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Module : 02 Operating Systems: Concept and Basic Features

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Operating Systems: Concept and Basic Features

I. Objectives

The objectives of this module are to impart knowledge on the following aspects of Operating Systems:

- History and evolution
- Features of operating systems
- Generations of operating systems
- Basic components of operating systems
- Different types of operating systems
- Features of popular operating systems

II. Learning Outcome

After completion of this lesson, you would understand operating system, its types and characteristics. You would learn about functionalities and features of three popular operating systems, namely Windows, Linux and MS-DOS, their characteristics and features.

III. Structure of the Module

The module has been broadly divided into8 sections:

1. Introduction
2. Generations of Operating Systems
3. Features of Operating Systems
4. Basic Components of Operating Systems
5. Types of Operating Systems
6. Features of Operating Systems
7. Summary
8. References

1. Introduction

Operating System (OS) acts as an interface between a user and computer. It controls all computer resources and provides an environment in which a user can execute programs. Operating systems evolved over last fifty years from the earlier resident monitor program to today's distributed operating environment. The history of operating systems is closely associated with the history of computer architecture, one influencing the other. Initially there was only computer hardware which was physically large with limited memory and very slow in operation. The computer system was operated by same person who used to write the program which was written absolutely in binary first on paper (George, 2003). Hence, it used to be time consuming and cumbersome operation as programmers used

spend more time performing the normal operation of entering the programme into the computer in addition to writing the programme.

The next remarkable development at this point was the introduction of punched cards and high speed punched card readers. Some software was needed to run the card readers. These programs once developed, tested and debugged could be incorporated in ROMand could be used by every programmer (George, 2003). As the time passed on, additional hardware, software were developed and new media was also introduced like card readers, paper tape readers, magnetic tapes etc. System programs were developed to run the devices. Higher level languages were developed and assemblers, compilers, loaders, linkers etc., became common. High level languages and language systems need the programming tasks much easier. Later, to speed up the process, similar programs were grouped together. These programs were then executed as a batch by the operator.

2. Generations of Operating Systems
The generations of Operating systems are based on the developments and it is not possible to set any time frames.

2.1 Zero^th Generation
There was no operating system. The programmer/operator hand coded the bare machine. The advantage with this system was its hands on interactive nature.

2.2 First Generation
First generation computer operating systems were characterized by machine and assembly language and stored program concept. This period also seen the introduction of different types of input and output (I/O) devices. Higher level languages and language systems were developed. First generation operating systems made the programming job very simple. However, system utilization was not very efficient.

2.3 Second Generation
Second generation started with automatic job sequencing and batch processing. Offline batch processing and spooling system were introduced. FMS (Fortran Monitoring System) and IBSYS (IBM's tape-based operating system for 7090 / 7094 computers.) are examples of typical second generation operating systems.

2.4 Third Generation

Multiprogramming time sharing and real time processing were introduced. Most of the third generation systems were multimode systems. Some of them simultaneously supported batch processing, multiprogramming, time sharing and real time processing. IBM 360, IBM MVS, IBM MVT are some of the examples. Therefore time sharing and operating systems are the key technologies of this period.

2.5 Fourth Generation

Operating system for personal computers and database systems gained importance. This facilitated non-technical computer users to develop applications without the support of programmers. Another feature is pre written application software packages that can be used by the end user directly.Network operating system and distributed operating system took the computing power to the user's door. The operating systems which are currently being in use fall into this generation (George, 2003).

3. Features of Operating Systems

The modern day operating systems are based on the following mechanisms:

- **Multitasking**

  The ability of an operating system to handle the execution of multiple tasks at a time is known as multitasking. When a task is waiting for the completion of an activity, the processor, meanwhile starts executing the next task. Hence, while one task is waiting for input from the user, another program could be reading from the hard disk.

- **Multiprogramming**

  An operating system allows many programs to be executed simultaneously by different users is known as multiprogramming feature. Text editor, game application and a calculator on a computer can be run at the same time where the operating system executes all the programs simultaneously.In other words the ability to perform three tasks is multiprogramming and the ability to divide time among three tasks is multitasking.

4. Basic Components of an operating system

Apart from providing a user interface, an operating system has four major components.

