

**Chapter
1**

**WINDOWS 2000
PLATFORM AND
ARCHITECTURE**

*Get on the
Fast Track!*



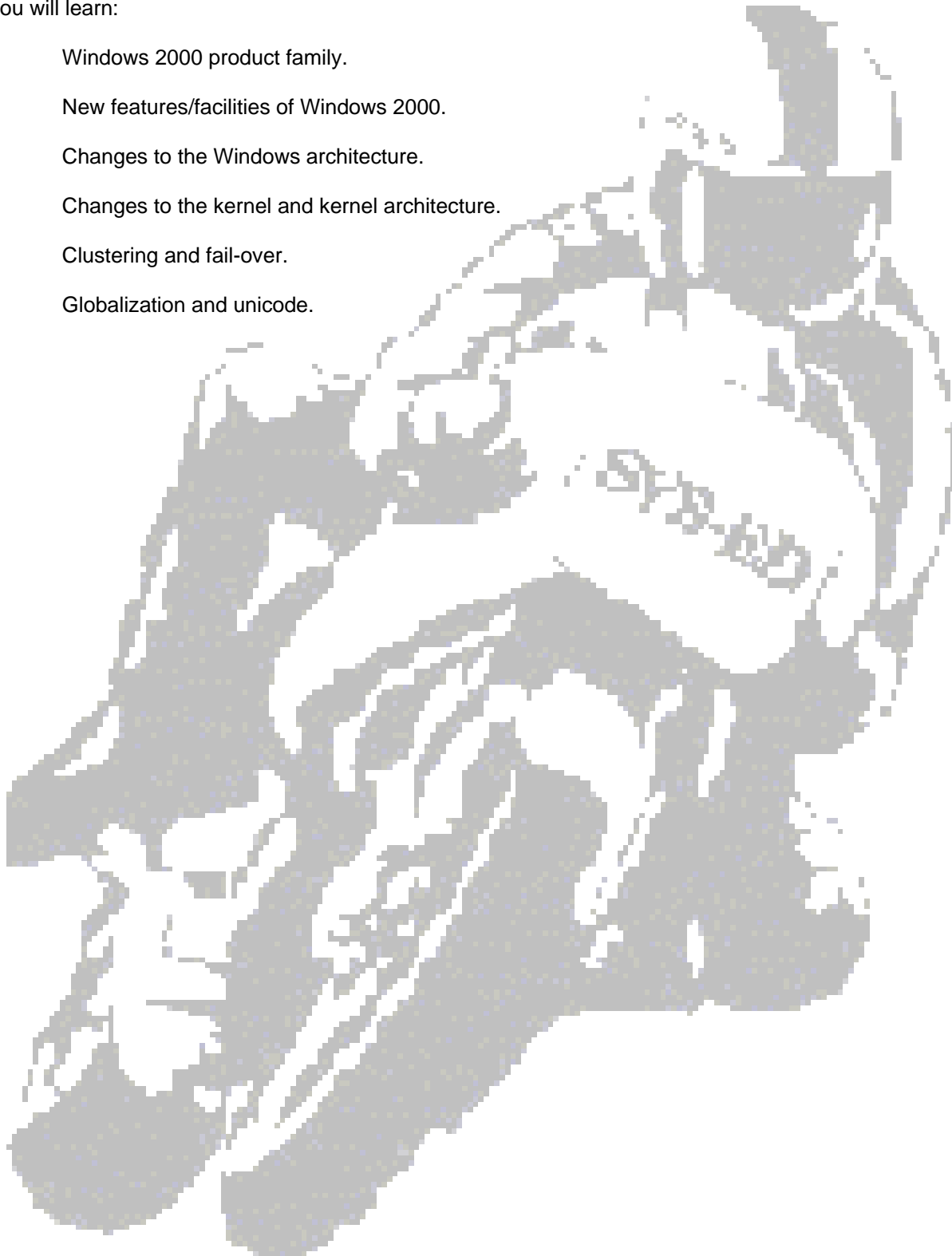
TM

**SYS-ED/
COMPUTER
EDUCATION
TECHNIQUES, INC.**

Objectives

You will learn:

- C Windows 2000 product family.
- C New features/facilities of Windows 2000.
- C Changes to the Windows architecture.
- C Changes to the kernel and kernel architecture.
- C Clustering and fail-over.
- C Globalization and unicode.



