ECS404: Linux Operating System

**Unit 1: Introduction of Linux**

An **operating system (OS)** is the most important program that runs on a computer. Operating systems enable you to store information, process raw data, use application software, and access all hardware attached to a computer, such as a printer or keyboard. In short, the operating system is the most fundamental computer program. It controls all the computer’s resources and provides the base upon which application programs can be used or written.



Different computer systems can have different operating systems. For example, the most common operating systems for desktop personal computers are Microsoft Windows, Mac OS, and Linux. Popular network and Web server computer operating systems are Microsoft Windows Server, UNIX/Linux, Novell NetWare, Novell Open Enterprise Server (which combines Netware and SUSE Linux Enterprise), and Mac OS X Server. Very large servers that are mainframe-class computers might use UNIX/Linux or the IBM z/OS operating system.

**Introduction of Linux:-**

UNIX and Linux are multiuser, multitasking operating systems with built-in networking functions. UNIX/Linux can be used on systems functioning as:

* Dedicated servers in a server-based network.
* Client workstations connected to a server-based network.
* Client/server workstations connected to a peer-to-peer network.
* Stand-alone workstations not connected to a network.

UNIX/Linux is **multiuser systems**, which let many people simultaneously access and share the resources of a server computer. Users must **log in** by typing their user name and a password before they are allowed to use a multiuser system. This validation procedure protects each user’s privacy and safeguards the system against unauthorized use.

UNIX and Linux are **multitasking systems** that allow one user to execute more than one program at a time. For example, you can update records in the foreground while your document prints in the background. UNIX/Linux is also portable operating system. **Portability** means these systems can be used in a variety of computing environments.

Most UNIX/Linux systems now employ Secure Shell (SSH), which is a form of **authentication** (a process of verifying that a user is authorized to access a computer) developed for UNIX/Linux systems to provide security for communications over a network, including FTP applications. Many organizations choose UNIX and Linux because these operating systems:

■ Enable employees to work on a range of computers (portability)

■ Stable, reliable, and versatile

■ Have thousands of applications written for them, both commercial and free

■ Offer many security options

■ Are well suited for networked environments (UNIX was one of the first server operating

systems to be used on a network in the late 1960s.)

**History of UNIX & Linux:-**

**History of UNIX**

The late 1960’s when a concerted to develop new operating system technique occurred. A special worked on an experimental operating system called **MULTICS (Multiplexed Information and Computing Service)**.it incorporated many new concepts in Multitasking, File Management and User Interaction.

In 1969, Ken Thompson, Dennis Ritchie and AT&T Bell Labs researchers a group of programmers at originally developed UNIX. It includes features of MULTICS. It runs on minicomputer. In 1973 Ken Thompson & Dennis Ritchie rewrite the programming code for UNIX in ‘C’ language. Users Attracted by its portability and low cost, universities began to modify the UNIX code to make it work on different machines. Eventually, two standard versions of UNIX evolved: AT&T Bell Labs produced **SystemV (SysV)**, and the University of California at Berkeley developed **Berkeley Software Distribution (BSD)**.Using features of both versions.

**History of LINUX:-**

Linux started out as a personal project of computer science student named ***Linus Torvalds*** at university of Helsinki. That time he use a program is called Minix, which developed by Andrew Tanenbaum. Linus’s intension was to create an effective PC version of UNIX for Minix user. Linus released it to the public free of charge in 1991, originally created Linux. A number of organizations and Companies now offer free and commercial distributions or versions of Linux. Linux might be considered a more integrated version of UNIX than its predecessors. Linux is a UNIX-like operating system because it is not written from the traditional UNIX code. Instead, it is original code (the kernel) created to look and act like UNIX, but with enhancements that include the POSIX standards. Currently, the **Portable Operating System Interface for UNIX (POSIX)** project, a joint effort of experts from industry, academia, and government, is working to standardize UNIX.

Linux offers all the complexity of UNIX and can be obtained at no cost; or for a relatively small amount of money, you can purchase commercial versions that have specialized tools and features. With all the networking features of commercial UNIX versions, Linux is robust enough to handle large tasks. You can install Linux on your PC, where it can coexist with other operating systems, and test your UNIX skills. All these features make Linux an excellent way to learn UNIX, even when you have access to other computers running UNIX.

Linux has all the networking tools, such as FTP (File Transfer Protocol), Web Browser and whole range of network services such as domain name, Email, Web, Print servers. It full set of program development utilities.

