UNIT 2:INTRODUCTION TO LINUX OPERATING SYSTEM

UNIT STRUCTURE

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2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- learn about proprietary, open source and free software
- define an operating system
- describe the Linux Operating System
- explain the internal architecture of Linux
- list the basic features of the Linux Operating System
- get brief overview of various Linux distributions like Fedora, Debian, SUSE, etc.

2.2 INTRODUCTION

In the first unit, we have learnt about the need of a system administrator in multiuser operating system. The role and power of a system administrator are also discussed in that unit. In this unit, we concentrate on about LINUX operating system. An operating system is a vital part of a computer system. In general, a computer system works in the presence of three general components: the hardware, the operating system and the applications. The hardware refers to various electronic as well as electro-mechanical parts such as a central processing unit (CPU), a keyboard, a hard drive, a mouse, a printer, etc. Applications are those which are used to operate the computer in order to perform the desired task. The operating system is the component that manages and controls the hardware on one side and manages the applications on other side.

2.3 BASIC IDEA ON PROPRIETARY, OPEN SOURCE AND FREE SOFTWARE

Proprietary Software

Proprietary Software, also known as Closed Source Software, is the software product that legally remains the property of an organisation, a group, or an individual who developed it. The organisation that owns the rights to the product usually does not release the source code, and may insist that only those who have purchased a special licence key can use it. This software is under restrictive copyright licensing and the source code is usually hidden from the users. The products developed and marketed by Microsoft such as Windows 2010, Oracle DBMS, etc. are some of the examples of proprietary software.

Free Software

Free Software, also called Freeware, is licensed at no cost or for an optional fee. It is usually closed source. According to Richard Stallman's definition and adopted by the Free Software Foundation (FSF), free software can be defined as a matter of liberty not price, and it upholds the Four

Essential Freedoms which include the following:

- The freedom to run the program as you wish, for any purpose (freedom 0).
- The freedom to study how the program works, and change it so it does your computing as you wish.
- The freedom to redistribute copies so you can help others.
- The freedom to distribute copies of your modified versions to others.

Open-Source Software

Open-source software is free and openly available to everyone. People who create open-source products, publish the code and allow others to use and modify it. Communities of programmers often work together to develop the software and to support users. Open-source products are usually tested in public by online contributors.

Large companies such as Twitter, Facebook and the BBC make use of open-source technology. For example, the BBC makes use of MySQL and it creates open-source software, such as the program to improve the compatibility of iPlayer on smart TVs.

2.4 LINUX OPERATING SYSTEM

Linux Operating System is one of the UNIX-like operating system, which is designed to offer a free or low-cost operating system for personal computer users. It has gained the status of a fast performing and very efficient operating system. This is a remarkably considered a complete operating system, which includes a GUI (Graphical User Interface), TCP/IP, the Emacs editor, X Window System, etc. Linux is based on the Linux kernel, an operating system kernel first released on September 17, 1991 developed by Linus Torvalds, a then-student at the University of Helsinki. Linux is typically packaged in a Linux distribution which includes the Linux kernel and supporting system software and libraries, many of which are provided by the GNU Project. Many Linux distributions use the word "Linux" in their name, but the Free Software Foundation uses the name GNU/Linux to emphasize the importance of GNU Software. Due to its open-

source licensing, Linux is freely available to anyone. However, the trademark on the name "Linux" rests with its creator, Linus Torvalds. The source code for Linux is under copyright by its many individual authors, and licensed under the GPLv2 license.

Popular Linux distributions include Debian, Fedora, CentOS and Ubuntu. Commercial distributions include Red Hat Enterprise Linux and SUSE Linux Enterprise Server. Desktop Linux distributions include a windowing system such as X11 or Wayland, and a desktop environment such as GNOME or KDE Plasma. Distributions intended for servers include a solution stack such as LAMP. Linux was originally developed for personal computers based on the Intel x 86 architecture, but later it has been ported to more platforms. Linux is the leading operating system on servers and other big iron systems such as mainframe computers and is the only OS used on TOP 500 supercomputer.

Further, Linux also runs on embedded systems, i.e. devices whose operating system is typically built into the firmware and is highly tailored to the system. This includes routers, automation controls, televisions, digital video recorders, video game consoles, and smart watches. Many smartphones and tablet computers run Android and other Linux derivatives. Because of the dominance of Android on smart phones, Linux has the largest installed base of all general-purpose operating systems.

Linux is one of the most prominent examples of free and opensource software collaboration which offers the source code be used, modified and distributed-commercially or non-commercially by anyone under the terms of its respective licenses, such as the GNU General Public License.

