

Operating System Installation

Hard Drive Setup Procedures

Hard Drive Partitioning

As a technician, you might have to perform a clean installation of an OS. Perform a clean install in the following situations:

- When a computer is passed from one employee to another
- When the OS is corrupt
- When the primary hard drive is replaced in a computer

The installation and initial booting of the OS is called the operating system setup. Although it is possible to install an OS over a network from a server or from a local hard drive, the most common installation method for a home or small business is with CDs or DVDs. To install an OS from a CD or DVD, first configure the BIOS setup to boot the system from the CD or DVD.

Important: If the hardware is not supported by the OS, you may need to install third party drivers when performing a clean installation.

Partitioning

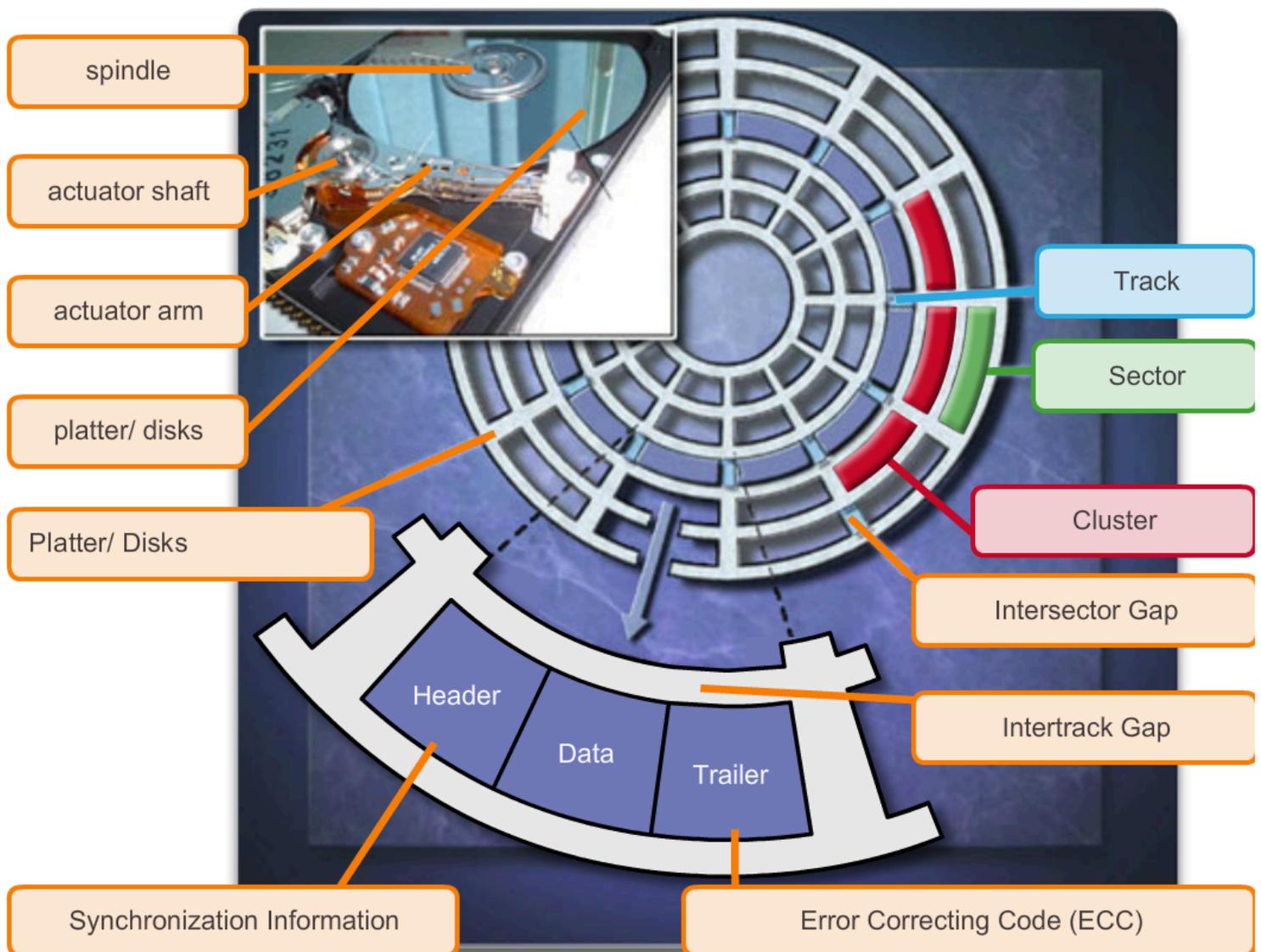
A hard drive is divided into specific areas called partitions. Each partition is a logical storage unit that can be formatted to store information, such as data files and applications. During the installation process, most operating systems automatically partition and format available hard drive space.

A technician should understand the process and terms relating to hard drive setup.

- **Primary partition** - This primary partition containing the operating system files is usually the first partition. There can be up to four primary partitions per hard drive. A primary partition cannot be subdivided into smaller sections.
- **Active partition** - The OS uses the active partition to boot the computer. Only one primary partition per disk can be marked active. In most cases, the C: drive is the active partition and contains the boot and system files. Some users create additional partitions to organize files or to be able to dual-boot the computer.
- **Extended partition** - The extended partition normally uses the remaining free space on a hard drive or takes the place of a primary partition. There can be only one extended partition per hard drive, but it can be subdivided into smaller sections called logical drives.
- **Logical drive** - A logical drive is a section of an extended partition. It can be used to separate information for administrative purposes.
- **Basic disk** - A basic disk (the default) contains primary and extended partitions, as well as logical drives. A basic disk is limited to four partitions.

- **Dynamic disk** - A dynamic disk has the ability to create volumes that span across more than one disk. The size of the partitions can be changed after they have been set. Free space can be added from the same disk or a different disk, allowing a user to efficiently store large files. After a partition has been extended, it cannot be shrunk without deleting the entire partition.
- **Formatting** - This process prepares a file system in a partition for files to be stored.
- **Sector** - A sector contains 512 bytes.
- **Cluster** - A cluster is also called a file allocation unit. It is the smallest unit of space used for storing data. It is made up of one or more sectors.
- **Track** - A track is one complete circle that can contain data on one side of a hard drive platter. A track is broken into groups of sectors.
- **Cylinder** - A cylinder is a stack of tracks lined up one on top of another to form a cylinder shape.

Structure of a Hard Drive



Hard Drive Formatting

A clean installation of an OS proceeds as if the disk were brand new. No information that is currently on the hard drive is preserved. The first phase of the installation process partitions and formats the hard drive. This process prepares the disk to accept the new file system. The file system provides the directory structure that organizes the user's operating system, application, configuration, and data files.

Windows operating systems use one of these file systems:

- **New Technology File System (NTFS)** - Supports partition sizes up to 16 exabytes, in theory. NTFS incorporates more file system security features and extended attributes than the FAT file system.
- **File Allocation Table, 32 bit (FAT32)** - Supports partition sizes up to 2 TB or 2,048 GB. The FAT32 file system is used by Windows XP and earlier OS versions.

The preferred file system type for a clean installation of Windows is NTFS. Security is one of the most important differences between FAT32 and NTFS. NTFS can support more and larger files than FAT32 and also provides more flexible security features for files and folders. Figure 1 is a comparison of the Windows file systems.

FAT32 and NTFS Comparison

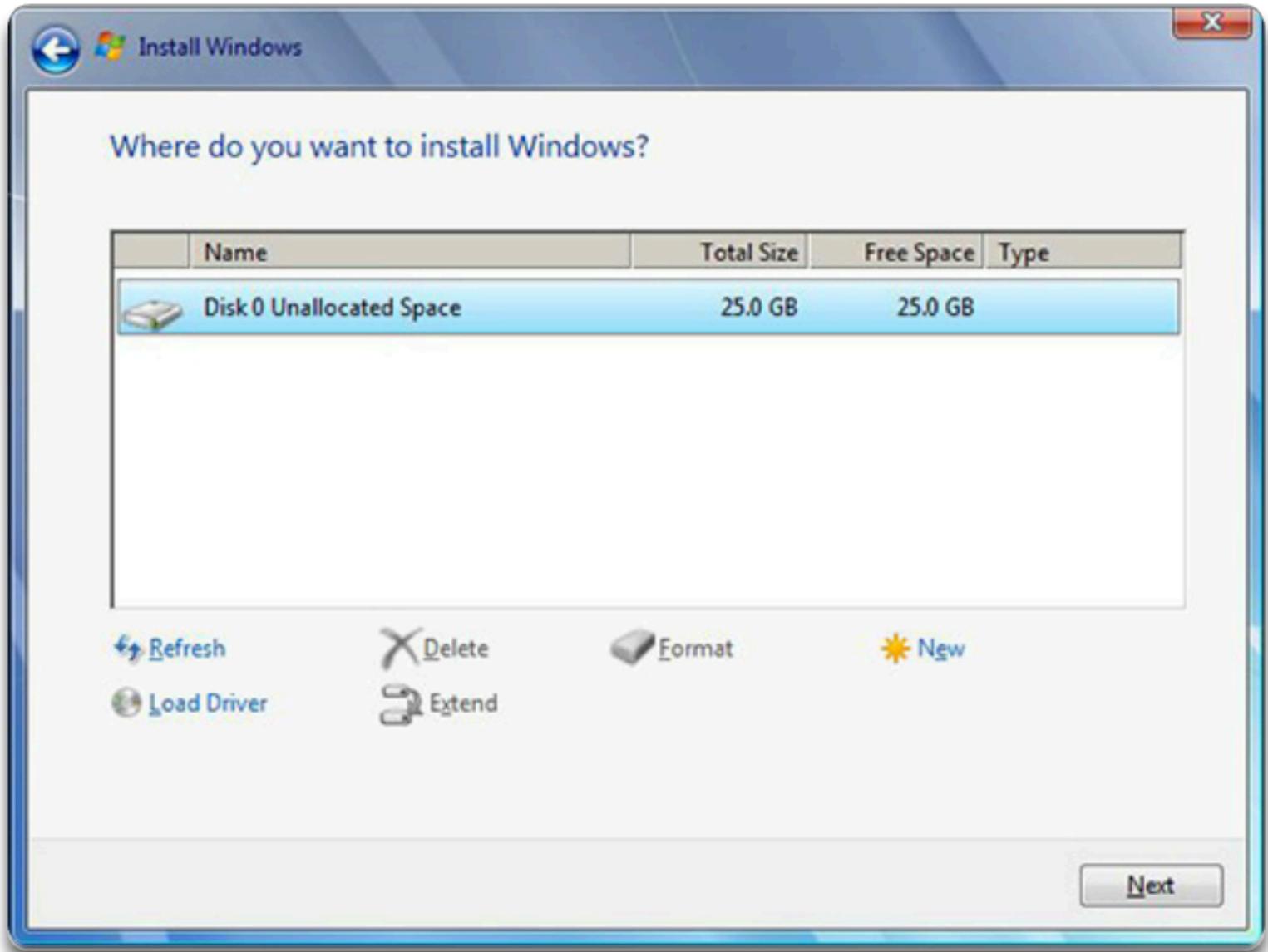
	FAT32	NTFS	exFAT (FAT64)
Security	Low security	File and Folder Level permissions Encryption	exFAT can support access control lists (ACLs) that define permissions for user access
Compatibility	Compatible with Windows	Compatible with Windows	Compatible with Windows XP with SP2 or SP3, Windows Vista with SP1, Windows 7, Windows Server 2003 with SP2, Windows Server 2008, and Linux
File Size	Limit of 4 GB files Limit of 32 GB volumes	Limit of 16 TB files Limit of 256 TB volumes	Limit of 64 zettabytes (ZBs) files Limit of 512 TB volumes
Files per Volume	4.17 million	4.29 billion	Maximum of 16 exabytes (EBs)

To use the extra security advantages of NTFS, you can convert partitions from FAT32 to NTFS using the CONVERT.EXE utility. To make an NTFS partition a FAT32 partition, back up the data, reformat the partition, and restore the data from a backup.

CAUTION: Before converting a file system, remember to back up the data.

Windows 7 and Windows Vista automatically create a partition using the entire hard drive. If a user does not create custom partitions using the New option, as shown in Figure 2, the system formats the partition and begins installing Windows. If users create a partition, they will be able to determine the size of the partition. In Windows 7 and Windows Vista, there is no option to select a file system. All partitions are formatted with NTFS.