**Architecture of Linux system**

The concept of layered components that make up an operating system also originated with

LINUX Layers of software contain the computer system’s inner core to protect its vital hardware

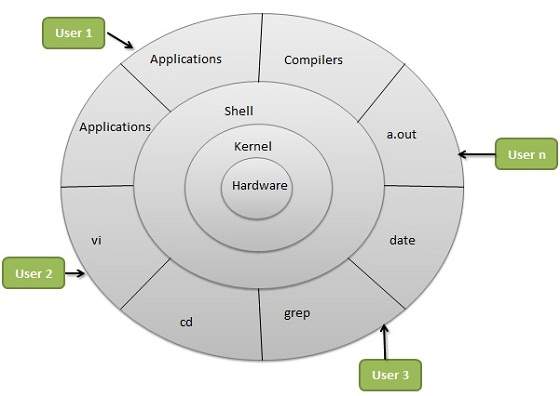
and software components and to manage the core system and its users.

The **kernel** is the base operating system, and it interacts directly with the hardware, software services, application programs, and user-created scripts (A files containing commands to execute). It is accessible only through **Kernel mode, User mode**

**Kernel mode**, which is reserved for the system administrator. This prevents unauthorized

commands from attacking basic operating system code and hardware, resulting in actions that might hang or disrupt smooth operating system functions.

**User mode** provides access to higher layers where all application software resides.



Linux System Architecture is consists of following layers

*Kernel*

*Shell*

*Hardware and* Utilities

***Kernel:***

Kernel is heart of Linux O/S. It is the innermost layer of the operating system that provides a

uniform interface to the hardware. It manages resource of Linux O/S. When the machine starts,

the Boot Loader passes the control to kernel. It is responsible for managing the peripherals such as VDU, mouse, keyboard etc. It also deals with memory management and process management. The kernel does not deal directly with the user; instead it creates a new startup, interactive process for the user – **shell**.

Kernel decides who will use this resource, for how long and when. It runs your programs & all programs running in memory or allocation of CPU time to all running programs. It also handles any interrupts issues, as it deals with H/W directly. It performance following task

( functions of kernel):-  I/O management

* Process management
* Memory management
* Disk and File System Management
* Networking
* Security
* Graphical User Interface (GUI)
* Device Driver Management

These services are requested by other parts of the operating system or by application programs

through a specified set of program interfaces referred to as system calls. Kernels can be classified into four broad categories: monolithic kernel, microkernel, hybrid kernel and exokernel.

**Shell**

The shell is a Linux program that interprets the commands you enter from the keyboard

standard input device (Keyboard) or from a file. Its environment provided for user interaction.

Shell is a command Interpreter. A *shell script* is a sequence of shell and operating system command that is stored in a file. Shells provide a way for you to communicate with the operating system. This communication is carried out either interactively (input from the keyboard is acted upon immediately) or as a shell script.

Receives commands from the user and sends those commands to kernel for execution. Linux provide several kind of environment

1. *Desktops*

2. Window Managers

3. Command line Shells.

Each user on Linux system has own user interface. If you use a *graphical user interface (GUI)*

desktop (similar to Microsoft Windows with graphics and icons), then your communications occur through the GUI desktop.

To use commands, you open a special window, called *a terminal window*, and your

communications with the operating system occur through a shell interpreter within the terminal window. Most versions of Linux that support using a GUI desktop offer a terminal window. This is a powerful feature because it is literally your window to using commands.

All of the commands that you learn in Linux can be used in a terminal window or directly from

the command line on a system that does not use a GUI desktop. Because the shell plays role of a command interpreter, the shell is also a programming language. As a programming language, it permits you to control how and when commands are carried out.

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

**Utilities**:- Utility programs giving user most of the functionalities of an operating systems.

**Linux of features:-**

***Multi-user capability***

In this system the same computer resources like hard-disk, memory, printer, floppy disk drive and optical disk are accessible to many users. There are lots of terminal connected to a main computer called “Host computer” or “Server”. All the terminals are called “Clients”. All terminals are connected to main computer whose resources are available by all users. So users at any of the terminal can use not only the computer but also any peripheral that may be attached safe for instance printer. One can easily how economical such as setup is then having as many computers as then are users and also how much more convenient when some data is to be shared by all. At the heart of LINUX installation is the host machine is known as “Console/Server”. The numbers of terminal that can be connected to the host machine dependent on the numbers of ports that are present in its controller card. For example part controller cards in host machine can support for terminal.