2.4.1 Components of Linux System

Linux Operating System is comprised of the following three components as shown in figure 2.1:

- **Kernel:** Kernel is the central part of Linux OS. All major activities of Linux OS are executed under the control of Kernel. It consists of various modules and by using these modules kernel 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 by using which application programs or system utilities can access features of the Kernel. These libraries implement most of the functionalities of the operating system.
- **System Utility:** System Utility refers to specialized programs which are responsible for doing specialized individual level tasks.

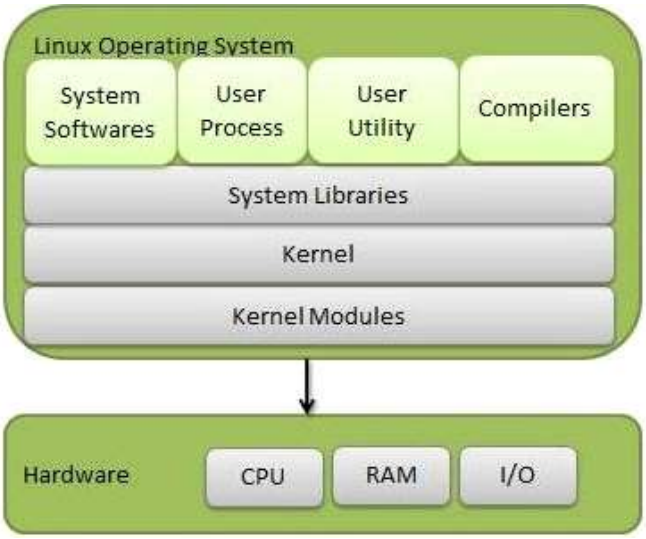


Fig. 2.1 Components of Linux OS

Kernel Mode vs User Mode

Kernel 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 does not require any context switch. Kernel runs each process and provides system services to processes. It also provides protected access to hardware for processes.

in User Mode which does not have access to system hardware and kernel code. User programs/utilities use System Libraries to access Kernel Functions to get system's low-level tasks.

2.4.2 Architecture of Linux operating System

The architecture of the Linux operating system, depicted in figure 2.2, consists of four layers.

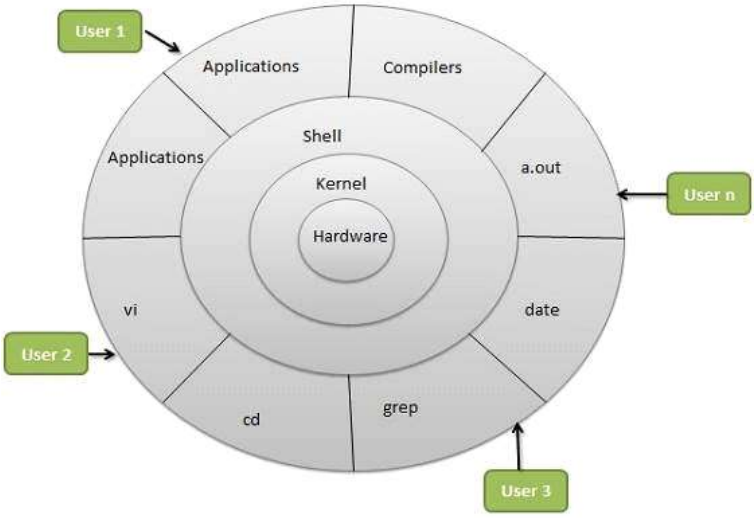


Fig. 2.2 Architecture of Linux Operating system

- Hardware layer - It consists of all peripheral devices such as RAM, HDD, CPU, etc.
- Kernel - It is the core component of Operating System, interacts directly with hardware, and provides low level services to upper layer components.
- Shell - It acts as an interface to kernel, hiding complexity of kernel's functions from users. The shell accepts commands from the user and sends to the kernel to execute.
- Utilities - Utility programs provide the user most of the functionalities of an operating systems.

2.5 BASIC FEATURES OF THE LINUX OPERATING SYSTEM

Linux Operating System provides the following basic features:

- **Portability:** This feature allows software to work on different types of hardware in the 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 provides a multiuser environment which means multiple users can access system resources like memory / RAM / application programs at the same time.
- **Multiprogramming:** This feature allows multiple applications to run at the same time.
- **Hierarchical File System:** Linux provides a standard tree form file structure in which system files/ user files are arranged.
- **Security:** It provides security in three ways namely authenticating (by assigning password and login ID), authorization (by assigning permission to read, write and execute) and encryption (converts file into an unreadable format).
- **Live CD/USB:** Almost all Linux distributions have Live CD/USB feature by which user can run the OS even without installing it on the system.
- **Graphical user interface (X Window System):** Though Linux is usually considered as a command-based OS, but Linux has packages which can be installed to make the whole OS graphic based.
- **Application Support:** Linux has its own software repository from where users can download and install thousands of applications just by issuing a command in Linux Terminal or Shell.