New Partition for Windows 7



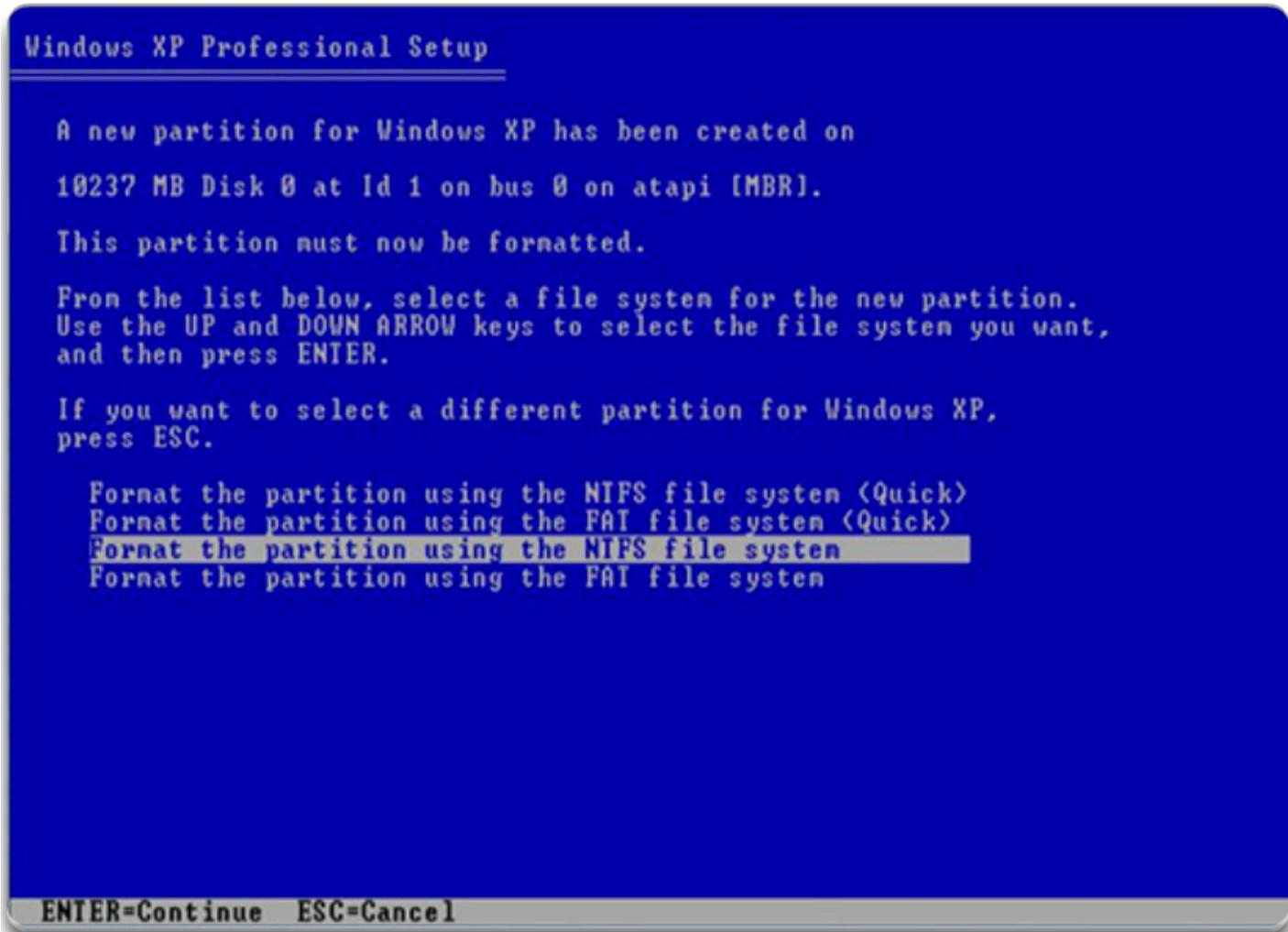
Before users can install Windows XP, they must create a new partition. When a user creates a new partition, they will be prompted to choose the size of the partition. After a partition has been created, Windows XP provides users with a choice of formatting it with the NTFS or FAT file systems. A technician should also be familiar with the following multimedia file systems:

- **exFAT (FAT 64)** - Created to address some of the limitations of FAT, FAT32, and NTFS when formatting USB flash drives, such as file size and directory size.
- **Compact Disc File System (CDFS)** - Created specifically for optical disk media.

Quick Format versus Full Format

When installing Windows XP, you can format a partition using a quick format or full format, as shown in Figure 3. The quick format removes files from the partition, but does not scan the disk for bad sectors. Scanning a disk for bad sectors can prevent data loss in the future. For this reason, do not use the quick format for disks that have been previously formatted. The quick format option is not available when installing Windows 7 or Windows Vista.

Quick Format vs. Full Format



The full format removes files from the partition while scanning the disk for bad sectors. It is required for all new hard drives. The full format option takes more time to complete.

Installation with Default Settings

When a computer boots with the Windows 7 installation disc (or USB flash drive), the installation wizard presents three options, as shown in Figure 1:

Windows 7 Installation



- **Install now** - Sets up and installs the Windows 7 OS.

- **What to know before installing Windows** - Opens a Help and Support window describing the Upgrade and Custom options for installing Windows 7. The window also describes how to prepare for and install Windows 7.

- **Repair your computer** - Opens the System Recovery Options utility to repair an installation. Select the Windows 7 installation that needs repair and click **Next**. You can then select from a number of recovery tools, such as Startup Repair. Startup Repair locates and

repairs problems with the OS files. If Startup Repair does not solve the problem, additional options, such as System Restore or System Image Recovery, are available.

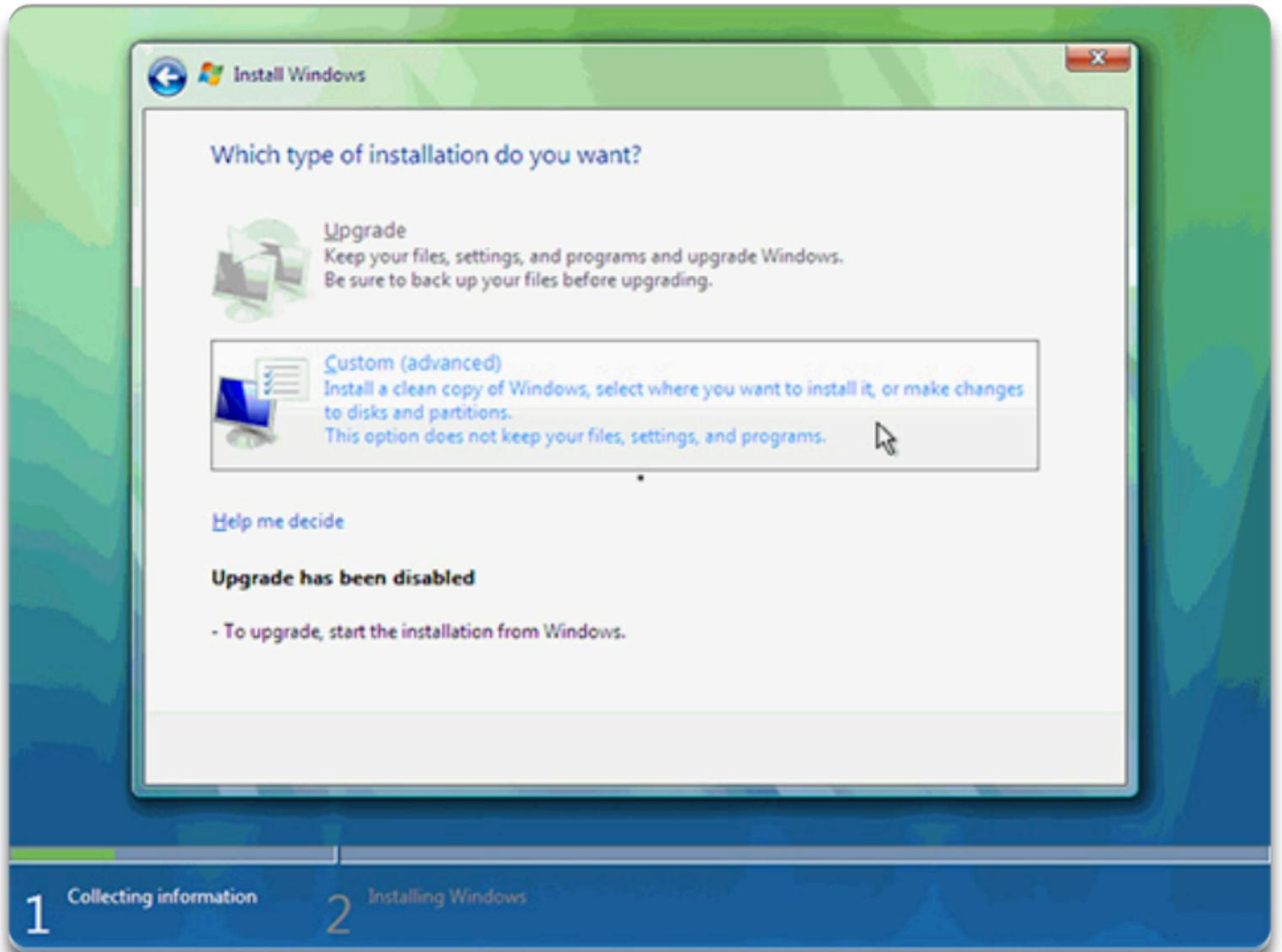
NOTE: Before performing a repair installation, back up important files to a different physical location, such as a second hard drive, optical disc, or USB storage device.

For this section, select the **Install now** option. Three options are available:

- **Upgrade** - Upgrades Windows but keeps your current files, settings, and programs. You can use this option to repair an installation.
- **Custom (advanced)** - Installs a clean copy of Windows in your choice of location and allows you to change disks and partitions. It is also known as a clean installation. Selecting a custom installation increases the likelihood of a successful installation.
- **Quit** - Exits Setup.

If existing Windows installations are not found, the Upgrade option is disabled, as shown in Figure 2.

Install Options



NOTE: Unless you perform a clean installation of Windows 7, the previous Windows folder is kept, along with the Documents and Settings and Program Files folders. During the Windows 7 installation, these folders are moved to a folder named Windows.old. You can copy files from the previous installation to the new installation if you need them.

During an installation, you must provide the following information:

