

# SYSTEMS PROGRAMMING – LINUX

## Lecture 1: Introduction to Linux Operating Systems

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### Lecture Outcomes

- Understand the concept of operating systems (OS)
- Understand the difference between Unix and Linux
- Understand the key features of Linux and Unix Oss
- Know the various distributions of Unix and Linux
- Appreciate the benefits of the Linux OS

### 1.0 Introduction to Operating Systems

The core program that controls a computer's hardware and software resources is called an operating system (OS). It serves as a bridge between the user and the hardware, offering an intuitive user interface.

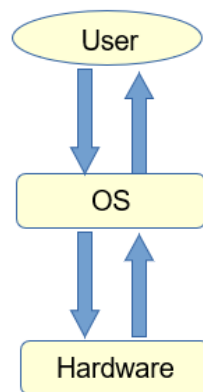


Figure 1. Role of the operating system

Hardware management is made possible via the shell, which offers the user interface through which the kernel can communicate with the hardware as illustrated in Figure 1 below [2] [3].

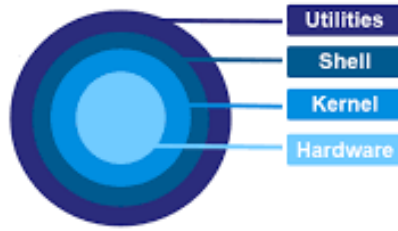


Figure 1: Kernel manages the hardware resources

## 1.2 Functions of Operating Systems

Through its kernel, the Linux operating system effectively manages system resources, handling crucial functions such as input/output device control, memory management, process scheduling, and file system administration.

- In Linux, memory management entails distributing system memory across different processes. Applications receive memory allocations from the kernel based on its availability. When RAM is full, it uses strategies including virtual memory, caching frequently accessed data to speed up access, and moving less often used data to disk. This guarantees that several processes can operate simultaneously without affecting one another's memory use.
- Process Scheduling is another key role. The kernel's scheduler decides which process gets to use the CPU at any given time. To guarantee an equitable distribution of CPU time among distinct activities, it uses a variety of scheduling techniques, including the Completely Fair Scheduler (CFS). By striking a balance between the demands of background and interactive jobs, the scheduler seeks to deliver a responsive and effective system.
- The file system layer of the kernel is in charge of file system administration. Linux offers a uniform interface for accessing many file system formats, including XFS, and ext4. In addition to handling file creation, deletion, reading, and writing activities, the kernel also maintains data integrity and controls how files and directories are arranged on storage media.
- Lastly, the kernel's device drivers oversee input/output (I/O) device control. These drivers serve as a bridge connecting the kernel to other hardware components, including printers, network cards, and hard drives. Applications can read and write data without having to understand the specifics of the

hardware thanks to the kernel's standard interface for interfacing with various devices. The kernel controls the data flow to and from these devices and handles the communication protocols.

## **2.0 The Origin of Unix and Linux**

A University of Helsinki student named Linus Torvalds for his use and to gain knowledge of operating system design, desired a more versatile and potent operating system [1]. He developed his own kernel and in 1991 along with other programmers, launched the Linux OS in 1991. This open nature of Linux Kernel has fostered a vast ecosystem of Linux distributions (distros), each tailored for different needs and hardware. Examples of these “distros” include; Red Hat, Ubuntu, Centos and many more. Its flexibility allows Linux to run on a wide array of systems, from powerful servers and mainframes to everyday computers. Notably, it has been adapted to more hardware platforms than many other operating systems, showcasing its adaptability. Its open-source model empowers a global community to contribute to its development, leading to continuous improvements and a wide range of available software.

### **2.1 Unix and Linux. What is the difference?**

Because of their shared origin, Linux and Unix are comparable in many aspects. Because they follow the POSIX standard and share fundamental ideas like a command-line interface, a hierarchical file system, and a kernel that controls system resources, both operating systems are Unix-like [3]. Both of them place a strong emphasis on modularity and offer an extensive collection of tools for program development and system.

