Implement, manage, and troubleshoot disk devices.

- Disk technology is constantly evolving in capacity and available features. During the life of your computer you will probably add new functionality to your storage or playback devices. Windows 2000 provides advanced support for new devices like logical disk volumes and DVD playback.

Implement, manage, and troubleshoot display devices.

- Configure multiple-display support.
- Install, configure, and troubleshoot a video adapter.

- Windows 2000 provides support for multiple display devices as well as a wide range of video adapters. Being able to utilize these features will impact what you can do with your system.

Implement, manage, and troubleshoot mobile computer hardware.

- Configure Advanced Power Management (APM).
- Configure and manage card services.

- Laptops were once an expensive item with limited availability; however, that is changing. Mobile computing is becoming the rule rather than the exception. With that come requirements for preserving the limited resources available when running on battery as well as supporting PCMCIA and CardBus devices required to fit the slim laptop form.
OBJECTIVES

Implement, manage, and troubleshoot input and output (I/O) devices.

- Monitor, configure, and troubleshoot I/O devices, such as printers, scanners, multimedia devices, mouse, keyboard, and smart card reader.
- Monitor, configure, and troubleshoot multimedia hardware, such as cameras.
- Install, configure, and manage modems.
- Install, configure, and manage Infrared Data Association (IrDA) devices.
- Install, configure, and manage wireless devices.
- Install, configure, and manage USB devices.

A Windows 2000 Professional computer system can have a variety of I/O devices connected to it, including printers, smart cards, cameras, and Infrared devices. Being able to manage a wide range of devices is important to getting the most out of your computer system.

Monitor and configure multiple processing units.

- If your processing requirements grow as you increasingly use a Windows 2000 Professional computer, there is the option of adding an additional processor. The ability to expand your computing power can have a significant impact on the workload your computer can manage.

Install, configure, and troubleshoot network adapters.

- Computers are attached to networks more often now than ever before. If your current computer is not attached to a network, there is a good chance that it soon will be. Additionally, network capacities are constantly improving. Being able to take full advantage of the network connections that you have will help you get the most out of your Windows 2000 Professional computer.

Update drivers.

- Equipment manufacturers are constantly improving the drivers that support their devices. Unfortunately when you buy a new device, the device driver may already be superceded by a better one. Windows 2000 Professional provides a way to automatically update the driver for a particular device either from a local source or over the Internet with a minimum of manual intervention.
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STUDY STRATEGIES

Windows 2000 Professional supports more types of devices than any previous version of the OS. In addition to the range of devices supported, configuration is made automatic because of Plug and Play. You can expect a number of questions related to installing and supporting newer hardware devices on your Windows 2000 Professional computer. Many of these questions will be presented as scenarios in which the capabilities of these devices are used to solve problems.

You should also expect to see questions dealing with new disk capabilities to provide fault tolerance as well as more options in configuring disk storage.

Greater disk storage capacity creates a need for offline storage capabilities. Expect to see questions on Removable Storage Management (RSM) and the configuration of robotic libraries and media pools.

Some new devices that you can expect to see questions on are support for Infrared (IrDA) and wireless support, plus support for Universal Serial Bus (USB) devices.

Finally, Windows 2000 Professional can support the usage of an additional processor. You can expect to see some questions that focus on the impact of improving the CPU power of your Windows 2000 Professional computer and the impact that may have on other resources available within your system.

In short, by focusing on the major areas just mentioned, you will be well-prepared for this portion of the exam.
INTRODUCTION

This chapter is mainly concerned with the hardware devices that can tailor the generalized personal computer into a device that does what you want. The extra pieces of hardware, from DVD devices to additional monitors, can greatly increase the functional value of the computer.

Understanding the available configuration options is key to arriving at solutions to problems likely to be presented in the exam. This chapter will examine the disk configurations and removable storage options that can provide solutions to disk storage problems. We will then look at I/O devices such as multiple displays, wireless I/O, cameras, scanners and printers, and USB devices, to name a few. Plug and Play features are fully supported in Windows 2000 Professional, so we will be looking at that feature as well.

We will round out the chapter with a look at the multiple CPU capability of Windows 2000 Professional and Network adapter configurations.

INSTALLING HARDWARE

The Windows 2000 Professional operating system includes many enhancements to simplify device management. Some of these include Advanced Power Management (APM), Advanced Configuration and Power Interface (ACPI), and Plug and Play (PnP).

Plug and Play is a combination of hardware and software that enables a computer to recognize and modify its hardware configuration changes with minimal intervention from the user. The hardware device that you are installing must support the Plug and Play initiative to be automatically configured correctly. You will find that some older devices that predate Plug and Play will not be recognized.
With Plug and Play, a user can add or remove a device dynamically without manual reconfiguration and without any intricate knowledge of the computer hardware. For example, you can have a laptop in a docking station that contains an Ethernet network connection and later use the same laptop connecting to the network using a built-in modem, without making any configuration changes.

With Plug and Play, you can make changes to the Windows 2000 Professional computer’s configuration with the assurance that all devices will work and the computer will reboot correctly after the changes are made.

When you install a Plug and Play device, Windows 2000 Professional automatically configures the device to allow it to function properly with the other devices already installed in your computer. Windows 2000 Professional assigns system resources to the device, including the following:

- Interrupt request (IRQ) number
- Direct memory access (DMA) channel
- Input/Output (I/O) port address
- Memory address range

Each resource must be unique, or the device will not function properly.

When the device you are installing is not Plug and Play-compatible, Windows 2000 Professional has no way of automatically configuring the device settings. You may have to manually configure the device driver or use the manufacturer-provided installation program.

You can configure devices using the Add/Remove Hardware applet in the Control Panel or by using the Device Manager, which is located in the Computer Management icon within the Administrative Tools folder in the Control Panel.

With most Plug and Play hardware, you simply connect the device to the computer and Windows 2000 Professional automatically configures the new settings. Plug and Play can be supported by devices and the drivers that control them. The possible combinations expand to four different support scenarios.

Full Plug and Play support is provided when the hardware and the device driver fully support Plug and Play.
If the hardware supports Plug and Play, but the device driver does not, Windows 2000 Professional will not support Plug and Play and the device will be treated as a legacy NT 4.0 device.

If the device driver supports Plug and Play, but the hardware does not, Windows 2000 can provide partial Plug and Play support. In this case, Windows 2000 will not be able to automatically configure the device drivers, but Plug and Play will be able to manage resource allocations and interface to the power management systems.

Windows 2000 will not provide support for Plug and Play if neither the device driver nor the hardware supports Plug and Play.

For hardware that cannot be automatically identified, the Add/Remove Hardware applet provides a method of manually configuring the device resources. Occasionally, you may need to initiate automatic installation even for some Plug and Play hardware.

**Using the Add/Remove Hardware Wizard**

The Add/Remove Hardware Wizard, started from the Control Panel, is used to initiate automatic hardware installation of both Plug and Play and non-Plug and Play hardware devices. The following steps will initiate a search for new Plug and Play hardware or, in its absence, present you with a screen to add a new device or troubleshoot an existing device.

**STEP BY STEP**

3.1 Searching for New Plug and Play Hardware

1. Click on Start, select Settings, and click on Control Panel.

2. Double-click the Add/Remove Hardware icon to start the wizard.

3. Click Next to close the Welcome page.

4. Select Add/Troubleshoot a Device and click Next to start the wizard.
Windows 2000 Professional will search for any new Plug and Play hardware and install any it finds. In the event that the wizard cannot detect any new hardware it will display a list of installed hardware for you to choose a device for troubleshooting (see Figure 3.1). The first entry on the hardware list is Add a New Device to provide the option of installing a new device.

**Confirming Hardware Installation**

After you have installed new hardware, you can confirm that the device is installed and functioning properly by using the Device Manager.

To start the Device Manager, double-click the System icon in the Control Panel. Select the Hardware tab and click the Device Manager button. This displays a list of installed hardware, as shown in Figure 3.2

Expanding a device type displays all the specific devices of that type installed on the computer. The device icon will indicate if the device is functioning properly. You can use the information in Table 3.1 to determine the device status.
### TABLE 3.1

**DEVICE MANAGER HARDWARE STATUS**

<table>
<thead>
<tr>
<th>Device Icon</th>
<th>Device Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal icon</td>
<td>The device is functioning normally.</td>
</tr>
<tr>
<td>Stop sign</td>
<td>Windows 2000 Professional has disabled the hardware due to resource conflicts. To correct this, right-click the device icon, click Properties, and set the resources manually according to what is available in the system.</td>
</tr>
<tr>
<td>Exclamation point</td>
<td>The device is not configured correctly or the device drivers are missing.</td>
</tr>
</tbody>
</table>

---

### Determining Required Resources

When you are manually installing and configuring non-Plug and Play hardware you need to understand the resources the hardware device expects to use. The manufacturer's product documentation will list the resources the device requires and you will have to determine how to fit them into your existing system. Table 3.2 describes the resources available in a Windows 2000 Professional computer system that hardware devices use to communicate with the operating system.

### TABLE 3.2

**HARDWARE DEVICE RESOURCES**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrupts</td>
<td>Hardware devices use interrupts to indicate to the processor that it needs attention. The processor uses this Interrupt Request (IRQ) as a way of determining which device is looking for service and what type of attention it needs. Windows 2000 provides interrupt numbers 0 through 15 to devices (IRQ 1 is always assigned to the keyboard).</td>
</tr>
<tr>
<td>Input/Output (I/O) port</td>
<td>I/O ports are areas of memory that the device uses to communicate with Windows 2000 Professional. When the processor sees an IRQ request, it checks the I/O port address to retrieve additional information about what the device wants.</td>
</tr>
</tbody>
</table>
Direct Memory DMAs are channels that allow the hardware device to access memory directly. This allows a device like a disk drive or floppy drive to write information into memory without interrupting the processor. Windows 2000 Professional provides DMA channels 0 through 7.

Memory Many hardware devices have onboard memory or can reserve system memory for their use. Any reserved memory is not available for any other device or for Windows 2000 Professional.

Some of the resources used by device drives are reserved for specific devices and some can be shared between devices.

The Interrupt Request (IRQ) uses a Programmable Interrupt Controller (PIC) to request a service for the device. When a request is seen, the current operation is suspended and control given to the device drive associated with the IRQ number (1–15). This resource therefore cannot be shared between devices.

The Input/Output (I/O) port is a memory block used by the device to communicate the service it is requesting. This is tied to the IRQ number and therefore is dedicated to a device.

The Direct Memory Access (DMA) is a direct channel between the device and the computer’s memory. The DMA controller supports a number of channels (usually seven) and they are shared between devices (one at a time).

A device memory block is a portion of system memory mapped to the internal memory of the device (usually). This is dedicated to the device and cannot be used by any other process (including Windows 2000 Professional).

**TABLE 3.2 continued**

**HARDWARE DEVICE RESOURCES**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Memory Access (DMA)</td>
<td>DMAs are channels that allow the hardware device to access memory directly. This allows a device like a disk drive or floppy drive to write information into memory without interrupting the processor. Windows 2000 Professional provides DMA channels 0 through 7.</td>
</tr>
<tr>
<td>Memory</td>
<td>Many hardware devices have onboard memory or can reserve system memory for their use. Any reserved memory is not available for any other device or for Windows 2000 Professional.</td>
</tr>
</tbody>
</table>
Determining Available Resources

After you determine what resources your device requires, you can use Device Manager to display the resources available on your computer. To view the available resources list, double-click on the System icon in the Control Panel and select the Hardware tab. Click the Device Manager button and select the Resources by Connection entry in the View menu. Figure 3.3 shows the Device Manager view of resources and their availability.

![Figure 3.3](image)

Hardware resources listed by connection.

Changing Resource Assignments

You might encounter two devices that request the same resources, resulting in a conflict. To change a resource setting use the Resources tab in the device's Properties information. The following procedure will allow you to modify a resource setting.
3.2 Modifying a Device's Resource Configuration

1. Click on Start, select Settings, and click on Control Panel.

2. Double-click on the System icon and select the Hardware tab.

3. Click on the Device Manager button.

4. Expand the device type that you wish to change.

5. Right-click the specific device you wish to modify.

6. Click on Properties and choose the Resources tab. If the Resources tab is not present, you will not be able to modify the device's resources.

7. Select the resource setting you will be modifying.

8. Clear the Automatic Settings box if it is checked. If this box is grayed out you will not be able to modify the device's resources.

9. Select the resource you wish to modify and click on the Change Setting button.

At this point you will be presented with a screen that will allow you to edit the value of the resource you have selected. Saving that new value will change what Windows 2000 Professional thinks the device will be using.

**Media Devices**

*Implement, manage, and troubleshoot disk devices.*

The following sections address disk and other media devices.


**Chapter 3  HARDWARE DEVICES AND DRIVERS  187**

**CD-ROM and DVD Devices**

Current CD-ROM and DVD devices support Plug and Play and therefore should be automatically configured when you install the devices.

Support for the CD-ROM File System (CDFS) is maintained in Windows 2000 Professional to support legacy applications and is used by RSM in storing CD-ROMs in Removable Storage libraries. CD-ROM devices support 650MB of storage per platter. Although this was once considered immense, it pales against the emerging standard of DVD, which currently can hold over 26 times as much data (up to 17GB of information).

DVD used to stand for Digital Versatile Disk. However, now it is recognized by the acronym alone. This line of devices is an enhancement of CD-ROM technology and is quickly replacing that as more multimedia technology is integrated into computer usage.

There are four primary types of DVD storage:

- **DVD-Video.** This is the actual technology usually referred to as **DVD.** This is a disk holding a video program such as a feature film that can be played back in either a DVD-Video player or a computer with a high-resolution display.

- **DVD-ROM.** This is the disk technology used to store computer data to be read by a DVD-ROM drive. All DVD devices should be able to read DVD disks, including double-sided, double-layered disks holding up to 17GB of data.

- **DVD-WO.** This is a variation of DVD-ROM that supports one-time recording capabilities like today’s CD-R. The “WO” stands for Write Once.

- **DVD-RAM.** This is a variation of DVD-ROM supporting multiple recording capabilities similar to magneto-optical (“MO”) disks.
Support for DVD in Windows 2000 Professional includes the following:

- **DVD-ROM driver.** The DVD-ROM industry standard command set (known as Mt. Fuji) is supported by the new Windows Driver Model (WDM) DVD-ROM device driver. Both Windows 2000 and Windows 98 can read data sectors from a DVD-ROM drive.

- **UDF file system.** The Universal Disk Format (UDF) provides support for UDF-formatted DVD disks.

- **WDM streaming class driver.** This is a driver written to follow the new Windows Driver Model (WDM) support. This driver supports MPEG-2 and AC-3 hardware decoders providing full-motion video and surround-sound capability.