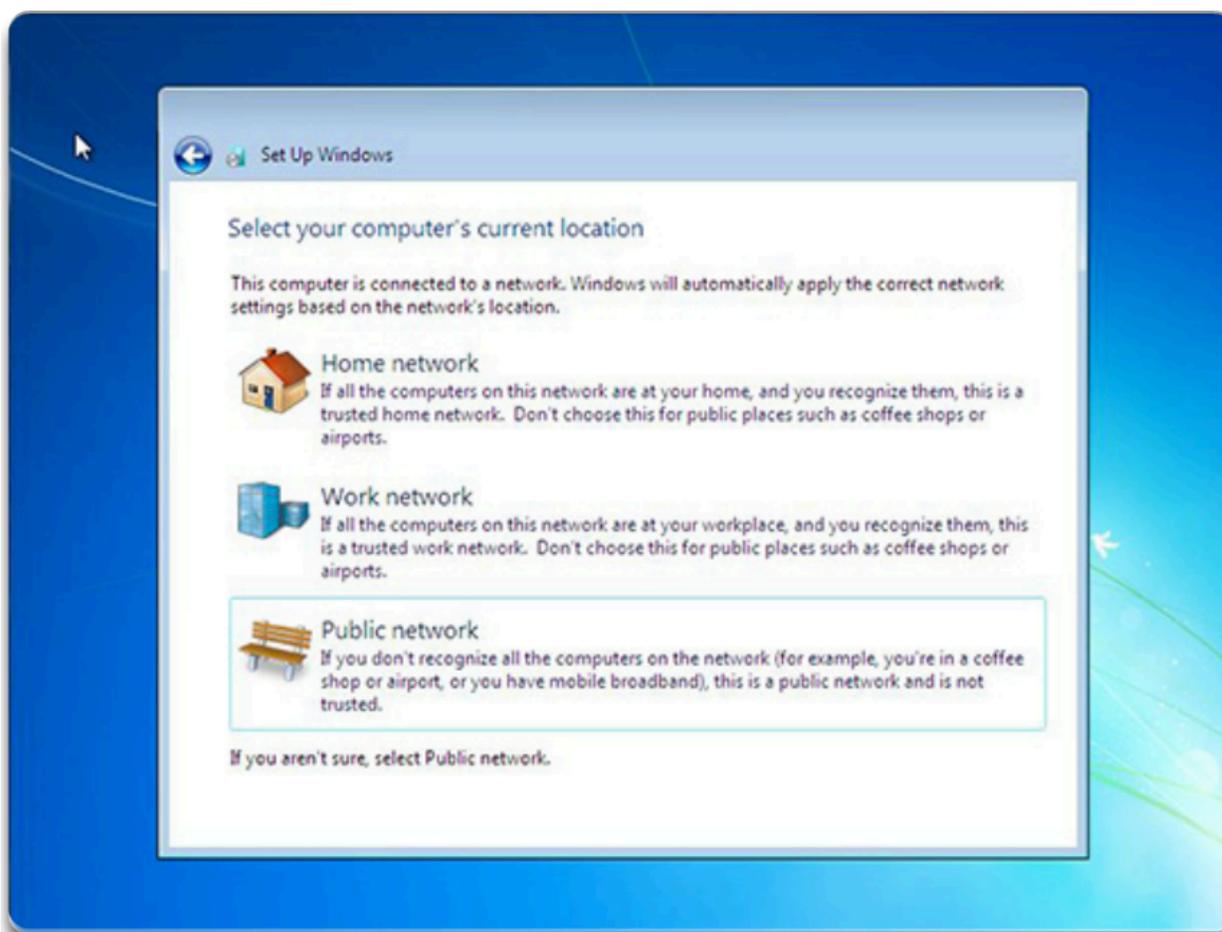
- Language to install
- Standards and formats that define currency and numerals
- Keyboard or input method
- Physical location of the installation

- Username and computer name
- Password for the administrative account
- Product key
- Time and date settings
- Network settings

Network Settings

When configuring initial network settings during installation, you are prompted to select one of the following current locations, as shown in Figure 3:

Network Settings



- Home network
- Work network
- Public network

Depending on the current location of the computer and version of the OS, you are prompted to select a method for organizing computers and sharing resources on a network. The options are Homegroup, Workgroup, and Domain.

If **Home network** is selected, you are prompted to enter the name of a

workgroup, with the option of configuring a homegroup. A workgroup provides a network structure that permits file and printer sharing. All computers in a workgroup must have the same workgroup name. A homegroup allows computers on the same network to automatically share files, such as music and pictures, as well as printers.

If **Work network** is selected, you can choose to enter the name of a domain or a workgroup. A computer on a domain is governed by a central administrator and must follow the rules and procedures set by the administrator. A domain, like a workgroup, provides users with the ability to share files and devices.

Account Creation

When users attempt to log in to a device or to access system resources, Windows uses the process of authentication to verify that the users are who they say they are. Authentication occurs when users enter a username and password to access a user account. Windows OSs use Single-Sign On (SSO) authentication, which allows users to log in once to access all system features versus requiring them to log in each time they need to access an individual resource.

User accounts allow multiple users to share a single computer, with each user having their own files and settings. Windows 7 and Windows Vista have three types of user accounts: Administrator, Standard, and Guest. Each account type provides a user with a different level of control over system resources.

An account with administrator privileges must be created when Windows 7 is installed, as shown in the figure. A user with administrator privileges can make changes that impact all users of the computer, such as altering security settings or installing software for all users. Accounts with administrator privileges should be used only to manage a computer and not for regular use, because drastic changes that affect everyone can be made when using the administrator account. Attackers also seek out an administrator account because it is so powerful. For this reason, it is recommended that a standard user account is created for regular use.

Standard user accounts can be created at any time. A standard user account has fewer permissions than an administrator account. For example, users might have the right to only read, but not modify, a file.

Individuals without a standard user account on the computer can use a guest account. A guest account has limited permissions and must be turned on by an administrator.

To create or remove a user account in Windows 7 and Windows Vista, use the following path:

Start > Control Panel > User Accounts > Add or remove user accounts

Windows XP features a fourth group of users called Power Users. Power Users have privileges that are extended beyond those of standard users, providing them with some of the capabilities given to Administrator accounts. Power users are not able to fully administrate system resources. The group has not been included in Windows 7 or Windows Vista.

To create or remove a user account in Windows XP, use the following path:

Start > Control Panel > User Accounts > Select the Users tab and click Add



Windows 7 Verification

Complete the Installation

After the Windows installation copies all the necessary OS files to the hard drive, the computer reboots and prompts you to create a user account.

Windows 7 must be registered. As shown in Figure 1, you must also complete the verification that ensures that you are using a legal copy. Doing so enables you to download individual updates called patches. A service pack is just several patches grouped together.

Windows Update

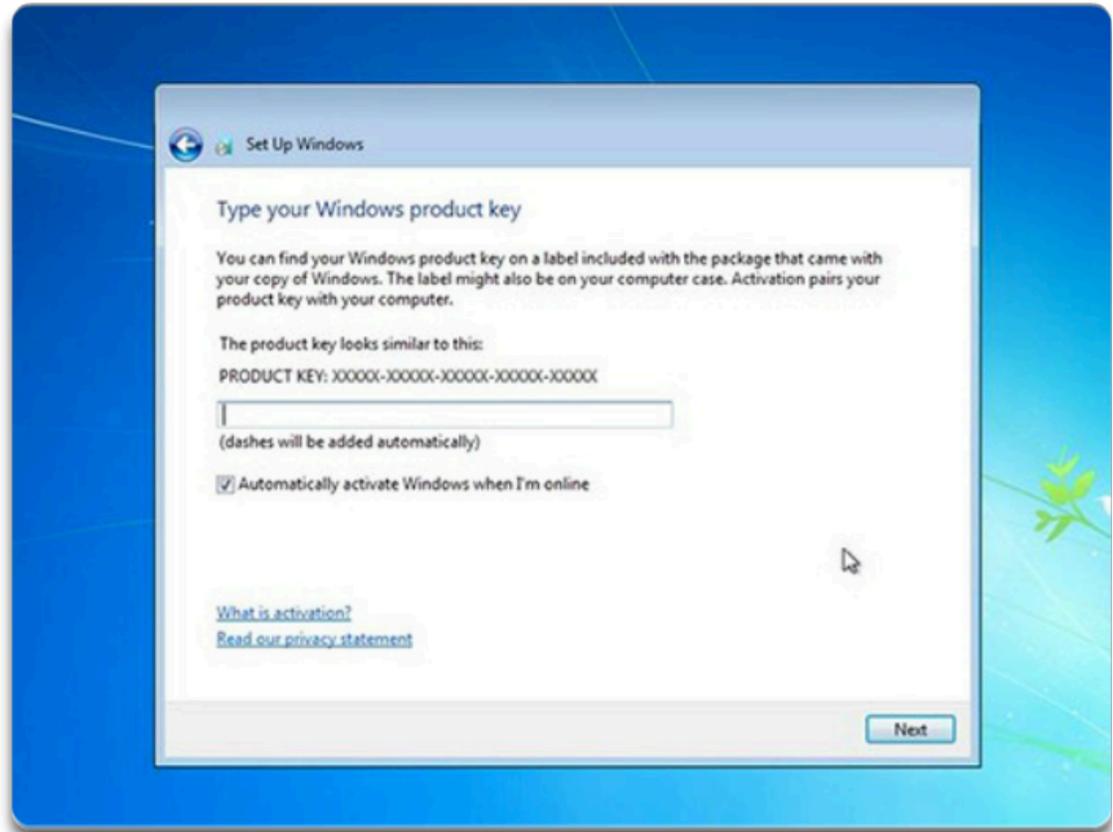
Depending on the age of the media at the time of your installation, there might be updates to install. As shown in Figure 2, you can use the Microsoft Update Manager from the Start Menu to scan for new software, as well as install service packs and patches.

To install patches and service packs in Windows 7 or Windows Vista, use the following path:

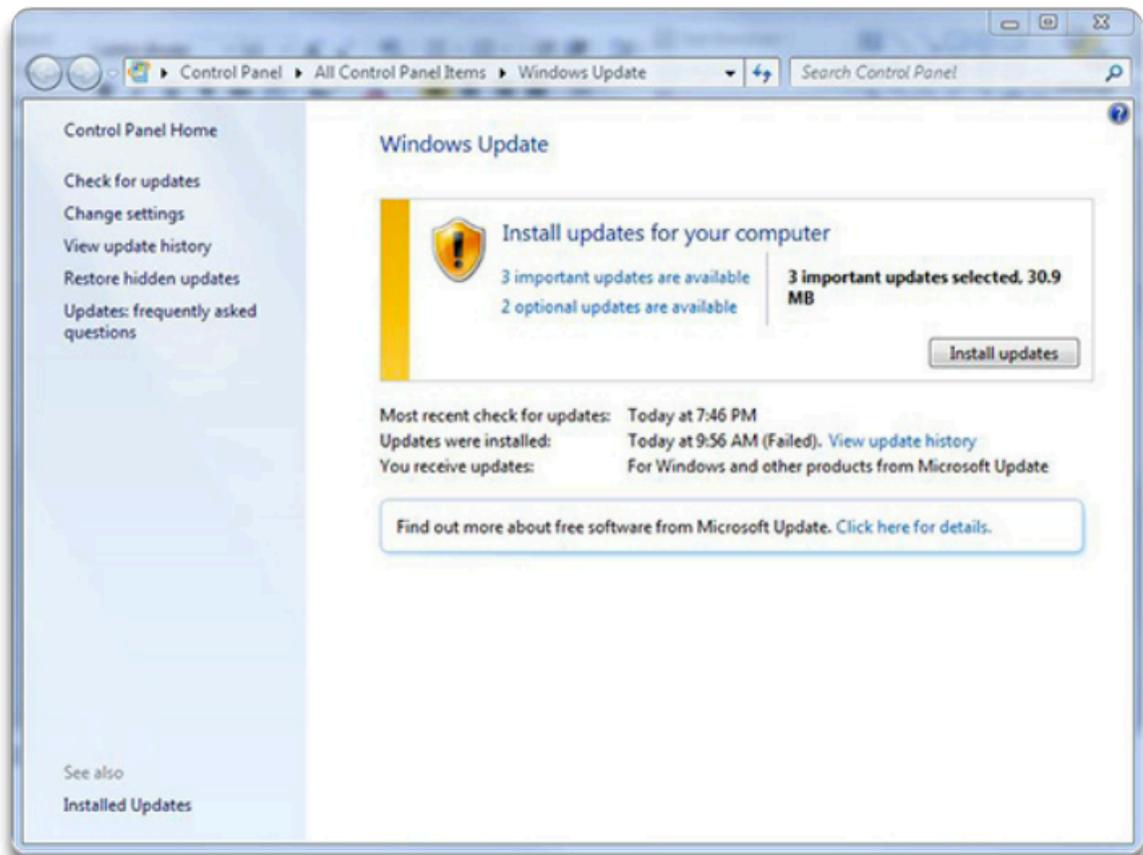
Start > All Programs > Windows Update

To install patches and service packs in Windows XP, use the following path:

Start > All Programs > Accessories > System Tools > Windows Update



Windows Update



Device Manager

After installation, verify that all hardware is installed correctly. As shown in Figure 3, you can use Device Manager to locate problems and to install the correct or updated drivers in Windows 7 and Windows Vista using the following path:

