Unit 3: Introduction of Linux

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Linux Overview

- Linux was first developed by Linus Torvalds, a student in Finland, in 1991. But, now, Linux is not owned by anyone. No one company or individual "owns" Linux, like as Windows are owned by a single company Microsoft.
- Linux is the most famous, free and open source Operating System.
- Open source Operating Systems are available in source-code format rather than as compiled binary code. Free software means not by money point of view. But, software that is free, like Linux, is distributed along with its source code. So that, anyone who receives it is free to make changes and redistribute it.
- Many people have done such type of work, and as a result there are many **versions** of Linux available in the market. Some of the known **versions** are Red Hat Enterprise Linux and its derivatives such as Fedora and CentOS, Debian and its derivatives such as Ubuntu and Linux Mint, Linspire, PCLinux.
- It is multi-tasking Operating System that also supports a handy (useful) Graphical User Interface (GUI). It is quite (relatives) robust (strong) and secure. You will rarely hear about virus attack on Linux system (as with Windows).
- Linux can be found in a wide range of devices – from personal computers, mobiles, tablets and embedded systems to mainframe computers and supercomputers.

Features of Linux

As an operating system, Linux contains all the features that any operating system should have. Also, Linux is a UNIX-like Operating System. So, it contains most of the features of UNIX too. In addition to these, Linux contains some special features, which makes it so much popular.

These features are as given below:

1. **Free and Open Source Software:**
   - Open source means Linux is available with its source code. And, free means users have freedom to make changes in source code according to their requirements. These modified versions can also be redistributed.
   - Also, most of the Linux flavors are either totally free or costs very less compared to other Operating Systems. (For example, Windows OS…!!!)

2. **Flexibility in Usage:**
   - Linux can be used for high performance server applications, desktop applications, and embedded systems.
   - Due to this flexibility, Linux can be found on wide variety of devices such as mobiles phones, tablet computers, network routers, personal computers, video game consoles, and even in super computers.

3. **A Multi-user System:**
   - Linux is a multi-user Operating System. This means, it allows multiple users to work simultaneously on the same system.

- Different users can login from different machines into the same machine by using programs like 'TELNET'.

4. Multi-tasking System:

- Linux is a multi-tasking Operating System too. It allows multiple programs to run simultaneously.
- Among simultaneously running processes, one process will be foreground process. User can interact with this process directly. While other processes will be background processes. They execute in background without requiring user interaction.

5. High Performance and Reliability:

- Linux provides high performance with minimum requirements of hardware compared to other Operating Systems.
- No other Operating System is more stable and reliable than Linux. System crashes, hangs, virus attacks are almost absent from the Linux world.

6. The Building-block Approach:

- Linux uses the building-block approach to perform complex tasks.
- It provides a few hundred commands each of which can perform one simple job. To perform complex tasks, such simple commands can be combined using pipes and filters. Thus, the small-is-beautiful philosophy is implemented here. (Pipes and filters are described later in this chapter.)

7. Flexible Interface:

- Linux supports both types of interfaces – GUI (Graphical User Interface) as well as CLI (Command Line Interface).
- GUI makes task of users easy, and so, makes Operating System user friendly. CLI provides more options and control to the user. For example, complex tasks can be performed by combing multiple commands or creating shell scripts.
- User can choose any interface according to their convenience and expertise.

8. File System Support:

- Linux supports a wide range of file systems such as ext, ext2, ext3, ext4, XFS, JFS, etc.

Along Operating Systems, it also supports file systems supported by other Operating Systems such as NTFS, so that, Linux users can also access files managed by those Operating Systems.

9. Programming Facility:

- The Linux shell is also a programming language.
- It supports all the programming features such as variable, control structures, loops and so on.
- These features can be used to develop shell programs, called shell scripts. Such programs can be used to control and automate(computerize) many of the system's functions. (Shell scripts are described in detail in section 5.9).

10. On-line help:

- Linux provides an on-line help facility for all the commands. For this purpose, it provides a command named 'man'. By using this command, user can have an instant help on any command, system call, or file format.
- Along with this, as Linux is a community driven Operating System, many developers and distributors work on it and there is a vast support available on internet.