1 Windows 2000 Product Family

Windows 2000 is built on NT Technology. It scales from one or two servers with a few dozen clients to hundreds of servers and thousands of clients.

	Windows Professional	Windows Server	Windows Advanced Server	Windows Datacenter Server
Target Audiences	Business desktops, notebooks	File, print, intranet, networking	Line of business, e-commerce	Large critical applications: OLTP, data warehouses, ASPs and ISPs
CPUs Supported	2	4	8	32
Memory Supported	4 GB	4 GB	8 GB	64 GB
Clustering	None	None	Two-node failover, 32-node network load balancing	Cascading fail-over among four nodes, 32-node network load balancing
Minimum System Requirements	133 MHz Pentium-compatible CPU, 64 MB RAM, 1 GB disk space	133 MHz Pentium-compatible CPU, 256 MB RAM, 1 GB disk space	133 MHz Pentium-compatible CPU, 256 MB RAM, 1 GB disk space	Pentium III Xeon processors or higher, 256 MB RAM, 1 GB free space.

1.1 Windows 2000 Server Family

The Windows 2000 Server family has two members:

Standard	Offers core functionality for essential services (including file, print, communications, infrastructure, and Web servers) appropriate to small- and medium-sized organizations with numerous workgroups and branch offices.
Advanced	The Advanced edition is designed to meet mission-critical needs, such as large data warehouses, e-commerce, or Web hosting services for medium-sized and large-sized organizations and Internet service providers (ISPs).

1.2 Windows 2000 Advanced Server

Windows 2000 Advanced Server provides a comprehensive clustering infrastructure for high availability and scalability of applications and services, including main memory support of up to 8 gigabytes (GB) on Page Address Extension (PAE) systems.

Designed for demanding enterprise applications, Advanced Server supports new systems by using up to eight-way symmetric multiprocessing (SMP). SMP enables any one of the multiple processors in a computer to run any operating system or application thread simultaneously with other processors in the system.

Windows 2000 Advanced Server is well suited to database-intensive work, and provides high-availability server clustering and load balancing for high system and application availability.

Windows 2000 Advanced Server includes the full feature set of Windows 2000 Server and adds the high availability and scalability required for enterprise and larger departmental solutions.

Key features of Advanced Server include:

- C All Windows 2000 Server features.
- C Network (TCP/IP) load balancing.
- C Enhanced two-node server clusters based on the Microsoft Windows Cluster Server (MSCS) in the Windows NT Server 4.0 Enterprise Edition.
- C Up to 8 GB main memory on PAE systems.
- C Up to eight-way SMP.
- C The Windows 2000 platform.

2 New Features/Facilities

The following features/facilities have been added to Windows 2000:

- C Active Directory, provides for searches to be initiated which will locate all of the people or software and hardware resources in the enterprise.
 - The same search dialog box can be used to search the computer's hard drive, network, or the Internet. All of the search results are displayed with a thumbnail view of the file, the file type and size, and the date the file was last modified.
 - Content indexing uses keywords to index files on every drive. This results in faster search results.
- C When Personalized Menus is turned on, Windows 2000 keeps track of which programs are used, and hides the programs that have not been used recently, while still keeping all of the programs easily accessible.
- C The desktop environment can be modified with customized toolbars by adding, removing, or arranging buttons.
- C Active Desktop provides a means for customizing the desktop, making it easy to start programs and use the Internet or intranet.
- C Enhanced Accessibility features.
- C Built-in support for multiple languages.
- C Enhanced Add/Remove Programs feature.
- C IntelliMirror, allows users to work from any workstation on the network and have their own documents, programs, and settings available to them, just as they are on their own computer.
- C Enhanced remote network management.
- C Microsoft Management Console - MMC provides a common framework for all administrative tools, such as Event Viewer, Service Manager, and Disk Administrator.
- C Improved driver support.
- C Increased support for new-generation hardware and multimedia technologies.
- C Integration of the new Euro currency symbol.

3 Windows 2000 Professional Features

Windows 2000 has improved hardware support and increased software. Enhancements to networking, printing, and storage help in finding resources more quickly and work more efficiently.

Desktop and window enhancements have made Windows 2000 easier to use.