- **DirectShow.** DirectShow is a replacement for ActiveMovie that supports DVD video and audio streams.

- **DirectDraw.** The video streams created by DVD devices can overwhelm a PCI bus on a computer. The solution to this is the creation of a dedicated bus to transfer decoded video streams from an MPEG-2 decoder to the display card.

- **Copyright protection.** DVD provides copyright protection by encrypting key sectors on a disk and then decrypting them prior to decoding.

- **Regionalization.** As part of the copyright protection scheme used for DVD, six worldwide regions have been defined by the DVD Consortiums. Disks are playable on DVD devices in some or all of the regions according to codes set by the creators of the content.

### Monitoring CD-ROM and DVD Devices

The following procedure will allow you to view information about the device drivers controlling your CD-ROM and/or DVD devices.


STEP BY STEP

3.3 Displaying CD-ROM and DVD Device Information

1. Click Start and select Settings and click on the Control Panel.
2. Double-click on the System icon.
3. Select the Hardware tab and click on Device Manager.
4. Expand the CD-ROM/DVD device type.
5. Right-click the specific device to view and select Properties.

A few properties can be manually adjusted, as shown in Figure 3.4.

Troubleshooting CD-ROM and DVD Devices

Most of these devices are now Plug and Play-compatible and therefore not prone to configuration errors. The CD-ROM and DVD devices are not immune to installation problems, however. These errors would be indicated by the tray door not opening, the usage light not being lit, or the device not showing up on your My Computer display. This type of problem (assuming the CD-ROM or DVD is not faulty) is probably caused by loose or badly installed power or data cables. To confirm this, you must physically open the computer case and examine the device connections. You may need the manufacturer's operator's guide information to correctly identify the data connections.

If the device is installed correctly but does not function correctly, follow the troubleshooting steps for these devices summarized in Table 3.3.
### TABLE 3.3

**Troubleshooting CD-ROM and DVD Devices**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>The device reads data but not audio.</td>
<td>The audio drivers are incorrect or missing. You must update the device drivers to the latest available from Microsoft (see “Maintaining Updated Drivers” later in this chapter) or the manufacturer.</td>
</tr>
<tr>
<td>The audio drivers are installed but no audio is heard.</td>
<td>Audio cables are installed incorrectly. To check this, you must open the computer case and examine the audio cables. With some devices, it is possible to have the cable ends reversed.</td>
</tr>
<tr>
<td>Audio is heard over headphones but not the computer speakers.</td>
<td>Audio drivers or adapters are missing from the computer or are not configured correctly. You must install the latest available drivers from either Microsoft (see “Maintaining Updated Drivers” later in this chapter) or the manufacturer.</td>
</tr>
<tr>
<td>The computer plays audio but cannot be read.</td>
<td>The CD-ROM is faulty.</td>
</tr>
<tr>
<td>The CD-ROM can’t be read or play audio.</td>
<td>Windows 2000 Professional is having difficulty detecting the hardware. The device driver or the hardware may not be Plug and Play-compatible. The next step would be to update the device drivers to the latest available.</td>
</tr>
</tbody>
</table>

---

**Fixed Disks**

Disk Management is a new graphical tool used in Windows 2000 Professional to manage disk and volumes. Disk Management can be started from within Computer Management or from inside Administrative Tools in the Control Panel, and can also be configured as an MMC snap-in.

Disk Management replaces the Disk Administrator in Windows NT and provides support for disk partitions, logical drives, and dynamic disks. Disk Management will do most of its support tasks dynamically without requiring a reboot of your computer. Disk Management also allows you to select the computer you are configuring, either the local machine or one on the network. In any case, you must have administrative rights on the computer you are configuring.
Once a new disk has been installed, Disk Management is used to rescan the drives. Normally you have to power off your computer hardware to install a new disk drive unless your system has support for hot-pluggable disk drive bays. When you rescan your disks, Disk Management will scan all attached disks looking for configuration changes, removable media, CD-ROM drives, basic volumes, file systems, and drive letters. If, however, the Rescan does not detect your new disk drive, it may be necessary to reboot your computer anyway.

Disk Storage is now configured as basic or dynamic. The terms basic disk and dynamic disk are not referring to a different type of disk, but rather the way the disk is configured. A disk can be configured as a basic disk and partitioned as you would have done in Windows NT 4.0 or configured as a dynamic disk and divided into volumes.

### Basic Disk Storage

Basic storage supports partition-oriented disk configurations. A disk initialized for basic storage is called a basic disk. A basic disk can contain primary partitions, extended partitions, and logical drives. Basic disks can also contain volume sets, mirror sets, striped sets, and stripe sets with parity created by Windows NT 4.0 or earlier. Basic storage is supported by all versions of Microsoft Windows 3.x and Microsoft Windows 9x, and on Windows 2000 Professional and Server.

On a basic disk, a partition is a part of the disk that functions as a physically separate unit. A primary partition is reserved for use by an operating system. An active partition is a primary partition that contains the startup files for the operating system. Any disk can have up to four primary partitions (or three if there is an extended partition). An extended partition is created from free space and can be partitioned into logical drives. Only one extended partition is allowed per physical disk.

The following is a list of tasks that are supported on basic disks:

- The creation and deletion of primary and extended partitions and logical drives
- Marking a partition as active
- Deletion of volume sets, stripe sets, mirror sets, and stripe sets with parity
Breaking a mirror from a mirrored volume
Repair of a mirrored volume
Repair of a RAID-5 volume
Upgrading basic disks to dynamic disks
Upgrading basic partitions and volumes to dynamic volumes

Disk Management will support existing mirror and RAID-5 configurations that were created under Windows NT 4.0; however, the creation of these configurations is restricted to dynamic disks only. The following is a list of tasks that are not supported on basic disks. These features are supported only on dynamic disks:

- Create simple, spanned, striped, mirrored, and RAID-5 volumes.
- Extend volumes and volume sets.
- Add a mirror to a simple volume.
- Remove a mirror from a mirrored volume.

**Dynamic Storage**

Dynamic storage is designed for new volume-oriented disk configurations. A disk initialized for dynamic storage is called a dynamic disk. Dynamic disks are physical disks that contain dynamic volumes created using Disk Management. Storage is divided into volumes instead of partitions. A volume consists of a part or parts of one or more physical disks laid out as a simple, spanned, mirrored, striped, or RAID-5 structure. Dynamic disks cannot contain partitions or logical drives and can be accessed only by computers running Windows 2000.

Dynamic disks can be reverted to basic disks using Disk Management; however, there is no procedure to convert dynamic volumes back to partitions. This limitation requires you to remove the volumes contained on a dynamic disk before reverting it to a basic disk.

Whereas basic disks use the partition table located in the Master Boot Record (MBR) to identify the start and end of partitions on the physical disk, dynamic disks do not follow the same format.
A dynamic disk still has a partition table, but it has only one entry that encompasses the entire disk. This allows the system to see a valid partition table when it is booting. A dynamic disk configuration stores the volume information on the physical disk in a small 1MB database at the end of the disk.

Each physical disk that has been initialized in a dynamic disk configuration contains a copy of this database replicated among each physical disk in the system. If one of the databases becomes corrupt, another copy is used and the corrupt one is refreshed with an uncorrupted copy.

Table 3.4 summarizes the major differences between basic disk configurations and dynamic disk configurations.

### Table 3.4

<table>
<thead>
<tr>
<th><strong>Basic Disks</strong></th>
<th><strong>Dynamic Disks</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The configuration is stored in the partition table.</td>
<td>The configuration is stored in a 1MB database at the end of the disk.</td>
</tr>
<tr>
<td>There can be four primary partitions, or three primary partitions and one extended partition.</td>
<td>There can be an unlimited number of volumes.</td>
</tr>
<tr>
<td>Free space in an extended partition can be used to create multiple logical drives.</td>
<td>Logical drives are not supported.</td>
</tr>
</tbody>
</table>

In addition, mirrored and RAID-5 configurations are not supported on Windows 2000 Professional (only on Server); however, Windows 2000 Professional can create these configurations on a remote Windows 2000 Server system. Dynamic disk configurations are not supported on portable computers. If you are using Disk Management on a laptop, you will find that the options for converting a basic disk to a dynamic disk are not present.
Disk Management

The Disk Management utility (see Figure 3.5) graphically displays disks and volumes and allows a user with administrative rights to configure disks and volumes.

One of the most basic commands is to rescan the hardware. This allows you to update any hardware information if a new disk has been installed that Disk Management has not detected automatically.

To set up new disks, Disk Management provides wizards to help with the following tasks:

- Add disks for basic or dynamic storage.
- Create primary or extended partitions and logical disk drives (on basic disks only).
- Create simple, spanned, striped, mirrored, or RAID-5 volumes (on dynamic disks only).
- Format volumes in either File Allocation Table (FAT), FAT 32, or Windows NT File System (NTFS) format.
- Upgrade disks from basic to dynamic.
- Mount a local drive at any empty folder on an NTFS formatted volume.

FIGURE 3.5
Disk management.
The ability to mount a local drive to a folder rather than using a drive letter is an interesting feature. For example, you might have an NTFS volume that is disk C: and you have a CD-ROM drive currently known as disk D:. If you create an empty folder at C:\CD-ROM (the name is not important here—just that it is empty and on an NTFS disk), Disk Manager can mount the CD-ROM drive at that folder. Now you can access the information on the CD-ROM from the C: drive and reuse the D: drive letter for other devices.

**Upgrading Basic Disks to Dynamic Disks**

When a basic disk has been converted to dynamic, all existing partitions become simple dynamic volumes. This cannot be reversed. Any existing striped, mirrored, spanned, or RAID-5 partition becomes the equivalent volume.

Once upgraded, a dynamic disk cannot contain partitions or logical drives and cannot be accessed by MS-DOS or Windows operating systems other than Windows 2000.

If the basic disk contains a partition that resides on multiple disks (such as a spanned volume) all other disks that contain part of the volume must be upgraded as well. Volumes cannot be created on any removable media.

**System and Boot Partitions**

A basic disk that contains the system or active partitions can be upgraded to dynamic. These partitions become simple system or active volumes. An existing volume cannot be marked as active.

A basic disk that contains the boot partition can also be upgraded to a dynamic disk. The boot partition becomes a simple boot volume. A fresh installation of Windows 2000 Professional cannot be performed on an existing dynamic volume, but Windows 2000 can be upgraded on a dynamic boot volume. This limitation results from the Windows 2000 Professional setup only recognizing dynamic volumes that contain partition tables. Partition tables only occur in basic volumes and dynamic volumes that were upgraded from basic volumes. If you create a new dynamic volume on a dynamic disk, the new volume will not contain a partition table.
Once the disk containing the boot and system partitions has been upgraded to dynamic volumes, you can create a mirror set onto another disk. If one of the disks in the mirror set fails, you can restart your computer from the mirrored disk. This requires an entry in Boot.ini to reference the mirrored disk.

**Troubleshooting Disk Problems**

If a disk or volume fails, you will naturally want to repair the problem as quickly as possible. Disk Management displays the status of disks or volumes in both the text and graphical view. The Disk Management display can be customized by selecting the View tab and then Top or Bottom. This allows you to set the top or bottom frames of the display to disk, volume, or graphical display.

One of the disk statuses shown in Table 3.5 will appear in the Status column of the Disk List view and in the Graphical view. If there is a problem with a disk, this will help you to diagnose and correct the problem.

**Table 3.5**

<table>
<thead>
<tr>
<th>Disk Status</th>
<th>Meaning of Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>The disk is accessible and has no detected problems.</td>
</tr>
<tr>
<td>Online (errors)</td>
<td>I/O errors have been detected. If the I/O errors are not permanent, you can reactivate the disk (using Reactivate Disk) to return it to Online status.</td>
</tr>
<tr>
<td>Offline</td>
<td>The disk is not accessible and may be powered down, disconnected, or corrupt.</td>
</tr>
<tr>
<td>Foreign</td>
<td>The disk has been moved to this computer from another Windows 2000 system. To set up this disk for use here, use the Import Foreign Disks task.</td>
</tr>
<tr>
<td>Unreadable</td>
<td>The disk cannot be accessed. It may have experienced hardware failure, corruption, or I/O errors. The 1MB database at the end of the physical disk may also be corrupted. Disks may be flagged as unreadable when they are spinning up or when Disk Management is rescanning all the disks in the system.</td>
</tr>
</tbody>
</table>
Unrecognized The disk has a signature that Disk Management will not allow you to use. A disk from a UNIX system displays the Unrecognized status.

No Media No media is in the CD-ROM or removable drive. This disk status changes when you insert the appropriate media into the device.

Volume Sets
Dynamic volumes are new in Windows 2000 and provide new disk storage strategies. There are five types of dynamic volumes:

- Simple
- Spanned
- Mirrored
- Striped
- RAID-5

Mirrored and RAID-5 volumes can be created only on systems running Windows 2000 Server. Because a system running Windows 2000 Professional can create mirrored and RAID-5 volumes remotely on servers, their definition is included in the following sections.

Simple Volumes
Simple volumes can be created only on dynamic disks. The number of volumes that can be created on a disk is limited only to the amount of free space available.

A simple volume can be extended to other regions on a disk or to other disks. When a simple volume extends to another disk it becomes a spanned volume. No portion of a spanned volume can be deleted without deleting the entire spanned volume. Extended volumes cannot be striped or mirrored.
Spanned Volumes

A spanned volume is a mechanism for effectively using the free space on several disks. The disks used in a spanned volume can be dissimilar types like IDE and SCSI disk devices. Spanned volumes are created by combining the free space from one to 32 disks into one large volume. When the space on one disk is filled up, the system starts writing at the beginning of the next disk. This process continues in the same way up to a maximum of 32 disks.

Existing spanned volumes formatted with NTFS can be extended by adding free space. Disk Management formats the new area without affecting the existing files on the original volume or the spanned volume. Spanned volumes formatted with FAT cannot be extended.

Striped Volumes

A striped volume is a mechanism for combining areas of free space from two to 32 disks into one logical volume. Data is divided into 64KB blocks and spread in a standard order among all the disks in the array.

With striped volumes, Windows 2000 Professional writes data to multiple disks such as spanned disks; however, the data is spread across all disks at the same rate.

Mirrored Volumes

A mirrored volume is a fault-tolerant volume that duplicates the data on two physical disks. It provides fault tolerance by using this copy to reduce the impact of a single disk failure. The mirror is always located on a different disk (locating it on the same disk is not only not fault-tolerant, it takes away needed bandwidth). If one disk in the mirror fails, the system continues to operate using its copy.