11. Portable:

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

The Linux Layered Architecture
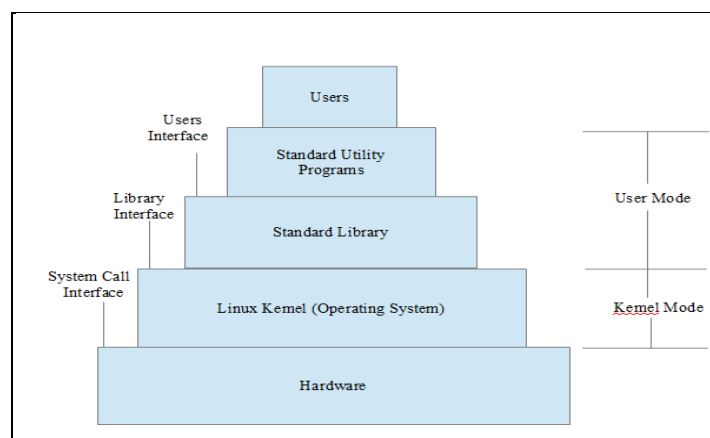
       Linux architecture is also known as the layered structured of the Linux. As Linux is a Unix-like Operating System, its architecture resembles to that of UNIX.

The various layers depicted in Linux architecture are as follows:

Hardware:

- The bottom layer is the hardware.
- It consists of various physical devices such as CPU, memory, disks, monitors, printers, etc.
- These devices provide various services. For example, printers are used for printout purposes.

Linux Kernel:

- The next higher layer is the Linux Kernel. It represents the core of the Operating System. (A kernel is described next).
- It manages all the underlying hardware.
- It directly interacts with the hardware and provides user programs required services.
- It hides the complex details of hardware also.
- In short, it provides the simple interface between user programs and hardware.
- The main services of an operating system includes process management, memory management, files system management, I/O management etc.

Standard Library:
- Above operating system, next layer in for standard library.
- It contains a set of procedures, one procedure per system call.
- These procedures are written in assembly language and used to invoke(raise) various system calls from user programs.

Standard Utility programs:
- In addition to operating system and system all library, all versions of Linux supply a large number of standard programs (Utility programs).
- These programs remain there in secondary storage device (Disk).
- When user wants to perform any task then related program is loaded first in main memory and then the execution is possible.
- Such programs include command processor (shell), compilers, editors, text processing programs, file manipulation utilities, a variety of commands, graphical user interfaces and so on.
- Such programs make the user tasks simpler. Users interact with them and they, in turn, interact with the operating system to get services from operating system.

Users:
- The top-most layer is of users.
- Users programs come in this layer. They interact with the system either by using library procedures to invoke system calls, or by using utility programs such as shell.

3.1 Introduction of Linux versions/Linux Distribution

- A Linux distribution or "Linux distro" is a version of the open source Linux operating system that is packaged with other components, such as an installation programs, management tools and additional software.
- Different users make different Linux OS based on their requirements and then make it open for other users.
- There are many versions/ distributions of OS available in market. Some most popular Linux versions are discussed here:

1. Debian

- o   Debian is an operating system composed only of free, open-source software.
- o   The Debian project has been operating since 1993 - over 20 years ago.
- o   This widely respected project is still releasing new versions of Debian, but it's known for moving much more slowly than distributions like Ubuntu or Linux Mint.
- o This can make it more stable and conservative, which is ideal for some systems.

2. Ubuntu

- o   Ubuntu is based on Debian, but it has its own software repositories.

o The Ubuntu project has a focus on providing a solid desktop
o Ubuntu used to use the GNOME 2 desktop environment, but it now uses its own Unity desktop environment.
o Ubuntu is even building its own Mir graphical server while other distributions are working on the Wayland.
o Ubuntu is currently working on expanding the Ubuntu distribution to run on smartphones and tablets.

3. Linux Mint

o Mint is a Linux distribution built on top of Ubuntu.
o It uses Ubuntu's software repositories.
o It included media codecs and proprietary software that Ubuntu didn't include by default.
o You get a more traditional Cinnamon or MATE desktop.
o Mint takes a more relaxed approach to software updates and won't automatically install critical software updates.