2.6 POPULAR LINUX DISTRIBUTIONS

Technically, Linux is an Operating System Kernel, the core part of an Operating System. The Linux kernel is commonly bundled with many other components to form a complete Linux Distribution. When most people refer to Linux, they are talking about this complete set of programs needed to run a computer, not just the kernel. Because Linux is an open-source operating system, anyone can extend and distribute the system. Several organizations put together the Linux kernel along with a host of programs

and their own special setup utility and distribute the whole package. These are called Linux distributions. Linux users usually obtain their operating system by downloading one of the Linux distributions, which are available for a wide variety of systems ranging from embedded devices (for example, OpenWrt) and personal computers to powerful supercomputers (for example, Rocks Cluster Distribution).

A typical Linux distribution comprises a Linux kernel, GNU tools and libraries, additional software, documentation, a window system (the most common one the X Window System), a window manager, and a desktop environment. Most of the included software is free and open-source software made available both as compiled binaries and in source code form, which allow modifications to the original software. Usually, Linux distributions optionally include some proprietary software that may not be available in source code form, such as binary blobs required for some device drivers. A Linux distribution may also be defined as a particular collection of application and utility software (various GNU tools and libraries, for example), packaged together with the Linux kernel in such a way that its functionalities meet the needs of many users. The software is usually adapted to the distribution and then packaged into software packages by the distribution's maintainers. The software packages are available online in so-called repositories, which are storage locations usually distributed around the world.

Some commercially backed Linux distributions include Fedora Linux, Red Hat Enterprise Linux, openSUSE (SUSE) and Ubuntu, etc. and entirely community-driven distributions include Debian, Slackware, Gentoo and Arch Linux, etc.

2.6.1 Red Hat Enterprise Linux/CentOS

Red Hat Enterprise Linux (RHEL) is a commercial Linux distribution intended for servers and workstations. Red Hat Enterprise Linux is a Linux distribution developed by Red Hat and targeted toward the commercial market. Red Hat Enterprise Linux is released in server

versions for x86-64, Power Architecture, ARM64, and IBM Z, and a desktop version for x86-64. All of Red Hat's official support and training, together with the Red Hat Certification Program, focuses on the Red Hat Enterprise Linux platform. Red Hat Enterprise Linux is often abbreviated to RHEL. The first version of Red Hat Enterprise Linux originally came into the market as "Red Hat Linux Advanced Server". In 2003, Red Hat rebranded Red Hat Linux Advanced Server to "Red Hat Enterprise Linux AS", and added two more variants, Red Hat Enterprise Linux ES and Red Hat Enterprise Linux WS.

Red Hat uses strict trademark rules to prevent their official Red Hat Enterprise Linux software from being redistributed, and yet freely provides its source code. Third-party derivatives can be built and redistributed by stripping away the non-free components like Red Hat's trademarks. CentOS is a community project that uses the Red Hat Enterprise Linux code, removes all Red Hat's trademarks, and makes it available for free use and distribution. 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. Nowadays, CentOS is now part of Red Hat itself. A screen shot of Desktop window of RHEL is shown in Figure 2.3.