4.1 Memory Manager

Memory management is the mechanism by which an operating system handles requests for memory. The operating systems allocate memory for various tasks that a user performs. In situations where multiple operations are being performed simultaneously, the operating system manages the system memory in a manner that no clashes occur. After a task is completed, the operating system cleans up the memory by releasing the memory space for other programs or tasks. A multi operating system also

has an additional function of managing the memory space of each user in such a way that the operations of one user do not interfere with those of another user.

4.2 Process Manager

A program submitted to the computer for execution is called a process. To enable several processes to run concurrently, an operating system has to ration out the microprocessor time. The process manager needs to ensure that all the programs get a fair share of the time and no program monopolizes the microprocessor time.

4.3 Device Manager

An operating system needs to mange devices (peripherals) attached to the computer. The device manager handles communication between the devices and the microprocessor. For example, it handles communication between the microprocessor and the scanner.

4.4 File Manager

Computer can store information on various media, such as CD/DVD ROM and hard disk. A file manager provides a logical view of information storage. It allows a user to manage information in the form of files. A file is a collection of related information. These components work closely to help the operating system to function properly. For example while saving a file in a computer, the file manager creates a new file and the device manager allocates a physical location for the file. The memory manger ensures that space is available in the memory while the content of the file is being stored.

5. Types of Operating Systems

Operating systems can be classified into different types based on their interfaces and user friendliness as mentioned below:

5.1 Character User Interface-based operating system (CUI-based operating system)

This type of operating system requires a user to type the instruction for the computer in a specific format. Then the operating system interprets the commands and generates the corresponding computer instructions. Hence, the user needs to remember the commands to interact with the computer. This type of operating systems is also known as command-line interface (CLI) and it displays data character by character and is only textual in nature. MS-DOS and UNIX are examples of CUI-based operating systems.

5.2 Graphical User Interface-based operating system (GUI-based operating system)

GUI-based operating system uses graphics to make the program easy to use. The GUI has menus, pointers and icons on the screen. An icon is a picture, which represents applications, and a pointer is a

symbol, which is displayed on the monitor.A mouse is used to move the pointer to an icon and one of the mouse buttons is pressed to activate the application associated with that icon. A GUI-based operating system is slower and takes more hard disk space.

MS Windows and Linux are examples for this type of operating system.

5.3 Single user operating system

This type of operating system can process instructions from only one user at a time. A personal computer is a popular single-user system. UT is a general purpose system that can execute programs to perform a wide variety of tasks. MS DOS(disk operating system), Windows 95 are examples of a single user operating system.

5.4 Multi user operating system

Multiuser operating system allows more than one user to work simultaneously on an operating system. It is also capable of running multiple programs concurrently and can share resources, such as printers and disks. It can simultaneously process instruction from multiple users and users work on different computers but a single computer perform their individual tasks simultaneously but independent of each other. Linux is an example for multi user operating system.

5.5 Single tasking operating system

Only one task is executed at a time in single tasking operating system. The execution is step-by step where the subsequent step is executed only after the preceding step is executed successfully. MS DOS is an example of single tasking operating system.

5.6 Multitasking operating system

In a multi tasking operating system many tasks are executed at a given time. The processor divides its time to execute multiple tasks. Windows 2000 is a multi-tasking operating system as it can handle simultaneous execution of multiple tasks. Linux is both multi user and multi tasking operating system(NIIT, 2003).

Based on the interactivity, time and network environment, the below mentioned are different types of operating systems:

5.7 Interactive systems

Interactive systems provide on line communication between the user and the system. User gives instructions to the program or the operating system and receives an immediate reply. A key board is used as user's input device and a cathode ray tube (CAT) display is used to get the output. When the

operating system finishes a command, it seeks the next command not from the control card, but from the user's key board. Example: Windows NT

5.8 Time sharing systems

This system combines the features of interactive and multiprogramming systems. It allows many users to share the system simultaneously. Since each action or command tends to be short, only a little CPU time is needed for each command to generate a response. Example:The Multics and Unix Operating Systems

5.9 Real time systems

Operating systems respond in real time are known as real time systems. It can be used as a control device in dedicated applications. Real time operating systems have very tight time constraints. A real time operating system must guarantee this time requirement. Process control systems, telecommunication systems, interactive graphics etc. are examples of applications requiring the services of real time operating systems. Examples: Process control systems, Telecommunication systems and interactive graphics

5.10 Network operating systems

With the development of computer networks, network operating systems and distributed operating systems came into existence. A computer network consists of a collection of interconnected autonomous computers. Individual computer in the network runs its own local operating systems and has its own local users. In network operating system, the users are aware of the existence of other computers, can login to a remote computer and can work on that computer (George, 2003). Example:Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux.