A mirrored volume has better overall I/O performance than a RAID-5 volume (slower on read than a RAID-5 configuration but slightly faster on write). There is also no performance loss when a member disk in a volume fails. Mirrored volumes are more expensive because you are doubling the number of disks in your storage system; however, more disks can fail in a mirrored configuration before the data becomes inaccessible.
For example, a mirrored disk structure made of four disks actually has eight disks configured, each disk having its partner on the opposite side of the mirror. If, for example, disk3 fails on one side of the mirror, its counterpart will continue to function normally. If the remaining disk3 fails, the volume is unavailable until the hardware repaired. In this way, up to half of the disks can go offline before the mirror fails.

Mirrored drives perform write functions faster than RAID-5 and therefore might be considered for write-intensive functions.

**RAID-5 Volumes**

A RAID-5 volume is fault tolerant, with data and parity information striped intermittently across three to 32 disks. If a portion of a physical disk fails, the RAID-5 structure allows the hardware to re-create the lost data using the remaining parity information. RAID-5 is a good fault-tolerant solution in which the application mainly reads data. The RAID-5 configuration requires the equivalent of an additional disk to store parity information. In small configurations (three disks), that consumes 33% of the disk space (two drives going to the volume and one drive consumed for parity information). However, as the number of physical drives in the RAID-5 structure increases it becomes more efficient (a 10-drive RAID-5 structure has nine disks going to the volume and one being consumed for parity information).

When a member disk of a RAID-5 volume has failed, the read performance is degraded by the need to recover the data using only the parity information. RAID-5 was designed to protect against physical disk failure and therefore protects only against a single device failing in the volume. If a second device fails before the first is repaired, then the volume goes offline and the data is lost.

**Troubleshooting Volume Problems**

If a disk or volume fails, it is important to repair the problem as quickly as possible. Disk Management displays the status of disks or volumes in both the list and graphical view. The Disk Management display can be customized by selecting the View tab and then Top or Bottom. This allows you to set the top or bottom frames of the display to disk, volume, or graphical display.
One of the disk statuses shown in Table 3.6 will appear in the Status column of the Volume List view and in the Graphical view. If there is a problem with a volume, this will help you to diagnose and correct the problem.

**Table 3.6**

**Volume Status Description in Disk Management**

<table>
<thead>
<tr>
<th>Disk Status</th>
<th>Meaning of Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>The volume is readable with no detected problems.</td>
</tr>
<tr>
<td>Healthy (at Risk)</td>
<td>The volume is currently readable, but I/O errors have been detected on one of the volume’s physical disks. The disk view will show a disk that is Online (Errors). Use Reactivate Disk to return the disk to Online status, which will return the volume to Healthy status.</td>
</tr>
<tr>
<td>Initializing</td>
<td>The volume is being initialized. Only dynamic volumes display the Initializing status.</td>
</tr>
<tr>
<td>Resynching</td>
<td>The volume’s mirrors are being resynchronized to contain identical data.</td>
</tr>
<tr>
<td>Regenerating</td>
<td>Data and parity are being regenerated for a RAID-5 volume. The RAID-5 volume can be accessed while regeneration is in progress.</td>
</tr>
<tr>
<td>Failed</td>
<td>The volume cannot be started automatically.</td>
</tr>
<tr>
<td>Failed Redundancy</td>
<td>The data on the volume is no longer fault-tolerant because one of the underlying physical disks is not online.</td>
</tr>
<tr>
<td>Failed Redundancy (At Risk)</td>
<td>The data on the volume is no longer protected by a fault-tolerant configuration, and I/O errors have been detected on the physical disk. The disk view will show a physical disk with Online (Errors) as the status. Returning the disk to Online status (using Reactivate Disk) will return the volume to Failed Redundancy status.</td>
</tr>
</tbody>
</table>

If the underlying disk is not online, but is successfully reactivated (using Reactivate Disk), the volume should automatically repair itself. A mirrored volume repairs itself by resynchronizing the data (sometimes called resilvering). A RAID-5 volume repairs itself by regenerating its parity and data.

If the disk returns to Online status but the volume does not, reactivate the volume manually using Reactivate Volume.
If the underlying disk will not reactivate, there is probably some-
thing wrong with the disk. Replace the disk and rebuild any mirror
by using the Remove Mirror and Add Mirror commands. A RAID-5
volume can be rebuilt using the Repair Volume command.

Removable Media

Removable Storage Management (RSM) is the interface in Windows
2000 Professional for accessing removable media, including auto-
mated devices such as changers, jukeboxes, and libraries. RSM is
installed by default to control most types of removable media,
including CD-ROM, DVD-ROM, magneto-optical (MO), JAZ,
and ZIP drives in both stand-alone and library configurations.
RSM cannot manage the A: and B: drives.

RSM considers all device changes as a subset of an ideal standard.
A given mini-driver tells RSM what functionality the actual changer
implements, allowing RSM to treat it appropriately. This model is
similar to the way Windows 2000 Professional treats network
adapters and printers, each one having a slightly different way of
doing common tasks, with an intermediate driver allowing client
applications to access services in standard ways.

Client programs such as backup applications and Hierarchical
Storage Management (HSM) systems use RSM to access their
media. Once the media is available, the client applications use
standard Windows 2000 API calls to read and write data.

This model provides the following benefits:

◆ **A common driver model.** The driver model allows a tape
library to be used with any RSM-compatible application. An
application written to use RSM can work with any device
changer where the manufacturer has provided an RSM
mini-driver.

◆ **Library sharing.** Multiple applications can now share a
common library. Previously, if you wanted to use both a
backup application and an HSM application supplied from
two different vendors, you required two device changers.
When using RSM, both applications can use the same
changer.
Offline media. A backup application does not need to know where the media is. It simply requests the media, and RSM loads it or asks the operator to mount it as required.

Media tracking. RSM tracks all media that it recognizes in an internal database. Applications can register with RSM, allowing it to recognize its own media. Applications can also use RSM to search the database and load a particular media.

A common interface. Backup applications that are RSM compatible work the same with a changer or with a stand-alone drive.

Windows 2000 Professional uses RSM to manage ATAPI CD-ROM changers and to mount and dismount all removable media. This includes disks contained in ATAPI CD-ROM changers that hold several CD-ROMs. This type of device receives only a single letter in Windows 2000.

Media Pools

RSM organizes removable media into media pools. RSM can then reassign media to different media pools to provide the amount of storage that different data management applications need.

A media pool is a logical collection of similar media with similar properties. All RSM media belongs to a media pool, and each media pool holds either tape or disk (but not both). Applications use media pools to gain access to specific types of media from a library.

RSM supports two classes of media pools:

- System, including unrecognized, import, and free
- Application, created for data management applications. There can be a number of application media pools created. Media reserved for an application (allocated) cannot be moved between media pools.

Unrecognized Media Pools

Unrecognized media pools contain new (blank) media. This should be immediately moved from the unrecognized media pool to the free media pool so it can be used by applications.
Import Media Pools
Import media pools contain media the RSM recognizes but has not catalogued in the RSM database. Media can be moved from import media pools to free or application media pools for reuse.

Free Media Pools
Free media pools contain media that is not currently allocated by an application and contains no current data. Media pools should be configured to draw from the free media pool when there is nothing available for a particular application.

Application Media Pools
Application media pools are created and used by data management applications. Media in an application pool is controlled by the management application or by the administrator. An application can use more than one media pool, and more than one application can share a media pool.

Library Types
Each media in RSM belongs to a library. There are two types of libraries, as described in the following sections.

Robotic Libraries
Robotic libraries are automated units (such as jukeboxes) that hold multiple tapes or disks and can have multiple drives.

Stand-Alone Libraries
Stand-alone libraries are single-slot CD-ROM or tape devices that hold a single piece of media.

RSM can also track offline media that is catalogued but not currently in a library. This media can be physically located elsewhere (for offsite storage supporting disaster recovery plans).

Media Resources
Before RSM can be set up and used, there must be removable media resources to manage. There are three types of removable media supported by RSM. They are described in the following sections.
Tape
The two major tape technologies in use today are Digital Audio Tape (DAT) and Digital Linear Tape (DLT).

Read-Only Optical Disk
Read-only optical media includes CD-ROM and DVD-ROM disks. These are written by the manufacturer and cannot be overwritten or erased. This type of media is most useful as reference material (such as online catalogues or documentation) or licensed software programs (such as applications and games).

Write-Able Optical Disk
Write-Able optical media includes Magneto-Optical (MO) devices, Phase Change (PC), Write Once Read Many (WORM), CD-Recordable (CD-R), and DVD-Recordable (DVD-R) disks. MO and PC media can be erased and overwritten, while WORM, CD-R, and DVD-R disks can be written to only once.

Operator Requests
An operator request is a message that requests a specific task. Operator requests are generated when offline media has been requested, or an application has requested media and none is available. An operator request will also be generated if a fault occurs in one of the libraries or a drive needs cleaning and no cleaner cartridges are available.

Troubleshooting RSM
Problems can occur when using RSM in either stand-alone configurations or with robotic libraries. To prevent problems, follow the guidelines in this list:

- Verify that the library is supported by Windows 2000. A good place to check is the Hardware Compatibility List (HCL) on the Microsoft Web site (www.microsoft.com/hcl).
- Verify that the library is properly connected. If the library uses a SCSI connection, make sure there are no SCSI ID conflicts with other devices in the computer, such as with hard drives or CD-ROMs. In addition, verify that all cables are installed and terminated properly and do not exceed the maximum length allowed.
Use Device Manager to ensure that Windows 2000 has recognized the library and associated drives and has configured the device drivers correctly.

If Removable Storage still cannot automatically configure the library correctly, it will need to be manually configured.

If the library is configured correctly but begins malfunctioning, look at the Windows 2000 system event log. Many problems can be caused by device errors.

- Devices support Plug and Play to make their installation and configuration automatic and dynamic (without a reboot).
- The Device Manager can display the resources a device is using and allow you to edit and change any (not all will be available).
- Disk Management is the MMC snap-in GUI interface for managing disks, partitions, volumes, logical drives, and other configurations.
- Disks are either basic disks or dynamic disks.
- Basic disk configurations are stored in the partition table on each disk.
- Basic disks can have four primary partitions, or three primary partitions and one extended partition.
- A basic disk’s extended partition can be divided into logical drives.
- Spanned, mirrored, striped, and RAID-5 configurations created under NT 4.0 can be maintained but not created on basic disks.
- Dynamic disk configurations are stored in a 1MB database at the end of the physical disk.
- Dynamic disks use volumes rather than partitions.
- Spanned, mirrored, striped, and RAID-5 configurations can be created on dynamic disks.
- Only Windows 2000 can access dynamic disks.
Removable Storage manages access to stand-alone and robotic libraries and allows you to group disks and tapes into media pools.

RSM keeps track of all catalogued media, even if it is currently not in a library device. Requesting the media will find the media or generate an operator message requesting the media be placed in a library.

DISPLAY DEVICES

Implement, manage, and troubleshoot display devices.

Windows 2000 Professional adds support for up to nine display adapters. This allows the desktop to extend to nine monitors supporting large graphical drawings (such as those produced by CAD systems). There are some important considerations to make if you’re setting up a multiple display system.

Multiple Display Support

All of the video adapters used with multiple display units must be Peripheral Component Interconnect (PCI) or Accelerated Graphics Port (AGP) devices.

The hardware requirements for the primary video adapter (which drives the first screen of the multiple displays) are different from the requirements for the secondary video adapters. If the video adapter built into the motherboard is to be used as a secondary screen in a multiple display, it must be compatible with those requirements.

If you are using a video adapter built into the motherboard for a multiple display, you must first completely install Windows 2000 Professional before adding any other adapters. The Windows 2000 Professional setup program will disable an on-board video adapter if it sees an additional one. The BIOS in some systems will also shut down the on-board video adapter if an additional one is seen. If you can’t defeat this detection, the built-in video adapter cannot be used in a multiple display.
One last consideration is to remember that the primary video adapter cannot be turned off. Since the multiple-display configuration uses the primary as the “anchor point” of the extended desktop, any system that shuts down the primary video adapter will not support multiple displays. Laptops that are placed in docking stations usually do just that and therefore will not function correctly in this configuration.

The Virtual Desktop
Windows 2000 Professional creates a virtual desktop when configuring multiple displays and uses this to determine the relationship of the displays to each other. The virtual desktop sets the coordinates of the top-left corner of the primary screen to (0,0). Additional screens are configured to exactly touch each other on the virtual desktop, allowing the mouse to move seamlessly from screen to screen; there are no spots not covered by a display.

The position of the displays on the virtual desktop can be viewed by clicking on the Display icon in the Control Panel. Select the Settings tab in the Control Panel to show the screen layout. Display positions are changed by dragging the icon representing the screen to its new location. There is also a check box to indicate which screen (and therefore video adapter) is going to be the primary monitor.

Configuring Multiple Display Adapters
Once the secondary adapter(s) are installed, the virtual desktop must be configured.

The following procedure is a configuration of a two-monitor system.

**STEP BY STEP**

3.4 Configuring Two Displays

1. Click Start, select Settings, and click Control Panel.

2. Double-click on Display.

3. Select the Settings tab. The numbers in the monitor representations indicate the displays. 1 is the primary display, and 2 through 9 are the secondary displays.

continues
continued

4. Select the primary display and click on the Use This Device as the primary monitor check box.
5. Select the video adapter for the primary display.
6. In the Colors box, select the color depth desired.
7. Move the screen area slider to select the resolution.
8. Select display number 2.
9. Select the Extend My Windows Desktop onto This Monitor check box.
10. Select the color depth desired.
11. Move the Screen Area slider to select the resolution.

This procedure is very similar to the one you would follow when configuring your display. In the case of multiple monitors, you must first choose the monitor you are configuring and then provide the same configuration for all the monitors in the system.

Troubleshooting Multiple Displays

Problems with multiple displays usually relate to the video adapter not initializing properly or not being supported as a secondary display. Table 3.7 indicates some typical symptoms and their solutions.

**TABLE 3.7**

**Problems with Multiple Displays**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no output on a secondary display.</td>
<td>Confirm that the device is activated in the Display Properties dialog box. Confirm that the correct video driver is installed. Confirm that the secondary display was initialized when the computer restarted. You can do this by checking Device Manager for the status of the video adapter. Physically switch the order of the adapters in the PCI slots. (This may require that the primary adapter also qualify as a secondary adapter.)</td>
</tr>
</tbody>
</table>
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Symptom  Solution
The Extend My Windows Desktop onto This Monitor check box is unavailable. Confirm that the secondary display is highlighted in the Display Properties dialog box.

Confirm that the secondary display adapter is supported.

Confirm that the secondary display is detected.

There are problems displaying an application on a multiple-display configuration. Run the application on the primary display rather than on a secondary display, or on a window that spans more than one screen.

Run the application on a full screen rather than on a window.

Disable the secondary display and rerun the application to see whether the problem is specific to multiple-display support.

Video Adapters

Most computers are designed with a video adapter built into the motherboard, and generally this device will work best with most applications. With some new games, however, additional hardware acceleration is needed to power the effects.

