

Computer Systems

Lecture 4: Operating Systems



Basic Function of an Operating System

- All computers rely on an operating system (OS) to provide the interface for interaction between users, applications, and hardware.
- The operating system boots the computer and manages the file system.
- The operating system has four main roles:
 - Control hardware access
 - Manage files and folders
 - Manage applications
 - Provide user interface

Operating Systems Interface

- Command Line Interface (CLI):
The user types commands at a prompt.
- Graphical User Interface (GUI):
The user interacts with menus and icons.



Most operating systems include both a GUI and a CLI.

Characteristics of an OS

- **Multi-user** – Two or more users have individual accounts that allow them to work with programs and peripheral devices at the same time.
- **Multitasking** – The computer is capable of operating multiple applications at the same time.
- **Multiprocessing** – The operating system can support two or more CPUs.
- **Multithreading** – A program can be broken into smaller parts that are loaded as needed by the operating system. Multithreading allows individual programs to be multitasked.

32Bit Vs 64Bit

- Refers to the way the processor handles information.
- 32-bit (x86)
 - Capable of addressing 4 GB of RAM
 - Will not work with 64 bit applications
 - Limited to assigning 2GB of virtual memory to an application
- 64-bit (x64)
 - Capable of addressing (in theory) 16.8 million terabytes of RAM (Windows 10 is limited to 2 terabytes or 128GB on Windows 10 Home)
 - Enhanced performance for memory management (less system memory used by secondary systems like video card).
 - x64 architecture is backward compatible with x86
 - Limited to assigning 8TB of virtual memory to an application!!
 - Advanced security features
 - Will not run 16 bit applications

32 and 64-bit Compatibility in Windows

Windows Operating System	32-Bit	64-Bit
Windows XP Media Center	X	
Windows XP Home	X	
Windows XP Pro	X	X
Windows Vista Starter	X	X
Windows Vista Home Basic	X	X
Windows Vista Home Premium	X	X
Windows Vista Business	X	X
Windows Vista Enterprise	X	X
Windows Vista Ultimate	X	X

32 and 64-bit Compatibility in Windows

Windows Operating System	32-Bit	64-Bit
Windows 7 Starter	X	
Windows 7 Home Basic	X	X
Windows 7 Home Premium	X	X
Windows 7 Pro	X	X
Windows 7 Enterprise	X	X
Windows 7 Ultimate	X	X

32 and 64-bit Compatibility in Windows

Windows Operating System	32-Bit	64-Bit
Windows 8	X	X
Windows 8 Pro	X	X
Windows 8 Enterprise	X	X
Windows 10 Home	X	X
Windows 10 Mobile	X	
Windows 10 Pro	X	X
Windows 10 Enterprise	X	X
Windows 10 Education	X	X

CPU Modes of Operation

- All modern CPUs can run in different modes of operation.
- The mode of operation refers to the capability of the CPU and the operating environment.
- **CPU modes** are operating modes for the central processing unit that:
 - Place restrictions on the type and scope of operations that can be performed by certain processes being run by the CPU.
 - This design allows the operating system to run with more privileges than application software.
 - Ideally, only highly-trusted kernel code is allowed to execute in the unrestricted mode; everything else runs in a restricted mode.
- There are four common modes of operation :

CPU Modes of Operation

Real Mode

- Executes only one program at a time
- Addresses only 1 MB of system memory at a time
- Directly accesses memory and hardware
- Subject to crashes
- Available to all modern processors
- Only used by DOS and DOS applications

Protected Mode

- Has access to all memory
- Can manage multiple programs simultaneously
- Allows the system to use virtual memory
- Provides 32-bit access to memory, drivers, and I/O transfers
- Each program is assigned a space in memory
- Computer is protected from program errors

CPU Modes of Operation

Virtual Real Mode

- Allows a real-mode application to run within a protected-mode operating system
- Creates virtual machines for each program that runs in real mode
- Each virtual machine receives 1 MB of memory and access to hardware
- In the event of a program error, only the virtual machine is affected

Compatibility Mode

- Creates the environment of an earlier OS for applications not compatible with the current OS. ie, an application that checks the version of the OS might be written for Windows NT and require a particular service pack. Compatibility mode can create the proper environment or version of the OS to allow the application to run as if it is in the intended environment.
- Windows Vista, 7, 8 and 10 are highly compatible with previous versions with two particularly useful features :
 - Windows 7 compatibility mode. This allows applications not compatible with Windows 7 to be executed as if the OS were Windows XP.
 - Override of the User Account Control (UAC). This allows an application to be run even if the user does not have the required administrative privileges.

Types of Operating Systems

Desktop Operating System	Network Operating System
<ul style="list-style-type: none">• Supports a single user	<ul style="list-style-type: none">• Supports multiple users
<ul style="list-style-type: none">• Runs single-user applications	<ul style="list-style-type: none">• Runs multi-user applications
<ul style="list-style-type: none">• Shares files and folders	<ul style="list-style-type: none">• Robust and redundant
<ul style="list-style-type: none">• Shares peripherals	<ul style="list-style-type: none">• Provides increased security
<ul style="list-style-type: none">• Used on a small network	<ul style="list-style-type: none">• Used on a network

Types of Operating Systems



- Desktop operating systems:
 - Microsoft Windows: Windows XP, Vista, 7, 8, 10
 - Macintosh: Mac OS X
 - Linux
 - UNIX
- A desktop OS has the following characteristics:
 - Supports a single user
 - Runs single-user applications
 - Shares files and folders on a small network with limited security

Network Operating Systems (NOS)

- Common NOS include:
 - Microsoft Windows Server 2016, 2012, 2008, 2003, 2000 and NT
 - Linux
 - UNIX
 - Mac OS X Server
- NOS has the following characteristics:
 - Supports multiple users
 - Runs multi-user applications
 - Robust and redundant
 - Provides increased security compared to desktop os

Network Operating System (NOS)

- A **network operating system (NOS)** is an operating system that contains additional features to increase functionality and manageability in a networked environment.
- Network operating systems provide several protocols designed to perform network functions.
 - Hypertext Transport Protocol (**HTTP**) defines how files are exchanged on the web
 - File Transfer Protocol (**FTP**) provides services for file transfer and manipulation
 - Post Office Protocol (**POP**) retrieves e-mail messages from an e-mail server
 - Domain Name Services (**DNS**) resolves URLs for websites with their IP addresses
 - Dynamic Host Control Protocol (**DHCP**) automates assignment of IP addresses

Why Network Operating Systems

- The NOS is designed to provide network resources to clients:
 - Server applications, such as shared databases
 - Centralised data storage
 - Directory services that provide a centralised repository of user accounts and resources on the network, such as LDAP or Active Directory
 - Network print queue
 - Network access and security
 - Redundant storage systems, such as RAID
 - Backups

Installing the Operating System

- **Reasons to perform a clean installation of an OS:**
 - When a computer is passed from one employee to another.
 - When the operating system is corrupted.
 - When the primary hard drive is replaced in a computer .
- **Before performing a clean installation:**
 - Back up all data first.
 - Explain to the user that existing data will be erased.
 - Confirm that all needed data has been successfully transferred.