- C Menus and toolbars can be customized to tailor Windows 2000 to the user's needs.
- C Windows Explorer displays more information about files and folders, including thumbnail views and encryption information.
- C The enhanced search capabilities now present the user's browse and search results in the same window.
- C The My Documents and My Pictures folders provide a convenient place to back up and store work.

3.1 Hardware Management

Windows 2000 includes hundreds of new printer, modem, and other hardware drivers.

New wizards have been added for configuring hardware.

- C The Add/Remove Hardware wizard automatically detects and configures new devices.
- C The Add Printer wizard helps in changing printer settings from within applications.

Windows 2000 also includes improved printing support - Internet printing, Image Color Management 2.0, and new font technologies.

3.2 Support for Mobile Users

The Network Connection wizard simplifies setting up network and dial-up connections.

Network-based files and folders can be taken offline, making them available when the computer is not connected to the network. Likewise, web pages can be saved for offline browsing.

Synchronization Manager ensures that offline and network versions of a file are up-to-date.

3.3 Scalable Security Technologies

Windows 2000 expands the existing capabilities of Windows NT.

The new Encrypting File System ensures that information is completely private and secure, even for users who share a computer. A virtual private network can be created to securely connect computers over the Internet.

Windows 2000 supports the following scalable security technologies:

- C Kerberos V5 protocol.
- C smart card.
- C public key cryptography.
- C Internet Protocol security (IPSec).

A user will only have to log on once to use all Windows 2000 Server network resources.

3.4 Software Installation

The revised Windows Installer:

- C helps prevent system file conflicts.
- C repairs incomplete installations.
- C updates out-of-date components.

The uninstall feature removes all traces of a program, including Registry entries.

3.5 File System Support

Windows 2000 supports the file allocation table (FAT) 32 file system.

The NTFS file system includes many performance enhancements and new features such as per-user disk quotas and file encryption.

3.6 Features from Windows 98

Windows 2000 has incorporated many features from Windows 98 including:

- C Advanced Configuration and Power Interface power management.
- C DirectX suite of technologies.
- C Web integration.

Windows 2000 also supports Plug and Play, IEEE 1394, DVD, and the universal serial bus (USB) standards.

Multiple monitors can be used with a single computer to increase the size of the workspace.

3.7 Applications Support

Windows 2000 continues to support software for previous versions of Windows - as well as older hardware. To ensure the quality of hardware drivers are used, the drivers are digitally signed by Microsoft after testing.

Windows 2000 supports new programs, including distributed programs written using Windows Distributed Internet Applications (Windows DNA) architecture.

3.8 IntelliMirror

IntelliMirror technology uses Windows 2000 Server to manage desktops remotely - each user's documents, system files, and administrative settings are stored on a server.

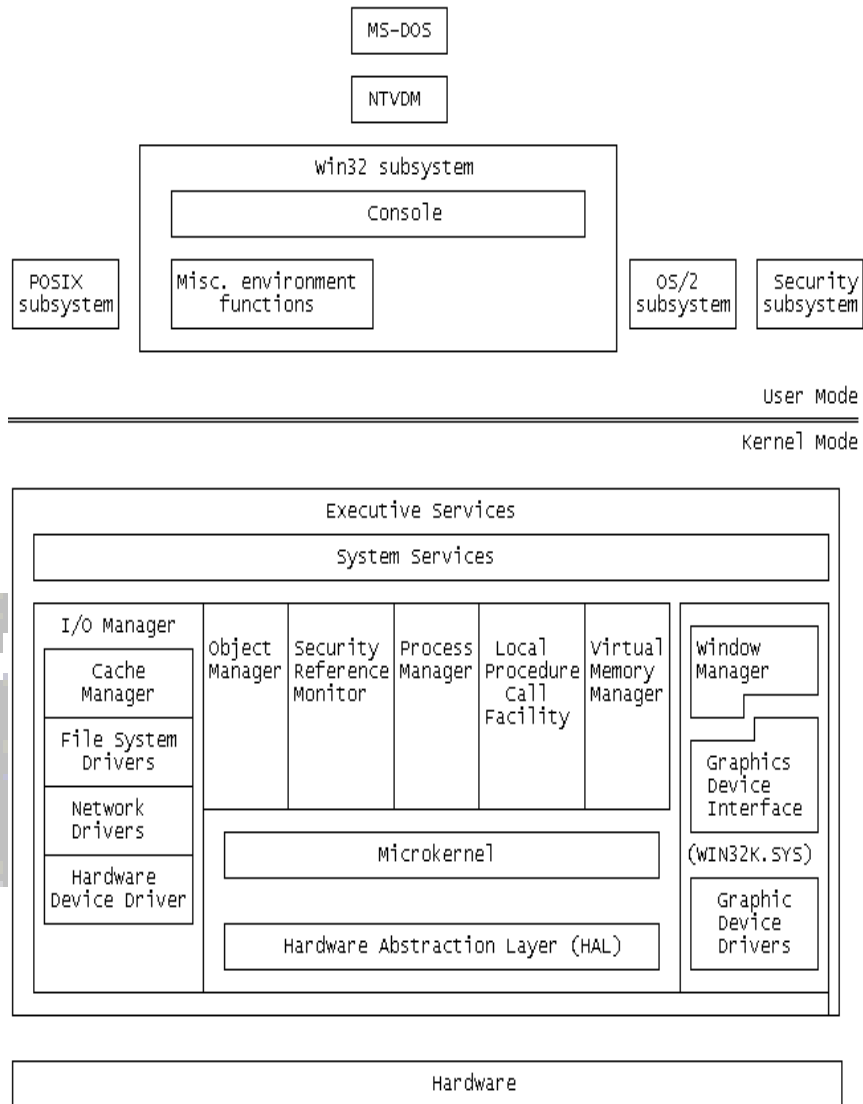
Administrators will be able to duplicate Windows 2000 installation from one computer to another.