Video adapters now support the Plug and Play standard and will be detected and installed by Windows 2000 Professional either during setup or when you reboot your computer after installing the device.

In the event that Plug and Play cannot detect the card directly, you can use the following procedure to install the new device.

STEP BY STEP

3.5 Installing a New Video Adapter

1. Click on Start, select Settings, and click on Control Panel.

2. Double-click on Add/Remove Hardware.

continues
3. Click Next to close the Welcome page.

4. Select Add/ Troubleshoot a Device and click Next.

5. After Windows searches for any new Plug and Play device, select Add New Device and click Next.

6. Select No, I Want to select the Hardware from a List and click Next.

7. Select Display Adapters and click Next.

8. Select the manufacturer and model of the display adapter you have installed and click Next. If the manufacturer or device model is not on the list of supported devices, click Have Disk. The Add/Remove Hardware Wizard will read the device information from the manufacturers disk.

9. Click Next to start the hardware installation.

10. Click Finish to complete the installation.

Once the new video adapter is installed, you can change the characteristics of your screen using the Display applet in the Control Panel. Figure 3.6 shows the Settings screen from the Display applet in Control Panel. From this point, you can vary the color depth and the screen resolution.

Table 3.8 lists the settings and advanced options for configuring your display.

### TABLE 3.8
**Advanced Display Options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colors</td>
<td>Lists the color options for the display adapter.</td>
</tr>
<tr>
<td>Screen Area</td>
<td>Configures the screen area used by the display.</td>
</tr>
<tr>
<td>Font Size</td>
<td>Allows selection of a small or large font size.</td>
</tr>
<tr>
<td>Monitor Type</td>
<td>Allows selection of the monitor type the display adapter is using.</td>
</tr>
</tbody>
</table>
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**MOBILE COMPUTING**

Implement, manage, and troubleshoot mobile computer hardware.

Being mobile with your computer is becoming the rule rather than the exception. Within corporations, a significant number of desktop systems are laptops in docking stations. Support for these devices requires special consideration compared to stationary desktop systems. Chiefly, this includes power management and support for PCMCIA cards.

**Power Management**

Advanced Power Management (APM) is the legacy power management scheme based on a BIOS approach that was first supported in Windows 95. Most of the interesting features of APM are in a machine-specific BIOS that is hidden from the Windows 2000 Professional operating system.

APM has been superseded by the Advanced Configuration and Power Interface (ACPI) standard. This is a more robust scheme for power management and system configuration supported in Windows 98 and Windows 2000 Professional.

Many laptop computers will have both ACPI and APM support, but some will have only APM support. Support for APM in Windows 2000 is mainly intended for laptops with limited support on desktop computers.
APM in Windows 2000 Professional is designed to support battery status, suspend and resume functions, and auto-off for hibernate. Functions such as wake on timed event, wake on LAN, and wake on ring are not supported.

When to Use APM

If the laptop has a supported ACPI BIOS, ACPI should be used for power management. Some functions, such as timed wakeups, are only available using ACPI under Windows 2000 Professional.

APM should not be used in the following circumstances:

- If the BIOS has been identified as incompatible with APM, the Windows 2000 Professional setup will not run APM on machines with these BIOSs.
- If the BIOS is not compliant with the APM standard, you shouldn’t use APM. This results in an unstable system with the potential for data loss.

APM can be used in the following circumstances:

- There is no ACPI BIOS.
- The ACPI BIOS is not compliant or not implemented properly. However, APM may not work any better.

During installation, Windows 2000 Professional setup procedures use values in the Biosinfo.inf file (supplied on the Windows 2000 Professional CD-ROM) to determine whether the system is on the AutoEnable APM list or the Disable APM list.

If the system is on the AutoEnable list, setup will automatically install APM support. If the system is on the Disable APM list, setup will not install or enable APM support. It may still be necessary to disable the APM BIOS settings using the computer’s BIOS setup routines.

If the system is not found on either list, the system is considered neutral. In this case, setup will install APM support but will leave it disabled. You can enable APM support by double-clicking the Power icon in the Control Panel and selecting the APM tab.
You can determine whether APM support is configured for your system by clicking on Start and then selecting Shutdown. If APM support is running, the Stand-By entry appears in the list of choices.

Troubleshooting APM in Windows 2000 Professional
The following are items you should consider when using APM support in Windows 2000 Professional:

- **APM and multiprocessors.** Ensure that APM is turned off in the BIOS on multiprocessor systems. If possible, use ACPI (Advanced Configuration and Power Interface), which is supported with multiprocessor systems.

- **Desktop system.** APM support should be disabled on all desktop systems. The APM BIOS cannot correctly save most of the video displays on desktop systems, resulting in a vanished display after a Suspend and Resume. Occasionally, having APM turned off in the Windows 2000 Professional operating system but turned on in the BIOS will result in a timeout and powerdown even if the CPU is very busy.

- **Incompatible systems.** If APM support has been enabled on a system in the Disable APM list, use the Power applet in the Control Panel to disable APM support. Reboot the system in Safe Mode (F8) and delete the NTAPM.SYS file from \WINNT\System32\drivers.

- **Additional video adapter.** Using a video adapter other than the one included with the computer will change the system’s APM configuration. If the adapter is not detected by the APM BIOS, suspend will not function properly.

- **Screen blanking.** If the video timeout is set in the BIOS and the screen blanks, moving a mouse will wake the system; however, an external USB mouse will not. To work around this, disable the BIOS timeout and use the Blank screen saver.

- **APM BIOS timeouts.** The BIOS should be configured to allow the Windows 2000 Professional operating system to blank the screen, turn off the disk, and so on. If APM is used to control these functions, the system will not always restore correctly on wake-up. BIOS timeouts should be set to none or for as long as possible.
Card Services

Windows 2000 Professional supports the connection of credit card-sized add-on devices through its card services.

Windows 2000 Professional supports PC Card socket controllers, 16-bit PC I/O cards (sometimes referred to as PCMCIA cards), and the newer 32-bit architecture that operates up to 33Mhz. Although PCMCIA cards were originally intended only as memory cards, the currently available cards are also used for many I/O devices, such as Global Positioning System (GPS) devices, modems, and network adapters. Windows 2000 Professional also supports power management and Plug and Play for PCMCIA cards.

If you are going to unplug a card device, it is important to allow Windows 2000 Professional to shut the device off prior to removing it from the computer.

The following procedure can be used to unplug a PC Card.

**STEP BY STEP**

### 3.6 Unplugging or Ejecting a PC Card

1. Click Start, select Settings, and click Control Panel.
2. Double-click on the Add/Remove Hardware icon.
3. Click Next to close the Welcome page on the Add/Remove Hardware Wizard.
4. Select Uninstall/Unplug a Device and click Next.
5. Click Unplug/Eject a device and click Next.
6. Select the device you want to unplug or eject and click Next. See Figure 3.7 for an example of selecting a PC device to eject.
7. Click Next to confirm that you are ejecting the device you selected.
8. Click Finish to complete the task.

---

**FIGURE 3.7**

Ejecting a PC Card device.
If you add and remove PC Cards frequently from your laptop computer, you may wish to add an Eject Device shortcut to your taskbar. The final screen of the Add/Remove hardware procedure outlined previously contains a check box that will add the Eject Device icon to your taskbar (see Figure 3.8).

**INPUT AND OUTPUT (I/O) DEVICES**

Implement, manage, and troubleshoot input and output (I/O) devices.

Since their introduction, personal computers have always been generalized in design. Additional functionality and personalizing features were provided by manufacturers of add-on cards and adapters. With many different manufacturers all providing different approaches to installing and configuring their devices, using PC add-ons was often confusing and contradictory.

Windows 2000 Professional supports the Plug and Play standard. Most new devices use this to standardize their installation steps.

**Configuring Input and Output (I/O) Devices**

Devices such as printers, image capturing devices, multimedia, pointing and input devices, and now smart cards form a class of device that works more at the Human Machine interface than other devices (such as display adapters or network cards). This means that there are more features combined into these devices, giving them more than a single-purpose device. The installation and configuration of these devices are therefore discussed separately.

**Printers**

The printing system is modular and works hand in hand with other systems to provide printing services. When a printer is a local printer and a print job is specified by an application, data is sent to the...
Graphics Device Interface (GDI). The GDI calls the printer driver for print device information useful in rendering the print job into the printer language of the print device. The GDI is therefore the main interface between the application and the printing system. The print job is passed to the spooler and is written to disk as a temporary file so it can survive a power outage or system shutdown. Print jobs can be spooled in either the RAW or Enhanced Meta File (EMF) printer language. Figure 3.9 shows the layout of the components of the Windows 2000 Professional printing subsystem.

**FIGURE 3.9**
Components of the Windows printing subsystem.
The client side of the print spooler is winspool.drv, and that driver makes an RPC call to the spoolsv.exe server side of the spooler. This split in functionality is what allows print devices to be local to your computer or remotely installed on a print server and still function the same. Clients for spoolsv.exe include winspool.drv for handling locally created print jobs and win32spl.dll for print jobs created on remote machines.

If the printer is located on a different Windows 2000 or Windows NT server, the network provider win32spl.dll is used. This module uses RPC calls to redirect the print jobs from the client’s computer to the server’s spoolsv.exe process. Once there, the server’s local print provider will handle the print job.

You generally install printers using the Add Printer Wizard that you find in the Printers folder in Control Panel. After you step through the wizard you will have created a local printer with the name you provided. You can create other local printers for the same physical printer configured to print differently, have different security schemes, or provide different access times. You can manipulate printers by performing the following actions:

- Double-click on the printer to see any spooled jobs, provided you have the privilege to do so.
- Right-click on the printer to view a shortcut menu that provides several options. You can delete a printer that no longer exists or use the Default Printer command to set this printer as the default one for your Windows 2000 Professional computer.
- Right-click on a printer and select the Properties command from the shortcut menu to access the Printer Properties and control any number of settings.

**Using a Basic Error Checklist**

Any number of things can go wrong when you attempt to print to a printer. In many cases, Windows 2000 Professional alerts you to an error and in some cases will actually tell you what the error type is.
Here is a standard checklist of the most common solutions to print problems.

If your print job spools but does not print, try the following:

- Check that the printer is turned on and all the connections are secure.
- Check that the paper tray is full and no paper is jammed inside the printer.
- Verify that the printer is operational. If the printer is a shared resource and other users can print, the problem is not with the printer or the print server.
- Verify that the printer does not have any outstanding error conditions set.
- If there is a job currently printing that is hung up (looking for paper that is not loaded on the printer, for example), you can delete it by pausing the printer and deleting the stopped print job. Restarting the printer will allow other spooled jobs to complete.

The preceding problems are so simple that it is easy to waste time and overlook them. A large percentage of printer problems will disappear when you restart your printer. If that fails, restart your Windows 2000 computer.

If none of these solutions seems to work, try the following:

- Verify that the printer is using the correct printer driver. If the printer is a shared resource and other users have operating systems other than Windows 2000 Professional, make sure you install all the drivers necessary.
- Verify that the printer you attempted to print to is either the default printer for your system, or the printer you selected from your application.
Verify that you can access the printer you are attempting to use. Select the Printers item from the Settings submenu on the Start menu. Right-click on the printer icon and select Open. If the printer control panel does not open correctly and the status persists at Opening or Unable to Connect, there could be a permissions problem.

Verify that there is enough hard disk space to create the temporary spool file.

Try printing a smaller page of text from Notepad. This will often confirm that the print problem is application-specific.

Print to a file and copy the file to the printer port being used either locally or on the printer server. If you can print in this manner, there could be a spooler or data-transmission error.

**IN THE FIELD**

**UPDATE YOUR PRINT DRIVERS**

At the very worst, you can try reinstalling the printer and supplying a new or updated printer driver.

There are a number of places to find updated printer drivers, including the following:

- The Windows 2000 Professional distribution disks
- The setup disks that come with the printer
- The printer manufacturer's Web site
- The Microsoft Web site. Use the Search button to search for the particular model of printer

**Scanners**

Scanners are added by using the Scanners and Cameras Wizard found in the Control Panel.
After installing the scanner and connecting any cables required to your Windows 2000 Professional computer, you can use the following procedure to install a scanner.

**STEP BY STEP**

### 3.7 Installing a Scanner

1. Click Start, select Settings, and click Control Panel.
2. Double-click the Scanners and Cameras icon.
3. Click the Add button to start the Scanners and Cameras Installation Wizard.
4. Click Next to close the Welcome screen.
5. Select the manufacturer and device model that you are installing and click Next.
6. Select the port that you have installed your scanner on and click Next.
7. Provide a name for the device and click Next.
8. Click Finish to complete the installation.

---

**Keyboards**

Keyboards can be built in, connected with a specific device port, or operate as a USB device connected directly or via a USB hub.

Windows 2000 Professional will detect a new keyboard if it is Plug and Play-compatible. If it is not, you will have to use the Add/Remove Hardware Wizard and use the manufacturer’s setup disks to install the device manually. Figure 3.10 shows the hardware properties of a typical keyboard.

Once the keyboard is installed, you can change the characteristics of the device to meet your personal requirements. Figure 3.11 shows the Speed tab on the Keyboard Properties page.
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Keyboard Customizations
The Accessibility Options applet in the Control Panel also provides a number of ways to customize how your keyboard functions. The following features allow you to customize your keyboard functions:

- **StickyKeys.** This option allows you to press a modifier key such as Ctrl, Alt, Shift, or the Windows Logo key and have it remain in effect until a non-modifier key is pressed.
- **FilterKeys.** This option allows you to ignore brief or repeated keystrokes.
- **ToggleKeys.** This option emits a sound when locking keys are pressed.

To enable any of these functions, double-click on the Accessibility applet in the Control Panel and select the Keyboard tab.

Shortcut Key Combinations
For those who are keyboard wizards and who like to use shortcuts rather than the mouse to find and select certain options, Windows 2000 Professional provides shortcuts to well-known tasks. See Table 3.9.