User Requirements for an OS

- **To select the proper operating system for a user, first determine:**
 - Budget constraints
 - Compatibility with current hardware
 - Compatibility with new hardware
 - How the computers will be used
 - Compatibility with existing applications
 - Types of new applications to be used

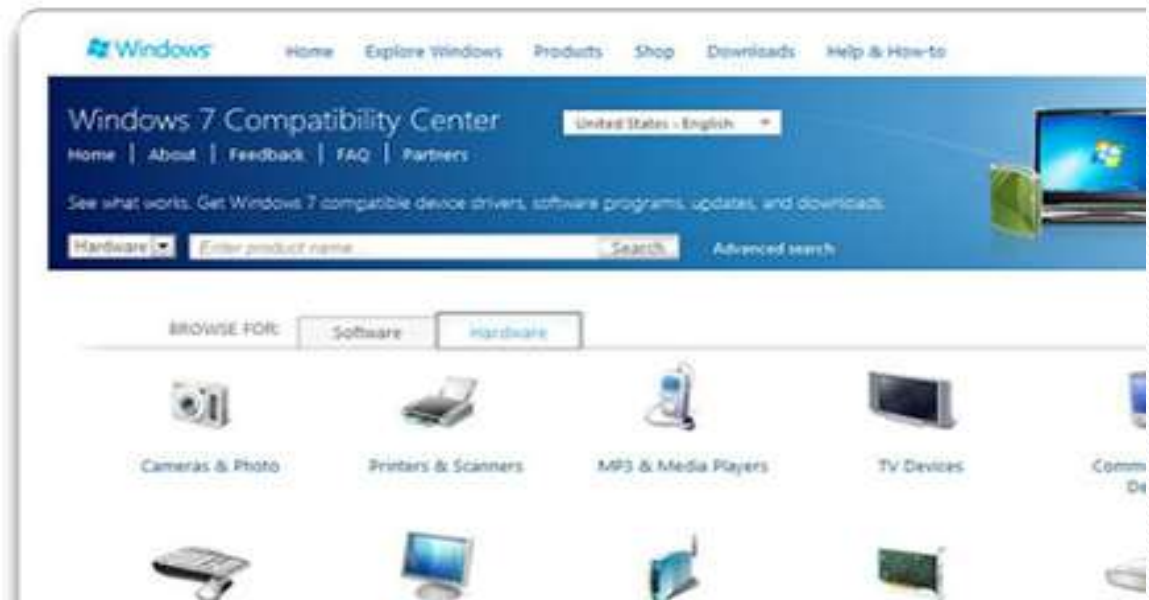
Identify Min Hardware Requirements

- User may need to upgrade or purchase additional hardware to support the required applications and OS.
- A cost analysis will indicate if purchasing new equipment is a better idea than upgrading.
- Possible hardware upgrades:
 - RAM capacity
 - Hard drive size
 - CPU
 - Video card memory and speed
 - Motherboard

Windows 7 Professional	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit) GB RAM (64-bit)
Windows 7 Ultimate	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit) GB RAM (64-bit)
Windows 7 Enterprise	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit) GB RAM (64-bit)

Hardware Compatibility

- Most operating systems have an HCL.
- HCLs can be found on the manufacturer's website.
- HCL includes list of hardware that is known to work with the operating system.
- Use Microsoft Compatibility Center for Windows 10, 8, 7 and Vista.



Operating System Upgrades

- Operating systems must be upgraded periodically.
 - To remain compatible with the latest hardware and software.
 - Because support for older OS is eventually withdrawn.
- Ensure that the new OS is compatible with the computer.
 - Use Microsoft Upgrade Advisor to scan the system for incompatibility issues before upgrading. Upgrade Advisor is free and downloadable from the Microsoft Windows website.
- Backup all data prior to beginning the upgrade.

OS can upgrade to:	Windows 2000	Windows XP	Windows Vista	Windows 7
Windows 98	Supported	Supported	Supported	Unsupported
Windows 2000	N/A	Supported	Supported	Unsupported
Windows 98	N/A	N/A	Supported	Unsupported
Windows Vista	N/A	N/A	N/A	Supported

Hard Drive Setup Procedures

- **Operating system setup methods:**
 - Install an OS over a network from a server.
 - Install from OS files stored on CDs or DVDs.
- **Partitioning and Formatting:**
 - Hard drive must be logically divided (partitioned).
 - File system must be created on the hard drive.
 - During the installation phase, most operating systems will automatically partition and format the hard drive.

Hard Drive Formatting

- The first portion of the installation process deals with formatting and partitioning the hard drive.
- The second portion prepares the disk to accept the file system.
- The file system provides the directory structure that organises the user's operating system, application, configuration, and data files.
- Examples of file systems:
 - **The New Technology File System (NTFS)** - Supports partition sizes up to 16 exabytes
 - **The FAT32 file system** - Supports partition sizes up to 2TB. Used by Windows XP and earlier OS versions.
 - Does not support files over 4GB

Install the Operating System

- When a computer boots up with the Windows installation CD, the Windows installation process starts with three options:
 - **Install now** - Sets up and installs the Windows OS.
 - **What to know before installing Windows** - Opens Help.
 - **Repair your computer** - Opens the System Recovery Options.
- Under **Install now** 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.
 - **Quit** - Exits Setup.