3.9 Active Directory

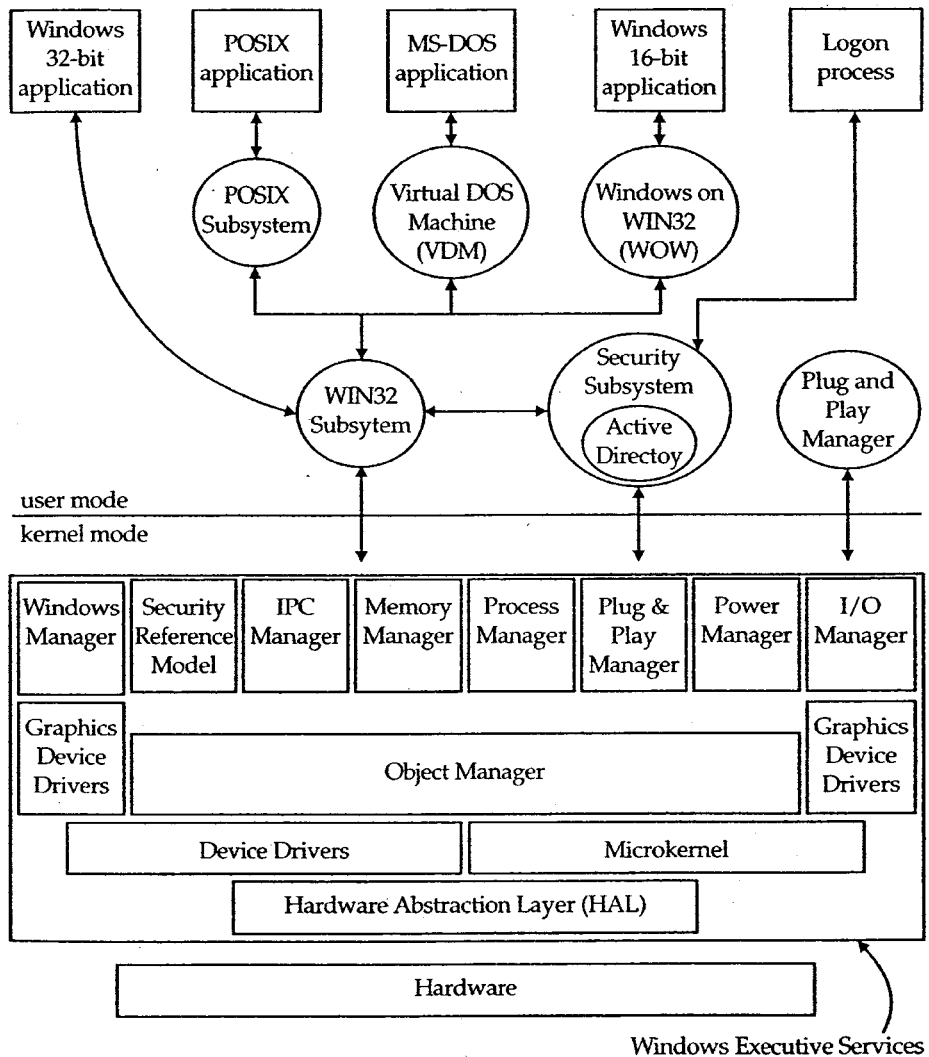
Active Directory and Group Policy support can be used for the central administration of desktops and for centralizing control of privileges, permissions, and capabilities of both users and computers.