Start > Control Panel > Device Manager

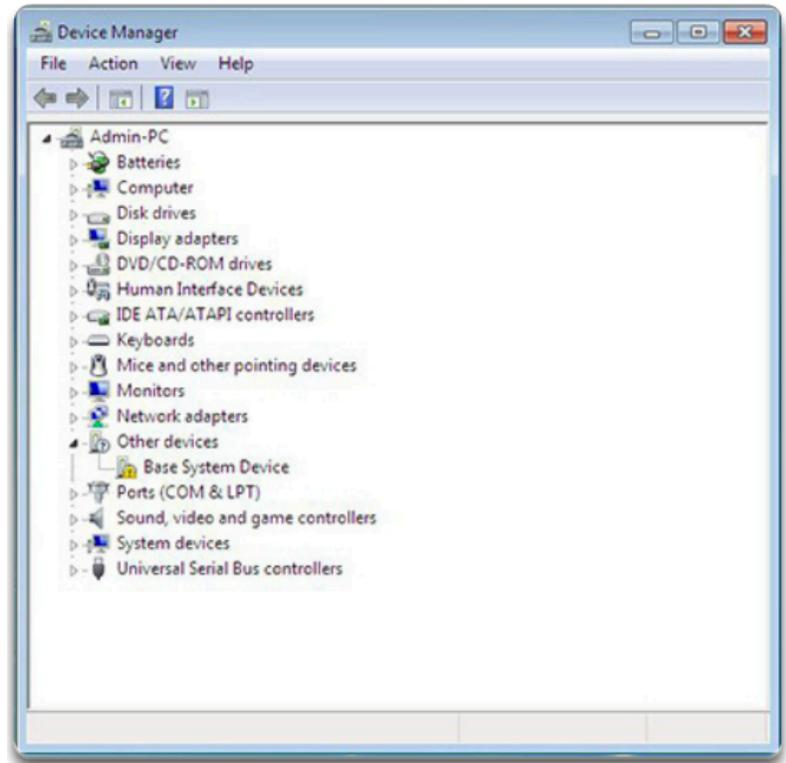
In Windows XP, use the following path:

Start > Control Panel > System > Hardware > Device Manager

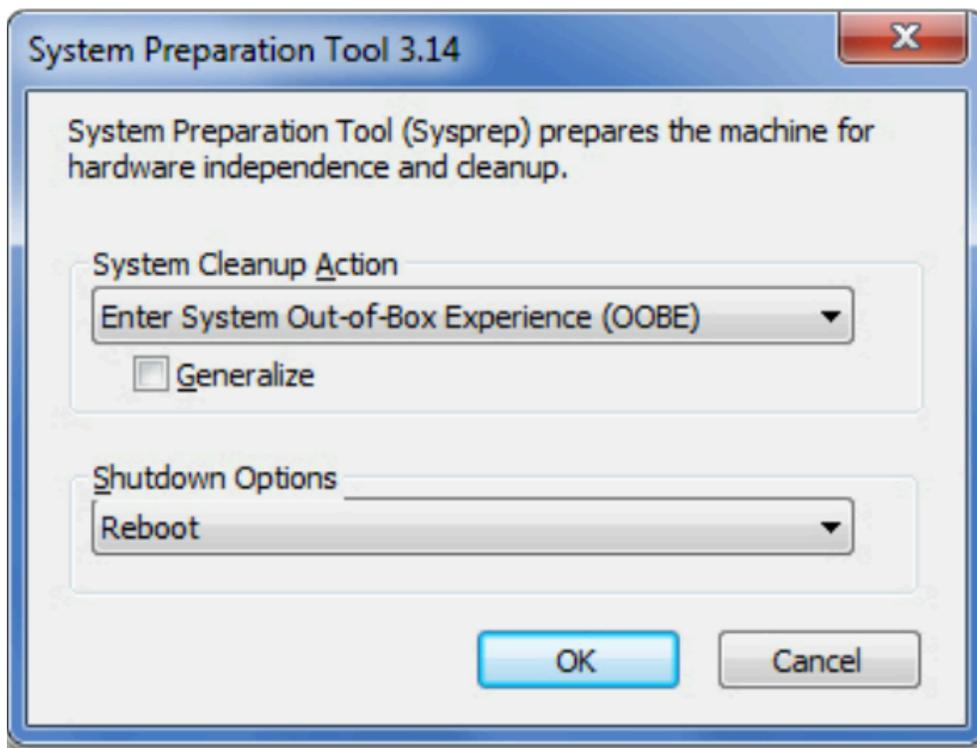
In Device Manager for Windows 7 and Windows Vista, a yellow triangle with an exclamation point indicates a problem with a device. To view the problem description, right-click the device and select **Properties**. A gray circle with a downward pointing arrow means that a device is disabled. To enable the device, right-click the device and select **Enable**. To expand a device category, click the right pointing triangle next to the category.

NOTE: In Windows XP, a red circle with a white X indicates a disabled device.

NOTE: When Windows detects a system error, a dialog box is displayed. If you choose to send the report, Microsoft Windows Error Reporting (WER) collects information about the application involved in the error and sends the information to Microsoft.



Sysprep



Device Manager

Custom Installation Options

Disk Cloning

Installing an OS on a single computer takes time. Imagine the time it would take to install operating systems on multiple computers, one at a time. To simplify this activity, you can use the Microsoft System Preparation (Sysprep) tool, as shown in the figure, to install and configure the same OS on multiple computers. Sysprep prepares the OS with different hardware configurations. With Sysprep and a disk cloning application, technicians can quickly install the OS,

complete the last configuration steps, and install applications.

Disk Cloning

Disk cloning creates an image of a hard drive in a computer. For disk cloning, follow these steps:

Step 1. Create a master installation on one computer. This master installation includes the OS, software applications, and common configuration settings that will be used by the other computers in the organization.

Step 2. Run Sysprep.

Step 3. Create a disk image of the configured computer using a third-party disk-cloning program.

Copy the disk image onto a server. When the destination computer is booted, a shortened version of the Windows setup program runs. The setup installs the drivers for the hardware components, creates user accounts, and configures network settings to finish the installation.

Other Installation Methods

A standard installation of Windows 7 is sufficient for most computers used in a home or small office environment. A custom installation of Windows 7 can save time and provide a consistent configuration across computers on a large network. When deploying Windows to multiple computers, technicians may elect to use a pre-installation environment such as Windows PE. Pre-installation environments are basic operating systems that enable a user to partition and format drives, or start an installation from a network.

Windows 7 has several different types of custom installations.

- **Network Installation** - Requires all setup files to be copied to a network server
- **Preboot Execution Environment (PXE) Installation** - Uses a PXE boot program and a client's network card to access the setup files
- **Unattended Installation** - Uses a network distribution point that uses an answer file
- **Image-based Installation** - Uses Sysprep and a disk-imaging program, such as ImageX, that copies an image of the OS directly to the hard drive with no user intervention
- **Remote Installation** - Downloads the installation across the network. The installation can be requested by the user or forced on to a computer by an administrator.

NOTE: To simplify OS deployment across an organization, consider using an OS Deployment Feature Pack using Microsoft System Center Configuration Manager (SCCM).

Network Installation

To install Windows 7 or Windows Vista over a network, follow these steps:

Step 1. Prepare the computer by creating a NTFS partition of at least 5 GB. You must make the partition bootable and include a network client. You can also use a boot disk that contains a network client so that the computer can connect to a file server over the network.

Step 2. Copy the installation media to the network server. Make sure to share the directory so that clients can connect and use the files.

Step 3. Boot the computer and connect to the shared directory.

Step 4. From the shared directory, run the setup program, setup.exe, located in the directory called Sources. The setup program copies the installation files to your hard drive. After the installation files have been copied, the installation continues.

To install Windows XP over a network, follow these steps:

Step 1. Prepare the computer by creating a FAT or FAT32 partition of at least 1.5 GB. You must make the partition bootable and include a network client. You can also use a boot disk that contains a network client so that the computer can connect to a file server over the network.

Step 2. Copy the Windows XP installation files (the I386 folder from the installation disc) to the network server. Make sure to share the directory so that clients can connect and use the files.

Step 3. Boot the computer and connect to the shared directory.

Step 4. From the shared directory, run the setup program, WINNT.EXE. The setup program copies the installation files from the network onto your hard drive. After the installation files have been copied, the installation continues.

PXE Installation

A PXE installation uses a method similar to a network installation. The only difference is that a PXE installation uses a PXE boot file instead of a boot disk. The PXE boot file allows the network interface card (NIC) to communicate with the server and obtain setup files. After a client has access to the setup files, it boots to a command window where the user is prompted for the network username and password.

Unattended Installation in Windows 7 and Vista

An unattended installation using an unattend.txt answer file or an autounattend.xml file is the easiest alternative installation method to perform on a network. To customize a standard Windows 7 or Windows Vista installation, the System Image Manager (SIM) is used to create the setup answer file. You can also add packages, such as applications or drivers, to an unattended answer file and an autounattend.xml file.

The figure shows an example of an answer file. After all questions have been answered, the file is copied to the distribution shared folder on a server. At this point, you can do one of two things:

Unattend.txt File Example

```
[Data]
AutoPartition=0
MsDosInitiated="0"
UnattendedInstall="Yes"
UseBIOSToBoot=1
[Unattended]
UnattendMode=FullUnattended
OemSkipEula=Yes
OemPreinstall=No
ExtendOemPartition=0
TargetPath=*
Repartition=No
[GuiUnattended]
AdminPassword=*
AutoLogon=Yes
OEMSkipWelcome=1
TimeZone=20
[UserData]
ComputerName=OEMComputerName
FullName="Windows Storage Server 2003"
OrgName="OEM Name"
ProductID="XXXXX-XXXXX-XXXXX-XXXXX-XXXXX"
```

- Run the unattended.bat file on the

client machine to prepare the hard drive and install the OS from the server over the network.

- Create a boot disk that boots the computer and connects to the distribution share on the server. You then run the batch file to install the OS over the network.

NOTE: Windows SIM is part of the Windows Automated Installation Kit (AIK). You can download it from the Microsoft website.

NOTE: In Windows XP, you can create an answer file with the application setupmgr.exe, located in the deploy.cab file on the Windows XP media.

Image-based Installation

When performing image-based installations, begin by completely configuring one computer to an operational state. Next, run Sysprep to prepare the system for imaging. A third-party drive-imaging application prepares an image of the completed computer, which can be burned on to a DVD. You can then copy the image on to computers with compatible Hardware Access Layers (HALs) to complete the installation of multiple computers. After the image is copied, boot up the computer, but you might have to configure some settings, such as the computer name and domain membership.

Remote Installation

With Remote Installation Services (RIS), the process is similar to an image-based installation, except you do not use a drive-imaging utility. You use an RIS network shared folder as the source of the Windows OS files. You can install operating systems on remote boot-enabled client computers. You can also start user computers that are connected to the network with a remote boot disk or network adapter capable of booting the computer. The user then logs on with valid user account credentials.

System Recovery Options

When a system failure occurs users can employ the following recovery tools:

- System Recovery Options
- Automated System Recovery (Windows XP Professional only)
- Factory Recovery Partition

System Recovery Options

The System Recovery Options are a set of tools that allow users to recover or restore an operating system when it has failed. The System Recovery Options are a part of the Windows Recovery Environment (WinRE). WinRE is a recovery platform based on the Windows Preinstallation Environment (PE). Windows PE is a basic operating system created to prepare a computer for Windows installation and help users troubleshoot operating system failures when no OS is available.

WinRE can be accessed by pressing and holding the **F8** key when starting a computer. Once the Advanced Boot Options screen appears, highlight **Repair your computer** and press **Enter** to access the System Recovery Options. You can then use system recovery tools to repair errors that prevent system startup. The following tools are available in the System Recovery Options menu:

- **Startup Repair** – Scans the hard drive for problems and automatically fixes missing or corrupt system files that prevent Windows from starting
- **System Restore** – Uses restore points to restore Windows system files to an earlier point in time
- **System Image Recovery** - Creates a system image that replicates the system drive that Windows requires to operate
- **Windows Memory Diagnostic** – Examines computer memory to detect malfunctions and diagnose problems
- **Command Prompt** – Opens a command prompt window where the bootrec.exe tool can be used to repair and troubleshoot startup issues for Windows. The bootrec.exe utility can be used with the fixmbr command to repair the Master Boot Record or the fixboot command to write a new boot sector that is compatible with the OS. This command prompt replaces the Recovery Console from Windows XP.

If Repair your computer does not appear as an option, users can access the System Recovery Options in WinRE by booting the computer from installation media or a system repair disc. A system repair disc allows users to access the System Recovery Options in the same way that installation media would. Before a system repair disc can be used to boot a computer, it must be created.