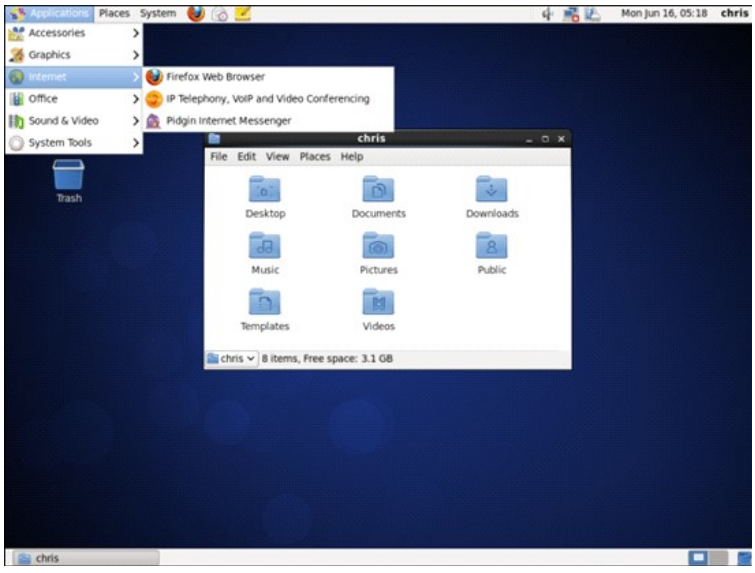


Fig. 2.3 Desktop window of RHEL

2.6.2 Ubuntu

Ubuntu is a free and open-source Linux distribution based on Debian. Ubuntu is officially released in three editions: Desktop, Server, and Core. Ubuntu is a popular operating system for cloud computing, with support for OpenStack. Ubuntu is developed by Canonical who provide security updates and support for each Ubuntu release, starting from the release date and until the release reaches its designated end-of-life (EOL) date. Ubuntu is named after the African philosophy of ubuntu, which Canonical translates as "humanity to others" or "I am what I am because of who we all are". It came into existence in 2004 by Canonical and quickly became popular for it's a graphical Linux desktop without the use of command line. It is the most well-known Linux distribution. Ubuntu is a next version of Debian and easy to use for beginners. It is comprised of lots of pre-installed apps and easy to use repositories libraries. A screenshot of Desktop window of Ubuntu is depicted in Figure 2.4.

A default installation of Ubuntu contains a wide range of software that includes LibreOffice, Firefox, Thunderbird, Transmission, and several lightweight games such as Sudoku and chess. Many additional software packages are accessible from the built in Ubuntu Software as well as any other APT-based package management tools. Many additional software packages that are no longer installed by default, such as Evolution, GIMP, Pidgin, and Synaptic, are still accessible in the repositories still installable by the main tool or by any other APT-based package management tool. Cross distribution snap packages and flatpaks are also available, that both allow installing software, such as default file manager is GNOME Files, formerly called Nautilus.



Fig. 2.4 Desktop window of Ubuntu

Ubuntu operates under the GNU General Public License (GPL) and all of the application software installed by default is free software. In addition, Ubuntu installs some hardware drivers that are available only in binary format, but such packages are clearly marked in the restricted component. Ubuntu aims to be secure by default. To increase security, the sudo tool is used to assign temporary privileges for performing administrative tasks, which allows the root account to remain locked and helps prevent inexperienced users from inadvertently making catastrophic system changes or opening security holes. Polkit is also being widely implemented into the desktop. Most network ports are closed by default to prevent hacking.

A built-in firewall allows end-users who install network servers to control access. Ubuntu also supports full disk encryption as well as encryption of the home and private directories.

2.6.3 Debian

Debian is a Unix-like operating system having entirely of free software. Ian Murdock started the Debian Project on August 16, 1993. Debian 0.01 was released on September 15, 1993, and the first stable version, 1.1, was marketed on June 17, 1996. The Debian stable branch is the most popular edition for personal computers and network servers, and is used as the basis for many other distributions.

Debian is one of the earliest operating systems based on the Linux kernel. The project work of Debian is carried out over the Internet by a team of volunteers guided by the Debian Project Leader and three foundational documents: the Debian Social Contract, the Debian Constitution, and the Debian Free Software Guidelines. New distributions are updated continually, and the next candidate is released after a time-based freeze. Debian has been openly developed and freely distributed according to the principles of the GNU Project founded by Richard Stallman. This philosophy drew the support of the Free Software Foundation, which sponsored the project from November 1994 to November 1995. When the sponsorship ended, the Debian Project formed Software in the Public Interest to continue financially supporting development. Debian has access to online repositories that contain over 51,000 packages making it the largest collection of software in the world. Debian officially contains only free software, but non-free software can be downloaded and installed from the Debian repositories. Debian includes popular free programs such as LibreOffice, Firefox web browser, Evolution mail, K3b disc burner, VLC media player, GIMP image editor, and Evince document viewer. Debian is a popular choice for servers. Desktop window of Debian Linux is presented in Figure 2.5.



Fig. 2.5 Desktop window of Debian Linux

2.6.4 Fedora

Fedora is a Linux distribution developed by the community supported Fedora Project and sponsored by Red Hat. Fedora contains software distributed under various free and open-source licenses and aims to be on the leading edge of such technologies. Fedora is considered the upstream source of the commercial Red Hat Enterprise Linux distribution.

Since the release of Fedora 21, different editions of Fedora are currently available: Workstation, focused on the personal computer, Server for servers, and Atomic focused on cloud computing.