Account Creation

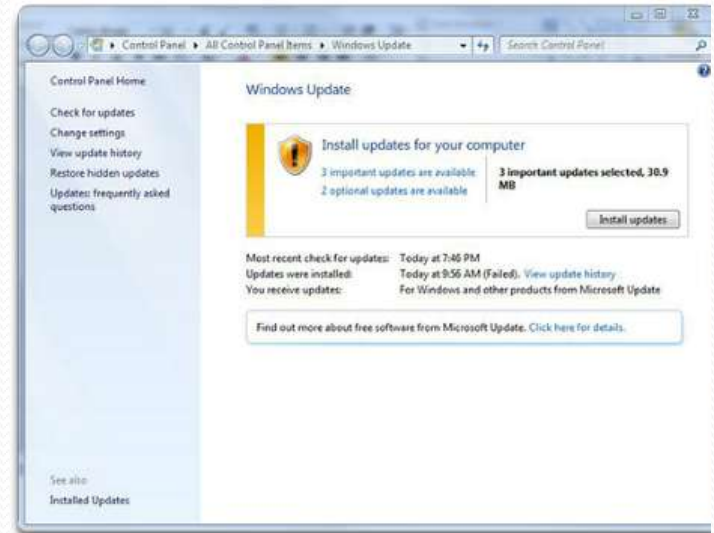
- Windows has three types of user accounts: Administrator, Standard, and Guest.
- The Administrator Account must be created when Windows is installed.
- **To create or remove a user account in Windows use the following path :**
 - **Start > Control Panel > User Accounts > Add or remove user accounts**

Administrator Account

- Setup creates the administrator account with the user name “administrator”
 - Change this name to keep the administrator account secure
 - Only use the administrator account occasionally for critical system changes
- Create a fictitious user account to use as a template
- Use secure passwords
 - These should be a minimum of 8 characters, containing at least one of each (letter, number, and symbol)

Complete the Installation

- **When Windows installation completes:**
 - Computer will reboot
 - Prompts to create user account
 - Register Windows and verify that you are using a legal copy of the OS
 - Verification enables you to download patches and service packs
- Use **Microsoft Update Manager** to scan for new software.



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

Startup Modes

Pressing the F8 key during the boot process opens the **Windows Advanced Startup Options** menu, which allows you to select how to boot Windows.

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

Directory Structures

- The root level of the Windows directory structure, the partition, is usually labeled drive C.
 - Contains a set of standardised directories, called folders, for the operating system, applications, configuration information, and data files.
 - Directories may contain subdirectories. Subdirectories are commonly called subfolders.
- **Drive Mapping** - letters are used to name physical or logical drives.
- **Mounting a Volume** - mapping a drive to an empty folder on a volume. Mounted drives are assigned drive paths instead of letters.

File Extensions and Attributes

- Windows file system naming conventions:
 - Maximum of 255 characters may be used.
 - Characters such as a period (.) or a slash (\ /) 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.
- Windows filename extension examples:
 - .docx- Microsoft Word
 - .txt - ASCII text only
 - .jpg - graphics format
 - .pptx - Microsoft PowerPoint
 - .zip - compression format

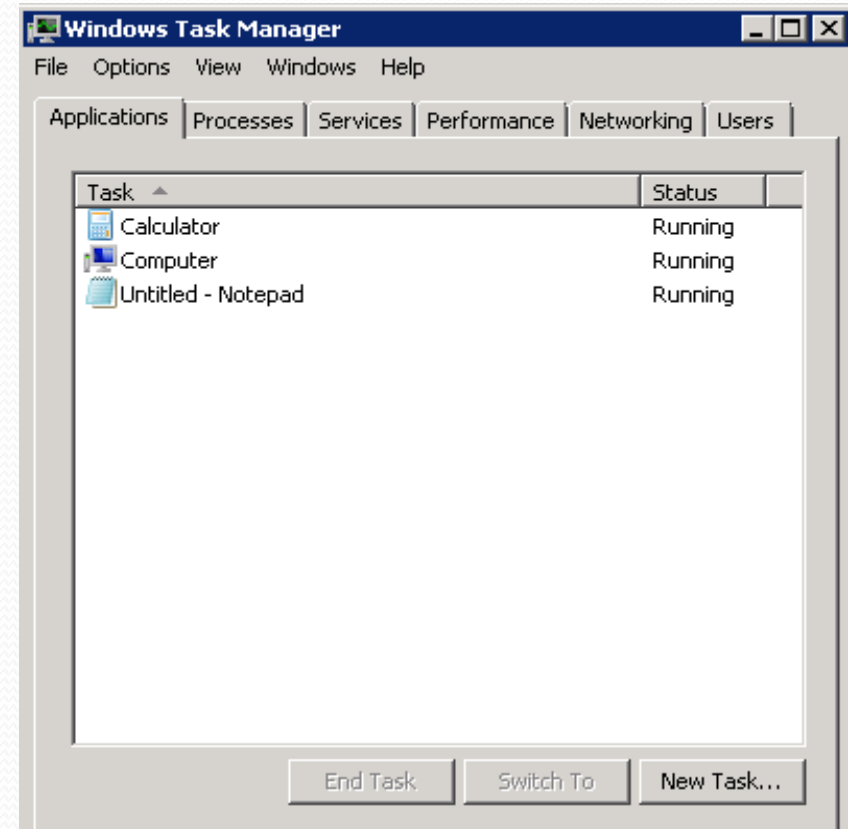
The Windows Registry Files

- The Windows Registry files are an important part of the Windows boot process.
- These files are recognised by their distinctive names, which begin with HKEY_ followed by the name of the portion of the operating system 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.
- Each user has a unique section of the Registry. The Windows login process pulls system settings from the Registry to reconfigure the system to the state that it was in the last time that you turned it on.

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

Windows Task Manager

- **The Task Manager** allows you to view all applications that are running and to close any applications that have stopped responding:
- **CTRL-ALT-DEL** and select **Start Task Manager**
- Right-click the taskbar and select **Start Task Manager**.