6. Features of Operating Systems

Below mentioned are important features of three different operating systems.

6.1 Microsoft Disk operating system:**MS-DOS** is a non-graphical command line operating system derived from 86-DOS that was created for IBM compatible computers. MS-DOS originally written by **Tim Paterson** and introduced by Microsoft in August 1981 and was last updated in 1994 when MS-DOS 6.22 was released. MS-DOS allows the user to navigate, open, and otherwise manipulate files on their computer from a command line instead of a GUI like Windows.Today, MS-DOS is no longer used; however, the command shell, more commonly known as the **Windows command line** is still used by many users.

DOS is an interpreter which creates an interface between hardware and software. DOS is a program loaded into the memory (RAM) of user's personal computer before execution of any application. It creates an environment for managing the resources and execution of any program having extension .Exe, .Com, .Bat. Dos are a single user operating system. A single user operating system caters to a single user and all the resources are available to this user. DOS works mostly on Micro Computers. The DOS software is divided into three parts stored in three different files on a disk (Floppy or Hard disk). The disk that contains all the three files is called a Bootable disk or System disk. These three files are:

i. **IO.SYS:** These files have two main parts. In one part device drivers for device like Printer, VDU, Keyboard, and Mouse are configured by the file. It verifies some more input output devices and its drivers. Second part of the IO.SYS file is SYS.INI which loads the file MSDOS.SYS from hard disk into memory.

ii. **MSDOS.SYS:** This file is also called DOS Kernel. It is a link between the BIOS (basic input output services) and user application programs which provides the logical interface for the application program. The MS-DOS Kernel has four important functions that are as mentioned below:

- Process Control
- Memory Management
- Application Program Interface
- File Management System

iii. COMMAND.COM: This file contains command processor or command executor and has all memory resident programs that is it has all internal commands in it. It is the user's interface to the operating system. This command loads and executes application programs("What is DOS," n.d.).

6.2 WINDOWS 7

Windows 7 is a personal computer operating system developed by Microsoft. It is a part of the Windows New Technology (NT) family of operating systems. Windows 7 was released to manufacturing on July 22, 2009, and became generally available on October 22, 2009.The primary features of Windows 7 are:

6.2.1 Start Menu – The Start Menu provides the primary access point for programs and applications

Click the Start Button **to open the Start Menu.**

- *Applications and Documents Shortcuts* – The "Pinned" applications are listed at the top above the divider line. The recently used applications are listed under the divider line. If you hover

over or click the arrow to the right of the application, you can access the most recently opened documents list for the associated program.

- *Start Menu Search* – The application/document search box can be found near the bottom of the Start menu. This search box is a great way to not only search for your files and documents, but also quickly find applications without hunting through the programs list. For instance, if you want to quickly find and start Microsoft Word, click the Start button and type just the letters "Word" into the search box, Windows will provide a list of search results with application listed at the top, then files and documents containing the search term listed next.

- *All Programs* – Clicking the All Programs link will open up a list of the available application shortcuts on your monitor.

- *Additional Features of the Start Menu*
    - Application Pinning – Applications icons can be "pinned" to the top of the Start Menu or to the Taskbar by right clicking the application in the All Programs, Start Menu or Taskbar, and selecting the "Pin to Taskbar" or the "Pin to Start Menu" menu item.
    - Jump Lists – Right-click a program in the taskbar to find and perform most common functions associated withthat specific application. Jump list also acts as a history of each application. For example if you right click onInternet Explorer in the taskbar, most browsed websites are displayed.
    - Quick Peek – Drag the mouse over any program on the taskbar to preview any open windows using that program.

- *Computer Shortcuts* – includes shortcuts to user documents, pictures, music and to the computer file system.

- *Shutdown button* – also includes other options for Restart, Sleep, Hibernate, Lock, Log Off, and Switch User via the arrow icon on the button.

- *Control panel* – provides access to operating system control and customization features.

- *Devices and Printers* – provides access to installed devices (printers, cameras, scanners, etc…).

- *Run* – provides a method to quickly execute a command line.