To create a Windows 7 system repair disc, as shown in Figure 1, follow these steps:

Step 1. Select **Start > Control Panel > Backup and Restore > Create a system repair disc.**

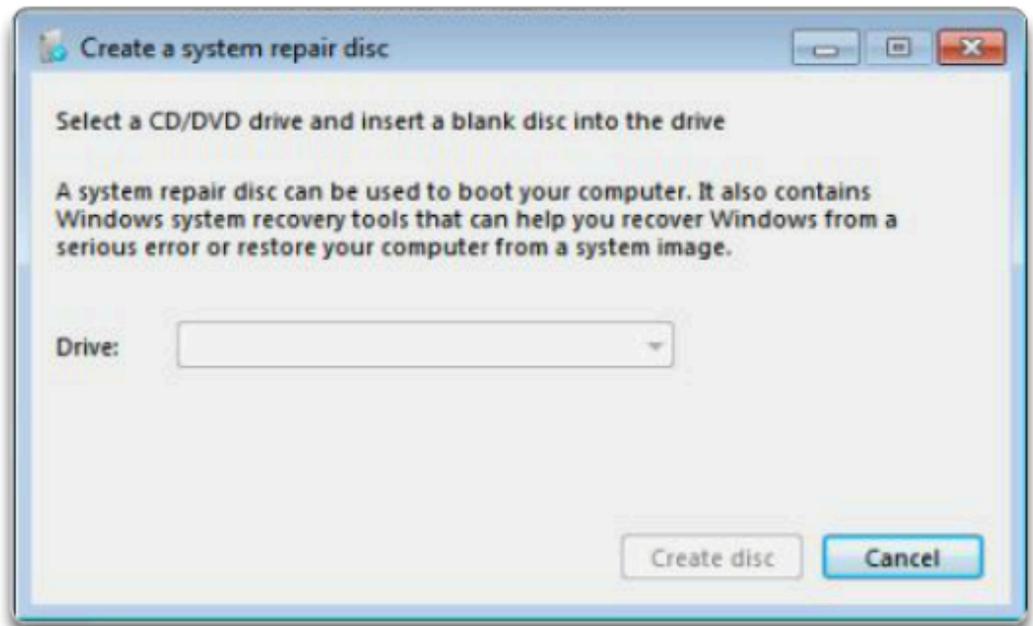
Step 2. Insert a blank disc in the optical disc drive and click **Create Disc.**

Step 3. Test the disc by using it to boot the computer.

Step 4. After the System Recovery Options window is displayed, highlight the OS that needs to be restored and click **Next.** The following tools should be available:

- Startup Repair
- System Restore
- System Image Recovery
- Windows Memory Diagnostic
- Command Prompt

System Repair Disc



NOTE: When using a recovery disc, make sure that it uses the same architecture as the OS being recovered. For example, if the computer is running a 64-bit version of Windows 7, the recovery disc must use a 64-bit architecture.

System Image Recovery

The System Image Recovery utility, as shown in Figure 2, is a new recovery option that is included in all versions of Windows 7. It allows users to back up the contents of their hard drive, including personal files and settings, if an operating system needs to be restored.

To create a system image in Windows 7, follow these steps:

Step 1. Select **Start > Control Panel > Backup and Restore > Create a system image**.

Step 2. Select a location for the system image:

- **On a hard disk** - Stores the system image on an external hard drive.
- **On one or more DVDs** - Burns the system image to a DVD.
- **On a network location** - Stores the system image in a shared folder on a network.

Step 3. Click **Next** and confirm the selections. A system image is created and stored in the selected location.

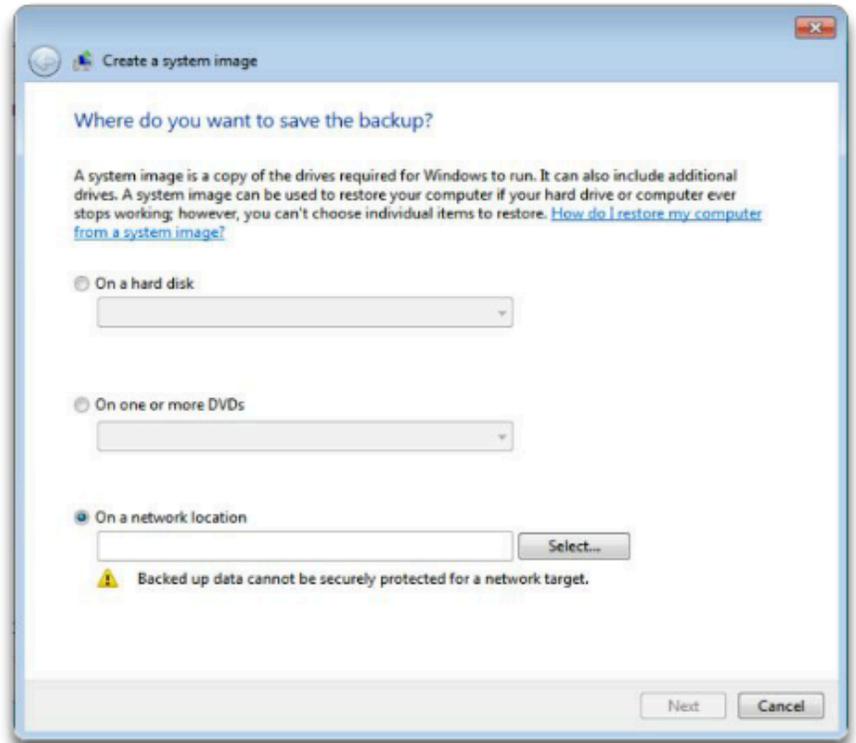
Automated System Recovery in Windows XP Professional

You must create an Automated System Recovery (ASR) set to use for the recovery. The ASR Wizard, as shown in Figure 3, creates a backup of the system state, services, and OS components. It also creates a file containing information about your disks, the backup, and how to restore the backup.

Use the following path:

Start > All Programs > Accessories > System Tools > Backup > click the Advanced Mode link > Automated System Recovery Wizard

System Image Recovery Tool



Automated System Recovery Wizard



To restore your system, press F2 after booting the Windows XP installation disc. ASR reads the set and restores the disks needed to start the computer. After the basic disk information has been restored, ASR installs a basic version of Windows and begins restoring the backup created by the ASR Wizard.

Factory Recovery Partition

Some computers that have Windows 7 pre-installed from the factory contain a section of the disk that is inaccessible to the user. This partition, called a factory recovery partition, contains an image of the bootable partition created when the computer was built. You can use this partition to restore the computer to its original configuration.

Occasionally, the option to reach this partition is hidden, and you must use a special key or key combination when the computer is starting. Sometimes, the option to restore from the factory recovery partition is located in the BIOS. Contact the computer manufacturer to find out how to access the partition and restore the original configuration of the computer.

Boot Sequence and Registry Files

Windows Boot Process

Understanding the boot process in Windows can help a technician troubleshoot boot problems. Figure 1 displays the boot sequence for Windows 7.

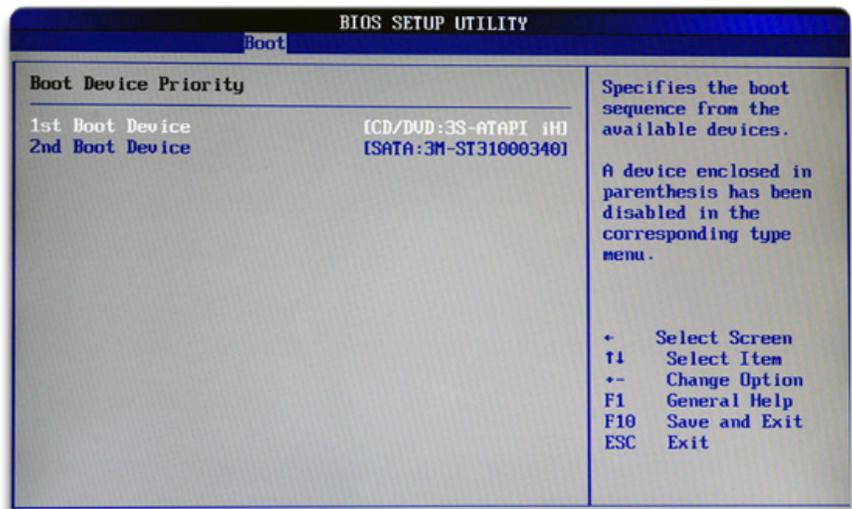
Boot Sequence for Windows 7
Power on Self Test (POST)
POST for each adapter card that has a BIOS
BIOS reads the MBR
MBR takes over control of the boot process and starts BOOTMGR
BOOTMGR reads the Boot Configuration Data file to know which OS to load and where to find the OS on the boot partition
BOOTMGR invokes WINLOAD.EXE in order to load the NTOSKRNL.EXE file and HAL.DLL
BOOTMGR reads the registry files and loads device drivers
NTOSKRNL.EXE starts the WINLOGON.EXE program and displays the Windows login screen

Windows Boot Process

To begin the boot process, turn on the computer. This is called a cold boot. When the computer is powered on, it performs a Power On Self Test (POST). Because the video adapter has not yet been initialized, errors that occur at this point in the boot process are reported by a series of audible tones, called beep codes.

After POST, the BIOS locates and reads the configuration settings that are stored in the CMOS memory. The boot device priority, as shown in Figure 2, is the order in which devices are checked to locate the operating system. The boot device priority is set in the BIOS and can be arranged in any order. The BIOS boots the computer using the first drive that contains an operating system.

Boot Device Priority



Hard drives, network drives, USB drives, and even removable magnetic media, such as CompactFlash or Secure Digital (SD) cards can be used in the boot order, depending on the capabilities of the motherboard. Some BIOS also have a boot device priority menu that is accessed with a special key combination while the computer is starting but before the boot sequence begins. You can use this menu to select the device to boot, which is useful if multiple drives can boot the computer.

Windows Boot Loader and Windows Boot Manager in Windows 7 and Windows Vista

When the drive storing the OS is located, the BIOS finds the Master Boot Record (MBR). At this point, Windows Boot Manager (BOOTMGR) controls several installation steps. For instance, if more than one OS is present on the disk, BOOTMGR gives the user a chance to select which one to use. If there are no other operating systems, or if the user does not make a selection before the timer expires, the following process occurs:

1. WinLoad uses the path specified in BOOTMGR to find the boot partition.
2. WinLoad loads two files that make up the core of Windows 7: NTOSKRNL.EXE and HAL.DLL.
3. WinLoad reads the Registry files, chooses a hardware profile, and loads the device drivers.

NOTE: If another OS version is on the disk that is Windows Vista or later, BOOTMGR repeats the process. If another OS version is on the disk that is Windows XP or earlier, BOOTMGR invokes the Windows XP boot loader (NTLDR).

NTLDR and the Windows Boot Menu in Windows XP

When the drive with the OS is located on a computer running Windows XP, the BIOS locates the MBR. The MBR locates the OS boot loader NTLDR. At this point, NTLDR controls several installation steps. For instance, if more than one OS is present on the disk, BOOT.INI gives the user a chance to select which one to use. If there are no other operating systems, or if the user does not make a selection before the timer expires, the following process occurs:

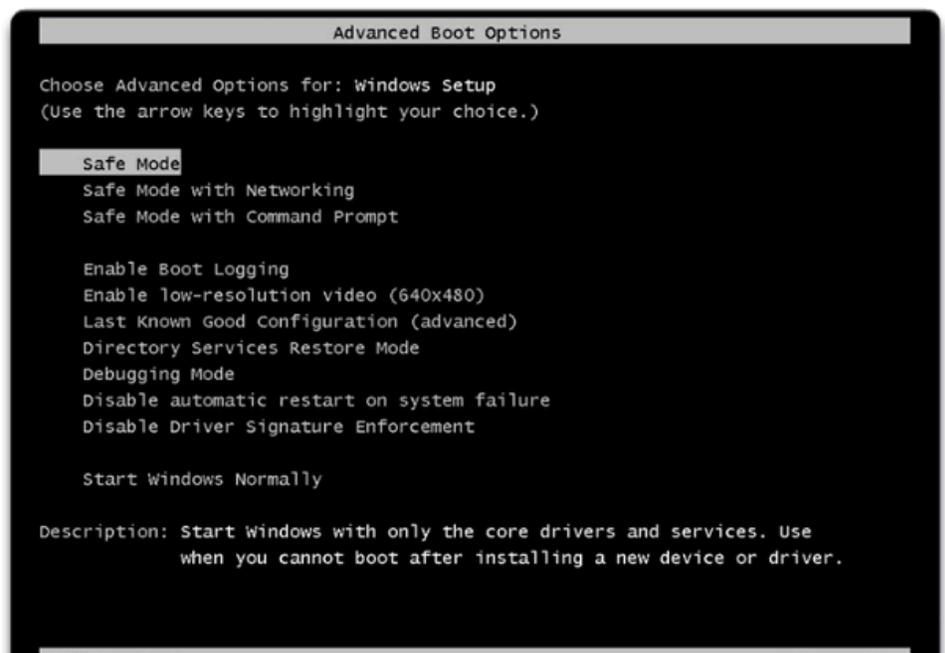
1. NTLDR runs NTDETECT.COM to get information about the installed hardware.
2. NTLDR uses the path specified in the BOOT.INI to find the boot partition.
3. NTLDR loads two files that make up the core of XP: NTOSKRNL.EXE and HAL.DLL.
4. NTLDR reads the Registry files, chooses a hardware profile, and loads the device drivers.