<table>
<thead>
<tr>
<th>Shortcut</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl+C</td>
<td>Copy</td>
</tr>
<tr>
<td>Ctrl+X</td>
<td>Cut</td>
</tr>
<tr>
<td>Ctrl+V</td>
<td>Paste</td>
</tr>
<tr>
<td>Ctrl+Z</td>
<td>Undo</td>
</tr>
<tr>
<td>Delete</td>
<td>Delete</td>
</tr>
<tr>
<td>Shift+Delete</td>
<td>Delete selected item permanently without placing the item in the Recycle Bin</td>
</tr>
<tr>
<td>Ctrl while dragging an item</td>
<td>Copy selected item</td>
</tr>
<tr>
<td>Ctrl+Shift while dragging an item</td>
<td>Create shortcut to selected item</td>
</tr>
</tbody>
</table>

*continues*
### TABLE 3.9 continued

**Windows 2000 Professional Keyboard Shortcuts**

<table>
<thead>
<tr>
<th>Shortcut</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>Rename selected item</td>
</tr>
<tr>
<td>Ctrl+right arrow</td>
<td>Move the insertion point to the beginning of the next word</td>
</tr>
<tr>
<td>Ctrl+left arrow</td>
<td>Move the insertion point to the beginning of the previous word</td>
</tr>
<tr>
<td>Ctrl+down arrow</td>
<td>Move the insertion point to the beginning of the next paragraph</td>
</tr>
<tr>
<td>Ctrl+up arrow</td>
<td>Move the insertion point to the beginning of the previous paragraph</td>
</tr>
<tr>
<td>Ctrl+Shift with any of the arrow keys</td>
<td>Highlight a block of text</td>
</tr>
<tr>
<td>Shift with any of the arrow keys</td>
<td>Select more than one item in a window or on the desktop, or select text within a document</td>
</tr>
<tr>
<td>Ctrl+A</td>
<td>Select all</td>
</tr>
<tr>
<td>F3</td>
<td>Search for a file or folder</td>
</tr>
<tr>
<td>Ctrl+O</td>
<td>Open an item</td>
</tr>
<tr>
<td>Alt+Enter</td>
<td>View properties for the selected item</td>
</tr>
<tr>
<td>Alt+F4</td>
<td>Close the active item, or quit the active program</td>
</tr>
<tr>
<td>Ctrl+F4</td>
<td>Close the active document in programs that allow you to have multiple documents open simultaneously</td>
</tr>
<tr>
<td>Alt+Tab key</td>
<td>Switch between open items</td>
</tr>
<tr>
<td>Alt+Esc</td>
<td>Cycle through items in the order in which they were opened</td>
</tr>
<tr>
<td>F6</td>
<td>Cycle through screen elements in a window or on the desktop</td>
</tr>
<tr>
<td>F4</td>
<td>Display the Address bar list in My Computer or Windows Explorer</td>
</tr>
<tr>
<td>Shift+F10</td>
<td>Display the shortcut menu for the selected item</td>
</tr>
<tr>
<td>Alt+spacebar</td>
<td>Display the System menu for the active window</td>
</tr>
<tr>
<td>Ctrl+Esc</td>
<td>Display the Start menu</td>
</tr>
<tr>
<td>Alt+underlined letter in a menu name</td>
<td>Display the corresponding menu</td>
</tr>
</tbody>
</table>
Chapter 3 HARDWARE DEVICES AND DRIVERS

Mouse

Like keyboards, the mouse can be directly connected to a mouse port, built into the keyboard as a piezoelectric control, or connected to the serial port or device on a USB port or hub.

After the mouse has been installed, you can adjust the characteristics of its action by changing the configuration on the Properties page of the Mouse applet in the Control Panel. Figure 3.12 shows a typical Mouse Properties page.

Using the Mouse applet you can select the mouse to be left-handed or right-handed, select double- or single-click to select objects, and set the speed at which a double-click is recognized.

You can also have the mouse pointer jump to the default dialog box or button, thereby requiring fewer mouse movements to make a selection. You can configure the mouse pointer to accelerate if you move the mouse faster. This results in the mouse pointer moving a longer distance with a quicker mouse movement than it would if you moved the mouse over the same distance but at a slower rate.

Windows 2000 Professional does not support the Intellipoint software because of conflicts with the new Power Management features. Windows 2000 Professional does, however, fully support...
the IntelliMouse wheel without any additional software. Windows 2000 Professional natively supports the positioning wheel found in many mouse devices. Figure 3.13 shows the Advanced Settings screen from the Mouse applet in Control Panel, showing the detection of a positioning wheel.

**Multimedia**

Categories of multimedia devices in Windows 2000 Professional include audio, video, and MIDI. In addition, the Microsoft Media Player can use the Web to access music files and radio stations that broadcast programming. The CD Player can be used to control the playback of music CDs from the system’s CD-ROM drive.

Figure 3.14 shows the Sounds configuration page from the Sounds and Multimedia folder in the Control Panel.

This provides a mechanism to control the sounds used for specific events within Windows 2000 and many of its installed services (such as Netmeeting, MSN messaging, and Active Sync). You can also customize the sounds used for these events and save the configuration as a sound scheme.

The Speakers tab also allows you to specify the type of speaker system you have attached to your Windows 2000 Professional computer. This can vary from the simple to a five-speaker surround-sound setup (see Figure 3.15).

**Smart Cards**

Smart cards are programmable computing devices that are usually credit card-sized. Applications and data can be downloaded onto these cards for a variety of uses, including authentication, certificate storage, record keeping, and so on.

Although the processor included in the card can give it great capability, a smart card is not a stand-alone computer. It must be connected to other computers to be useful. Smart cards today contain an 8-bit micro-controller with 16KB or more of memory.

In the Windows 2000 operating system, smart cards and certificate-based logon are fully supported. In this architecture, the smart card contains the certificate and associated private key. When you are logging on to your Windows 2000 Professional computer, a challenge is
sent to the smart card. The smart card signs the challenge with the private key, and the result, along with the certificate, is submitted to the authentication service. The authentication service verifies the signature and permits or denies the logon request.

To communicate with its host computer, a smart card must be placed in a smart card reader. The following procedure describes how to connect a smart card reader to your Windows 2000 Professional computer.

**STEP BY STEP**

3.8 Installing a Smart Card Reader

1. Shut down and turn off your computer.
2. Attach the smart card reader to an available serial port or insert it into an available PCMCIA slot.
3. If you are installing a serial reader and it has a supplemental cable, attach your keyboard or mouse connector to it and then connect the smart card reader to your keyboard or mouse port. Newer smart card readers use power from the keyboard or mouse port.
4. Boot your machine and log on.
5. If your smart card reader is a Plug and Play-compliant device, Windows 2000 Professional will automatically detect it and install the correct device drivers.
6. If your device is not Plug and Play-compliant, you will require a setup disk from the manufacturer and possibly the Windows 2000 Professional CDs to load the correct device drivers.
7. Click on Start, select Settings, and click on Control Panel.
10. Expand Services and Applications and click on Services.

continues
11. Right-click on Smart Cards Resource Manager, select Properties, and choose Automatic from the Startup Option.

12. Click Start to start the Smart Card Resource Manager and click OK.

Cameras
Cameras are added by using the Scanners and Cameras Wizard found in the Control Panel. After installing the camera and connecting any cables required to your Windows 2000 Professional computer, you can use the following procedure to install a camera.

**STEP BY STEP**

### 3.9 Installing a Camera

1. Click Start, select Settings, and click Control Panel.
2. Double-click the Scanners and Cameras icon.
3. Click the Add button to start the Scanners and Cameras Installation Wizard.
4. Click Next to close the Welcome screen.
5. Select the manufacturer and device model that you are installing and click Next.
6. Select the port that you have installed your camera on and click Next.
7. Provide a name for the device and click Next.
8. Click Finish to complete the installation.
Modems
Windows 2000 Professional supports many different brands of modems. To check whether the modem you are installing is supported, you can review the Hardware Compatibility list (HCL) on the Microsoft Web site (www.microsoft.com/hcl).

Modems are most commonly used to dial up remote systems or Internet service providers using speeds up to 56Kb over analog phone lines. Modems from different manufacturers achieve high-speed transmission by using a variety of techniques (some of which are proprietary to that company). Compatibility problems between these different methods can cause your modem to drop to a lower speed in search of a compatible transmission technique.

Installing Modems
The following procedure will allow you to install a new modem into your Windows 2000 Professional computer.

**STEP BY STEP**

3.10 Installing a Modem

1. Click Start, select Settings, and click Control Panel.
2. Click Phone and Modem options and select the Modems tab.
3. Click Add to start the Add/Remove Hardware Wizard.
4. If your modem supports Plug and Play click Next to allow Windows 2000 Professional to detect any new hardware.
5. If your modem is not detected automatically, click on Don't Detect My Modem and click Next.
6. Select the manufacturer and model of modem you have installed and click Next.
7. Select the port you have installed your modem on and click Next to start the modem installation.
8. Click Finish to complete the modem setup.
Troubleshooting Modem Installations
The following are some troubleshooting suggestions when you run into problems while installing a new modem:

◆ **Turn on external modems.** Plug and Play-compliant devices may not be detected correctly if they are not powered on.

◆ **Check the manufacturer’s Web site.** The modem manufacturer may have new installation files (.INF files) available online.

◆ **Use diagnostics.** By selecting your new modem (after installation and setup), clicking on Properties, and selecting the Diagnostics tab, you can query the modem and view log files.

◆ **Check hardware settings.** Typical settings for a modem are 8 data bits, no parity, and 1 stop bit. An alternate (and older) configuration is 7 bits, even parity, and 1 stop bit.

◆ **Use the Add/Remove Hardware Wizard.** If you install an internal modem card or PCMCIA modem card that is not Plug and Play-compatible, you may need to configure its internal COM port using the Add/Remove Hardware Wizard in the Control Panel.

**Infrared Data Association (IrDA) Devices**
Windows 2000 Professional supports the IrDA protocols enabling data transfer over infrared connections. The Windows 2000 Professional Plug and Play architecture will automatically detect and install the IrDA components for computers with built-in IrDA hardware (most laptops, for example, will have an infrared port somewhere). For computers that do not have built-in infrared ports, you can attach a serial IrDA device to a COM port or connect one using a USB port or hub.

Most laptops now ship with IrDA ports that provide either 115Kbps or 4Mbps transmission speeds. Figure 3.16 shows the properties page of the IrDA port where the maximum speed of the port is configured.
The most common implementation of the infrared ports on portable computers is the Serial IrDA (SIR) standard. This is a half-duplex system with a maximum transmission speed of 115Kbps. It will adjust to accommodate lower speed devices. This standard provides short-range infrared asynchronous serial connections with 8 bits of data, no parity, and 1 stop bit.

There is a high-speed extension (FIR) that supports half-duplex connections at 4Mbps. This standard is commonly installed on new devices and can communicate with existing lower-speed devices. In a device that is half-duplex, communications cannot go in both directions at once. Access to the line is signaled, and control of the communications link will flip back and forth between one device and the other. This turnaround does take some time to happen, so if many small messages are being sent, full duplex (even at a slower speed) may be more efficient. The high-speed half-duplex connections are best for devices that are transmitting data in bulk (such as cameras or scanners).

**Installing Infrared Devices**

Most internal IrDA devices will be installed automatically by Windows 2000 Professional setup or when you reboot your computer after adding an IrDA device.

The following procedure shows you how to install a new infrared serial transceiver.

**STEP BY STEP**

3.11 Installing an Infrared Device

1. Click on Start, select Settings, and click on Control Panel.
2. Double-click on the Add/Remove Hardware icon.
3. Click Next to close the Welcome page.
4. Select the Add/Troubleshoot a Device option and click Next.

*continues*
In the Choose a Hardware Device window, select Add a New Device and click Next.

Select No, I Want to Select the Hardware from a List option and click Next.

In the Hardware Types window, select Infrared Devices and click Next.

Select the manufacturer and model of the device you are installing and click Next.

Click Finish to complete the installation.

**Wireless Devices**

The Wireless Link file transfer program, infrared printing functions, and image transfer capability are installed by default with your Windows 2000 Professional operating system. In addition, IrDA supports Winsock API calls to support programs created by other software and hardware manufacturers. The Winsock API calls can be used to provide infrared connections to printers, modems, pagers, PDAs, electronic cameras, cell phones, and handheld computers.

In addition to sending or printing files, you can also set up network connections between two computers using the infrared port. This capability can be used to set up shared drives and work with files and folders from your laptop to a host computer.

If your computer comes with an infrared port or you have installed an infrared transceiver, Windows 2000 Professional will include an infrared port as a local port in the Add Printer Wizard dialog box. If you associate a printer with this port, Windows 2000 Professional will use the IrDA port (using a protocol called IrLPT) to transmit output to the printer. Figure 3.17 shows the point in the Add Printer Wizard dialog box where the infrared printer port can be selected.

**Linking Infrared Devices**

Infrared links are established between two infrared devices. In any link, one device is considered to be primary and one secondary. This role is determined dynamically when the link is established.
and continues until the link is broken. Normally, any station can assume any role, so data transfer can be initiated from either side. When communications are first established, the commanding station sends out a connection request at 9600 bps. The responding station assumes the secondary role and returns information listing its capabilities. Both the primary and secondary stations then change the connection rate and link parameters to the common set established by this initial negotiation. With the connection established, data transfer is put under the control of the primary device.

A single IrDA device cannot link to more than one other IrDA device at a time. You can, however, install multiple IrDA devices to COM ports or USB hubs to provide simultaneous links to multiple remote devices. For example, you can have a desktop computer connect to a notebook and a digital camera simultaneously using two IrDA transceivers.

The Winsock API does support multiple simultaneous connections over a single IrDA device. This allows different programs to use the infrared device to perform many tasks with the remote device. For example, your laptop can connect to a desktop device, share files, synchronize offline folders, and send and receive mail. Each task is controlled by a different program on the laptop; however, they all use the single connection over an IrDA device.

### Printing to an Infrared Printer

Printing to an infrared-connected printer is much the same as printing to a locally connected printer. After you establish an infrared connection to the printer, Windows 2000 Professional automatically installs the printer onto your system. You may need to install the printer manually using the Add Printer Wizard if Plug and Play does not detect or install the new printer, or if you have installed the infrared transceiver to the COM port.

### Infrared Network Connections

If your computer has a built-in infrared port or you have installed an infrared transceiver, you can create a direct connection to another computer using the infrared port. When Windows 2000 Professional detects an infrared port, it includes that information as an available connection using Network and Dial-up Connections. This enables you to map shared drives on your network (through a host computer) to your laptop.

---

**Establish a Connection** Before printing to the infrared attached printer, you must always establish a connection first. You do that by aligning the IR “eyes” until the InfraRed connection icon appears in the taskbar.
To connect two computers using the infrared port, you must first create an infrared network connection on both computers. When you use the Network and Dial-Up Connections Wizard to create a network connection, you specify a local connection using the infrared port.

The following procedure can be used to create an infrared network connection.

**STEP BY STEP**

3.12 Creating an Infrared Network Connection

1. Click on Start, select Settings, and click on Control Panel.
2. Double-click on Network and Dial-Up Connections.
3. Double-click on Make New Connection.
4. Click Next to close the Network Connection Wizard Welcome page.
5. Select Connect Directly to Another Computer and click Next.
6. Select Host if this computer will receive dial-up connections, or Guest if it will be dialing out.
7. Click Next.
8. Under Select a Device, select Infrared Port and click Next.
9. To make this connection available for all profiles, select For All Users and click Next.
10. Enter the name of the connection and click Finish.

