

Experiment 1

Overview and Fundamentals of Unix(Linux) Operating System.

Introduction to Operating Systems

An operating system (OS) is the program that, after being initially loaded into the computer by a **boot program**, manages all of the other application programs in a computer. Operating System lies in the category of system software. It basically manages all the resources of the computer. An operating system acts as an interface between the software and different parts of the computer or the computer hardware. The operating system is designed in such a way that it can manage the overall resources and operations of the computer.

	Windows	macOS	Linux
Cost	Freemium, costs approx \$150 to access all features	Free, but comes on a pricey hardware	Mostly free, some distros offer premium versions
Hardware Quality	Very versatile	Proprietary hardware, very high-quality	Versatile, can run on low-spec PCs
Ease of Installation	Easy	Very easy	Requires some computing knowledge
Software Compatibility	Unparallel	It has its own app ecosystem	Open-source substitutes for proprietary software
Ease of use	Easy to use	Very easy to use	Ease of use dictated by distro
Security and Stability	Generally good, has plenty of updates	Very good, fewer updates (which is a good thing!)	The safest and most stable OS

Unix Operating System

Unix is a powerful and versatile operating system that originated in the late 1960s by **Ken Thompson and Dennis Ritchie** at Bell Labs. It was designed to provide a flexible and stable computing environment. Unix has been the foundation for many other operating systems, including Linux and macOS. Its principles and design have had a profound influence on the development of modern computing systems.

Features:

1. **Multi User:** Unix supports multiple users working on the same system simultaneously. Each user can have their own account, files, and processes.
2. **Multitasking:** It allows multiple processes to run concurrently, giving the appearance that they are all executing at the same time.
3. **Multiplatform:** Unix is highly portable and can run on various hardware architectures. This portability has led to its adoption on a wide range of devices, from supercomputers to embedded systems.

4. **Hierarchical File System:** Unix organizes files in a hierarchical directory structure, which allows for easy organization and management of files and directories.

5. **Command Line Interface (CLI):** Unix primarily uses a text-based command-line interface for interaction. This allows users to perform tasks by typing commands rather than relying on graphical interfaces.

6. **Modularity:** Unix is composed of small, specialized utilities that perform specific tasks. These utilities can be combined using pipes and filters to accomplish more complex operations.

7. **Shell:** The shell is the command interpreter that provides a user interface for interacting with the Unix system. There are different shells available, such as Bash, C-shell, and Korn shell, each with its own features and syntax.

8. **Networking Capabilities:** Unix was designed from the ground up with networking in mind. It includes a suite of networking tools and protocols that allow for seamless communication between Unix systems and with other types of systems.

9. **Security:** Unix has a robust security model, including user authentication, file permissions, and access control lists, which helps protect system resources and data.

10. **Stability and Reliability:** Unix systems are known for their stability and robustness. They can run for long periods of time without needing to be restarted.

11. **Open Standards and Compatibility:** Unix adheres to open standards, which means that software developed for one Unix system can often run on another Unix system without modification.

12. **Extensibility:** Unix supports the development of custom software through its rich set of programming tools and libraries, making it a popular choice for software development environments.

13. **Scripting and Automation:** Unix provides powerful scripting capabilities that allow users to automate tasks and create custom workflows using shell scripts and other scripting languages.



Experiment 2

Installation of Virtual -Box and Ubuntu Operating System

What is VirtualBox ?

VirtualBox is a powerful x86 and AMD64/Intel64 **virtualization** product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, **high-performance** product for enterprise customers, it is also the only professional solution that is freely available as **Open Source Software** under the terms of the GNU General Public License (GPL) version 3. Presently, VirtualBox runs on Windows, Linux, macOS, and Solaris hosts and supports a large number of guest operating system including but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and OpenSolaris, OS/2, and OpenBSD.