6.2.2 Taskbar and Notification Area – The Taskbar contains 3 main components, the Start button, the Task/Quick Launch bar and the System Notification Area.

Task/Quick Launch Bar – This bar contains shortcut icons to applications that are "pinned" to the Taskbar or applications that are actively running on your ThinkPad. A grey box will appear around any application that is actively running. In this example, Firefox is the only running application.

Snapshot 1. Windows 7 - Taskbar

System Notification Area – Some applications run unseen in the background on your monitor. Many of these applications will provide a tool icon in the System Notification Area to assist a user inchanging the configuration of the monitor.

6.2.3 Windows Snipping Tool – Windows 7 includes an application to capture, save and share "snipped" images from your desktop.

The Snipping Tool can be used to capture any part of the visible screen and save the capture as an image file or copy and paste the capture into a document or email to share with others.

To use the Snipping Tool:
- Make sure that the portion of the computer screen is visible.
- For Windows 7, Click the Start Button and start the tool by:
  - Search text box to search for "Snipping Tool", or,
  - Locate the Snipping Tool in the All Programs list
- For Windows 8, use the keyboard combination of "Windows Key + Q" and search your apps for Snipping Tool.
- When the Snipping Tool starts, the screen will "grey out" and allow you to draw a selection box around the area of the screen that you wish to capture.
- When you release the mouse button, the captured portion of the screen is copied into the Snipping Tool window.
- You can save the captured screen to an image file, or copy and paste the image into your document or email.

6.2.4Windows Explorer Favorites –File system favorites are quick links to specific directories (folders) located on your computer hard drive. Favorites function much like web bookmarks do in your browser. To access your file system favorites, open any Windows Explorer window, like Computer, and look in the left hand pane.Below mentioned points can be followed to add favorites.

Adding Favorites
- browse to the directory that you want to add a favorite link for
- right click the Favorite link in the left hand pane

- click the "Add current location to Favorites" menu item

6.2.5Windows Explorer Libraries – Libraries are an easy way to collect and track documents on your computer that are related to one another but are not necessarily located in the same directories (folders).

Adding a New Library
- right click on the Libraries link in the left hand panel
- click on New -> Library
- type in the desired library name
- hit the Enter key

Adding Directories to Your Library
- right click the library that you wish to add a directory to
- click on the Properties menu
- click the "Include a folder…" button
- browse to the folder that you would like to add to the library
- click the "Include Folder" button
- click the OK button(Murphy, n.d.)

6.3 LINUX

In 1991, a student in Finland, Linus Torvalds, released a rudimentary UNIX-like kernel using the GNU compilers and tools and invited contributions worldwide. Releasing updates once a week allowed this so-called Linux operating system to grow rapidly, enhanced by several thousand programmers. The resulting GNU/Linux operating system has spawned hundreds of unique distributions, or custom builds, of the system. Major distributions include RedHat, SUSE, Fedora, Debian, Slackware, and Ubuntu (Silberschatz, Galvin, &Gagne, 2011).

Linux is one of popular version of UNIX operating System. It is open source as its source code is freely available. It is free to use. Linux was designed considering UNIX compatibility. Its functionality list is quite similar to that of UNIX. Though open source it adheres to standards of UNIX – POSIX and Linux file system standards (FSSTND). As an open operating system, Linux is developed collaboratively. The Linux system is based on GNU tools (Gnu's Not UNIX), i.e. a set of standard ways to handle and use the system. The advantage is all GNU tools are open source, so they can be installed on any system. The Linux kernel uses the same license as GNU software.