The primary distinction, though, is where they are from and how they are licensed. AT&T Bell Laboratories was the original developer of the proprietary operating system Unix. Although there are several commercial versions of Unix, their source code is not publicly accessible. The GNU General Public License governs the development of Linux, an open-source operating system created by a global community. This indicates that anybody can use, alter, and share its source code without restriction.

With the benefits of open access and community-driven development, Linux is essentially a free and open-source version of the Unix philosophy, providing a comparable user experience and functionality.

### **3.0 Features of Linux Operating Systems**

Linux is a powerful and versatile operating system characterized by several key features that have contributed to its widespread adoption across various computing environments.

- **Open Source**

Unlike proprietary operating systems, Linux's source code is freely available under the GNU General Public License, allowing anyone to study, modify, and distribute it. This fosters a collaborative development environment where a global community of developers contributes to its continuous improvement, leading to a robust and feature-rich operating system. This openness also promotes transparency and allows for thorough security audits.

- **Portable**

Portability means Linux can run on a vast range of hardware platforms, from embedded systems and smartphones to supercomputers and mainframes. This adaptability is a major advantage, making it a versatile choice for diverse computing needs. The modular design of the Linux kernel allows it to be tailored to specific hardware architectures, ensuring efficient performance across different devices.

- **Customizable**

There is a lot of customization available with Linux. Numerous Linux distributions are available to users, each offering a unique collection of pre-configured desktop environments, system utilities, and software. Well-known distributions like Ubuntu, Fedora, Debian, and CentOS serve a range of user requirements, from novices to seasoned system administrators. Because of

this flexibility, users can choose a distribution that best fits their technical proficiency and unique needs.

- **Stability and security**

Its dependability is a result of both its strong architecture and the active participation of a sizable community in locating and fixing vulnerabilities. Regular security updates are made available, and because it is open-source, security vulnerabilities can be found and fixed quickly. Because of its design and the criticism, it receives from a global community, Linux is frequently regarded as more secure than other proprietary operating systems.

- **Command-line Interface**

Linux also offers a robust command-line interface (CLI). The CLI is still an essential component of Linux, even if the majority of contemporary distributions provide intuitive graphical user interfaces (GUIs). For jobs including scripting, automation, and system management, it provides a high level of efficiency and control. Because of the CLI's speed and flexibility, seasoned users frequently use it.

- **Modularity and Flexibility**

Lastly, Linux is renowned for its versatility and adaptability. Because of its modular nature, users can choose and install just the components that are required, resulting in an operating system that is effective and lightweight and can be customized to meet particular demands. Because users may upgrade specific components without necessarily changing the entire system, this modularity also makes maintenance and updates easier. Fundamentally, Linux is a very flexible and favoured alternative for a variety of computer applications due to its open-source nature, portability, customization possibilities, stability, security, robust command-line interface, and flexibility.

## 4.0 Linux Distribution

Numerous features offered by well-known Linux distributions are tailored to accommodate varying user requirements and technical proficiency levels [1] [3].

There is a distribution for everyone, ranging from easy-to-use options like Ubuntu and Linux Mint, which are perfect for novices, to more configurable options like Arch Linux, which are best suited for seasoned users. Modern Fedora and stability-focused Debian both provide clear benefits in the IT community.

- **Ubuntu**

For people who are new to Linux or are looking for a basic desktop experience, Ubuntu is a popular option. It is simple to get started because of its extensive software library and user-friendly UI. Its sizable and vibrant online community, which provides easily accessible tools and support for users, is a major advantage. Ubuntu is a friendly distribution because of its vibrant community, which guarantees that assistance is always available.

- **Linux mint**

Linux Mint, a well-known Unix-like distribution, strives to offer an intuitive and unconventional experience, particularly for Windows migrations. It emphasizes usability and frequently comes with proprietary software drivers and multimedia codecs pre-installed, making it practical for daily use. Its desktop environment, such as Cinnamon or XFCE, is usually familiar and provides a smooth transition. Based on Ubuntu and Debian and boasting a robust community, Linux Mint provides users looking for a simple and easy-to-use Linux experience with a stable and well-supported platform.