4. Fedora

o Fedora is a project with a strong focus on free software — you won't find an easy way to install proprietary graphics drivers here, although third-party repositories are available.
o Fedora is bleeding edge and contains the latest versions of software.
o Fedora doesn't make its own desktop environment or other software.
o Instead, the Fedora project uses "upstream" software, providing a platform that integrates all this upstream software without adding their own custom tools or patching it too much.
o Fedora comes with the GNOME 3 desktop environment by default, although you can also get "spins" that come with other desktop environments.

5. CentOS/Red Hat

o CentOS and Red Hat recently announced about their collaboration, so CentOS is now part of Red Hat itself.
o Red Hat Enterprise Linux is a commercial Linux distribution intended for servers and workstations. It's based on the open-source Fedora project, but is designed to be a stable platform with long-term support.
o Red Hat uses trademark law to prevent their official Red Hat Enterprise Linux software from being redistributed. However, the core software is free and open-source.
o CentOS is a community project that takes the Red Hat Enterprise Linux code, removes all Red Hat's trademarks, and makes it available for free use and distribution.
o It's a free version of RHEL, so it's good if you want a stable platform that will be supported for a long time.

6. openSUSE

- o openSUSE is a community-created Linux distribution sponsored by Novell.
- o Novell purchased SuSE Linux in 2003, and they still create an enterprise Linux project known as SUSE Linux Enterprise.
- o Novell has the openSUSE project that feeds into SUSE Linux Enterprise.
- o SUSE was once one of the great user-friendly desktop Linux distributions, but Ubuntu eventually took that crown.

7. Mageia

- o Mageia is a fork of Mandriva Linux created in 2011. Mandriva was once one of the great user-friendly Linux distributions.
- o Like Fedora and openSUSE, this is a community-created project to create an open-source Linux distribution.
- o Mandriva SA no longer creates a consumer Linux distribution for desktop PCs, but their business Linux server projects are based on Mageia code.
- o It provides code to its enterprise.

8. Arch Linux

- o Arch Linux is more old school than many of the other Linux distributions here.
- o It's designed to be flexible, lightweight, minimal, and to "Keep it Simple."
- o Keeping it simple doesn't mean Arch provides tons of graphical utilities and automatic configuration scripts to help you set up your system.
- o You're in charge of configuring your system properly and installing the software you like. Arch doesn't provide an official graphical interface for its package manager or complex graphical configuration tools. Instead, it provides clean configuration files designed for easy editing.
- o The installation disc dumps you at a terminal, where you'll need to enter the appropriate commands to configure your system, partition your disks, and install the operating system yourself.
- o This version was designed for users who know how their systems work or who are at least willing to learn.
- o However, Arch uses binary packages while Gentoo had an (unnecessary) focus on compiling every bit of software from source — this means it's quick to install software on Arch as you don't have to spend CPU cycles and time waiting for software to compile.

9. Slackware Linux

o   Slackware is another institution. Founded in 1993, Slackware is the oldest Linux distribution that's still maintained and putting out new releases today.

o   Its pedigree shows — like Arch, Slackware dispenses with all those unnecessary graphical tools and automatic configuration scripts.

o   There's no graphical installation procedure — you'll have to partition your disk manually and then run the setup program. Slackware boots to a command-line environment by default.

o   It's a very conservative Linux distribution.

10. Puppy Linux

o   Puppy Linux is another fairly well-known Linux distribution. Previous versions have been built on Ubuntu, but the latest is built on Slackware.

o   Puppy is designed to be a small, lightweight operating system that can run well on very old computers.

o   The puppy ISO file is 161 MB, and Puppy can boot from that disc in a live environment. Puppy can run on PCs with 256 MB or RAM, although it does recommend 512 MB for the best experience.

o   Puppy isn't the most modern and doesn't have all the flashiest bells and whistles, but it can help you revive an old PC.