4 Architecture

4.1 Windows NT 4.0



4.2 Windows 2000



5 Kernel Architecture

The core of Windows 2000 Server is the kernel. The kernel is based on the same basic architecture as Windows NT Advanced Server 3.1 but has evolved to meet the changing needs of modern networks.

Microsoft Windows 2000 is composed of many different layers that all interact to present the user with a complete operating system. At the core of this architecture lies the kernel which has special rights over the hardware of the system.

The kernel is responsible for:

- C allocating memory to applications.
- C communicating with device drivers.
- C determining which processes run at any given time.

The kernel allows the operating system to scale higher, supporting up to 32 processors and 32 GB of RAM. It allows database applications like Microsoft SQL Server to take advantage of that larger hardware, and increases their performance by moving pieces of functionality into the kernel itself.

Applications depend on the kernel to allocate memory, processor time, and hardware resources.

Microsoft has changed several aspects of the kernel:

- C Windows 2000 Server scales much higher than was possible with Windows NT.
- C Network applications are more reliable and will run more efficiently.
- C Users in other countries will have an easier time using the operating system and its applications in their environments.

Features such as processor quotas and process accounting make Windows 2000 Server an extremely attractive platform for web hosting environments.

Clustering features are now built into the kernel, allowing for greatly improved uptime in networks where redundancy is available.

Process and Sessions

Windows 2000 launches a separate Win32 process is launched for each user session. This ensures that applications do not communicate between user sessions, eliminating potential violations of a user's privacy. These kernel changes will not affect administrators who choose not to use Terminal Services.

Windows 2000 Win32 Architecture

The Windows 2000 Win32 subsystem is capable of handling multiple user sessions.

6 Kernel - New Facilities

6.1 Processor Quotas and Accounting

It is common practice for Internet Service Providers (ISPs) to share a single Web server between many customers.

Two new features make multiuser environments more effective:

- C Processor accounting.
- C CPU throttling.

Processor accounting is used by IIS to record the number of processor cycles consumed by individual Web requests. This allows ISPs to bill based on processor usage, and enables developers to determine which pages can most benefit from optimization.

CPU throttling stops a Web site's out-of-process applications from stealing so much processor time that the other Web sites cannot function correctly.

The job object is the underlying technology that enables processor accounting and CPU throttling. Services such as IIS spawn many processes so that multiple tasks can be accomplished at the same time. While multiple processes improve performance, they make it complicated to track which processes are associated with which tasks. Because IIS 4 supported many virtual servers sharing the same application space, it was impossible to audit or control how much processor resources each virtual server consumed.

Job objects allow the operating system to manage groups of processes as a single unit. This makes it much easier for applications to monitor and throttle the amount of processor time that separate tasks consume. This feature is critical for environments where multiple customers share the same server.

One or more processes can work together to complete a single job, which is represented by a job object.

6.2 Spin Count

Spin count is a method for improving performance on multiprocessor systems when multiple programs need access to the same resources simultaneously.

Spin count controls how many times a process will attempt to access a resource before waiting.

On a single processor system, the different processes will have to wait for each other to execute anyway, in which case repeated attempts to access the resource will not be successful until the other process has a chance to execute.

Applications that use spin count on single processor systems will not hurt their performance; they just will not benefit.

6.3 Scatter/Gather I/O

Scatter/Gather I/O is a new feature in Windows 2000 Server that improves the performance of application servers on a network. Its use is entirely transparent to system administrators, because applications can make use of it without any special configuration.