Installation of Virtual Box

Download and install Oracle VirtualBox from the official website: **virtualbox.org**

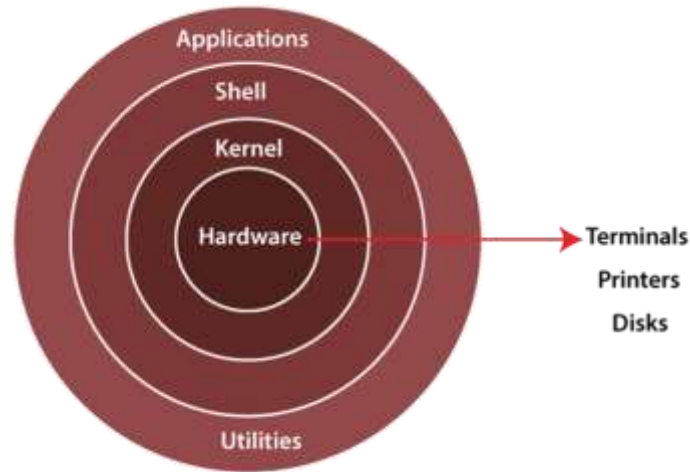
Download the Ubuntu ISO image from the official website: **ubuntu.com**

1. **Create a New Virtual Machine:** Open VirtualBox and click the "New" button. Provide a name for your virtual machine, select "Linux" as the type, and choose the appropriate version (usually "Ubuntu (64-bit)"). Click "Next."
2. **Allocate Memory:** Choose how much RAM you want to allocate to the virtual machine. Ubuntu generally requires at least 2GB for smooth operation. You can allocate more if your host system has enough resources. Click "Next."
3. **Create a Virtual Hard Disk:** Choose the "Create a virtual hard disk now" option and click "Create."
4. **Virtual Hard Disk File Type:** Choose the default "VDI (VirtualBox Disk Image)" and click "Next."
5. **Storage on Physical Hard Disk:** You can choose between "Dynamically allocated" (which will grow as needed) or "Fixed size" (which will be a fixed size on your host system). Choose one and click "Next."

6. **File Location and Size:** Choose the location to save the virtual hard disk file and specify its size. At least 20-30GB is recommended for Ubuntu. Click "Create."
7. **Configure Settings:** In the VirtualBox manager, select your newly created virtual machine and click on "Settings." Here, you can configure various options such as processor cores, video memory, etc.
8. **Mount Ubuntu ISO:** In the "Settings" window, go to the "Storage" tab. Under the "Controller: IDE" section, click the icon that looks like a CD/DVD and choose "Choose a disk file." Select the Ubuntu ISO you downloaded.
9. **Start the Virtual Machine:** Click "OK" in the "Settings" window. Then, start the virtual machine by selecting it and clicking the "Start" button.
10. **Install Ubuntu:** The virtual machine will boot from the Ubuntu ISO. Follow the on-screen instructions to install Ubuntu. You'll need to select language, keyboard layout, and installation type. You can choose to install updates and third-party software during the installation process.
11. **Partitioning:** When prompted, choose the installation type. You can either erase the disk and install Ubuntu or choose "Something else" for manual partitioning.
12. **Complete Installation:** Follow the remaining steps to set up your user account, password, and system settings. Once the installation is complete, the virtual machine will restart.
13. **Install VirtualBox Guest Additions (Optional):** After Ubuntu is installed, it's recommended to install VirtualBox Guest Additions for better integration and performance. You can do this by selecting "Devices" in the VirtualBox menu of the running virtual machine window and choosing "Insert Guest Additions CD image."

Experiment 3

Architecture of Unix (Linux) Operating System.



The Linux operating system's architecture mainly contains some of the components: **the Kernel, System Library, Hardware layer, System, and Shell utility.**

1. Kernel:- The kernel is one of the core sections of an operating system. It is responsible for each of the major actions of the Linux OS. This operating system contains distinct types of modules and cooperates with underlying hardware directly. The kernel facilitates required abstraction for hiding details of low-level hardware or application programs to the system. There are some of the important kernel types which are mentioned below:

- Monolithic Kernel
- Micro kernels
- Exo kernels
- Hybrid kernels

2. System Libraries: - These libraries can be specified as some special functions. These are applied for implementing the operating system's functionality and don't need code access rights of the modules of the kernel.