Linux Distribution Comparison Table

Sr. No	Distribution	Founder	Maintainer	Initial release year	Current stable version	Security updates (years)	Release date	System distribution commitment	Forked from	Target audience	Cost	Status
1	Debian	Ian Murdock	Debian Project	1993	9.3	~3 years	07-10-2017	Debian Social Contract and D FSG	—	general, server, desktop	Gratis	Active
2	Ubuntu	Canonical Ltd.	Canonical Ltd.	2004	17.1	Standard releases 9 months, LTS releases 5 years. Flavor LTS releases 3 or 5 years.	19-10-2017	×	Debian	general, server, desktop	Gratis	Active
3	Linux Mint	Clement Lefebvre	dev team	2006	18.3	~3 years (LMDE); 5 years (main editions)	27-11-2017	×	Debian, Ubuntu	desktop	Gratis	Active
4	Fedora	Fedora Project	Fedora Project	2003	27	?	14-11-2017	Fedora Licensing Guidelines	—	general	Gratis	Active
5	CentOS/Red Hat	Red Hat	Red Hat	2002	7.4	?	01-08-2017	×	Red Hat Linux, Fedora	server, workstation	Commercial	Active
6	openSUSE	SUSE Linux, Novell, openSUSE Project	openSUSE Project	2006	42.3	3 years	26-07-2017	×	—	general, desktop	Gratis	Active
7	Mageia	Mageia Community	mageia.org	2010	6	1	16-07-2017	×	Mandriva Linux	general	Gratis	Active
8	Arch Linux	Judd Vinet	dev team	2002	Rolling	Rolling	Rolling	×	—	general	Gratis	Active
9	Slackware Linux	Patrick Volkerding	dev team	1993	14.2	?	30-06-2016	×	Softlanding Linux System (SLS)	general	Gratis	Active
10	Puppy Linux	Barry Kauler	Puppy Foundation	2003	6.3.2	?	22-06-2016	×	—	lightweight, portable	Gratis	Active

3.2 Components of Linux

Linux Operating System has primarily three components which are shown in following diagram.
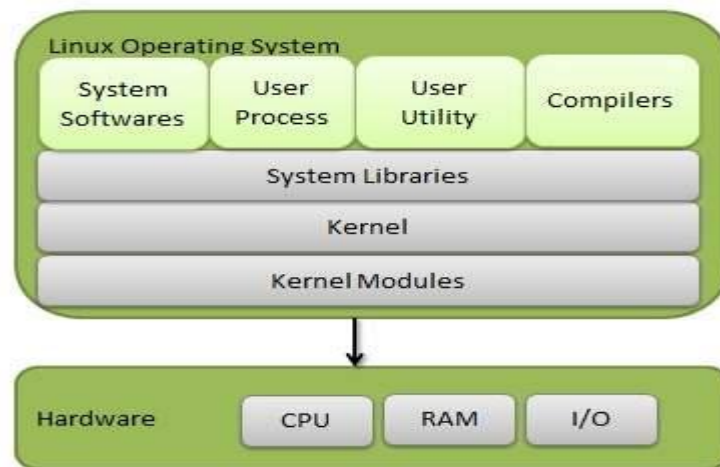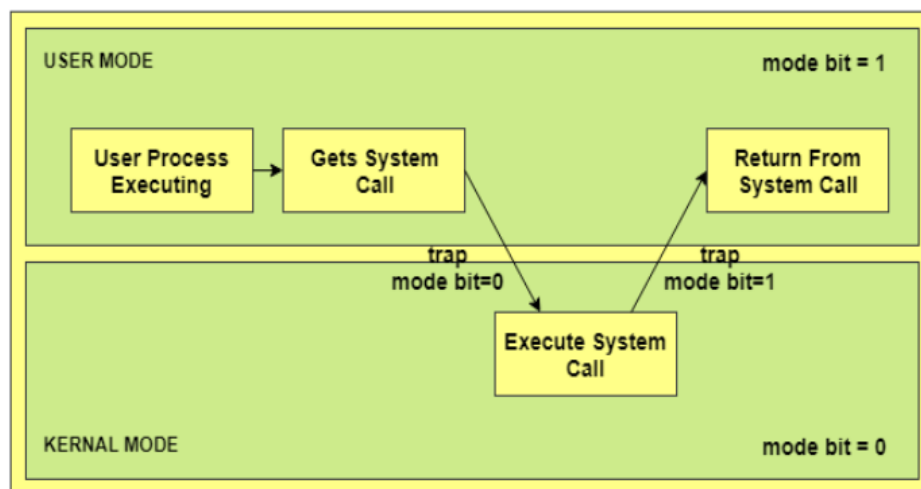