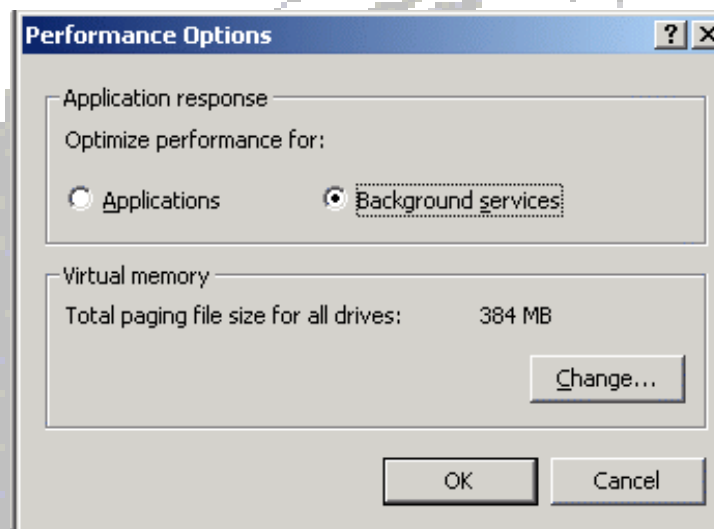
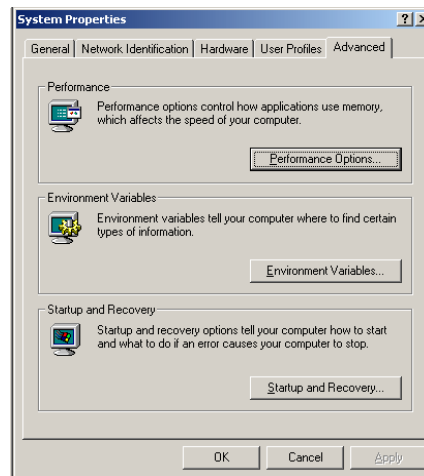
The technology streamlines the process of moving data from discontinuous sections of the system's RAM to a contiguous space on the disk drive. Applications must be written specifically to take advantage of it. Therefore, existing services will not realize any benefit.

6.4 Quantum

A quantum is a property of a thread that defines how long a thread will be allowed to execute before control is handed over to another thread.

Since it takes time to switch the CPU between multiple threads, some applications will benefit from increasing the thread quantum length. The trade-off with this action is that increasing a thread's time slice makes multitasking less smooth.

The quantum type can also be adjusted between fixed length and variable length. This can be configured from the Performance Options dialog box, which is accessed from the Advanced tab of the System Properties dialog box.



Administrators and developers have control over quantum type and length.

- C Giving priority to applications allocates short, variable quanta, providing smoother multitasking.
- C Giving priority to background services causes the operating system to use long, fixed quanta, which improves performance of network services.

By default, Windows 2000 Server gives priority to background services, and Windows 2000 Professional gives priority to applications.

6.5 Windows Driver Model

A driver is a piece of software that allows the operating system to communicate with a piece of hardware. All hardware accessories require drivers: network cards, SCSI cards, modems, scanners, and printers.

Previous versions of Windows required different drivers for each operating system. This was a burden to hardware vendors who created the drivers and to any administrators who managed multiple operating systems. Windows 2000 and Windows 98 systems can now use the same drivers.

The WDM Kernel Streaming architecture improves the performance of real-time streaming media. Previous versions of Windows required streaming media applications to do the bulk of processing in user mode. Many of these functions have been moved to kernel mode, where they execute much faster. However, applications must be specifically written to take advantage of the WDM Kernel Streaming, however, so legacy applications will not benefit.

The WDM Still Image Architecture provides operating system level support for scanners and digital cameras.

6.6 EMA: Enterprise Memory Architecture

Memory allocation can create bottlenecks for many large application servers and is particularly true for massive database servers that must handle hundreds of gigabytes of data.

Windows 2000 Server incorporates Enterprise Memory Architecture which allows up to 32 GB of memory to be addressed by servers with 64-bit processors. Although most servers will not require this level of RAM, data warehouses will benefit because data can be manipulated faster in memory than on hard disks. At the current time the Alpha and Pentium II Xeon chips can utilize the memory model.

Applications must be specifically coded to use the Very Large Memory APIs. Microsoft SQL Server is coded to use this, and other relational database services are in the process of being modified to use the new APIs. Most applications will not benefit from adding more than 4 GB of RAM.