NT Kernel

At this point, the NT kernel takes over. The NT kernel is the heart of all Windows operating systems. The name of this file is NTOSKRNL.EXE. It starts the login file called WINLOGON.EXE and displays the Windows Welcome screen.

Startup Modes

Advanced Startup Options



Windows can boot in one of many different modes. Pressing the F8 key during the boot process opens the Windows Advanced Startup Options menu, as shown in the figure. This allows users to select how to boot Windows. The following startup options are commonly used:

- **Safe Mode** - Starts Windows but only loads drivers for basic components, such as the keyboard and display.
- **Safe Mode with Networking** - Starts Windows as for Safe Mode, but also loads the drivers for network components.
- **Safe Mode with Command Prompt** - Starts Windows and loads the command prompt instead of the GUI.
- **Last Known Good Configuration** - Loads the configuration settings that were used the last time that Windows started successfully. It does this by accessing a copy of the registry that is created for this purpose.

NOTE: Last Known Good Configuration is not useful unless it is applied immediately after a failure occurs. If the machine is restarted and manages to open Windows, the registry is updated with the faulty information.

Windows Registry

The Windows Registry keys are an important part of the Windows boot process. These keys are recognized by their distinctive names, which begin with HKEY_, as shown in the figure, followed by the name of the portion of the OS under their control. Every setting in Windows, from the background of the desktop and the color of the screen buttons, to the licensing of applications, is stored in the Registry. When a user makes changes to the Control Panel settings, file associations, system policies, or installed software, the changes are stored in the Registry.

Each user account has a unique section of the Registry. The Windows login process pulls system settings from the Registry to reconfigure the system for each individual user account.

The Registry is also responsible for recording the location of Dynamic Link Library (DLL) files. A DLL file consists of program code that can be used by different programs to perform common functions. As a result, DLL files are very important to the functionality of an operating system and any application users may install.

To ensure that a DLL can be located by the operating system or a program, it must be registered. It is typically registered automatically during the installation process. A user may need to manually register a DLL file when a problem is encountered. Registering a DLL maps the path to the file, making it easier for programs to locate necessary files. To register a DLL file in Windows using the command-line tool, use the following path:

Start > Type **cmd** in the **Search Programs and Files** bar > Type **regsvr32 filename.dll**

Registry Keys

HKEY	DESCRIPTION
HKEY_CLASSES_ROOT	Information about which file extensions map to a particular application
HKEY_CURRENT_USER	Information, such as desktop settings and history, related to the current user of a PC
HKEY_USERS	Information about all users who have logged onto a system
HKEY_LOCAL_MACHINE	Information relating to the hardware and software
HKEY_CURRENT_CONFIG	Information relating to all active devices on a system

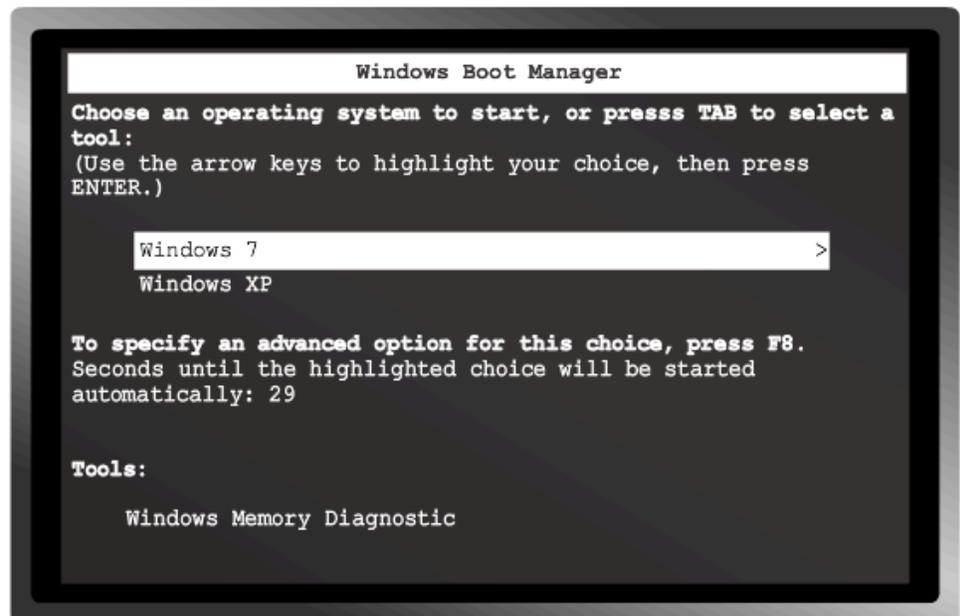
Multiboot

You can have multiple operating systems on a single computer. Some software applications may require the most recent version of an OS, while other applications require an older version. There is a dual-boot process for multiple operating systems on a computer. During the boot process, if the Windows Boot Manager (BOOTMGR) determines that more than one OS is present, you are prompted to choose the OS that you want to load, as shown in Figure 1.

To create a dual-boot system in Microsoft Windows, the hard drive must contain more than one partition.

The oldest OS should be installed on the primary partition or the hard drive marked

Windows Boot Manager



as the active partition first. Install the second OS on the second partition or hard drive. The boot files are automatically installed in the active partition.

BOOTMGR File

During the installation, the BOOTMGR file is created on the active partition to allow selecting the OS to boot on startup. You can edit the BOOTMGR file to change the order of the operating systems. You can also change the length of time allowed during the boot phase to select the OS. Typically, the default time is 30 seconds. This time period delays the boot time of the computer by the specified time, unless the user intervenes to select a particular OS. If the disk has only one OS, change the time to 5 or 10 seconds to boot up the computer faster.

NOTE: In Windows XP, the BOOT.INI file fills the role of the BOOTMGR file.

To change the time to display the operating systems, use the following path:

Select **Start > Control Panel > System and Security > System > Advanced System Settings > click the Advanced tab > In the Startup and Recovery area, select Settings**

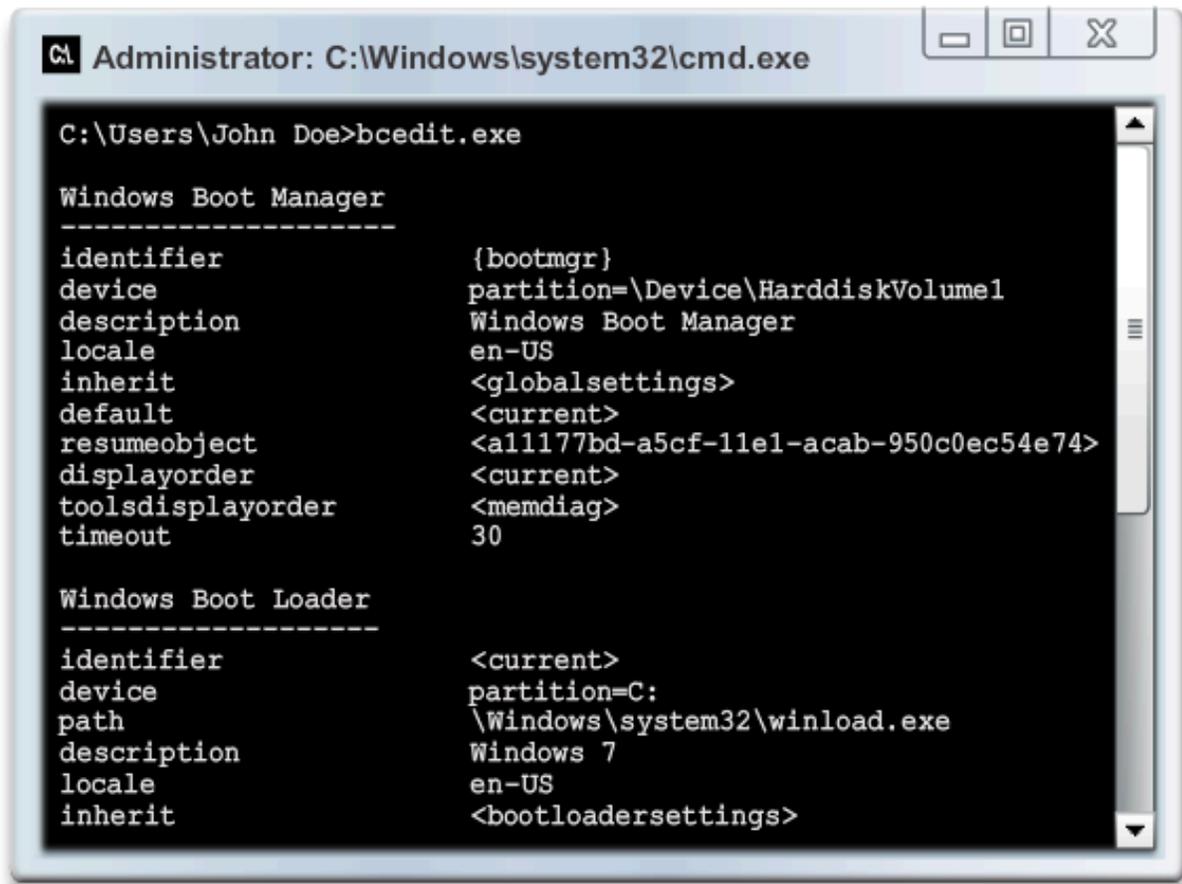
To edit general boot configuration data in Windows 7 and Vista, use the bcdedit.exe command-line tool, as shown in Figure 2. To access the bcdedit.exe tool, use the following path:

Select **Start > All Programs > Accessories > right-click Command Prompt > Run as administrator > Continue > type bcdedit.exe**

To edit the boot.ini file in Windows XP, use the following path:

Select **Start > right-click My Computer > Properties > Advanced tab > in the Startup and Recovery area, select Settings > click Edit**

bcdedit.exe Command Line Tool



```
Administrator: C:\Windows\system32\cmd.exe
C:\Users\John Doe>bcdedit.exe

Windows Boot Manager
-----
identifier                {bootmgr}
device                    partition=\Device\HarddiskVolume1
description                Windows Boot Manager
locale                    en-US
inherit                    <globalsettings>
default                    <current>
resumeobject               <a11177bd-a5cf-11e1-acab-950c0ec54e74>
displayorder               <current>
toolsdisplayorder         <memdiag>
timeout                    30

Windows Boot Loader
-----
identifier                 <current>
device                     partition=C:
path                       \Windows\system32\winload.exe
description                 Windows 7
locale                     en-US
inherit                     <bootloadersettings>
```

Disk Management Utility

A multiboot setup requires multiple hard drives or a hard drive that has multiple partitions. To create a new partition, access the Disk Management Utility, as shown in Figure 1. You can also use the Disk Management utility to complete the following tasks:

- View drive status
- Extend partitions
- Split partitions
- Assign drive letters
- Add drives
- Add arrays