User Accounts

- **User Accounts Utility:**

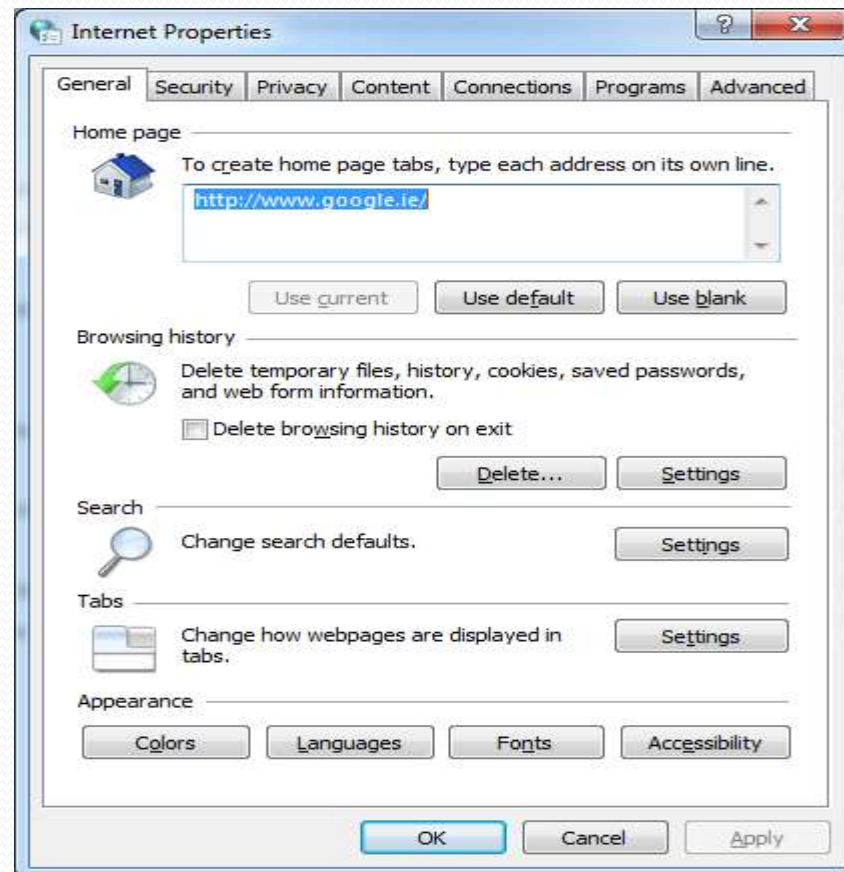
- Create a user account.
- Manage password, change picture, change account name and type, manage another account, and change User Account Control (UAC) settings.
- **Start > Control Panel> select User Accounts**

- **User Account Control (UAC):**

- Monitors programs on a computer and warns users when an action might present a threat to the system.

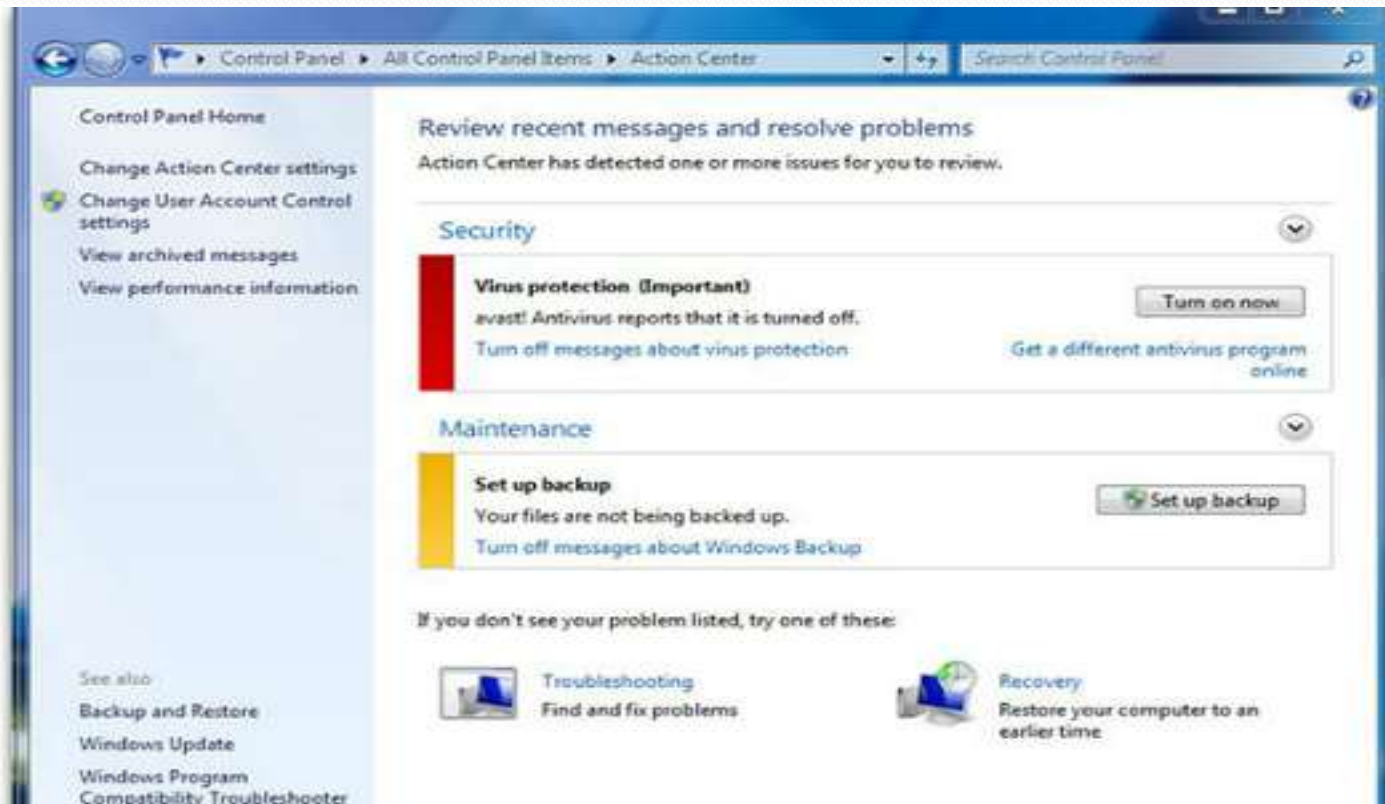
Internet Options

- To access Internet Options select **Start > Control Panel > Internet Options**



Action Center

- Used to configure security settings in Windows 10, 8, 7 and Vista.
- Select **Start > Control Panel > Action Center**.