**Universal Serial Bus (USB) Devices**

The Universal Serial Bus (USB) is an external polled serial bus deployed in a star topology that allows you to connect high-speed, low-latency devices to your computer. The USB protocol runs at 1 to 12Mb/sec, and supports Plug and Play and power management. USB devices are hot-pluggable to allow you to add or change devices.
without restarting your Windows 2000 Professional computer. The higher speed and polling rate that USB performs provides better support for games, and the higher bandwidth provides better support for multimedia devices.

USB is a token-based protocol that Windows 2000 Professional polls to detect changes to the number and type of devices connected. A computer equipped with a USB port can support up to 127 devices attached simultaneously. This means you can have a scanner, printer, camera, mouse, keyboard, game controller, and speakers running simultaneously. Connecting this many devices to the USB port is accomplished using a USB hub (or set of USB hubs).

Hubs can be self-powered with an external power source or they can be bus-powered and get their power from the bus itself. The USB definition allows for a total of five tiers (that is, hubs attached to hubs) in a USB network. With the Windows 2000 Professional computer acting as the USB host, that leaves a total of four tiers (or network segments) for actual devices.

Figure 3.18 is a representation of the way that USB connections are depicted.

**FIGURE 3.18**
USB architecture.
There are a few restrictions on using a multi-tiered architecture. The following is a list of restrictions:

- Bus-powered hubs cannot be plugged into bus-powered hubs if a device is connected after the second hub that uses the full bandwidth of 12Mb/sec.
- Bus-powered hubs cannot have more than four downstream ports.
- Bus-powered hubs cannot support bus-powered devices that use more than 100 milliamps. Bus-powered hubs will, however, support self-powered devices.
- The hub cascade depth including the host computer cannot exceed five tiers.

Configuring Accessibility Options

If you have a motion-related disability, you can use Windows 2000 Professional to configure the keyboard and mouse to provide a more comfortable environment. The Keyboard applet in Control Panel contains configurations for people who use alternate keyboard layouts or type with one hand. The Mouse applet in Control Panel can be used to configure the mouse for left- or right-handed usage and to vary the double-click speed or acceleration of the pointer.

On Screen Keyboard

The On Screen Keyboard is a utility that displays a virtual keyboard on the display screen and allows you to type in data using a pointing device such as a mouse or joystick. This is intended to provide a minimum level of functionality for users with mobility impairments. It also works if you can't type.

The On Screen Keyboard is started by clicking on Start, selecting Programs, Accessories, Accessibility and clicking the On Screen Keyboard menu item.
The On Screen Keyboard has the following three modes for typing:

- **Clicking mode.** You click the onscreen keys to type in text.
- **Scanning mode.** The On Screen Keyboards continually scan the keyboard and highlight areas where you can type by pressing a hot key or using a joystick.
- **Hover mode.** You use a mouse or joystick to point to a key for a predefined period of time, and the selected character is automatically typed.

**MouseKeys**

Through the Accessibility Options applet in the Control Panel and by selecting the Mouse tab you can enable MouseKeys. This allows the numeric keyboard to move the cursor and provides for left- and right-clicking plus dragging and dropping. To perform these actions, try one of the following:

- To click, press 5 on your numeric keypad.
- To double-click, press the plus sign (+) on your numeric keypad.
- To right-click, press the minus sign (-) on your numeric keypad, and then press 5 to click, or press the plus sign (+) to double-click.
- To click as if you were using both mouse buttons at once, press the asterisk (*) on your numeric keypad, and then press 5 to click or use the plus sign (+) to double-click.
- To switch back to standard clicking, press slash (/) on your numeric keypad.

The mouse is also used in an additional accessibility option called Magnifier. This is a utility that makes the screen more readable if you have low vision. Magnifier creates a separate window that displays a magnified portion of your screen. The magnifier will track
the mouse pointer as it moves on the screen, follow the keyboard focus, and follow text editing. Magnifier also provides the following functionality:

- You can change the magnification level.
- You can change the size of the magnification windows.
- You can change the position of the magnification windows on your desktop.
- You can invert the screen colors.
- You can set the contrast high.

**MAINTAINING UPDATED DRIVERS**

*Update drivers.*

Windows 2000 Professional provides a mechanism to automatically update device drivers on your computer. The following procedure can be used to update a single device driver.

**STEP BY STEP**

3.13 Updating a Device Driver

1. Click Start, select Settings, and click Control Panel.
2. Double-click the System icon and select the Hardware tab.
3. Click the Device Manager button to display the list of devices by type.
4. Expand a device type to show the specific devices installed.
5. Right-click a specific device and select Properties.
6. Select the Driver tab and click the Update Driver button.
7. Click Next to close the Welcome page of the Update Device Driver Wizard.
8. Select the Search for a Suitable Driver for My Device button and click Next.

9. Click Next to start a search for an updated driver for this device. The search will be made on disk, on CD (if available), or at the Windows Update Web site.

Windows 2000 Professional provides an additional mechanism for updating all device drivers and software at once, rather than by individually addressing each device on your computer.

When using Windows Update, the hardware IDs for the devices installed are compared to what the Microsoft Web site has to offer. If an exact match is made, the new driver is downloaded and installed. If an update to an existing driver is found, the new software components will be listed in the Web site and a download button will load the updated drivers onto your Windows 2000 Professional computer into a temporary directory for installation.

The following procedure will update all the device drivers on your computer.

**STEP BY STEP**

3.14 Using Windows Update

1. Click Start and select Windows Update.

2. Click Products Updates on the Microsoft Windows Update Web page.

3. Select the components to download and click on the Download icon.

**Administrative Privileges** You must be logged in with a user ID that has administrative privileges to update device drivers. The permissions that your user ID requires will allow you to load and unload a driver, copy files to the system32\drivers directory, and write settings to the registry.

**Administrative Privileges** You must be logged in with a user ID that has administrative privileges. Your computer must also be connected to a network with access to the Internet. The first time you visit the Product Updates page you may be required to install additional software or controls.
MULTIPLE PROCESSOR MACHINES

Monitor and configure multiple processing units.

Windows 2000 Professional is designed to run uniformly on uniprocessors and symmetric multiprocessor platforms.

Windows 2000 Professional supports the addition of a second CPU. Support for multiprocessors has the following conditions:

- Both CPUs are identical and either have identical coprocessors or no coprocessors.
- Both CPUs can share memory and have uniform access to memory.
- Both CPUs can access memory, process interrupts, and access I/O devices.

Although the Windows 2000 Professional operating system has been designed for both uniprocessor and multiprocessor operations, if you originally installed Windows 2000 Professional on a computer with a single CPU, the Hardware Abstraction Layer (HAL) must be updated to use the additional CPU.

The following procedure will install support for multiple CPUs.

STEP BY STEP

3.15 Supporting Multiple CPUs

1. Click Start, select Settings, and click on Control Panel.

2. Double-click on the System icon and select the Hardware tab.

3. Click on the Device Manager button.

4. Expand the Computer item. Make note of the current CPU support.

5. Double-click on the computer type listed and select the Drivers table.

6. Click the Update Driver button and then click Next to close the Welcome screen of the Update Driver Wizard.
7. Select Display a List of Known Drivers for This Device and click on Show All Hardware of This Device Class.

8. Click on Next and then click Finish.

**Monitoring Multiple CPUs**

Scaling is the process of adding processors to your system to achieve greater throughput. CPU-intensive applications such as database servers, Web servers, and file and print servers will benefit from multiple CPUs. Applications such as scientific, financial, or CAD systems may also demand the power of multiple CPUs.

You can monitor the activity of your multiprocessor system by using the Performance Monitor counters and charts. The following factors are important when looking at the performance of multiple CPUs:

- **Processor utilization and queue length.** Your workload may be structured such that one CPU is overloaded.
- **Processor data.** Context switches and interrupts, for example, can provide information on the workload your system is handling.
- **Resource utilization information.** Disk, memory, and network components, for example, may indicate that your system requires an increase in the capacity of these resources.

**Impact on Resources**

Increasing the performance power of your computer will place additional strain on system resources. For example, sharing resources will increase memory latency. A multiprocessor system needs to lock out shared data to ensure data integrity, and locked shared data may result in contention for shared data structures. The synchronization mechanism used to lock shared structures increases the processor code path. As a rule of thumb, it may be necessary to increase other resources when adding additional processor resources.
Memory

It is recommended that you scale the amount of memory with the number of CPUs. For example, if your uniprocessor system required 64MB of memory, a dual-processor system will require 128MB of memory.

Disk and Networking

When adding processors to your system, it is generally necessary to increase the disk capacity and network capacity. This can mean replacing your disks with disks of higher rotational speed or by striping or mirroring some data disks. Networking components can be upgraded to intelligent interrupt pooling adapters that reduce the processor workload. Table 3.10 contains the Performance Monitor objects that are most useful in monitoring a system with multiple CPUs.

<table>
<thead>
<tr>
<th>Counter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process: Thread Count</td>
<td>Shows the instantaneous value, not the average. You need to monitor this counter at various times to get an accurate picture of activity.</td>
</tr>
<tr>
<td>Processor: % DPC Time</td>
<td>Determines how much time the processor is spending processing Deferred Procedure Calls (DPCs). DPCs originate when the processor performs tasks requiring immediate attention (such as answering an interrupt request), and then defers the remainder of the task to be handled at lower priority. DPCs represent further processing of client requests.</td>
</tr>
<tr>
<td>Processor: % Interrupt Time</td>
<td>Determines how much time the processor is spending processing interrupts. If processor time is more than 90 percent and this value is greater than 15 percent, the processor is probably overloaded with interrupts.</td>
</tr>
<tr>
<td>Processor: DPCs Queued/Sec</td>
<td>Monitors the rate at which DPCs are queued on a particular processor.</td>
</tr>
<tr>
<td>Processor: Interrupts/Sec</td>
<td>Reflects the rate at which the processor is handling interrupts.</td>
</tr>
</tbody>
</table>
### System: Context Switches/Sec

Indicates that the kernel has switched the thread it is running on a processor. A context switch occurs each time a new thread runs or takes over from another. A large number of threads is likely to increase the number of context switches. Context switches allow multiple threads to share time slices on the processors, but they also interrupt the processor and might reduce overall system performance, especially on a multiprocessor. You should also observe the level of context switching over time.

### System: System Calls/Sec

Monitors the frequency of calls to Windows 2000 Professional system service routines. These are the services exported to applications from the kernel.

### Thread: % Processor Time

Monitors processor time usage by threads on the system.

### Thread: Context Switches/Sec

Monitors context switches generated by individual threads.

## Network Adapters

**Install, configure, and troubleshoot network adapters.**

If you install a new network adapter in your computer, the next time you start Windows 2000 Professional, a new local area connection icon appears in the Network and Dial-Up Connections folder. Plug and Play functionality finds the network adapter and creates a local area connection for it. By default, the local area connection is always activated. If your computer has more than one network adapter, a local area connection icon is displayed for each adapter in the Network and Dial-Up Connections folder.

The new network adapter is linked into the operating system by using Bindings. Windows 2000 Professional divides networks into several layers, each acting independently of the other. The bottom layer is the network adapter card and driver.

A binding is the process that links the network components on different layers. A component in a layer can be linked to multiple components in the layer just above or below. Figure 3.19 is an example of the network architecture and how bindings connect different components in different layers.
In this example, the workstation service is bound to all possible protocols; however, the server service is only bound to the routable protocols (NWLink and TCP/IP). When configuring a network card, you assign protocols to it. The order in which these protocols are assigned can significantly improve the response you get from your network. If you have NWLink and TCP/IP traffic on your network, but your computer usually uses TCP/IP, moving that binding to the top of the list will provide better response overall. If you are connecting to a server, the server does not need to have the protocols ordered, just the Windows 2000 Professional workstation. The following procedure allows you to modify the Network Binding order.

**STEP BY STEP**

3.16 Modifying the Network Binding Order

1. Click Start, select Settings, and click Control Panel.
2. Double-click Networking and Dial-Up Connections.
3. Select the Advanced tab and click on Advanced Settings.
4. Under Client for Microsoft Networks, click one of the protocols listed.

5. Click the Up Arrow or Down Arrow button.

6. Click OK and then close the Network and Dial-Up Connections window.

Installing a Network Adapter

In addition to checking the connection into the operating system, you can also view and change the characteristics of a network card itself from the Device Manager screen.

The following procedure allows you to view and modify Network Adapter options.

**STEP BY STEP**

3.17 Modifying Network Adapter Options

1. Click on Start, select Settings, and click on Control Panel.

2. Double-click on System.

3. Select the Hardware tab and click the Device Manager button.

4. Expand the Network Adapters entry and select a specific network adapter.

5. Right-click the network adapter and select Properties.

6. Select the Advanced tab to display the options available for your network adapter.

If you disconnect your local area connection, the connection will not be automatically activated. Because your hardware profile saves this setting, it can accommodate your requirement for differing devices at different locations. For example, if you travel to a remote
sales office and use a separate hardware profile for that location that does not enable your local area connection, you do not waste time waiting for your network adapter to time out. The network adapter does not even try to connect.

By selecting the Advanced tab in Network and Dial-Up Connections and clicking on Advanced Settings, you can modify the order in which adapters are used by a connection and the associated clients, services, and protocols for the adapter.

Managing Network Adapters

Windows 2000 Professional creates a local area connection in the Network and Dial-Up Connections folder for each network adapter installed in your computer. You can eliminate possible confusion by renaming each local area connection to reflect the network it is connected to.

You must enable the network clients, services, and protocols that are required for your local area connections. When you do so, the client, service, or protocol is enabled in all other network and dial-up connections automatically.

You can create multiple dial-up, VPN, or direct connections by creating new ones with the wizard or by copying them in the Network and Dial-Up Connections folder. After you copy the connections, you can rename them and modify the connection settings.
Case Study: The Amaranth Engineering Company

Essence of the Case
The following points summarize the essence of the case study:
- The back-end database has all the important files on one disk.
- The disk failed with no recent backup.
- Recovery to the previous night required the next day’s data to be reentered.

Scenario
Although you work at an engineering company, your responsibility is to oversee the computer systems that support the company’s work. In this case, you are analyzing the recent events of the company’s accounting system. The company uses a commercial accounting system that uses a single server for a back-end database. This was installed over a year ago and has been working well. However, the database was installed with all the default settings, and a single large database file holding indexes and data was created. The transaction log files are also held on this main disk, and full backups are done each night. The incident you are reviewing involves a disk failure on the database disk late one afternoon last week. The disk was replaced, but the database needed to be recovered from the previous backup. No transaction logs are available to apply, and the entire day’s work needs to be reentered. Your task is to prevent this from happening again.

