Lecture 2 Introduction to Linux Notes

1. What is an Operating System? An *operating system* (OS) is software that manages computer hardware and software resources while providing services for applications. It facilitates process and memory management, file organization, device control, user interfaces, security, and networking. Acting as an intermediary between users and hardware, an OS ensures efficient multitasking and system stability. Common examples include Windows, macOS, and Linux for desktops, Android and iOS for mobile devices, and specialized systems for servers and embedded devices.

2. What is a kernel? A *kernel* is the core of an operating system, managing hardware interactions and system resources such as CPU scheduling, memory allocation, device control, and security. It enables process execution, file management, and inter-process communication while ensuring system stability. There are different types of kernels: monolithic kernels (where all services run in one space, like in Linux), microkernels (which keep only essential functions in the kernel, like MINIX), hybrid kernels (a mix of both, used in Windows and macOS), and exokernels (which provide minimal abstraction for direct hardware access). The kernel is fundamental to the OS, ensuring seamless operation between software and hardware.

3. Which other parts aside from the kernel identify an OS? An operating system (OS) consists of several key components beyond the kernel, including system libraries, which provide functions for applications to interact with the OS; system utilities, which assist in administrative tasks like file and disk management; and shells or command-line interfaces (CLI) for text-based user interaction. Many OSs also feature a graphical user interface (GUI) for visual interaction, as well as device drivers that enable communication between hardware and software. The file system management component organizes data storage, while networking components handle internet connectivity and remote access. Lastly, security and authentication modules ensure user authentication, encryption, and system protection. These elements work together to provide a functional, user-friendly, and secure computing environment.

4. What is linux and linux distribution? *Linux* is an open-source, Unix-like operating system kernel developed by Linus Torvalds in 1991, serving as the foundation for various operating systems. A *Linux distribution (distro)* is a complete OS that includes the Linux kernel along with system utilities, libraries, a package manager, and optional graphical interfaces. Distributions are tailored for different purposes, such as desktop use (Ubuntu, Fedora, Linux Mint), server environments (Debian, CentOS, RHEL), security and penetration testing (Kali Linux, Parrot OS), lightweight systems (Arch, Alpine, Puppy Linux), and privacy-focused computing (Tails, Qubes OS). The flexibility of Linux makes it widely used across personal, enterprise, and embedded systems.

5. List at least 4 linux characteristics: Linux is an *open-source operating system*, licensed under the GNU General Public License (GPL), allowing free modification and distribution. It supports *multiuser and multitasking capabilities*, enabling multiple users and processes to operate simultaneously without system slowdowns. Its *portability* allows it to run on diverse hardware, from personal computers to embedded devices and supercomputers. Known for its *security and stability*, Linux incorporates strong user permission controls, firewalls, and encryption, making it a reliable choice for servers and long-running systems.

In addition to its core features, Linux is *highly customizable*, allowing users to modify the system to meet specific needs, whether by adjusting the kernel or choosing lightweight desktop environments. It has a *strong community-driven development model*, where contributors worldwide collaborate on updates,

improvements, and bug fixes. Linux also supports a wide range of **software packages** through its package management systems, such as APT (Debian-based) and YUM (Red Hat-based), which simplify installation and updates. Additionally, it offers **robust networking tools**, enabling advanced network configuration, security, and administration. These traits make Linux a powerful, flexible, and adaptable operating system for various environments.

6. What is Ubuntu? *Ubuntu* is a user-friendly Linux distribution based on Debian, designed for ease of use with a focus on accessibility, stability, and community support. Developed and maintained by Canonical Ltd., it features the GNOME desktop environment, a wide range of software available through the Snap Store and APT package manager, and a predictable release cycle with Long-Term Support (LTS) versions that receive updates for 5 years. Ubuntu is popular among beginners for its simplicity but is also powerful enough for developers, system administrators, and enterprises, offering both community and commercial support.

7. What is Debian? *Debian* is a free, open-source Linux distribution known for its stability, security, and strict adherence to open-source principles. Developed by the Debian Project, it serves as the foundation for many other distributions, including Ubuntu. Debian offers an extensive repository of over 50,000 software packages organized into Stable, Testing, and Unstable branches, ensuring reliability for both servers and desktop use. It supports a variety of hardware architectures and desktop environments, such as GNOME, KDE, and XFCE. With a dedicated security team and a strong commitment to free software, Debian is favored by experienced Linux users and those seeking a reliable, customizable system for mission-critical applications.

8. List and define the different types of licensing agreements *Licensing agreements* are legal contracts that govern the use, distribution, and modification of software or intellectual property. Key types include proprietary licenses, which restrict modifications and redistribution (e.g., Microsoft Windows); open-source licenses, which allow modification and distribution of the source code (e.g., GPL, MIT License); freeware licenses, offering software for free but with no modification rights (e.g., Adobe Acrobat Reader); shareware licenses, which provide free trials with limited features (e.g., WinRAR); Creative Commons licenses, enabling sharing of creative works under specific conditions; dual licenses, offering both open-source and proprietary options (e.g., MySQL); End-User License Agreements (EULA), outlining user restrictions and permissions; and commercial licenses, which allow business use and often come with a fee. These licenses offer various levels of control and access, depending on the intended use and distribution model.

9. What is Free Software? Define the 4 freedoms. *Free Software* is software that grants users the freedom to run, modify, share, and distribute it without restrictions. The focus is on the rights of users rather than the price of the software, and it emphasizes the idea that software should be accessible to everyone, allowing for modification, redistribution, and the improvement of the code. Popularized by the Free Software Foundation (FSF) and its founder Richard Stallman, the movement advocates for these freedoms to ensure software remains open, collaborative, and user-centric.

The **four essential freedoms** of Free Software are:

- Freedom 0, which allows users to run the software for any purpose without restrictions;
- Freedom 1, which provides the right to study and modify the source code;
- Freedom 2, which permits users to share copies of the software with others; and
- Freedom 3, which allows the distribution of modified versions of the software. These freedoms empower users to control the software they use, fostering a collaborative community where improvements and adaptations can be made and shared.

10. What is virtualization? *Virtualization* is the process of creating a virtual version of a resource, such as a server, storage device, network, or operating system, within a physical system. It allows multiple virtual instances to run on a single physical machine, making efficient use of resources and improving flexibility. Virtualization is achieved through a software layer called a hypervisor that abstracts and allocates hardware resources to virtual machines (VMs). Each virtual machine functions like an independent computer, running its own operating system and applications, even though they share the same physical hardware.

There are several types of virtualization, including server virtualization, which allows multiple virtual servers to run on one physical server, and desktop virtualization, which enables users to run multiple desktop environments on a single machine. Storage virtualization aggregates storage from multiple devices into a single, unified system, while network virtualization combines multiple network resources to improve performance and management. Virtualization improves resource utilization, isolation, scalability, and cost-effectiveness, making it a core technology for data centers, cloud computing, and enterprise IT infrastructures.