Windows Firewall

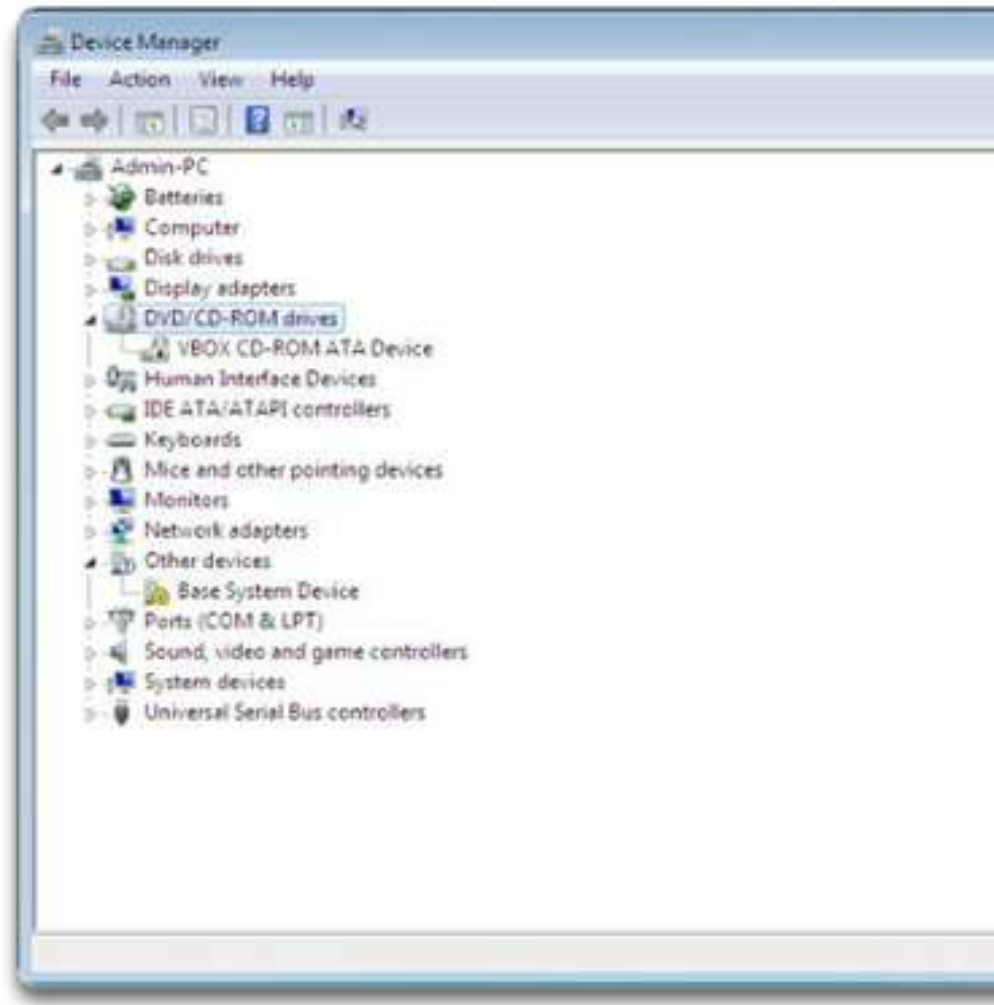
- The **Windows Firewall Utility** implements a security policy by adjusting the following settings:
 - Allow a program or feature through Windows Firewall
 - Change notification settings
 - Turn Windows Firewall on or off
 - Restore defaults
 - Advanced settings
- **Start > Control Panel > Windows Firewall.**

The System Utility

- View basic system information, access tools and configure advanced settings including:
 - **Computer Name** -View or modify the name and workgroup settings for a computer, as well as change the domain or workgroup.
 - **Hardware** - Access the **Device Manager** or adjust the device installation settings.
 - **Advanced** -Configure settings for performance, user profiles, startup, and recovery.
 - **System Protection** - Access System restore and configure protection settings.
 - **Remote** -Adjust settings for Remote Assistance and Remote Desktop.
- **Start > Control Panel > System**

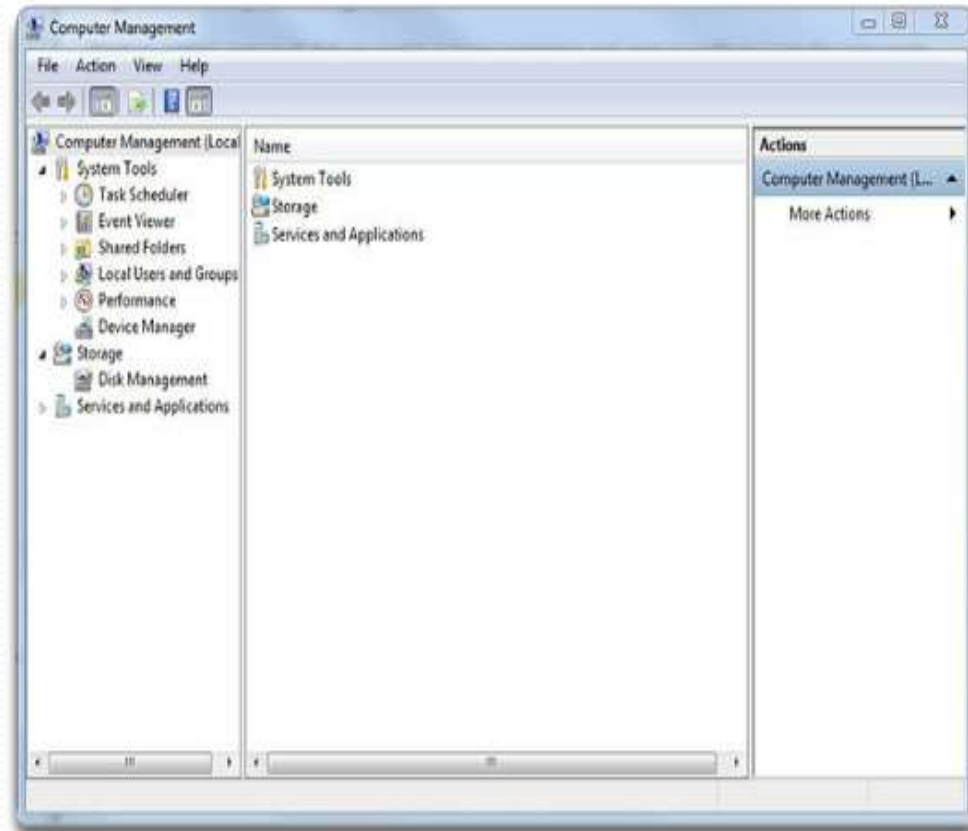
Device Manager

- View settings for devices in the computer and:
 - **Update a driver** - Change the currently installed driver.
 - **Roll back a driver** - Change the currently installed driver to the previously installed driver.
 - **Uninstall a driver**
 - **Disable a device**
- **Start > Control Panel > System > Device Manager**