6.7 Multiprocessor Capabilities

Windows 2000 Server offers improved multiprocessor support.

Multithreaded applications executing on multiprocessor systems will perform better; developers do not need to write special code to take advantage of the improved scalability.

Multiprocessor Utilization:

- C Windows 2000 Server supports two processors simultaneously. Existing users of Windows NT 4.0 Server who upgrade to Windows 2000 Server will be allowed to use four processors.
- C Windows 2000 Advanced Server supports four simultaneous processors. Existing users of Windows NT 4.0 Server Enterprise Edition who upgrade to Windows 2000 Advanced Server can continue to use eight processors.
- C Windows 2000 Advanced Server doubles the maximum number of processors from what was previously available - 16 processors can be used simultaneously.

Hardware vendors can extend this to support 32-way concurrent processing.

Processes can now be pinned to specific processors. Administrators can use the Task Manager to set the processor affinity of a process. This forces the process to use only that specific processor, which can improve performance by reducing the number of processor cache flushes as processes are swapped between processors. A potential drawback with this feature is that it can also reduce performance by not allowing the process to move to the least busy processor.

6.8 I2O Support

I2O (Intelligent I/O Architecture) is a new technology that reduces the load on a system's CPU and improves I/O performance. I2O works by adding a dedicated processor that is optimized for input and output operations.

This technology is designed to streamline bandwidth-intensive activities such as realtime audio and video.

6.9 Improved Sorting

Large-scale databases and warehousing applications will realize performance improvements by using the improved sorting capabilities of Windows 2000 Advanced Server.

Performance has been improved by moving these processor-intensive algorithms to the kernel. Applications will need to be written specifically to take advantage of the new APIs, and the newest version of Microsoft SQL Server already has been.

7 Zero Administration for Windows Initiative

Four architectural changes have been made to support the Zero Administration for Windows Initiative.

Architectural Change	Description
Plug and Play	<p>Results in administrators spending less time configuring and troubleshooting hardware.</p> <p>The Windows 2000 Server Device Manager and Hardware Wizard will detect and resolve hardware conflicts, decreasing administration time. When the operating system boots, Windows 2000 will automatically detect new hardware and launch the Hardware Wizard when an administrator logs in.</p> <p>Conflicts will often be detected and resolved automatically, and online help files are available for those circumstances when the administrator must troubleshoot the hardware manually.</p>
Advanced Configuration and Power Interface	<p>Improves the power efficiency of all Windows 2000 systems, reducing costs by directly reducing electrical requirements.</p> <p>The OnNow/ACPI initiative allows for greater control over how systems use power. Laptop users will be the primary beneficiaries. The new standards have been implemented as part of the Windows Driver Model.</p>
Disk quotas	<p>Helps administrators conserve drive space, reducing the need to purchase additional hardware.</p> <p>A new version of the NTFS file system has been included with Windows 2000. An administrator has the ability to limit the disk space consumed by users on specific partitions. It will allow administrators of file servers and web servers to tightly control how their users store files.</p>
Remote boot functionality	<p>Allows desktop systems to be installed at a much faster pace than was previously possible. The remote boot functionality included with Windows 2000 Server makes it easier to control when desktop systems are powered on. Controlling when systems boot from a central server makes it simpler to configure large numbers of desktop systems, because they can be booted and configured without visiting each station.</p> <p>Changes to support remote booting must be implemented within network cards and network card drivers. In order to implement this capability, the network cards must be able to listen for boot requests even when the system is powered down.</p>

8 Clustering

Organizations that depend on their networks require extremely high uptime.

Downtime is caused by several different events:

- C Hardware failures.
- C Application failures.
- C Reboots as a result of configuration changes.
- C Upgrades and patches.

The clustering features of Windows 2000 Datacenter Server allow two servers to back each other up. When one server fails, a second server can automatically take over those services in less than a minute, in a process known as fail-over. The monitoring services will detect the failure and shift responsibility to the backup server.

For scheduled downtime events, one server can cover for the other server while it is taken offline. This process, called a rolling upgrade, reduces downtime to a minimum when applying patches.

Clustering is designed to allow better scalability by load-balancing requests between multiple machines. In addition to improving uptime by providing fail-over capabilities, many aspects of the operating system are capable of being load balanced. Requests can be automatically distributed between two or more systems, and clients will automatically select a different server in the event one server in a cluster fails.

