easy Access Server 3.0
ABOVE AVERAGE

Windows NT Server 4.0/EE
AVERAGE

Solaris Easy Access Server ships with an LDAP V3-compliant directory service that has been tested with up to 1 million entries. Windows NT 4.0's directory service, NTDS, is based on proprietary Microsoft protocols. LDAP-compliant directory service options exist for Windows NT 4.0, but they must be obtained from third parties and integrated separately with NTDS.

KERBEROS SERCURITY

KERBEROS SECURITY

Solaris Easy Access Server 3.0
GOOD

Windows NT Server 4.0/EE
AVERAGE

Solaris includes Kerberos V5 support in the base operating system. Although Kerberos will be an integral part of the Windows 2000 security mechanism, Windows NT 4.0 EE does not build in Kerberos support. Current NT users must obtain and install third-party solutions.