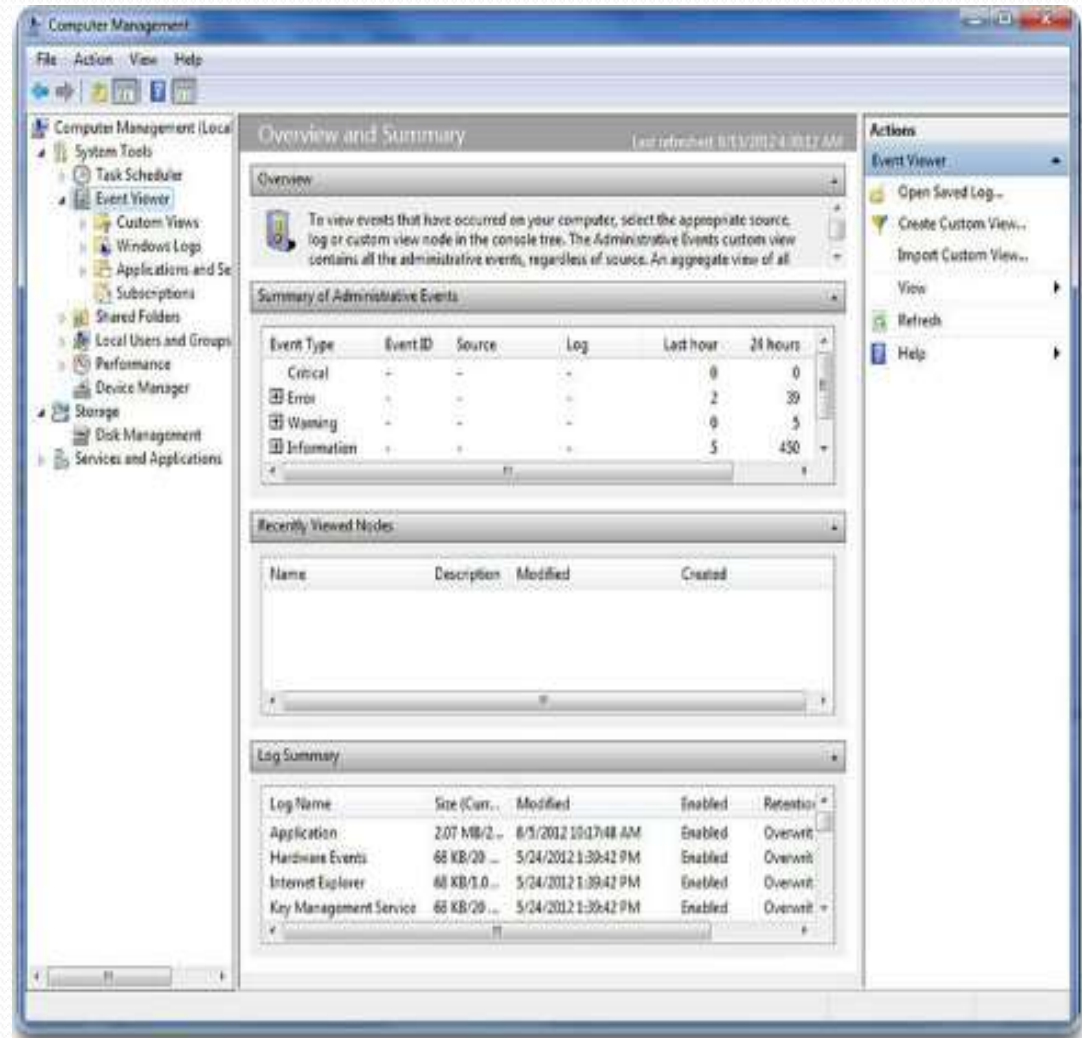
Computer Management Console

- Provides utilities to manage your computer including:
 - Task Scheduler
 - Event Viewer
 - Shared Folders
 - Local Users and Groups
 - Performance
 - Device Manager
 - Disk Management
- **Start > Control Panel > Administrative Tools > Computer Management**



Event Viewer

- Logs a history of events regarding applications, security, and the system.
- These log files are a valuable troubleshooting tool.
- **Start > Control Panel > Administrative Tools > Event Viewer**



Disk Management Utility

- This utility can be used to complete the following tasks:
 - View drive status
 - Extend partitions
 - Split partitions
 - Assign drive letters
 - Add drives
 - Add arrays

Volume	Layout	Type	File System	Status	Capacity	Free Space	% Free
	Simple	Basic		Healthy (EFI System Partition)	500 MB	500 MB	100 %
	Simple	Basic		Healthy (OEM Partition)	40 MB	40 MB	100 %
	Simple	Basic		Healthy (Recovery Partition)	500 MB	500 MB	100 %
	Simple	Basic		Healthy (Recovery Partition)	13.97 GB	13.97 GB	100 %
	Simple	Basic		Healthy (Primary Partition)	8.00 GB	8.00 GB	100 %
OS (C:)	Simple	Basic	NTFS	Healthy (Boot, Page File, Crash Dump, Primary Partition)	683.52 GB	568.53 GB	83 %