***Multitasking capability (Time Sharing):***

It is capable of carry of more than one job at the same time it allows due to type in a program in its editor. While it’s simultaneously execute some other command you might have given easily, say to surd and copy a use file.

***Communication:***

The communication may be within the network of a single main computer or between two or more such computer networks. The user can be easily exchange mail, data, programs which such as networks

***Security:***

Using allows sharing of data but not at random. LINUX has three inherent positions

for processing data. The first is providing accessing password and login name to individual user in security that not anybody can come and have accesses to your work. At the file level there are read, write, and execute permission to each file which decide who excess a particular file. Lastly there is file inscription this utility encodes yours file into an unreadable format even if someone succeed in opening it your secrete is safe. If you want to see the instants of incrusted file than you have to descript it.

***Portability:***

Portability means software’s can works on different types of hardware’s in same

way. A Linux kernel and application program supports 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’ works in collaboration to enhance the capability of Linux operating

system and it is continuously evolving.

***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.

***Stability:***

Linux doesn’t need to be rebooted periodically to maintain performance levels. It doesn’t freeze up or slow down over time due to memory leaks and such. Continuous uptimes of hundreds of days are not uncommon.

***Performance:***

Linux provides constant high performance on workstations and on networks.

It can handle unusually large numbers of users simultaneously, and can make old computers sufficiently responsive to be useful again.

***Flexibility:***

Linux can be used for high performance server applications, desktop applications, and embedded systems. You can save disk space by only installing the components needed for a particular use. You can restrict the use of specific computers by installing for example only selected office applications instead of the whole suite.

***Compatibility:***

It runs all common Linux software packages and can process all common file formats.

## 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 is 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 implements most of the functionalities of the operating system and do not requires kernel module's code access rights.

**System Utility**:-

System Utility programs are responsible to do specialized, individual level tasks.

**Kernel**

Kernel is hart of Linux O/S. It manages resource of Linux O/S. Resources means facilities available in Linux. For eg. Facility to store data, print data on printer, memory, file management etc . Kernel decides who will use this resource, for how long and when. It runs your programs (or set up to execute binary files) It's Memory resident portion of Linux. It performance following task :-

● I/O management

● Process management

● Device management

● File management

● Memory management

**Shell and its Type**

The **shell** is the basic program that allows you to interact with the operating system (Linux, in this case). Through the shell you give commands to the computer, and read the output of those commands.

**Types of shell**

**Bourne Shell (sh)**

The Bourne shell, called "sh," is one of the original shells, developed for Unix computers by

Stephen Bourne at AT&T's Bell Labs in 1977. Its long history of use means many software developers are familiar with it. It offers features such as input and output redirection, shell

scripting with string and integer variables, and condition testing and looping.

**Bourne-again Shell (BASH)**

The popularity of **sh** motivated programmers to develop a shell that was compatible with it, but with several enhancements. Linux systems still offer the sh shell, but "bash" -- the

"Bourne-again Shell," based on **sh** has become the new default standard. One attractive

feature of bash is its ability to run sh shell scripts unchanged. Shell scripts are complex sets of

commands that automate programming and maintenance chores; being able to reuse these

scripts saves programmers time. Conveniences not present with the original Bourne shell

include command completion and a command history.

**csh and tcsh**

Developers have written large parts of the Linux operating system in the C and C++ languages. Using C syntax as a model, Bill Joy at Berkeley University developed the "C-shell," csh, in 1978.

Ken Greer, working at Carnegie-Mellon University, took csh concepts a step forward with a

new shell, tcsh, which Linux systems now offer. Tcsh fixed problems in csh and added command completion, in which the shell makes educated "guesses" as you type, based on your system's directory structure and files. Tcsh does not run bash scripts, as the two have substantial differences.

**ksh**

David Korn developed the Korn shell, or ksh, about the time tcsh was introduced. Ksh is

compatible with sh and bash. Ksh improves on the Bourne shell by adding floating-point

arithmetic, job control, command aliasing and command completion. AT&T held proprietary

rights to ksh until 2000, when it became open source.