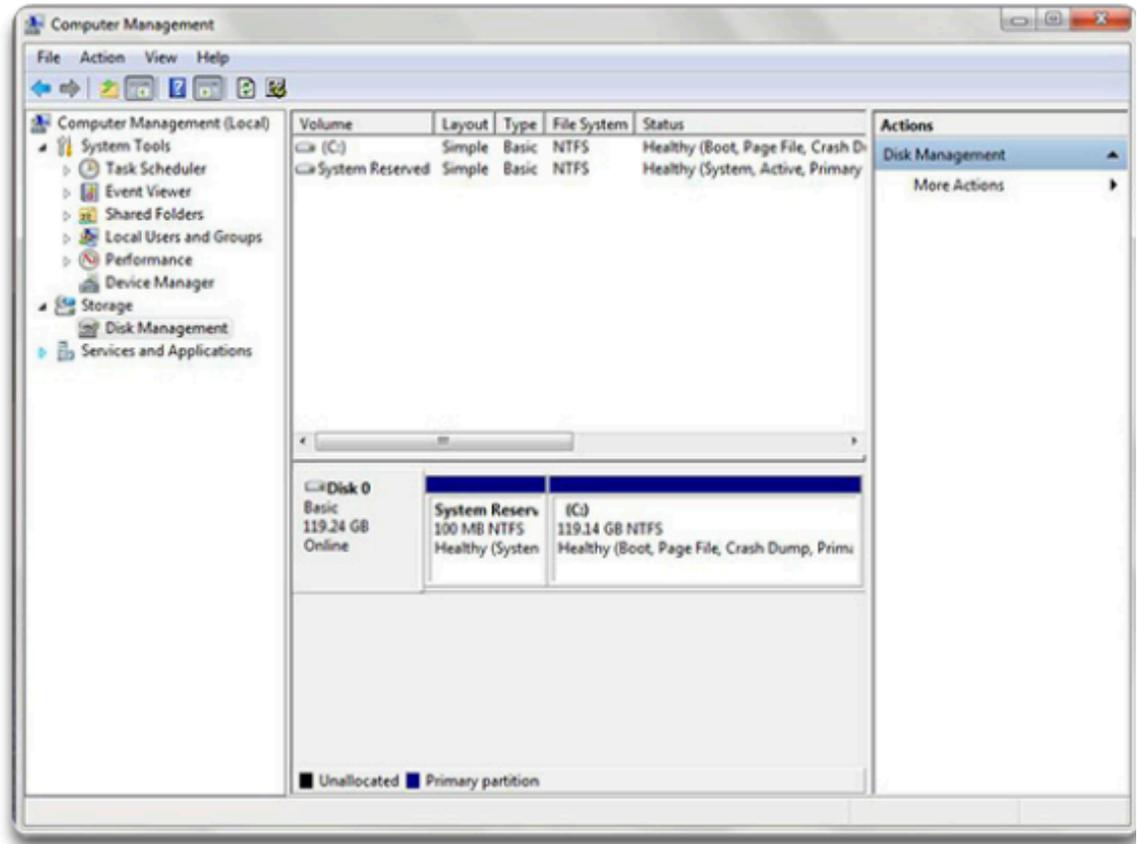
To access the Disk Management utility in Windows 7 and Windows Vista, use the following path:

Start > right-click Computer > Manage > select Disk Management

To access the Disk Management utility in Windows XP, use the following path:

Start > right-click My Computer > Manage > select Disk Management

Disk Management

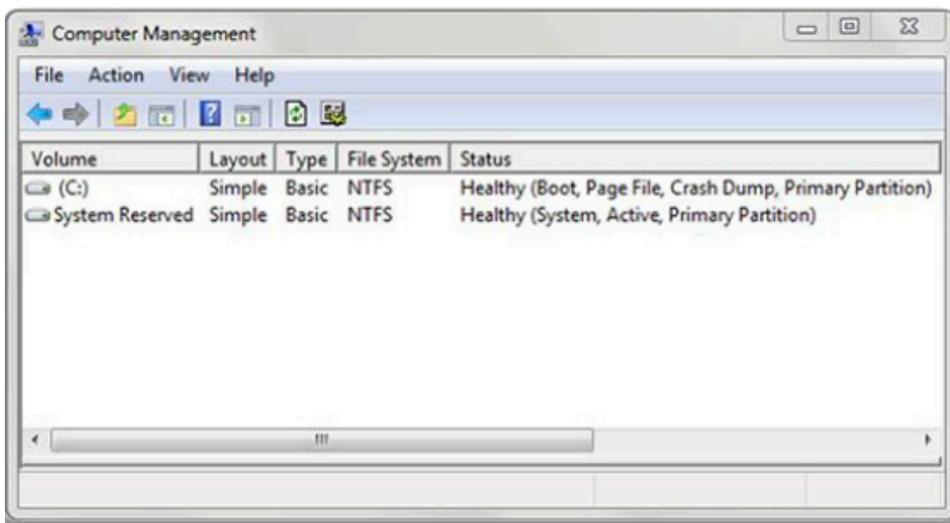


Drive Status

Drive Status

The Disk Management utility displays the status of each disk, as shown in Figure 2. The drives in the computer display one of the following conditions:

- **Foreign** - A dynamic disk that has been moved to a computer from another computer running Windows XP
- **Healthy** - A volume that is functioning properly
- **Initializing** - A basic disk that is being converted into a dynamic disk



- **Missing** - A dynamic disk that is corrupted, turned off, or disconnected
- **Not Initialized** - A disk that does not contain a valid signature
- **Online** - A basic or dynamic disk that is accessible and shows no problems
- **Online (Errors)** - I/O errors detected on a dynamic disk
- **Offline** - A dynamic disk that is corrupted or unavailable
- **Unreadable** - A basic or dynamic disk that has experienced hardware failure, corruption, or I/O errors

Other drive status indicators might be displayed when using drives other than hard drives, such as an audio CD that is in the optical drive or a removable drive that is empty.

Extending Partitions

In Disk Manager, you can extend primary partitions and logical drives if there is unallocated space on the hard disk. To extend a basic disk, it must be formatted with the NTFS file format. Extending a hard disk increases the amount of space available on a primary partition or logical drive. Logical drives and system volumes must be extended into contiguous space, and the disk type must be converted to dynamic. Other partitions can be extended into noncontiguous space, and the disk type must be converted to dynamic

To extend a partition in the Disk Manager, follow these steps:

Step 1. Right-click the desired partition.

Step 2. Click **Extend Volume**.

Step 3. Follow the instructions on the screen.

Splitting Partitions

If a hard drive is partitioned automatically in Windows 7 and Windows Vista, there is only one partition. If you want to split the partition, you can use the Shrink Volume feature. This feature reduces the size of the original partition, which creates unallocated disk space that is used to create a new partition. You must format the unallocated space and assign it a drive letter.

To shrink a partition in Windows 7 and Windows Vista from the Disk Management utility, right-click the drive and select **Shrink Volume**.

Assigning Drive Letters

You can change, add, and remove drive letters and paths. By default, Windows assigns a letter to a partition or drive after it is created or added. You can change the drive designation to any letter as long as that letter is not already in use.

To change a drive letter in Windows 7 from the Disk Management utility, right-click the drive and select **Change Drive Letter and Paths**.

Adding Drives

To increase the amount of storage space available on a computer, or implement a RAID setup, you can add drives to the computer. If the additional hard drive has been installed correctly, the BIOS should automatically recognize it. After the drive is installed, you can check if it is recognized using the Disk Management utility. If the disk is available, it probably requires formatting before it can be used. If it does not appear, troubleshoot the problem.

Adding Arrays

To set up a RAID, two or more drives must be installed in a computer. You can add an array with the Disk Management utility. You have the following options:

- **New Spanned Volume** - Creates a disk partition that consists of disk space from more than one physical disk. The data on a spanned volume is not fault tolerant.
- **New Striped Volume** - A dynamic partition that stores data in stripes on more than one physical disk. The data on a striped volume is not fault tolerant.
- **New Mirrored Volume** - Duplicates data from one disk to one or more additional physical disks. The data on a mirrored volume is fault tolerant.
- **New RAID-5 Volume** - A dynamic partition that stores data in stripes on more than one physical disk, while also providing parity for each stripe. The data on a RAID-5 volume is fault tolerant.

NOTE: The options available for adding an array are based on system limitations. Not all options may be available.

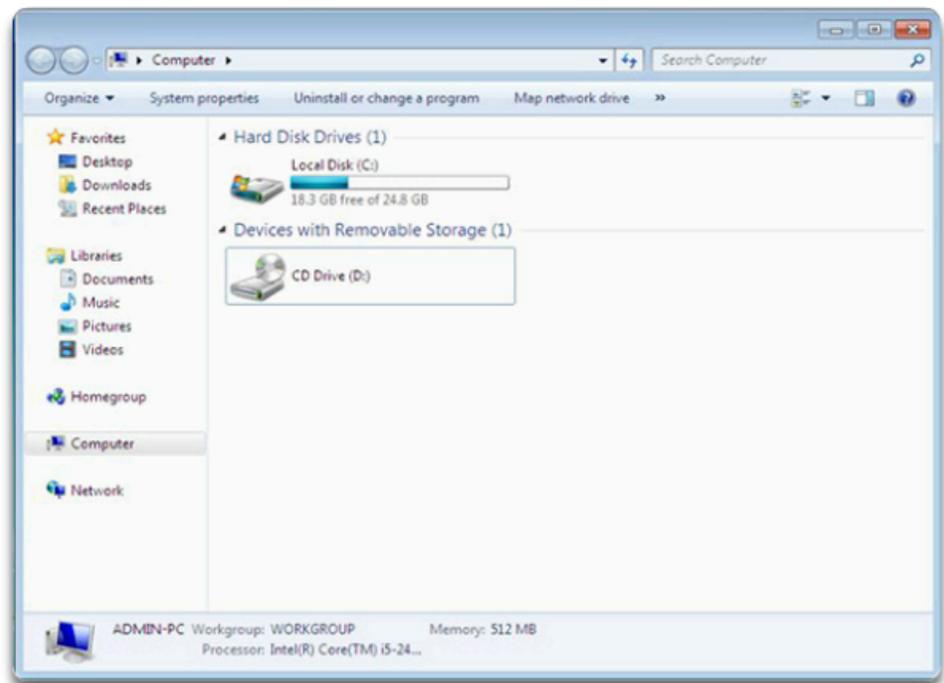
To add an array in the Disk Management utility, right-click the desired disk and select an option.

Directory Structure and File Attributes

In Windows, files are organized in a directory structure. A directory structure is designed to store system files, user files, and program files. The root level of the Windows directory structure, the partition, is usually labeled drive C, as shown in the figure. Drive C contains a set of standardized directories, called folders, for the operating system, applications, configuration information, and data files. Directories may contain subdirectories. Subdirectories are commonly called subfolders.

Following the initial installation, you can install most applications and data in whichever directory you choose. The Windows setup program creates directories that have specific purposes, such as storing photos or music files. When files of the same type are saved to a certain location, it is easier to find things.

C and D Drives



NOTE: It is a best practice to store files in folders and subfolders rather than at the root level of a drive.

Drive Mapping

In Windows, letters are used to name physical or logical drives. This process is called drive mapping. A Windows computer can have up to 26 physical and logical drives, because there are 26 letters in the English alphabet. Drives A and B have traditionally been reserved for floppy disk drives, and drive C is reserved for the primary, active partition. In Windows Vista and Windows 7, you can assign drives A and B to volumes if you do not have floppy drives. An optical drive is traditionally labeled as drive D. The maximum number of additional drives is dependent on the hardware of a specific computer.

Mounting a Volume

With the NTFS file system, you can map a drive to an empty folder on a volume. This is referred to as a mounted drive. Mounted drives are assigned drive paths instead of letters and are displayed as a drive icon in Windows Explorer. Windows Explorer is a tool that allows users to view all the drives, folders, and files on a computer in an organized manner. Use a mounted drive to configure more than 26 drives on your computer or when you need additional storage space on a volume.

To mount a volume in Windows, follow these steps:

Step 1. Select **Start > Control Panel > Administrative Tools > Computer Management**.

Step 2. Click **Disk Management** in the left pane.

Step 3. Right-click the partition or volume to mount.

Step 4. Click **Change Drive Letter and Paths**.