Disk 0 Basic 698.51 GB Online	500 MB Healthy (EFI Syst)	40 MB Healthy I	500 MB Healthy (Recove	OS (C:) 683.52 GB NTFS Healthy (Boot, Page File, Crash Dump,	13.97 GB Healthy (Recovery Partitior
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Disk 1 Basic 8.00 GB Online	8.00 GB Healthy (Primary Partition)
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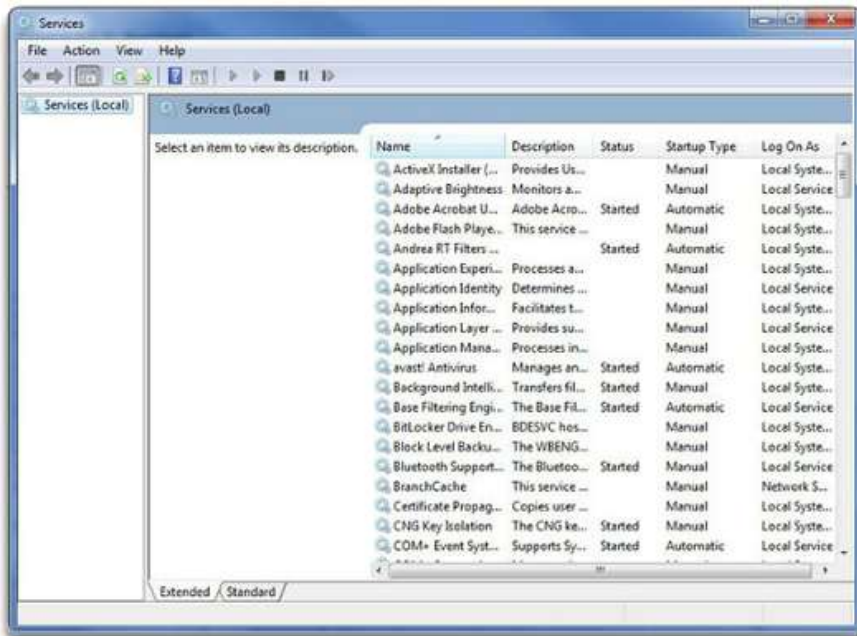
CD-ROM 0 DVD (D:) No Media

- To access the Disk Management utility in Windows 10, 8, 7 and Windows Vista, use the following path:
Select **Start** > right-click **Computer** > **Manage** > select **Disk Management**

Services and Performance Monitor

Services:

- Start, stop, or disable services.
- **Start > Control Panel > Administrative Tools > Services.**



Performance Monitor:

- Record performance data and configure alerts.
- **Start > Control Panel > Administrative Tools > Performance Monitor**

Disk Defragmenter and Disk Error-Checking Tool

- Disk Defragmenter makes files on the hard drive contiguous and speeds up the reading of files.
- To access the Disk Defragmenter in Windows, select **Start > All Programs > Accessories > System Tools > Disk Defragmenter**.
- **CHKDSK** checks the integrity of files and folders by scanning the hard disk surface for physical errors.
- Access CHKDSK from within the Disk Defragmenter or enter CHKDSK in command line to detect and repair disk errors.

Command-Line Tools

- **Start** > Type **Cmd** in the **search box** > Press **Enter**

Command	Command Function
Help [command-name]	Provides specific information for any CLI command . Alternatively, you can use [command-name]/?
Taskkill	Kill or stop a running application
Bootrec	Use to repair the MBR
Shutdown	Shuts down a local or remote machine
Tasklist	Displays currently running applications
MD	Creates a new directory
RD	Removes a directory
CD	Changes to a different directory
DEL	Deletes a file
FDISK	Tool used to partition disks in Windows XP
FORMAT	Formats a drive, mount point, or volume with a file system
COPY	Copies files from one location to another

Virtualisation

- Host machine uses its system resources to host a **virtual machine**.
- Hosting a virtual machine allows users to access the functionality and resources provided by an OS that is not on the local PC.
- Provides access to applications, file-sharing services, and other productivity tools.
- Users can further increase the functionality of their system by running multiple virtual machines.

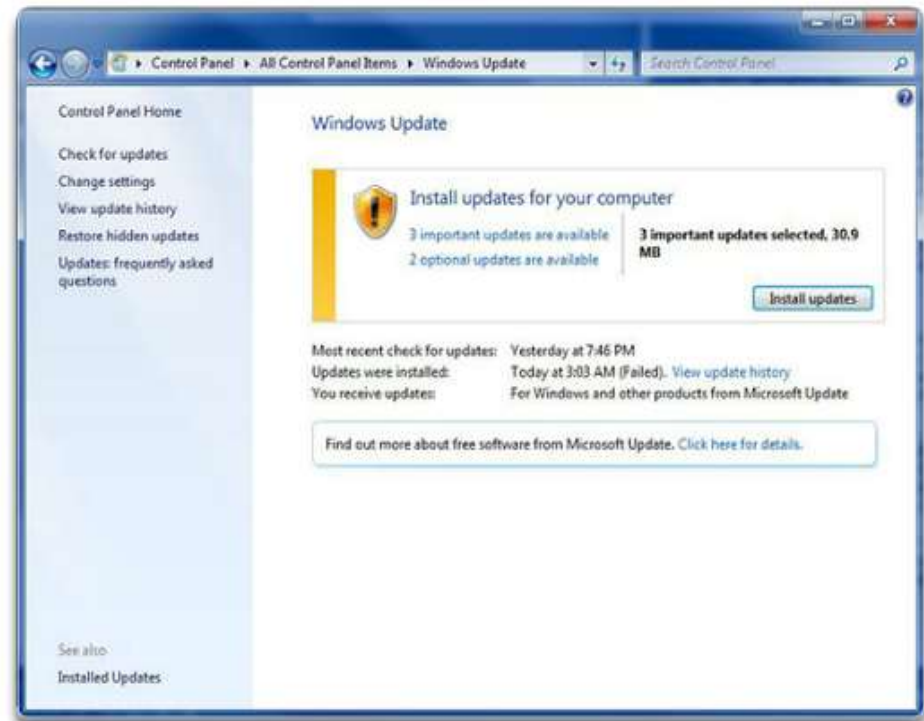
Virtualisation

- The software that creates and manages a virtual machine on a host machine is called **the hypervisor, or Virtual Machine Manager (VMM)**.
 - Allocates the physical system resources, such as CPU, RAM, and hard drive, to each virtual machine as needed.
- **Examples :**
 - Windows Virtual PC
 - Hyper V
 - Vmware
 - Oracle VirtualBox