3. System Utility Programs: - It is responsible for doing specialized level and individual activities.

4. Hardware layer: - Linux operating system contains a hardware layer that consists of several peripheral devices like CPU, HDD, and RAM.

5. Shell: - It is an interface among the kernel and user. It can afford the services of the kernel. It can take commands through the user and runs the functions of the kernel. The shell is available

in distinct types of OSes. These operating systems are categorized into two different types, which are the **graphical shells** and **command-line shells**. The graphical line shells facilitate the graphical user interface, while the command line shells facilitate the command line interface. Thus, both of these shells implement operations. However, the graphical user interface shells work slower as compared to the command-line interface shells.

Advantages of Linux

1. The main advantage of Linux is it is an open-source operating system. This means the source code is easily available for everyone and you are allowed to contribute, modify and distribute the code to anyone without any permissions.
2. In terms of security, Linux is more secure than any other operating system. It does not mean that Linux is 100 percent secure; it has some malware for it but is less vulnerable than any other operating system. So, it does not require any anti-virus software.
3. The software updates in Linux are easy and frequent.
4. Various Linux distributions are available so that you can use them according to your requirements or according to your taste.
5. Linux is freely available to use on the internet.
6. It has large community support.
7. It provides high stability. It rarely slows down or freezes and there is no need to reboot it after a short time.
8. It maintains the privacy of the user.
9. The performance of the Linux system is much higher than other operating systems. It allows a large number of people to work at the same time and it handles them efficiently.
10. It is network friendly.
11. The flexibility of Linux is high. There is no need to install a complete Linux suit; you are allowed to install only required components.
12. Linux is compatible with a large number of file formats.
13. It is fast and easy to install from the web. It can also install on any hardware even on your old computer system.
14. It performs all tasks properly even if it has limited space on the hard disk.

Disadvantages of Linux

1. It is not very user-friendly. So, it may be confusing for beginners.
2. It has small peripheral hardware drivers as compared to windows.

Experiment 4

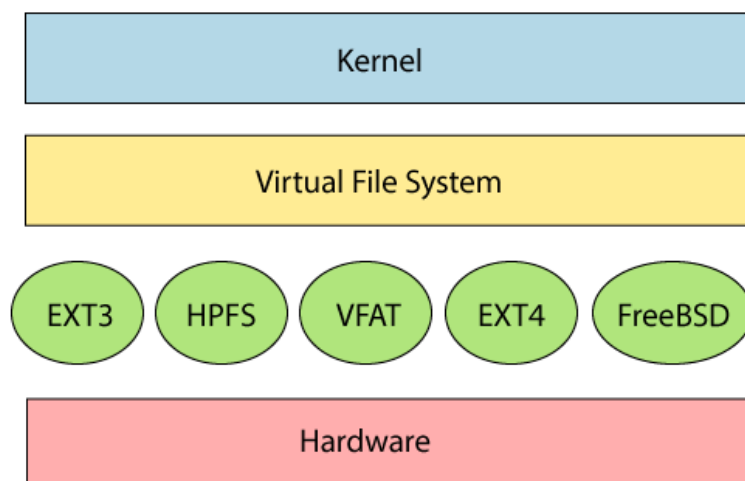
Linux File System

A Linux file system is a structured collection of files on a disk drive or a partition. A partition is a segment of memory and contains some specific data. In our machine, there can be various partitions of the memory. Generally, every partition contains a file system. Linux file system is generally a built-in layer of a Linux Operating System used to handle the data management of the storage. It helps to arrange the file on the disk storage. It manages the file name, file size, creation date, and much more information about a file. The general-purpose computer system needs to store data systematically so that we can easily access the files in less time. It stores the data on hard disks (HDD) or some equivalent storage type. There may be below reasons for maintaining the file system:

- Primarily the computer saves data to the RAM storage; it may lose the data if it gets turned off. However, there is non-volatile RAM (Flash RAM and SSD) that is available to maintain the data after the power interruption.
- Data storage is preferred on hard drives as compared to standard RAM as RAM costs more than disk space. The hard disks costs are dropping gradually comparatively the RAM.