6.3.1 Components of Linux System

Linux Operating System has primarily three components

- **Kernel** − Kernel is the core part of Linux. It is responsible for all major activities of this operating system. It consists of various modules and it interacts directly with the underlying hardware. Kernel provides the required abstraction to hide low level hardware details to system or application programs.
- **System Library** − System libraries are special functions or programs using which application programs or system utilities accesses Kernel's features. These libraries implement most of the functionalities of the operating system and do not require kernel module's code access rights.
- **System Utility** − System Utility programs are responsible to do specialized, individual level tasks.
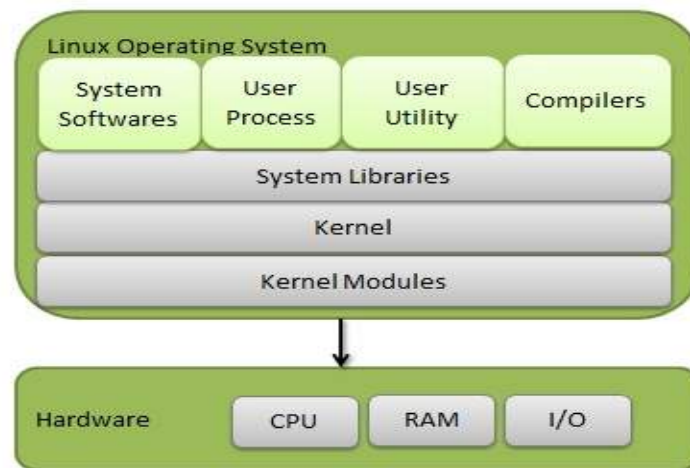

Fig 1. Linux Operating System

6.3.2 Kernel Mode and User Mode

Kernel component code executes in a special privileged mode called **kernel mode** with full access to all resources of the computer. This code represents a single process, executes in single address space and do not require any context switch and hence is very efficient and fast. Kernel runs each process and provides system services to processes, provides protected access to hardware to processes.

Support code which is not required to run in kernel mode is in System Library. User programs and other system programs works in 'User Mode' which has no access to system hardware and kernel code. User programs/ utilities use System libraries to access Kernel functions to get system's low level tasks.

6.3.3 Basic Features of Linux

Following are some of the important features of Linux Operating System.

- **Portable** − Portability means software can work on different types of hardware in same way. Linux kernel and application programs support their installation on any kind of hardware platform.

- **Open Source** − Linux source code is freely available and it is community based development project. Multiple teams work in collaboration to enhance the capability of Linux operating system and it is continuously evolving.

- **Multi-User** − Linux is a multiuser system which means multiple users can access system resources like memory/ ram/ application programs at same time.

- **Multiprogramming** − Linux is a multiprogramming system which means multiple applications can run at same time.

- **Hierarchical File System** − Linux provides a standard file structure in which system files/ user files are arranged.

- **Shell** − Linux provides a special interpreter program which can be used to execute commands of the operating system. It can be used to do various types of operations, call application programs. etc.

- **Security** − Linux provides user security using authentication features like password protection/ controlled access to specific files/ encryption of data.

6.3.4 Architecture

The following illustration shows the architecture of a Linux system −
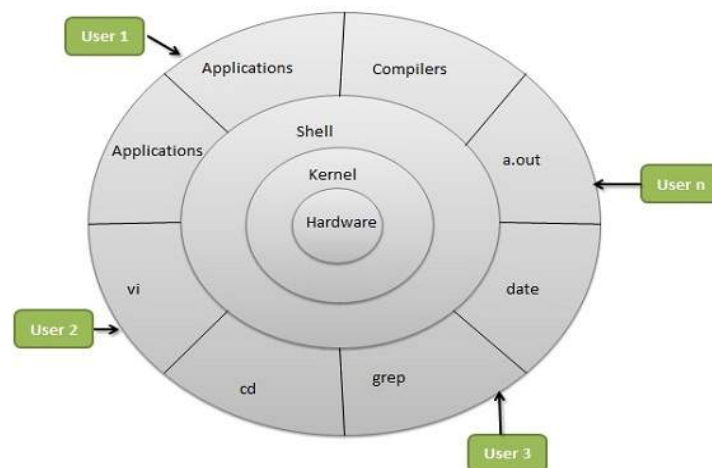

Fig 2. Linux Architecture

The architecture of a Linux System consists of the following layers:

- **Hardware layer** − Hardware consists of all peripheral devices (RAM/ HDD/ CPU etc).

- **Kernel** − It is the core component of Operating System, interacts directly with hardware, provides low level services to upper layer components.

- **Shell** − An interface to kernel, hiding complexity of kernel's functions from users. The shell takes commands from the user and executes kernel's functions.

Utilities − Utility programs that provide the user most of the functionalities of an operating systems(tutorialspoint.com, n.d.).

6.3.5 FileSystem of Linux Everything in Linux can be reduced to a file. Partitions are associated with files such as /dev/hda1. Hardware components are associated with files such as /dev/modem. Detected devices are documented as files in the /proc directory. The Filesystem Hierarchy Standard (FHS) is the official way to organize files in Unix and Linux directories.