Preventive Maintenance Planning

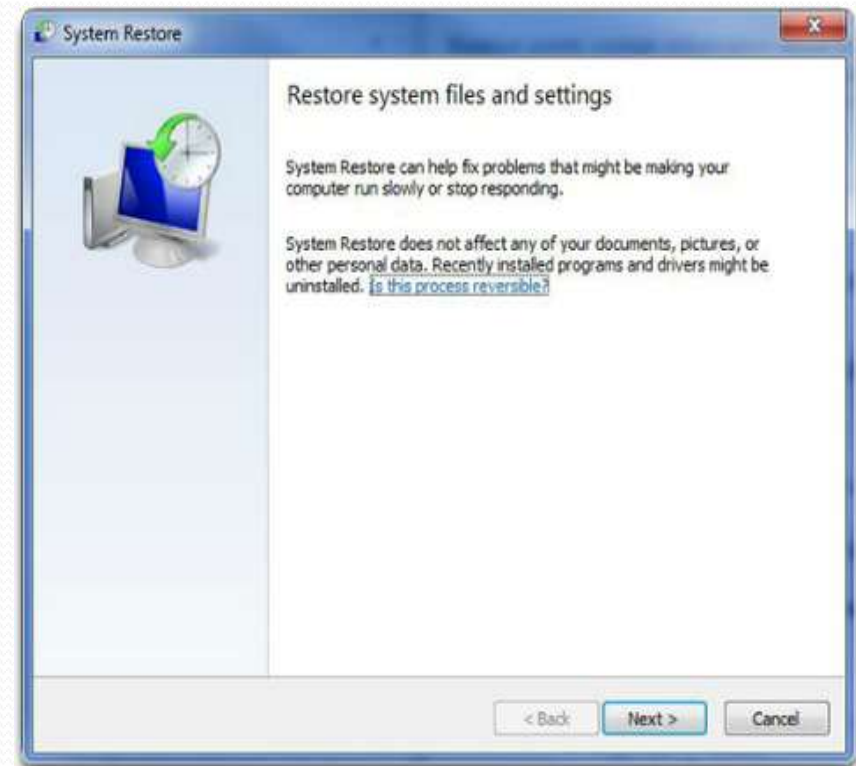
Components of a preventive maintenance plan:

- Updates to the operating system and applications
- Updates to anti-virus and other protective software
- Hard drive error checking
- Hard drive backup
- Hard drive defragmentation
- Device drive updates
- Firmware updates
- Startup programs



Restore Point

- If a computer crashes, the OS can roll back to a restore point using the System Restore Utility.
 - The restore utility only operates on OS and application files.
 - Anti-virus software should be run to remove malware before creating a restore point.
- When to create a restore point:
 - Before updating or replacing the OS.
 - When installing or updating hardware.
 - When an application or driver is installed.
- **Start > All Programs > Accessories > System Tools > System Restore**



Backup the Hard Drive

- Use the **Microsoft Backup Tool** to perform backups.
- Establish a backup strategy that will allow for the recovery of data.
- Decide how often the data must be backed up and the type of backup to perform.
- It is only necessary to make copies of the files that have changed since the last backup.
-
- To access the backup utility in Windows, select **Start > Control Panel > Backup and Restore**.

Types of Backups

	Description	Clear marker
Normal	Selected files and folders	Yes
Copy	Selected files and folders	No
Differential	Selected files and folders that changed since the last backup	No
Incremental	Selected files and folders that changed since the last backup	Yes
Daily	Selected files and folders that changed during the day	No

Linux OS



- Created in 1991 by Linus Torvalds, a student at the University of Helsinki.
- Originally intended to name it “Freax,” but the administrator of the server Torvalds used named his directory “Linux” after a combination of Torvalds’ first name and the word Unix, and the name stuck.
- Free and open-source software based on the Unix OS.
 - Libre Office, Gimp.
- One of it’s other biggest selling points is its reliability.
- Many versions by different organisations.
 - i.e. Ubuntu, OpenSUSE, Debian, Fedora.
- Used to be command line only but now has graphical interface.
- Different desktop environments available, most popular are Gnome, KDE, Unity and Cinnamon.
- File system includes : ext2, ext3 and ext4, XFS, JFS, ReiserFS and btrfs



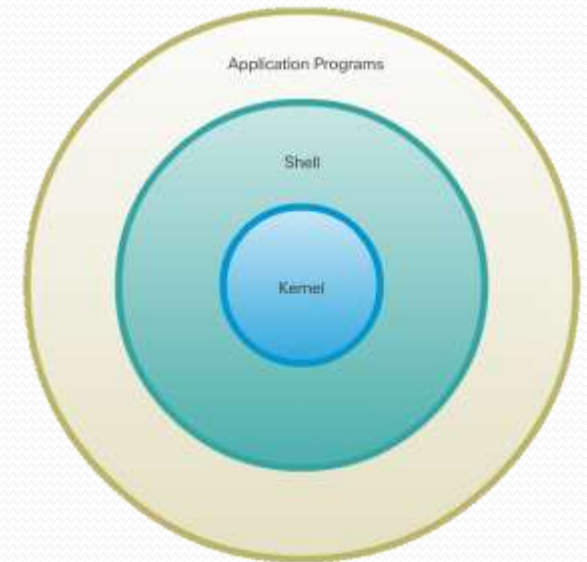
Mac OS

- Mac (Macintosh up until 1998) is a series of personal computers designed, developed, and marketed by Apple Inc.
- Latest version is Mac X.
- Built on the Darwin open-source Unix operating system (Unix command lines can be used).
- Uses a more graphics-based interface, while Windows is more text-centered.
- File system is HFS+ (Hierarchical File System Plus) but changing to APFS (Apple file System).
- Specialised for graphics and video editing.
- More expensive than Windows pc.
- And Yes, they get viruses!!!



Linux and OS X Tools and Features

- Introduction to Linux and OS X Operating Systems
 - Linux and OS X are similar to UNIX.
 - Both OSs kept most of the UNIX basic structure traits.
- Overview of Linux and OS X GUI
 - Modern versions of Ubuntu Linux include Unity.
 - Modern versions of OS X include Aqua.
 - Unity and Aqua GUIs have similar UI elements.
- Overview of Linux and OS X CLI
 - Due to their relation to UNIX, both Linux and OS X have similar CLI interfaces.
 - Text-based tools, the use of a *shell*, file system structure, file permissions and case-sensitivity are a few common characteristics inherited from UNIX and present in both OSs.



Android OS



- Initially developed by Android Inc. in 2003 and bought by Google in 2005.
- Based on the Linux kernel.
- First commercial Android device in September 2008 (HTC Dream smartphone).
- Today devices include smartphones, tv's, cars, microwaves, fridges, watches etc.
- Android is open source and as a result manufacturers are able to tweak Android, it can look quite different on devices from different companies.
- Android applications run in a sandbox.
- Google releases new versions of Android approximately every year. Each version is whimsically named after a candy, along with its number.
 - the most recent release is 7.0 Nougat