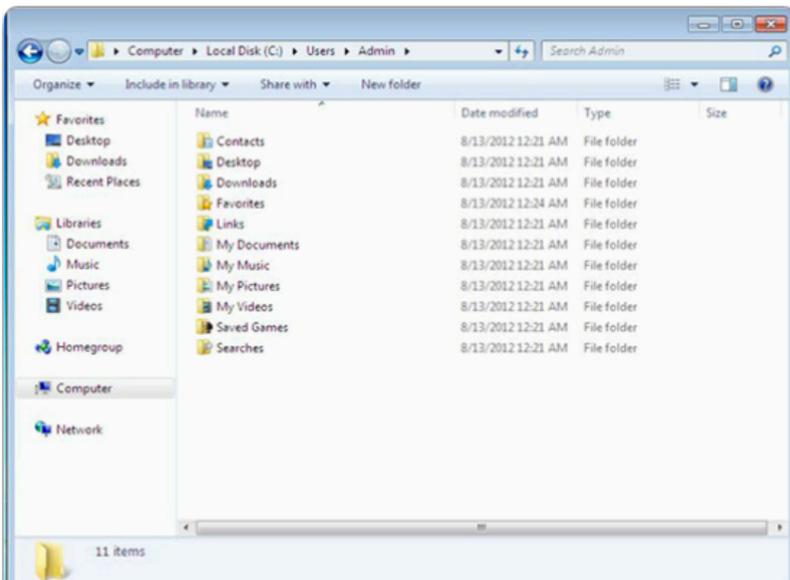
Step 5. Click **Add**.

Step 6. Click **Mount in the following empty NTFS folder**.

Step 7. Browse to an empty folder on an NTFS volume or create one, and click **OK**.

Step 8. Close Computer Management.

User Folders



User and System File Locations

User File Locations

By default, Windows 7 and Windows Vista stores most of the files created by users in the folder **C:\Users\User_name**. Windows XP uses the folder **C:\Documents and Settings\User_name**.

Each user's folder contains folders for music, videos, websites, and pictures, among others, as shown in Figure 1. Many programs also store specific user data here. If a single computer has many users, each user has their own folder containing their favorites, desktop items, and cookies. Cookies are files that contain information from web pages that the user has visited.

System Folder

When the Windows OS is installed, all files that are used to run the computer are located in the folder **C:\Windows\system32**. The content of the Windows System Folder is shown in Figure 2.

Fonts

The folder **C:\Windows\Fonts** contains the fonts installed on the computer. Fonts come in several formats, including TrueType, OpenType, Composite, and PostScript. Some examples of font typefaces are Arial, Times New Roman, and Courier. You can access the Fonts folder through the Control Panel. You can install fonts using the **File > Install New Font** menu.

Temporary Files

The Temporary Files folder contains files created by the OS and programs that are needed for a short period of time. For example, temporary files might be created while an application is being installed to make more RAM available for other applications.

Almost every program uses temporary files, which are usually automatically deleted when the application or the OS is finished using them. However, some temporary files must be deleted manually. Because temporary files take up hard drive space that could be used for other files, it is a good idea to delete them as necessary every two or three months.

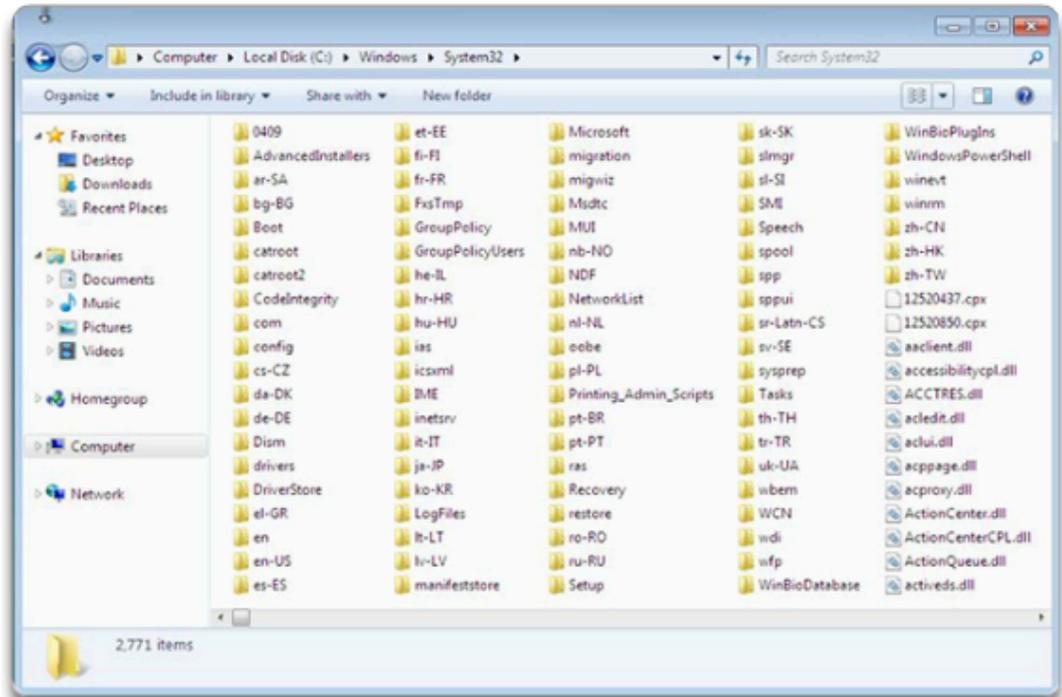
In Windows Vista and Windows 7, temporary files are usually located in the following folders:

- C:\Windows\Temp
- C:\Users\User_Name\AppData\Local\Temp
- %USERPROFILE%\AppData\Local\Temp

In Windows XP, temporary files are usually located in the following folders:

- C:\Temp
- C:\Tmp

System Folders



- C:\Windows\Temp
- C:\Windows\Tmp
- C:\Documents and Settings\%USERPROFILE%\Local Settings\Temp

NOTE: %USERPROFILE% is an environment variable set by the OS with the username that is currently logged on to the computer. Environment variables are used by the operating system, applications, and software installation programs.

To see the environment variables that are configured on Windows 7, use the following path:

Start > Control Panel > System > Advanced System Settings > Advanced tab > Environment Variables

To see the environment variables that are configured on Windows Vista, use the following path:

Start > Control Panel > System > Advance system settings > Advanced tab > Environmental Variables

To see the environment variables that are configured on Windows XP, use the following path:

Start > Control Panel > System > Advanced > Environment Variables

Program Files

The Program Files folder is used by most application installation programs to install software. In 32-bit systems, programs are usually installed in the folder **C:\Program Files**. In 64-bit systems, 64-bit programs are usually installed in the folder **C:\Program Files**, while 32-bit programs are usually installed in the folder **C:\Program Files (x86)**.

File Extensions and Attributes

Files in the directory structure adhere to a Windows naming convention:

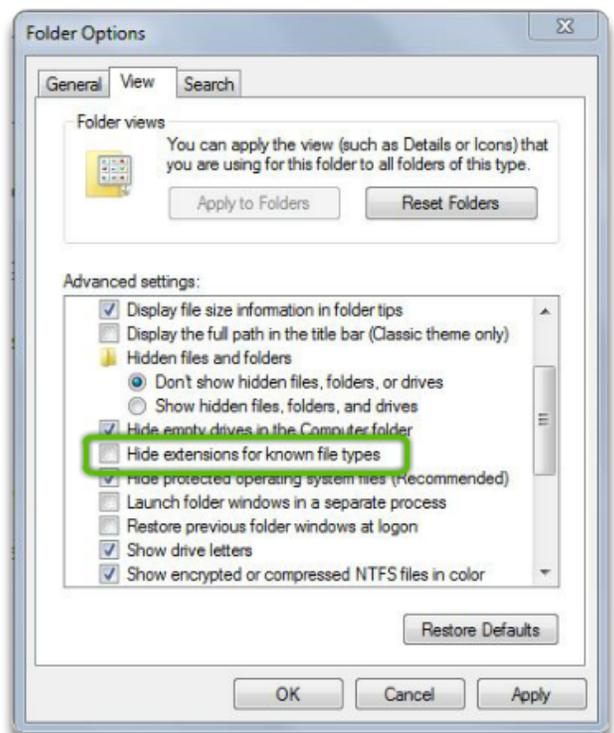
- A maximum of 255 characters is allowed.
- Characters such as a slash or a backslash (/ \) are not allowed.
- An extension of three or four letters is added to the filename to identify the file type.
- Filenames are not case sensitive.

By default, file extensions are hidden. To display the file extensions you must disable the **Hide extensions for known file types** setting in the Folder Options control panel utility, as shown in the figure.

To display file extensions, use the following path:

Start > Control Panel > Folder Options > View > uncheck

Show Known File Types



Hide extensions for known file types

The following filename extensions are commonly used:

- **.docx** - Microsoft Word (2007 and later)
- **.txt** - ASCII text only
- **.jpg** - Graphics format
- **.pptx** - Microsoft PowerPoint
- **.zip** - Compression format

The directory structure maintains a set of attributes for each file that controls how the file can be viewed or altered. These are the most common file attributes:

- **R** - The file is read-only.
- **A** - The file will be archived the next time that the disk is backed up.
- **S** - The file is marked as a system file, and a warning is given if an attempt is made to delete or modify the file.
- **H** - The file is hidden in the directory display.

Application, File, and Folder Properties

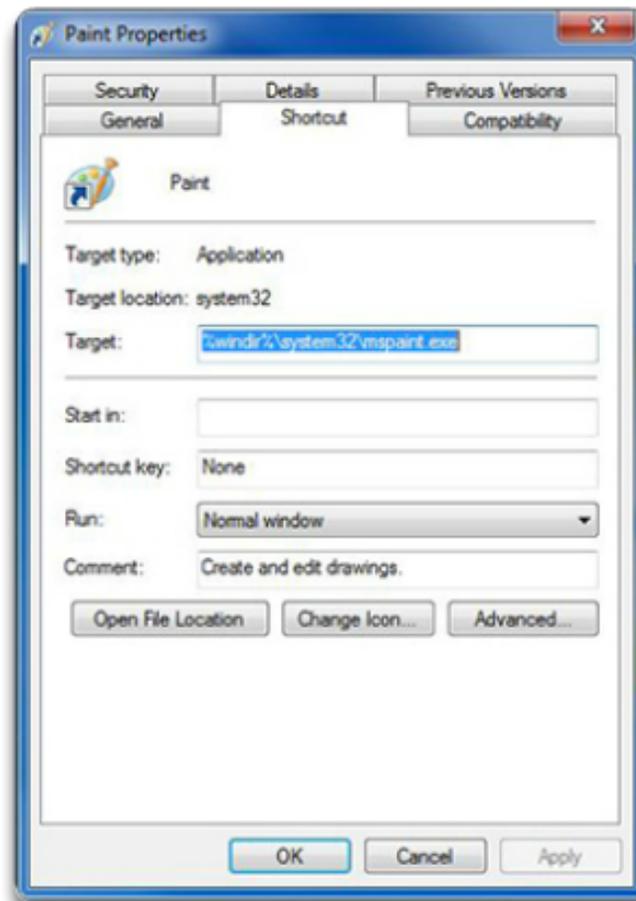
To view or change the properties of an application, file, or folder, right-click the icon and select **Properties**.

Application and File Properties

The Properties view, as shown in Figure 1, for an application or file may contain the following tabs:

- **General** - Displays basic information, including location and the attributes.
- **Security** - Provides the option to change file access permissions for user accounts and the system.
- **Details** - Displays basic information for the file, including attributes.
- **Compatibility** - Provides options for configuring file compatibility mode and operational settings. In Windows 7, compatibility mode allows a user to run a program created for earlier versions of the Windows OS. For Windows Vista and Windows XP, the number of options available in compatibility mode is limited.

Application Properties



Folder Properties

The Properties view, as shown in Figure 2, for an individual folder may contain the following tabs:

- **General** - Displays basic information, such as location and size. Provides options to change attributes, such as making a folder read-only or hidden.
- **Sharing** - Displays options for folder sharing. Users can share folders with computers on the same network. Password protection settings can also be configured.
- **Security** - Displays options for basic and advanced security settings.
- **Previous Versions** - Displays options for restoring a folder from a previous version.
- **Customize** - Displays options for customizing the appearance of the folder and optimizing it for specific file types, such as music or photo files.

Shadow Copy

Shadow Copy is a feature of Windows Operating Systems that automatically creates backup copies of files and data on a hard drive. It can be found under the Previous Versions tab, and is often referred to as the previous versions feature. Shadow Copy requires the hard disk to be formatted as NTFS and works in conjunction with System Restore and Windows Backups. Before Shadow Copy can be used, it must be enabled. To enable Shadow Copy, use the following path:

Start > Control Panel > System Protection link > Click the checkboxes next to the desired drives > Click OK.

After Shadow Copy has been enabled, users can view, copy, or restore previous versions of file. Selecting the view option will open the file as read-only, while the copy option will save an older version of the file in another folder. Restore will overwrite the file in its current state.

Folder Properties