6.3.5.1 Linux file system and directory structure
Several major directories are associated with all modern Unix/Linux operating systems. These directories organize user files, drivers, kernels, logs, programs, utilities, and more into different categories. The standardization of the FHS makes it easier for users of other Unix-based operating systems to understand the basics of Linux. Every FHS starts with the root directory, also known by its label, the single forward slash (/). All of the other directories shown in Table 1 are subdirectories of the root directory. Unless they are mounted separately, you can also find their files on the same partition as the root directory("Linux file system and directory structure," n.d.), (NIIT, 2003).

/	The root directory, the top-level directory in the FHS. All other directories are subdirectories of root, which is always mounted on some partition. All directories that are not mounted on a separate partition are included in the root directory?s partition.
/bin	Essential command line utilities. Should not be mounted separately; otherwise, it could be difficult to get to these utilities when using a rescue disk. This directory is named *bin* because the utilities are stored in the binary format.
/boot	Includes Linux startup files, including the Linux kernel. Can be small; 16MB is usually adequate for a typical modular kernel. If you use multiple kernels, such as for testing a kernel upgrade, increase the size of this partition accordingly.
/etc	Most basic configuration files. Occasionally, users and the operating system might need to refer to configuration files, such as the *passwd* file.
/dev	Hardware and software device drivers for everything from floppy drives to terminals. Do not mount this directory on a separate partition.
/home	Home directories for almost every user.
/lib	Program libraries for the kernel and various command line utilities. Do not mount this directory on a separate partition.
/mnt	The mount point for removable media, including floppy drives, CD-ROMs, and Zip disks.
/opt	Applications such as WordPerfect or StarOffice.
/proc	Currently running kernel-related processes, including device assignments such as IRQ

	ports, I/O addresses, and DMA channels.
/root	The home directory of the root user.
/sbin	System administration commands. Don't mount this directory separately.
/tmp	Temporary files. By default, Red Hat Linux deletes all files in this directory periodically.
/usr	Small programs accessible to all users. Includes many system administration commands and utilities.
/var	Variable data, including log files and printer spools.

Table 1 Subdirectories of the root directory

6.3.5.2 Types of Files Used by Linux

When working with Linux, you need to be aware of the fact that there are a number of different file types used by the file system. This is another area where the Linux file system differs significantly from the Windows file system. With Linux, however, there are a variety of different file types used by the file system. These include the file types shown in Table 2 ("Linux file system and directory structure," n.d.)

File Type	Description
Regular files	These files are similar to those used by the file systems of other operating systems—for example, executable files, OpenOffice.org files, images, text configuration files, etc.
Links	These files are pointers that point to other files in the file system.
FIFOs	FIFO stands for First In First Out. These are special files used to move data from one running process on the system to another. A FIFO file is basically a queue where the first chunk of data added to the queue is the first chunk of data removed from the queue. Data can only move in one direction through a FIFO.
Sockets	Sockets are similar to FIFOs in that they are used to transfer information between sockets. With a socket, however, data can move bi-directionally.

Table 2 Type files used in Linux

7. Summary

An operating system is a type of system software. An operating system consists of four components: memory manager, process manager, device manager, and file manager. Different types of operating systems are CUI-based & GUI- based and Single-user & multiple-user. The features of an operating system are multitasking and multiprogramming. Multitasking is the ability to handle the execution of

multiple tasks at a time. Multiprogramming refers to the ability to enable different users to execute programs simultaneously.

MS DOS is an acronym for Microsoft disk operating system. The main features are it is a character user interface (CUI-based operating system. It is a command-line operating system. It supports single-user and single-tasking.

Microsoft's Windows family consists of various graphical user interface (GUI-based operating systems.The most popular are Windows 95 windows 98, Windows New Technology (NT) and Windows 2000 etc. The primary features of Windows 7 are Start menu, Taskbar and Notification area, Snipping tool, Windows Explorer Favorites and Windows Explorer Libraries.

Linux is a freely distributed operating system that follows the open development model. Some main features are it is GUI-based operating system. It supports multiprogramming, timesharing and multitasking. It is also multiuser operating system. The Linux system is based on GNU tools (Gnu's Not UNIX), i.e. a set of standard ways to handle and use the system. The advantage is all GNU tools are open source, so they can be installed on any system. The Linux kernel uses the same license as GNU software.

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