Analysis
This situation is quite a common one. An application system (in this case, an accounting application) uses a back-end database to store data and produce invoices and reports. Once all this is set up, there is a tendency to not revisit the initial configuration again until there is a problem.

Having the database tables and indexes on one disk is generally considered a potential disk performance bottleneck; however, the real problem comes when the previous night’s backup continues.
The database tables, however, are read and written randomly. In an accounting application, it may seem that you are entering a great deal of data, but almost every field must be validated against existing data (customer name, address, existing invoice number, and so on); therefore, the database is read from much more than it is written to. Because of this, the database tables should be striped (to allow parallel reads) but configured as a striped mirror or RAID-5 structure to provide redundancy.

The combination of separating the transaction logs onto a mirrored set of disks, and the database files to a mirrored striped set of disks or a RAID-5 structure, reduces your system's vulnerability to single device failures in the future.

**Case Study: The Amaranth Engineering Company**

Continued

is restored to disk. There are no transaction logs left to apply to the database in order to bring it up to the current time. With the database recovered to the previous night, all the day's transactions are lost.

The solution to this problem lies in using the disk management features of Windows 2000 Professional to create a fault-tolerant disk structure on the Windows 2000 Server to house the database and transaction logs. First, transaction logs should always be separated from the database tables since they are written sequentially and the database is accessed randomly. Because the transaction logs are usually only written and not read, they are best on mirrored volumes that are not striped. Striping divides the data across multiple spindles so that reading can proceed in a parallel fashion. If you are only writing to a file, this is not important.

The database tables, however, are read and written randomly. In an accounting application, it may seem that you are entering a great deal of data, but almost every field must be validated against existing data (customer name, address, existing invoice number, and so on); therefore, the database is read from much more than it is written to. Because of this, the database tables should be striped (to allow parallel reads) but configured as a striped mirror or RAID-5 structure to provide redundancy.

The combination of separating the transaction logs onto a mirrored set of disks, and the database files to a mirrored striped set of disks or a RAID-5 structure, reduces your system's vulnerability to single device failures in the future.
This chapter focused on devices and drivers that you can add to your computer to customize it for your needs.

First, the Windows 2000 Professional implementation of Plug and Play was discussed, along with resources available in Windows 2000 Professional and ways of assigning them to devices. The new dynamic disk structures available were discussed, along with CD-ROM technology and removable storage.

Second, the new Windows 2000 Professional feature allowing multiple video displays was discussed, along with the procedures for configuring your virtual desktop.

Third, to support mobile computing, the card services and APM/ACPI features of Windows 2000 Professional were discussed, along with problems associated with these devices.

Fourth, the general I/O devices available for both the desktop and laptop computer were discussed. This includes keyboards, the mouse, printers, scanners, and cameras.

Fifth, the procedures for automatically updating device drivers on Windows 2000 Professional were discussed, along with the procedure for installing multiple CPUs into your computer and the performance characteristics you should measure when you do this.

Finally, the installation and troubleshooting of network adapters was discussed.

**KEY TERMS**

- Plug and Play
- Dynamic disks
- Simple volumes
- Spanned
- Striped
- RAID-5
- Mirrored
- Media pools
- Libraries
- Advanced Power Management (APM)
- Advanced Configuration and Power Interface (ACPI)
- IrDA devices
- USB devices
Apply Your Knowledge

Exercises

3.1 Upgrading a Basic Disk to Dynamic

This exercise will go through the steps necessary to convert a basic disk with enough free space to support the dynamic volume database to a simple volume on a dynamic disk.

Estimated Time: 10 Minutes

1. Open Disk Management by clicking on Start, selecting Settings, Control Panel, Administrative Tools, Computer Management, and clicking on Disk Management.

2. Right-click on the disk you wish to convert to dynamic and select the Upgrade to Dynamic Disk menu option (see Figure 3.20).

3. Select the disk drive to upgrade and click OK.

4. Right-click the unallocated space on the new dynamic disk and select Create Volume.

5. Click Next to close the Welcome screen of the Create Volume Wizard.

6. Select the Simple Volume button and click Next.

7. Set the size of the volume to approximately one half of the available space on the dynamic disk and click Next.

8. Select Don’t Assign a Drive Letter or Drive Path and click Next.

9. Check off Perform a Quick Format (for brevity) and click Next.

10. Click Finish to start the volume creation process.

3.2 Extending a Volume

This exercise will extend the volume created in the previous exercise to use the remaining disk space on the dynamic disk.

Estimated Time: 10 Minutes

1. Open Disk Management by clicking on Start, selecting Settings, Control Panel, Administrative Tools, Computer Management, and clicking on Disk Management.

2. Right-click on the disk volume you wish to extend and select Extend Volume.

3. Click Next to close the Welcome screen on the Extend Volume Wizard.

4. Select the amount of disk to use in extending the existing volume and click Next.

5. Click Finish to start the extension process.
### Apply Your Knowledge

#### 3.3 Placing a Volume Under a Folder

This exercise will create an empty folder and then mount the volume created in the preceding exercises under that volume.

**Estimated Time:** 10 Minutes

1. Open Windows Explorer and create an empty folder under the system drive (C:).
2. Open Disk Management by clicking on Start, selecting Settings, Control Panel, Administrative Tools, Computer Management, and clicking on Disk Management.
3. Right-click on the volume to mount under the empty folder and select Change Drive Letter and Path.
4. Click on the Add button and choose the Mount in the NTFS Folder button.
5. Enter the path of the empty folder created in step 1 (or use Browse to locate it) and click Next.
6. Return to the Windows Explorer screen to see that the new folder is now associated with a disk icon.

#### 3.4 Creating an RSM Media Pool

This exercise will walk through the steps to create a media pool using an Iomega ZIP device and two removable disk media.

**Estimated Time:** 20 Minutes

2. Expand the Removable Storage item.
3. Insert the first blank disk into the Iomega ZIP device.
4. Right-click the physical device in Removable Storage and select Inject.
5. Select Next to close the Welcome screen of the Media Inject Wizard.
6. Wait for the inject process to finish and click on Finish.
7. Select the Iomega ZIP icon in the Import Media pool.
8. Right-click the new disk icon and select Properties.
9. Change the name of the disk to “Disk1” and click OK.
10. Right-click the Disk1 icon and select Prepare. (The disk will move from the Import Media pool to the Free Media pool.)
11. Right-click the Disk1 icon in the Free Media pool and select Eject. (Disk1 should now be part of the Offline Media Pool as well.)
12. Repeat steps 3–11 for a second disk, labeling it Disk2.
13. Right-click the Media Pool icon in Removable Storage of Computer Management and select Create Media Pool.
14. Name the new pool “Test” and select IOMega ZIP as the media type it contains.
15. Check the Draw Media from Free Media Pool and Return Media to Free Media Pool boxes and click OK.
Apply Your Knowledge

16. Start a command prompt window and enter the command RSM ALLOCATE /Mtest /Onew /LNBack1.

17. Click OK on the Messenger Service window.

18. Load Disk1 into the Iomega ZIP device. (Disk1 will have moved from the Free Media pool to the Test Media pool.)

19. The disk can now be formatted using the sample command format g:/FS:NTFS/V:Disk1 and mounted and dismounted using the commands RSM MOUNT/LFBack1/Owrite and RSM DISMOUNT /LFBack1. The device can be ejected using the command RSM EJECT/PFDisk1/ASTART.

3.5 Enabling Hibernation

This exercise will enable your system to go into hibernation depending on conditions within your computer.

Estimated Time: 5 Minutes

1. Open Power Options in Control Panel by clicking on Start, selecting Settings, Control Panel, and clicking on Power Options.

2. Select the Hibernate table and select the Enable Hibernate Support check box.

3. Click Apply to set up Hibernation. (If Enable Hibernate is not available, your system does not support hibernation or there is not enough disk space available to support the process.)

4. Selecting the Power Schemes tab will allow you to set the time delays for blanking the monitor, spinning down hard drives, and putting the system on standby when under battery power.

3.6 Installing a USB Device and Measuring Power Used

This exercise will go through the steps to install a bus-powered USB device (a Microsoft IntelliMouse Optical) and then cover how to measure the power consumed.

Estimated Time: 10 Minutes

1. Unplug any existing mouse currently connected to your Windows 2000 Professional computer.

2. Plug in the Microsoft IntelliMouse Optical mouse to a USB port on your computer.

3. Wait until the Found New Hardware window closes (it should find a Microsoft IntelliMouse Optical and a USB Human Interface Device). The new optical mouse should now function.

4. Click on Start, select Settings, and click on Control Panel.

5. Double-click on Administrative Tools.

6. Double-click on Computer Management, then click on Device Manager.

7. In the right window expand the Universal Serial Bus Controllers item.

8. Right-click on USB Root Hub and select Properties.

9. Select the Power tab. You should see a device on the hub identified as an HID-compliant mouse using a total of 100mA.
3.7 Transferring Files Using a Wireless Connection

This exercise will walk through the steps necessary to set up a connection and transfer files between computers using a wireless (IrDA) connection.

Estimated Time: 10 Minutes

1. Click Start, select Settings, Control Panel, and double-click on Wireless Link.
2. Select the File Transfer tab and check the Display an Icon on the Taskbar Indicating Infrared Activity check box.
3. Click OK to close the Wireless Link window.
4. Reposition the two infrared transceiver windows until the Infrared icon appears on the taskbar.
5. Click on the Infrared icon on the taskbar.
6. In the Wireless Link dialog box, select the files you want to send and click Send.
7. You can also send files using the IRFTP program started from Start/Run or any command prompt.

Review Questions

1. After you change the resources your non-Plug and Play video adapter uses in Device Manager, the system will not boot correctly. What is wrong?
2. Your application currently uses logical disks on which to store some of its data. The application needs to reference these logical devices using drive letters. You have converted your system to use dynamic disks and would like to organize these files into a subdirectory. Will your application be able to read its data? Why or why not?
3. What devices does RSM manage on a typical desktop computer?
4. You have a laptop that you have configured with multiple display adapters while it is in its docking bay. When you boot your laptop, the multiple displays do not work correctly. What is the reason?
5. When you installed Windows 2000 Professional, you noticed that Advanced Power Management (APM) was not enabled. After you enable APM, you find that your system will not boot correctly. What is the reason?
6. You install a new high-speed modem that the salesman said would run at 56Kb. When you dial up to your Internet Service Provider (ISP), you find you can’t get as much speed as you expected. What is the reason?
7. You have just purchased a new desktop computer that has Windows 2000 Professional already installed on it. You want to ensure that the latest device drivers available are installed and the drivers are all signed. What is your most efficient course of action?
8. You are using Performance Monitoring to display how busy your computer is. You note that the CPU is at 100% utilized for extended periods of time. What other performance variable should you chart to help you decide if adding an additional CPU would help the throughput of your system?
9. Your business has a network that uses both IPX and IP for data communications, but your Windows 2000 Professional computer uses IP almost exclusively. How should you configure your network connections to reflect this usage?


Exam Questions

1. You are the system administrator with a small engineering firm. You look after all the application and database systems.

You have three applications that all share a common database server. The database supports many transactional systems for the company.

The server is running Windows 2000 Advanced Server and has three large disk drives.

You have been tasked with the job of recommending a new configuration to minimize system downtime in case of disk hardware failure.

Required Result:

You must protect the application data from loss when a disk fails.

Optional Desired Results:

You should configure the disks to give the best performance.

You should allow the disk system to grow with additional activity.

Proposed Solution:

Split the disk structure into two logical sections: a basic disk system for the Windows 2000 operating system and a dynamic disk supporting the database tables and logs. You make the dynamic disks part of a RAID-5 structure.

Which result(s) does the proposed solution produce?

A. The proposed solution produces the required result and produces all of the optional desired results.

B. The proposed solution produces the required result and produces only one of the optional desired results.

C. The proposed solution produces the required result but does not produce any of the optional desired results.

D. The proposed solution does not produce the required result.

2. You are the system administrator with a small engineering firm. You look after all the application and database systems.

You have three applications that all share a common database server. The database supports many transactional systems for the company.

The server is running Windows 2000 Advanced Server and has three large disk drives.

You have been tasked with the job of recommending a new configuration to minimize system downtime in case of disk hardware failure.
**Apply Your Knowledge**

**Required Result:**
You must protect the application data from loss when a disk fails.

**Optional Desired Results:**
You should configure the disks to give the best performance.
You should allow the disk system to grow with additional activity.

**Proposed Solution:**
Split the disk structure into three logical sections: a basic disk system for the Windows 2000 operating system, a dynamic disk supporting the database tables, and a separate dynamic disk supporting the transaction logs. You make the dynamic disks supporting the database files part of a RAID-5 structure and the dynamic disk supporting the transaction logs part of a mirrored disk structure.

Which result(s) does the proposed solution produce?
A. The proposed solution produces the required result and produces all of the optional desired results.
B. The proposed solution produces the required result and produces only one of the optional desired results.
C. The proposed solution produces the required result but does not produce any of the optional desired results.
D. The proposed solution does not produce the required result.

3. You are responsible for maintaining online copies of graphical images used by an application program. These images need to be available all the time; however, you have no idea how much storage space will be needed. How should you configure storage on your computer?
   A. Connect a tape drive to your computer and save the image files to tape when your disk fills.
   B. Add additional disks to your computer when storage space runs low and use Disk Management to create a spanned volume.
   C. Compress the images and place them in .ZIP files.
   D. Create a RAID-5 disk structure on a Windows 2000 Server and store the images there.

4. You are the applications expert at an engineering firm.
   You are attempting to install multiple display adapters to your Windows 2000 Professional workstation to enhance your CAD application.
   You are at the point in the process when you are about to extend the virtual desktop to the new display, but Windows 2000 Professional has grayed out the check box, indicating that it cannot use the device.
   What should be your first debugging step?
   A. Run the application full screen.
   B. Confirm that the video adapter is supported as a secondary display.
C. Confirm that the secondary display is detected.
D. Run the application on the primary screen.

5. You have an application that performs an analysis of statistical data captured by your engineering firm. To do this analysis, your application reads and writes a large number of temporary files to disk. You wish to provide the best throughput possible for this temporary information, but you do not need to provide any fault tolerance. What should you do?
A. Create a spanned volume across several disks.
B. Create a striped volume across several disks.
C. Create a RAID-5 structure on a Windows 2000 Server and store the temporary files there.
D. Create a single large volume named \TEMP and direct your application to store its temporary files there.

6. You are the local business lead for your department and are considered the local IT expert and the person people go to for help before involving the company’s help desk.

Your new desktop standard includes APM support in the BIOS.

You have enabled APM on several pilot machines in your department to see what the effect is on the systems and applications your group runs. You configure APM and try a suspend and resume. The video display does not restart after the resume.