The Linux file system contains the following sections:

- The root directory (/)
- A specific data storage format (EXT3, EXT4, BTRFS, XFS and so on)
- A partition or logical volume having a particular file system.



Linux File System Structure

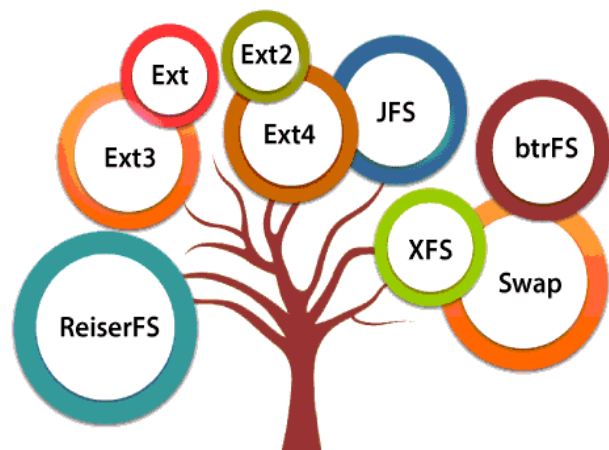
Directory Structure

- **/ (root filesystem):** It is the top-level filesystem directory. It must include every file needed to boot the Linux system before another filesystem is mounted. Every other filesystem is mounted on a well-defined and standard mount point because of the root filesystem directories after the system is started.
- **/boot:** It includes the static kernel and bootloader configuration and executable files needed to start a Linux computer.
- **/bin:** This directory includes user executable files.
- **/dev:** It includes the device file for all hardware devices connected to the system. These aren't device drivers; instead, they are files that indicate all devices on the system and provide access to these devices.
- **/etc:** It includes the local system configuration files for the host system.
- **/lib:** It includes shared library files that are needed to start the system.
- **/home:** The home directory storage is available for user files. All users have a subdirectory inside /home.
- **/mnt:** It is a temporary mount point for basic filesystems that can be used at the time when the administrator is working or repairing a filesystem.
- **/media:** A place for mounting external removable media devices like USB thumb drives that might be linked to the host.
- **/opt:** It contains optional files like vendor supplied application programs that must be placed here.
- **/root:** It's the home directory for a root user. Keep in mind that it's not the '/' (root) file system.
- **/tmp:** It is a temporary directory used by the OS and several programs for storing temporary files. Also, users may temporarily store files here. Remember that files may be removed without prior notice at any time in this directory.
- **/sbin:** These are system binary files. They are executables utilized for system administration.
- **/usr:** They are read-only and shareable files, including executable libraries and binaries, man files, and several documentation types.
- **/var:** Here, variable data files are saved. It can contain things such as MySQL, log files, other database files, email inboxes, web server data files, and much more.

Linux File System Features

- In Linux, the file system creates a tree structure. All the files are arranged as a tree and its branches. The topmost directory called the **root (/) directory**. All other directories in Linux can be accessed from the root directory.
- Some key features of Linux file system are as following:
- **Specifying paths:** Linux does not use the backslash (\) to separate the components; it uses forward slash (/) as an alternative. For example, as in Windows, the data may be stored in C:\ My Documents\ Work, whereas, in Linux, it would be stored in /home/ My Document/ Work.
- **Partition, Directories, and Drives:** Linux does not use drive letters to organize the drive as Windows does. In Linux, we cannot tell whether we are addressing a partition, a network device, or an "ordinary" directory and a Drive.
- **Case Sensitivity:** Linux file system is case sensitive. It distinguishes between lowercase and uppercase file names. Such as, there is a difference between test.txt and Test.txt in Linux. This rule is also applied for directories and Linux commands.
- **File Extensions:** In Linux, a file may have the extension '.txt,' but it is not necessary that a file should have a file extension. While working with Shell, it creates some problems for the beginners to differentiate between files and directories. If we use the graphical file manager, it symbolizes the files and folders.
- **Hidden files:** Linux distinguishes between standard files and hidden files, mostly the configuration files are hidden in Linux OS. Usually, we don't need to access or read the hidden files. The hidden files in Linux are represented by a dot (.) before the file name (e.g., ignore). To access the files, we need to change the view in the file manager or need to use a specific command in the shell.