Clustering services are built into the operating system itself. Cluster-aware administration tools can be used for changing settings to multiple servers simultaneously. Windows 2000 Server clustering capabilities can be utilized/implemented without purchasing any special equipment. Servers in the cluster can have different hardware configurations.

The following components have been improved to support fail-over between systems in a cluster:

WINS	Windows Internet Name Service
DHCP	Dynamic Host Configuration Protocol
Dfs	Distributed File System

9 Terminal Services

Terminal Services is built in to Windows 2000 Server. Terminal services allows clients to run interactive applications on a remote server. The client system accepts input from and displays output to the user. The network infrastructure is used to carry the data between the client system and the server. All processing is done on the server.

Terminal services allows the use of thin clients. A thin client is a desktop system that has a bare minimum of hardware. Instead of requiring end-user systems to have fast processors, large amounts of RAM, and large hard drives, the network Terminal Services will do all the work. The thin client will forward requests to the server. The experience for the user is similar to that of having a fully equipped desktop system. While hardware requirements for the client are minimal, Terminal Services may be used with any type of desktop system.

The light requirements of the clients provide an added benefit to organizations with legacy hardware. Existing Windows for Workgroups 3.11 and Windows 95 systems can act as clients without upgrading the operating system. This allows an older piece of desktop hardware to run new 32-bit applications, increasing its lifetime. Terminal Services clients for Windows NT 4.0, Windows 95, Windows 98, and Windows 2000 Professional are included with Windows 2000 Server.

To allow multiple users to each have a session over the network, Windows 2000 incorporates a highly modified Win32 subsystem. The new Win32 subsystem can track different user sessions and keep them separate. Keyboard and mouse input are funneled not only to the proper application, but also to the proper session. Each user does work within his or her own security limitations.

A separate Win32 process is launched for each user session. This ensures that applications do not communicate between user sessions.

10 Globalization

The original Microsoft operating systems were intended for a United States audience. It provided only the Roman alphabet and English text, and did nothing to help developers write applications for other languages and cultures.

The Windows 2000 operating system has an extensive set of globalization features. The Windows 2000 kernel was designed specifically to support globalization. Unicode is used making it much simpler to adapt the operating system to multiple languages.

Native Language Support, allows location and language information to be stored in the registry and provides a uniform localization interface for applications to query. These features help developers create applications that will work in a variety of locales, and they help users customize their environment to their needs.

10.1 Unicode

Unicode refers to a standard created by the Unicode Consortium, an organization dedicated to creating standards that allow systems all over the world to communicate. The standard defines what bytes will correspond to which characters, similar to the ANSI standards. It is an improvement over ANSI, however, because a single character set is used for all languages. ANSI required a different character set for each language that needed a distinct alphabet.

Unicode allows for many more characters than ANSI. ANSI uses 8-bit characters, so 256 characters can be supported—not nearly enough for uppercase and lowercase character sets in many languages. Unicode uses 16 bits for each character, providing up to 65,536 possibilities.

Currently, 38,887 characters have been coded, covering the principal written languages of Africa, India, Asia, Europe, the Middle East, North America, and South America.

10.2 Unicode Fonts

Unicode supports almost 40,000 characters. However, there is no font that can display all of these. Various fonts support various parts of the total Unicode character set, so different languages still require locale-specific fonts to be installed and used.

Windows 2000 supports Unicode and relies on it for everything internal to the operating system. For example, all NTFS file names are composed of Unicode characters. This allows the same file system to be used regardless of the locale in use on the operating system.

11 NLS: Native Language Support

Native Language Support allows administrators to configure an operating system with locale-specific information.

The API has been part of Windows NT since the first version. It stores about one hundred settings in the registry and provides an interface to that information, allowing applications to easily determine what locale-specific settings should be used on a particular system.

Locale-specific information goes beyond remembering which language the user prefers. Different countries use different formats for dates, times, days of the week, money, and more. By providing a standard set of APIs, users do not need to configure individual applications for their environment.

The operating system is configured once, and all applications can query the operating system's settings. Only files required for the specific language and country are installed. The space consumed by these files is small compared to the space that would be required to install language support for all of the countries supported by Windows 2000.