- **Debian**

Debian is a well-known and respected Linux distribution that is well-known for its vast software repository, dedication to reliability, and support for free software. It is a global community-maintained non-profit project that prioritizes dependability and long-term support. Debian is a well-liked option for servers

and users who value dependability above the newest software versions because of its thorough testing procedure, which guarantees a stable operating system. Numerous packages are available in its extensive repository, and it forms the basis of numerous other well-known distributions, such as Ubuntu. Debian is a great option for users looking for a stable, community-driven Linux experience.

- **Fedora**

One of the top Linux distributions, Fedora, is renowned for emphasizing the newest open-source software and technology. It is supported by Red Hat and acts as a test site for new developments before they might be incorporated into Red Hat Enterprise Linux. Because Fedora provides a comparatively modern and feature-rich experience, it is preferred by developers and users who wish to stay on the cutting edge. It strikes a decent mix between stability and innovation. For people who are eager to learn about the latest advancements in the Linux world, its robust community and regular release cycle make it a compelling choice.

- **Arch Linux**

A well-liked distribution, Arch Linux is distinguished by its simplicity and great degree of customization. With its "rolling release" strategy, users get regular updates instead of significant version upgrades. Although users must actively manage updates, this guarantees access to the most recent software. By providing a basic installation where users can construct their system from the ground up and choose only the packages they require, Arch places emphasis on user control. This method encourages a thorough comprehension of the operating system. Arch offers a lightweight, effective experience that is exactly customized to the user's tastes, although it does require more technological know-how.

- **Elementary OS.**

A well-liked option, Elementary OS sets itself apart with an emphasis on sophisticated design and ease of use. With its neat, user-friendly design and carefully chosen apps, it seeks to deliver an experience similar to macOS. The distribution appeals to people who are new to Linux or are looking for a visually pleasing system because it places a strong emphasis on simplicity of use and a polished appearance. It comes with a unique suite of applications that are made to blend in well with the overall style. Elementary OS is a fashionable and approachable choice for users, despite having less features than some other distributions right out of the box. It places a high value on a streamlined and consistent user experience.

## **5.0 Benefits of the Linux Kernel**

Linux operating systems offer a multitude of benefits that contribute to their widespread popularity and adoption, particularly in a dynamic environment.

- **Open Source**

Firstly, the open-source nature provides significant advantages. The freely available source code fosters a collaborative development model, leading to rapid innovation, a vast community support network, and increased transparency. This also allows for customization and tailoring of the operating system to specific needs.

- **Cost Effective**

Secondly, cost-effectiveness is a major draw. Unlike proprietary operating systems, Linux distributions are often free to download, use, and distribute, reducing the overall cost of computing. This makes it an accessible option for a wider range of users and budgets.

- **Security and Stability**

Furthermore, Linux boasts stability and security. Its robust architecture and the scrutiny of a global community contribute to its reliability and make it less susceptible to malware compared to some other operating systems [2].

Regular security updates and a proactive community ensure a secure computing environment.

- **Flexible**

Flexibility and customization are also key benefits. Linux offers a wide array of distributions, each with different pre-configured software and desktop environments, allowing users to choose an operating system that best suits their specific needs and technical expertise. This adaptability makes it suitable for various use cases, from personal computing to server infrastructure.

- **Good performance**

Performance and efficiency are often cited as advantages. Linux is known for its lightweight nature and efficient resource management, allowing it to run smoothly on a wide range of hardware, including older or less powerful machines, which can be particularly beneficial where hardware availability and cost can be factors. Finally, the strong command-line interface provides powerful control and automation capabilities for more advanced users and system administrators

#### **REFERENCE BOOKS:**

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3. Stevens, W. R., & Rago, S. A. (2013). *Advanced programming in the UNIX environment*. Addison-Wesley.