What is the problem?
A. The BIOS timeout for video blanking is enabled and resume does not restore the video configuration correctly.
B. The timeout value for the screen saver to blank the video elapsed while the suspend was in place. When resume restarts the system, the screen immediately will blank out until a mouse movement or keyboard entry restarts it.
C. The video adapters found in the desktop system cannot normally be corrected by suspend. When resume restores the system, the video is not restarted.
D. Suspend will save the video configuration correctly, but resume will not restore it if the APM is enabled in the BIOS.

7. You are visiting one of your company’s remote customer offices and need to transfer some files from your laptop to a local machine. For security reasons you do not want to join your customer’s domain, but you still need to transfer the files. What should you do?
A. Create a null modem cable and transfer the files via FTP.
B. Create a crossover network cable and copy the files via command line or Windows Explorer drag and drop.
C. Align the machines’ IrDA ports and copy the files using the wireless link.
D. Connect to your ISP host and copy the files to the customer’s Web site using FTP.
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Apply Your Knowledge

8. You have a small network installed at your home office and are installing a new printer.

The printer is attached to a Windows 2000 Server on your network.

You wish to share the printer with the other systems you use. You have installed the printer with the driver provided by the manufacturer, but you can't get anything to print from the other Windows 2000 Professional workstations you use.

When you open the Printer icon on the task bar you see Opening as the status but nothing is ever printed.

What is the first thing you need to check?
A. The share permissions are not correct for this printer.
B. The server does not have enough disk space for the spooling operation and the printer will not initialize.
C. The driver is incorrect or out of date and should be updated.
D. The printer is jammed and will not initialize until the problem is cleared and the printer comes back online.

9. As the system administrator, you set the policy on the configuration of new computer hardware purchased for the company. You decide that, for flexibility, you will have all the disk storage devices for new Windows 2000 Professional computers configured as simple volumes. When you configure this on a new laptop you find that the option to do the conversion from basic to dynamic disks is not present. What is your course of action?
A. Make sure you purchase disk drives that support being dynamic disks.
B. Amend your policy to allow laptops to remain configured with basic disks.
C. Manually fix the DMA, I/O, and IRQ resources used by the disk drive rather than letting Plug and Play choose them.
D. The disk drives cannot be made dynamic until a small partition is created at the end of the device.

10. You are setting up a computer system to be used in displaying CAD output in a lecture theater. You have already set up the nine display devices and are now ready to install the computer system to drive them. What is your course of action?
A. Install Windows 2000 Professional and then install the display adapters.
B. Install the display adapters and then install Windows 2000 Professional.
C. Disable the built-in AGP-compliant video adapter.
D. Turn off the built-in video adapter after the system is set up.

11. You are a local expert in a department of financial analysts.

Some of the financial models you and your staff run are very computer-intensive. They use a common network server for the model. You have several machines in your group that are running at 100% CPU usage for extended periods of time.
Required Result:
You need to increase the amount of CPU available for these systems.

Optional Desired Results:
You should ensure that the system does not develop any other bottlenecks.
You should ensure that the workload is utilizing the system resources correctly.

Proposed Solution:
You add a CPU to the system.
You replace the network adapter with an intelligent device that supports interrupt pooling.

Which result(s) does the proposed solution produce?
A. The proposed solution produces the required result and produces all of the optional desired results.
B. The proposed solution produces the required result and produces only one of the optional desired results.
C. The proposed solution produces the required result but does not produce any of the optional desired results.
D. The proposed solution does not produce the required result.

12. You are a local expert in a department of financial analysts.
Some of the financial models you and your staff run are very computer-intensive. They use a common network server for the model. The machines in your group are running at 100% CPU usage for extended periods of time.

Required Result:
You need to increase the amount of CPU available for these systems.

Optional Desired Results:
You should ensure that the system does not develop any other bottlenecks.
You should ensure that the workload is utilizing the system resources correctly.

Proposed Solution:
You add a CPU to the system.
You replace the disk subsystem with devices that have a higher rotational speed.
You replace the network card with an intelligent device that supports interrupt pooling.
You monitor the processor queue length in the Performance Monitor to make sure your workload does not overwork one of the CPUs.

Which result(s) does the proposed solution produce?
A. The proposed solution produces the required result and produces all of the optional desired results.
B. The proposed solution produces the required result and produces only one of the optional desired results.
C. The proposed solution produces the required result but does not produce any of the optional desired results.
D. The proposed solution does not produce the required result.
APPLY YOUR KNOWLEDGE

13. You have installed an infrared printer on your desktop for use with your laptop. When you first go to use the printer you find that you cannot connect to it. What is your first step in troubleshooting this problem?

A. You should manually adjust the speed of the ports to the manufacturer’s specifications.
B. Check that the Infrared ports are aligned and you have a connection icon on the taskbar.
C. The device driver must be verified and upgraded to the latest available.
D. Check to make sure you have administrative privileges; you must have them the first time you access the printer in order to correctly install the printer driver.

14. You are an analyst working with the desktop support group. You are responsible for configuring new desktop machines according to the company standards.

You install all protocols used in the company and bind them to all adapters.

Several Windows 2000 Professional users have complained that their machines do not connect to network resources very quickly. You want to improve access to network resources with the minimum reconfiguration necessary.

**Required Result:**
You must improve the performance of the network configuration for the new machines.

**Optional Desired Results:**
You should ensure that the system does not develop any other bottlenecks.

**Proposed Solution:**
You review the binding order and make the most common connections first in the list.

Which result(s) does the proposed solution produce?

A. The proposed solution produces the required result and produces all of the optional desired results.
B. The proposed solution produces the required result and produces only one of the optional desired results.
C. The proposed solution produces the required result but does not produce any of the optional desired results.
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15. You are an analyst working with the desktop support group. You are responsible for configuring new desktop machines according to the company standards.

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Several Windows 2000 Professional users have complained that their machines do not connect to network resources very quickly. You want to improve access to network resources with the minimum reconfiguration necessary.

**Required Result:**
You must improve the performance of the network configuration for the new machines.
Optional Desired Results:

You should ensure that the system is using the network resources efficiently.

You should ensure that the system does not develop any other bottlenecks.

Proposed Solution:

You review the binding order and make the most common connections first in the list.

You run Performance Monitoring to see if the network device is causing a high rate of interrupts to the CPU. If it is, you plan to replace the adapter with an intelligent network adapter that supports interrupt pooling.

You run Performance Monitoring to baseline the performance characteristics of the system to track the impact that any networking changes have on the rest of the system.

Which result(s) does the proposed solution produce?

A. The proposed solution produces the required result and produces all of the optional desired results.

B. The proposed solution produces the required result and produces only one of the optional desired results.

C. The proposed solution produces the required result but does not produce any of the optional desired results.

D. The proposed solution does not produce the required result.

Answers to Review Questions

1. Non-Plug and Play devices are not detected by Windows 2000 Professional and therefore their requirements as far as the Device Manager are concerned are unknown. By manually configuring the resources used, you have told Windows 2000 Professional which resources to reserve for your device. You now need to reconfigure the device by using the manufacturer-supplied configuration program or by manually selecting onboard switches or jumpers. See “Implementing, Managing, and Troubleshooting Hardware Devices and Drivers.”

2. Dynamic disks can be accessed using an assigned drive letter as well as a path. If, however, you are going to reorganize your files into subdirectories, your only access is via the path. Your application that expects to use drive letters will not be able to access its data. See “Fixed Disks.”

3. Removable Storage Manager (RSM) manages all devices that can be removed or replaced with other media. This includes tape drives, CD-ROM and DVD-ROM drives, and JAZ and ZIP drives. RSM can handle any removable device except A: and B:. See “Removable Media.”

4. One of the rules for using multiple displays on your Windows 2000 Professional computer is that the primary display cannot be turned off. When you insert a laptop into its docking station, the display is usually disabled. This prevents the multiple display system from functioning. See “Troubleshooting Multiple Displays.”
5. If APM was installed but not enabled, Windows 2000 Professional has not found your system in its list of systems on which APM is unsafe to run. It also has not found your system in its list of APM safe systems. Thus, it considers your system to be APM-neutral. When you enabled APM, you discovered that your system should have been placed on the APM unsafe list since it has destabilized your computer. See “When to Use APM.”

6. Modems get their speed from various compression techniques. The faster the modem, the more elaborate the compression techniques. Unfortunately, these methods are not always compatible and, when connecting to an ISP, your system has negotiated a lower speed to where both devices agree on the compression methods being used. See “Modems.”

7. The most efficient way to ensure that you have the latest device drivers installed on your system and that these drivers have been signed is to use the Windows Update option directly from the Start menu. This will canvas the Microsoft Web site for the latest signed version of drivers for your system and allow you to download them for installation. See “Maintaining Updated Drivers.”

8. The other variable to chart would be the Processor Queue Length. A busy processor may be handling the workload very efficiently, or it could be overwhelmed by the workload. In that case, the backlog of work waiting to be done by the CPU would be building. This situation is identified by the processor queue length, or the number of tasks that are ready to execute if there were enough CPU resources available. See “Monitoring Multiple CPUs.”

9. The priority of the protocols used by your Windows 2000 Professional computer is reflected in the binding order. By moving TCP/IP to the top of the list and lowering IPX below it, you can significantly improve the response you get from your network. See “Managing Network Adapters.”

**Answers to Exam Questions**

1. **B.** The solution provides for fault tolerance when one disk drive fails. RAID-5 will protect you from a single device failure. (Mirrors allow 50% of the devices to fail provided that the two disks that make up the mirror do not fail together.) The dynamic disks that make up a RAID-5 structure allow additional disks to be added without interrupting the application. Earlier versions of RAID-5 required you to unload and restructure the disks, and reload the data; however, newer hardware-enabled RAID-5 does not require it. The system is still not optimal because both the applications data and the transaction logs are on the same disk. This reduces the fault tolerance and does not give the best performance possible because transaction logs are only written sequentially. Writing to a RAID-5 device is slower than other fault-tolerant solutions. See “RAID-5 Volumes.”

2. **A.** The solution provides for fault tolerance when one disk drive fails. RAID-5 protects you from a single device failure. (Mirrors allow 50% of the devices to fail provided that the two disks that make up the mirror do not fail together.) The dynamic disks that make up a RAID-5 structure allow additional disks to be added without interrupting the application. Earlier versions of
RAID-5 required you to unload and restructure the disks and reload the data; however, newer hardware-enabled RAID-5 does not require it. Separating the transaction logs to a mirrored disk structure provides additional fault tolerance and provides the best performance. Transaction logs are only written sequentially and would benefit best from a mirrored fault-tolerant disk structure over other fault-tolerant configurations. See “Raid-5 Volumes.”

3. B. The solution calls for online storage but there is no performance requirement mentioned. The application that uses the image files will not be able to find them if the images are rolled out to tape. Although this solution provides for all the images to be available, manual intervention would be required to load needed images back to disk. Likewise, most applications would not be able to extract a file from a ZIP library, and creating a RAID-5 structure provides more fault tolerance and I/O performance than is requested. The most efficient solution would be to create a dynamic disk with a simple volume and span that volume to additional disk devices when space runs low. This allows the images to appear to be available from one location even though they may span several disks. See “Spanned Volumes.”

4. B. The first thing to check is whether the device to which you are trying to extend is actually supported as a secondary display. You can assume that if the display adapter is listed in Device Manager, it has been detected successfully. Running the application in full-screen mode or on the primary display are steps that you would take if you were having problems running the application on multiple screens. In this case, you have not gotten that far in the process yet. See “Multiple Display Support.”

5. B. The problem requires better throughput on disk for data that is not going to be stored. There is no requirement for a fault-redundant RAID-5 configuration. Likewise, providing a single large volume or a spanned volume would not give the same performance as a striped volume. A striped volume will write 64KB blocks to each disk in rotation. This will have the effect of spreading the I/O load across all drives evenly. See “Striped Volumes.”

6. C. The problem with using APM on the desktop is that most video adapters used here are not expecting to be powered down (since that is more often a requirement of mobile systems). Suspend cannot correctly save the configuration, and therefore resume has nothing to reload and restart. See “Power Management.”

7. C. The easiest solution uses the built-in capabilities of Windows 2000 Professional. The built-in IrDA ports can transfer data at a rate up to 4Mb per second. This would be far faster and easier than using the COM port or built-in modem. See “Infrared Network Connections.”

8. A. A problem that shows up as Opening or Unable to Connect is probably a permissions problem. This would be caused by not configuring the share permissions on the server or by not having access to the server. See “Printers.”

9. B. Windows 2000 does not support dynamic disks on laptops, so your policy must be changed to reflect that. Neither Plug and Play nor the type of disk defines whether it can be dynamic. The “dynamic” part of dynamic disks refers to the storage structures created on the device, not the device itself. Finally, the Disk Management application will automatically reserve space at the end of the disk for its
database when converting a basic disk to dynamic. See “Upgrading Basic Disks to Dynamic Disks.”

10. **A.** Windows 2000 Professional must be completely installed before you add any additional devices for a virtual desktop. There would be no reason to disable a built-in adapter that is AGP-compliant because that is one of the accepted standards for multiple displays on Windows 2000 Professional. Once the virtual desktop has been established, you cannot turn off the first adapter since it forms the anchor point for the displays. See “Multiple Display Support.”

11. **C.** Adding a CPU to the overloaded systems will improve response in that area. Changing one component always has some impact on the rest of the resource usage in the system. Improving the network resource and reducing the number of interrupts it generates will reduce bottlenecks on the network; however, the CPU also consumes memory and disk resources that have not been addressed. See “Monitoring Multiple CPUs.”

12. **A.** Adding an additional CPU provides more computing power but it will have an impact on other resources in the system. By providing reduced network interrupts, higher rotational speed disks, and, most importantly, additional physical memory, you have guaranteed that by adding a CPU you have not just shifted the bottleneck to the next most scarce resource. See “Monitoring Multiple CPUs.”

13. **B.** The most obvious problem is misalignment of the IR eyes. To print to an infrared printer, you must first establish a connection. As soon as this is done, the printer should start to install (if it supports Plug and Play). User privilege is enough to install printer devices. The protocol used to connect to IR devices will automatically negotiate the correct speed during initialization. See “Printing to an Infrared Printer.”

14. **C.** The Windows 2000 Professional workstation will attempt to access a network resource in the order the bindings appear. The solution, however, does not address any performance problem within the network devices themselves and does not address any system bottlenecks created by networking. See “Managing Network Adapters.”

15. **A.** The Windows 2000 Professional workstation will attempt to access a network resource in the order in which the bindings appear. By charting the performance of the network components, you can address any system slowdown caused by network-generated interrupts. Changing the network adapter to a newer intelligent adapter that supports interrupt pooling will alleviate some performance problems if they occur, and baselining the performance of the entire system will allow you to track the impact of the configuration changes you are making. See “Managing Network Adapters.”
Suggested Readings and Resources