Fedora has a reputation for focusing on innovation, integrating new technologies early on and working closely with upstream Linux communities. Making changes upstream instead of specifically for Fedora ensures that the changes are available to all Linux distributions. The default desktop environment in Fedora

is GNOME and the default user interface is the GNOME Shell. The other desktop environments include KDE Plasma, Xfce, LXDE, MATE and Cinnamon.

Fedora comes preinstalled with a wide range of software such as LibreOffice and Firefox. Additional software is available from the software repositories and can be installed using the DNF package manager or GNOME Software. Additionally, extra repositories can be added to the system, so that software not available in Fedora can be installed easily.

2.6.5 SUSE

SUSE Linux Enterprise Server is an operating system which is built on top of the free and open-source Linux kernel. It is distributed with system and application software from other open-source projects.

SUSE Linux is of German origin, basically an acronym of "Software und System-Entwicklung" (software and systems development), and was mainly developed in Europe. The first version was released in early 1994, making SUSE one of the oldest existing commercial distributions. It is known for its YaST configuration tool.

SUSE Linux is available under two brands, openSUSE and SUSE Linux Enterprise. openSUSE is a free, community distribution driven by the openSUSE Project. It includes some of the latest Linux technologies and is designed for home users and enthusiasts. SUSE Linux Enterprise is the tested and certified open-source solution for major enterprises. openSUSE is a freely available, community project that releases versions on a comparatively frequent basis, and generally uses the latest versions of the various open- source projects that it includes.

SUSE Linux Enterprise is the commercial version of SUSE Linux, which enables it to offer support more effectively for enterprise and production deployments. It is certified for a wide variety of

enterprise applications and offers a number of special enterprise features including, High Availability and Point of Sale extensions. SUSE historically uses a heavily-tested subset of packages from openSUSE Linux as the basis for SUSE Linux Enterprise.



CHECK YOUR PROGRESS

Q 1: Linux is free and open-source operating system. (True/False)

.....

Q 2: Which type of software product has the legal right to use?

.....

Q 3: Shell acts as an interface between the .....and

.....

Q 4: The Linux system is a single-user or multi-user operating system?

.....

Q 5: How many layers are there in Linux OS architecture and what are these?

.....



2.7 LET US SUM UP

- An operating system is an important part of a computer system. A computer system can be viewed as being built from three general components: the hardware, the operating system and the applications.
- The operating system is the component that on one side manages and controls the hardware and on the other, manages the applications.
- Linux operating system is one of the popular versions of the UNIX operating system, which is designed to offer a free or low-cost operating system for personal computer users.
- Linux is a family of free and open-source software operating systems based on the Linux kernel; an operating system kernel was first released on September 17, 1991 by Linus Torvalds. Linux is typically packaged

in a Linux distribution.

- Linux Operating System has primarily three components: kernel, system library and system utilities.
- The architecture of Linux Operating System has the following layers- hardware, kernel, shell, and utilities.
- Some basic features of Linux are: portability, multi-user, multiprogramming, hierarchical file system, shell and security.
- Linux also provides many additional features like live CD/USB, graphical user interface, support most national or customized keyboards and application support.
- A typical Linux distribution comprises a Linux kernel, GNU tools and libraries, additional software, documentation, a window system (the most common being the X Window System), a window manager, and a desktop environment.
- Some popular Linux distributions are - Red Hat Enterprise Linux, Ubuntu, Fedora, SUSE and Debian.



2.8 FURTHER READINGS

1) Das, S. (2012). Your UNIX/Linux: The Ultimate Guide. (Third Edition). (Science/ Engineering/Math). McGraw-Hill.
2) Negus, C. (2012). Linux Bible. (Vol. 772). John Wiley & Sons.



2.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: True

Ans to Q No 2: Proprietary software

Ans to Q No 3: Kernel, user

Ans to Q No 4: Multi user operating system

Ans to Q No 5: Four layers. Kernel, shell, Hardware and Utilities



2.10 MODEL QUESTIONS

Q 1: Define Operating system. What is Linux? What are the core components of Linux?

Q 2: Distinguish between Proprietary, free and open-source software.

Q 3: Discuss about different layers of Linux architecture.

Q 4: What are the basic features of the Linux Operating System?

Q 5: What is a Linux distribution? Name some of the popular Linux distributions.

Q 6: What is Ubuntu? What are the features of Ubuntu?

Q 7: What is Fedora? What are the features of Fedora?

Q 8: Discuss about RHEL system with various features.

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