- **Kernel**
  - ➢ The next higher layer is the Linux Kernel. It represents the **core** of the Operating System.
  - ➢ It manages all the underlying hardware.
  - ➢ It directly interacts with the hardware and provides user programs required services.
  - ➢ It hides the complex details of hardware also.
  - ➢ In short, it provides the simple interface between user programs and hardware.
  - ➢ The main services of an operating system includes process management, memory management, file system management, I/O management etc.
- **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.
  - ➢ This programs are stored on disk and when user wants to perform any task then respective utility program is stored on main memory for execution.Kernel Mode vs User Mode

Kernel Mode:
- Kernel component code executes in a special privileged (private) 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.
- The system starts in kernel mode when it boots and after the operating system is loaded, it executes applications in user mode. There are some privileged instructions that can only be executed in kernel mode.
- These are interrupt (stop) instructions, I/P management etc. If the privileged instructions are executed in user mode, it is illegal and a trap is generated. The mode bit is set to 0 in the kernel mode. It is changed from 0 to 1 when switching from kernel mode to user mode.

User Mode:
- 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.
- The system is in user mode when the operating system is running a user application such as handling a text editor. The transition from user mode to kernel mode occurs when the application requests the help of operating system or an interrupt or a system call occurs.
- The mode bit is set to 1 in the user mode. It is changed from 1 to 0 when switching from user mode to kernel mode.

In the above image, the user process executes in the user mode until it gets a system call. Then a system trap is generated and the mode bit is set to zero. The system call gets executed in kernel mode. After the execution is completed, again a system trap is generated and the mode bit is set to 1. The system control returns to kernel mode and the process execution continues.

3.3 Comparison of Windows and Linux

	LINUX OS	WINDOWS OS
Introduction	Linux is a free open source operating system means source code can be changed.	Windows is not open source software.
Development and Distribution	Linux is developed by Open Source development i.e. through sharing and collaboration of code and features through forums etc and it is distributed by various vendors.	Developed and distributed by Microsoft.
Company / developer	Linus Torvalds and the Linux community.	Microsoft
Update method	Many	Windows Update
Preceded by	Basic Terminal (CLI) – command line interface	MS-DOS
License	GNU General Public License	Proprietary
Available language(s)	Multilingual	Multilingual
OS family	GNU	DOS
Programmed in	C	Assembly, C, C++
Marketing target	Server, Personal,	Personal, business
Compatibility	New version of Linux support many kinds of hardware	Can coexist on local networks with Windows, BSD, Macs, and other Unix-like systems. Sometimes file compatibility issues may arise.
Usage	Linux can be installed on a wide variety of computer hardware, ranging from mobile phones, tablet computers and video game consoles, to mainframes and supercomputers.	On PC's desktops, laptops, servers and some phones.
Default user interface	Gnome or KDE	Graphical (Windows Aero)
Source model	Free Software	Closed / Shared source
Users	Regular Administrative(root) Service	Administrator Standard Child Guest
File System	Unix/Linux uses a tree like a hierarchical file system.	Windows uses different data drives like C: D: E to stored files and folders.
Drives	There are no drives in Linux	Windows has different drives like C: D: E
Peripheral Device	Peripherals like hard drives, CD-ROMs, printers are also considered files in Linux/Unix	Hard drives, CD-ROMs, printers are considered as devices
Privileges(rights)	Root user is the super user and has all administrative privileges.	Administrator user has all administrative privileges of computers.
File name	Linux file naming convention is case sensitive. Thus, sample and SAMPLE are 2 different files in Linux	In Windows, you cannot have 2 files with the same name in the same folder
Default Directory	For every user /home/username directory is created which is called his home directory.	In windows, My Documents is default home directory.