**Differeence Between Linux and Windows.**

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| --- | --- | --- |
|  | **Linux** | **Windows** |
| **What is it?** | Linux is Open Source software  development & developed by the Linus  Torvalds | Windows is the family of operating  systems (OS) from Microsoft. |
| **Cost** | Free | Not Free |
| **Usage** | Linux can be installed on a wide variety of computer hardware, ranging from  notebooks, mobile phones, tablet  computers and video game consoles, to  mainframes and super computers. | On PC's desktops, laptops, servers and  some phones. |
| **Development**  **and**  **Distribution** | Open Source development i.e. through  sharing and collaboration of code and  features through forums etc. and it is  distributed by various vendors. | Windows is developed and distributed  only by Microsoft |
| **GUI** | Linux typically provides two GUIs, KDE and Gnome. But there are millions of  alternatives such as LXDE, Xfce, Unity, Mate | The Windows GUI is an integral  component of the OS and is not  replaceable. |
| **File System**  **Support** | Ext2, Ext3, Ext4, Jfs, Xfs, FAT, FAT32, NTFS | FAT, FAT32, NTFS, exFAT |
| **Text mode**  **interface** | Bourne Again Shell(BASH) is the Linux  default shell. It can support multiple  command interpreters. | Windows has a single command  interpreter with dos-like commands. |
| **Security** | 60-100 viruses listed till this date. none of them are actively spreading nowadays. | more than 60,000 viruses in Windows.  Anti Virus for protection? |
| **Threat**  **detection and**  **solution** | Threat detection and solution is very fast, as Linux is mainly community driven and whenever any Linux user posts any kind of threat, several developers start working on  it from different parts of the world,  immediately. | Microsoft generally releases a patch  that can fix the problem and it can  take more than 2/3 months.  Sometimes releases patches and  updates weekly. |
| **Processors** | Dozens of different kinds. | Limited but will run on most(80%) |
| **Examples** | Ubuntu, Fedora, Red Hat, Debian, etc. | Windows 7 8, 8.1, 10, Vista, XP,XP2 |
| **Gaming** | Very few games available natively. Some games can be played through Wine, but often not all features are available. | Almost all games are compatible with  Windows. Some CPU intensive and  graphics intensive games are exclusive  to Windows PC's. |
| **User**  **experience** | many GUI applications, most of the work is done through Terminal (a console window), and if a problem arises, a GUI is rarely usable to fix them. | Everything can be controlled through  a GUI and incompatibility problems  are rare. |
| **Terminal** | Multi Terminal Windows | Single Terminal Windows |

**Linux Distributions**

**openSUSE**

The beginnings of openSUSE in 1992 developed by German Linux fans. The Developers adopted the RPM package management format and introduced YaST, an easy-to-use graphical system administration tool.

**Debian GNU/Linux**

Debian GNU/Linux was announced in 1993 founder Ian Murdock The actual

development of Debian takes place in three main branches of increasing levels of stability: "unstable" , "testing" and "stable". This progressive integration and stabilization of packages and features, together with the project's well-established quality control mechanisms, has earned Debian its reputation of being one of the best-tested and most bug-free distributions available today.

**Fedora**

September 2004, its origins effectively date back to 1995 when it was launched by

two Linux visionaries - Bob Young and Marc Ewing-- under the name of Red Hat Linux. Fedora is often referred to as a “bleeding-edge” distribution, meanst it’s focused on innovation and latest technologies, sometimes at the cost of stability. It comes in three main editions: Workstation, Server and Cloud, and there are numerous Spins or versions of Fedora which provide different desktop environments and software collections. The default DE, however, is GNOME. Fedora is a RPM distribution with its own repositories. A particularly important feature is Security-Enhanced (SE) Linux which is implemented in the kernel and serves to make Fedora a safer distribution, but also lets the user control different security policies.

**CentOS**

Launched in late 2003, CentOS is a community project with the goals of rebuilding

the source code for Red Hat Enterprise Linux (RHEL) into an installable Linux

distribution and to provide timely security updates for all included software packages.

**Ubuntu**

The launch of Ubuntu was first announced in September 2004. Ubuntu is a Debianbased

distribution that redefined the meaning of “user-friendly” on Linux, and its immense popularity contributed to the widespread acceptance of Linux over the past few years. Ubuntu comes in many flavors – you can install any DE you want, but it also has its own desktop shell called Unity. Two new Ubuntu releases are expected in 2015, and one of them might bring the (controversial) new display server called Mir that’s supposed to replace the now outdated X Window System.

**Linux Mint**

Linux Mint, a distribution based on Ubuntu, was first launched in 2006 by Clement Lefebvre, a French-born IT specialist living in Ireland. Linux Mint has been steadily rising in popularity ever since it came out as a Ubuntu spin-off with multimedia codecs offered out-of-the-box. Today it has its own desktop environment –Cinnamon, handy system utilities (Update Manager, Mint Menu, Software Manager…), and comes in several flavors (KDE, XFCE, Mate). Current stable version is 17.1 (Rebecca) which is a LTS release that will be supported until 2019. There’s also a semi-rolling release based on Debian, which comes in Cinnamon and Mate versions. Linux Mint offers many applications by default (LibreOffice, Firefox, Pidgin, GIMP), it’s highly customizable and fully compatible with Ubuntu’s repositories, and works well even on older computers.