Types of Linux File System



Types of Linux File System

Ext, Ext2, Ext3 and Ext4 file system

The file system Ext stands for **Extended File System**. It was primarily developed for **MINIX OS**. The Ext file system is an older version, and is no longer used due to some limitations.

Ext2 is the first Linux file system that allows managing two terabytes of data. Ext3 is developed through Ext2; it is an upgraded version of Ext2 and contains backward compatibility. The major drawback of Ext3 is that it does not support servers because this file system does not support file recovery and disk snapshot.

Ext4 file system is the faster file system among all the Ext file systems. It is a very compatible option for the SSD (solid-state drive) disks, and it is the default file system in Linux distribution.

JFS File System

JFS stands for **Journaled File System**, and it is developed by **IBM for AIX Unix**. It is an alternative to the Ext file system. It can also be used in place of Ext4, where stability is needed with few resources. It is a handy file system when CPU power is limited.

ReiserFS File System

ReiserFS is an alternative to the Ext3 file system. It has improved performance and advanced features. In the earlier time, the ReiserFS was used as the default file system in SUSE Linux, but later it has changed some policies, so SUSE returned to Ext3. This file system dynamically supports the file extension, but it has some drawbacks in performance.

XFS File System

XFS file system was considered as high-speed JFS, which is developed for parallel I/O processing. NASA still using this file system with its high storage server (300+ Terabyte server).

Btrfs File System

Btrfs stands for the **B tree file system**. It is used for fault tolerance, repair system, fun administration, extensive storage configuration, and more. It is not a good suit for the production system.

Swap File System

The swap file system is used for memory paging in Linux operating system during the system hibernation. A system that never goes in hibernate state is required to have swap space equal to its **RAM** size.

Experiment 5

Commands on Linux Console (TryHackMe)

1. **echo:** Output text that we provide.

```
tryhackme@linux1:~$ echo "Try Hack Me"
Try Hack Me
tryhackme@linux1:~$
```

2. **whoami:** Find's what user we're currently logged in as.

```
tryhackme@linux1:~$ whoami
tryhackme
tryhackme@linux1:~$
```

3. **ls:** Listing files in current directory. Before we can do anything such as finding out the contents of any files or folders, we need to know what exists in the first place. This can be done using the "**ls**" command (short for listing).

```
tryhackme@linux1:~$ ls
access.log  folder1  folder2  folder3  folder4
tryhackme@linux1:~$
```

4. **mkdir:** For adding new directories.

```
tryhackme@linux1:~$ mkdir ada
tryhackme@linux1:~$ ls
access.log  ada  folder1  folder2  folder3  folder4
```

5. **rmdir:** For removing directories.

```
tryhackme@linux1:~$ rmdir ada
tryhackme@linux1:~$ ls
access.log  folder1  folder2  folder3  folder4
```

6. **cat:** Read the contents of the file.

```
tryhackme@linux1:~/folder4$ cat note.txt
Hello World!
```

7. **man**: Know all related commands using **man** (function/command name).

```
LS(1)                                User Commands                                LS(1)

NAME
    ls - list directory contents

SYNOPSIS
    ls [OPTION]... [FILE]...

DESCRIPTION
    List information about the FILES (the current di-
    rectory by default). Sort entries alphabetically
    if none of -cftuvSUX nor --sort is specified.

    Mandatory arguments to long options are mandatory
    for short options too.

    -a, --all
        do not ignore entries starting with .

    -A, --almost-all
        do not list implied . and ..

    --author
        with -l, print the author of each file

    -b, --escape
        print C-style escapes for nongraphic charac-
Manual page ls(1) line 1 (press h for help or q to quit)
```