[Red Hat](https://www.redhat.com/en)

Red Hat is a commercial distribution used by large businesses all around the world.

Red Hat remains popular in the business world but more casual users are more likely to use Fedora or CentOS which are community versions of Red Hat.If you are planning a career in Linux then at some stage you are likely to end up using this distribution.

**Working environments**:- KDE, GNOME, Xface4

**GNOME**, **KDE and Xfce4** is the most popular desktop environments for Linux but experienced users prefer one over for ***usability, performance, design or customizability***.

**GNOME:-**

GNOME began as a project to develop a free and open-source desktop environment and

corresponding applications in August 1997. Its design idea can be best described as efficient and easy to use.

The ***G****NU* ***N****etwork* ***O****bject* ***M****odel* ***E****nvironment, also known as* ***GNOME***, is a powerful and

easy-to-use environment *consisting primarily of a panel, a desktop, and a set of GUI tools with*

*which program interfaces can be constructed*. *GNOME is designed to provide a flexible platform for the development of powerful applications.* GNOME is free and released under the GNU Public License i.e free available. Several companies have joined together to form the GNOME Foundation, an organization dedicated to coordinating the development of GNOME and GNOME software applications.

The core components of the *GNOME desktop consist of a panel for starting programs and*

*desktop functionality*. Other components such *as a file manager, a web browser, and a window*

*manager*, are provided by GNOME-compliant applications. GNOME provides libraries of GNOME GUI tools that developers can use to create GNOME applications. Programs that use buttons, menus, and windows that stay to a GNOME standard can be said to be GNOME-compliant. *The official or default file manager for the GNOME desktop is Nautilus.* The GNOME desktop does not have its own window manager as KDE does. Instead, it uses any GNOME-compliant window manager. *The Metacity window manager is the one bundled with the GNOME distribution.*

The standard used in GNOME for such interfaces is the **Common Object Request Broker Architecture (CORBA)**, developed by the Object Model Group for use on UNIX systems. GNOME uses the ORB it implementation of CORBA. With such a framework, GNOME applications and clients can directly communicate with each other, enabling you to use components of one application in another. With GNOME 2.0, GNOME officially adopted GConf and its libraries as the underlying method for configuring GNOME and its applications. GConf can configure independently coordinating programs such as those that make up the Nautilus file manager.

**KDE**

KDE community started in October 1996. Its design idea is dedicated to functionality and expansion of its features.

*The K Desktop Environment (KDE) is a network-transparent desktop that includes the standard desktop features, such as a window manager and a file manager, as well as an extensive set of applications that covers most Linux tasks. KDE is an Internet aware system that includes a full set of integrated network/Internet applications, including a mailer, a newsreader, and a web browser*. The file manager doubles as a Web and FTP client, enabling you to access Internet sites directly from your desktop. KDE aims to provide a level of desktop functionality and ease of use found in Windows systems, combined with the power and flexibility of the Unix operating system.

The KDE desktop is developed and distributed by the KDE Project. KDE is entirely free and open software provided under a GNU Public License and is available free of charge along with its source code.

*Multiple applications written specifically for KDE are easily accessible from the desktop.*

*These include editors, photo and paint image applications, spreadsheets, and office applications*.

Example: KWord or KMail. *A variety of tools are provided with the KDE desktop. These include calculators, console windows, notepads, and even software package managers.*

On a system administration level, *KDE provides several tools for configuring your system.*

With KUser, you can manage user accounts, adding new ones or removing old ones. Practically all your Linux tasks can be performed from the KDE desktop. KDE version 3 includes support for the office application suite KOffice, based on KDE’s KParts technology. KOffice includes a presentation. application, a spreadsheet, an illustrator, and a word processor, among other components.

**Xfce4**

*Xfce4 is a desktop environment based on the GTK+ toolkit used by GNOME*. It is more

lightweight and provides a simple, efficient, easy-to-use desktop. It is fully configurable, has a main panel with menus, applets, and application launchers, provides a file manager and sound manager, and is theme able. Since it is fast, light, and efficient, it is ideal for older or slower machines with memory limitations.