Systems Programming

The Unix/Linux Operating System

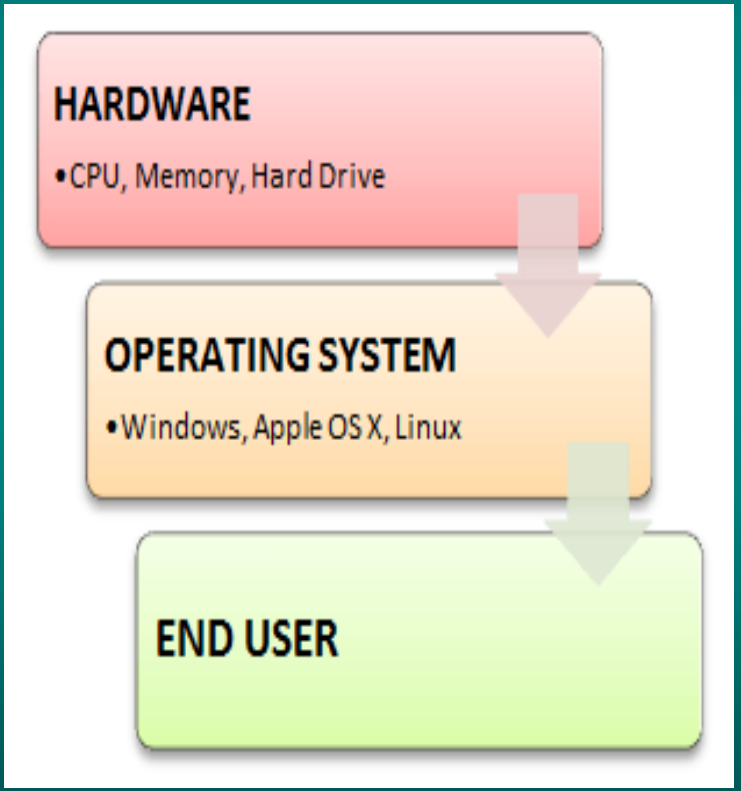
What is UNIX?

A *modern* computer *operating system*

Operating system:

- "a program that acts as an intermediary between a user of the computer and the computer hardware"
- Software that manages your computer's resources (files, programs, disks, network, …)
- e.g. Windows, MacOS

Modern: features for stability, flexibility, multiple users and programs, configurability, etc.



What is Unix?

A multi-user networked operating system

- "Operating System"
  - Handles files, running other programs, input/output
  - Looks like DOS…but more powerful
  - The internet was designed on it, thus networking is an intrinsic part of the system
- "Multi-user"
  - Every user has different settings and permissions
  - Multiple users can be logged in simultaneously

Why UNIX?

- Used in many scientific and industrial settings
- Huge number of free and well-written software programs
- Open-source OS
- Internet servers and services run on UNIX
- Largely hardware-independent
- Based on standards

Brief history of UNIX

Ken Thompson & Dennis Richie originally developed the earliest versions of UNIX at Bell Labs for internal use in 1970s

- Borrowed best ideas from other Oss
- Meant for programmers and computer experts
- Meant to run on “mini computers”

Early UNIX History

- Thompson also rewrote the operating system in high level language of his own design which he called B.
- The B language lacked many features and Ritchie decided to design a successor to B which he called C.
- They then rewrote UNIX in the C programming language to aid in portability.

UNIX variants

Two main threads of development:

- Berkeley software distribution (BSD)
- Unix System Laboratories System V

Sun: SunOS, Solaris

GNU: Linux (many flavors)

SGI: Irix

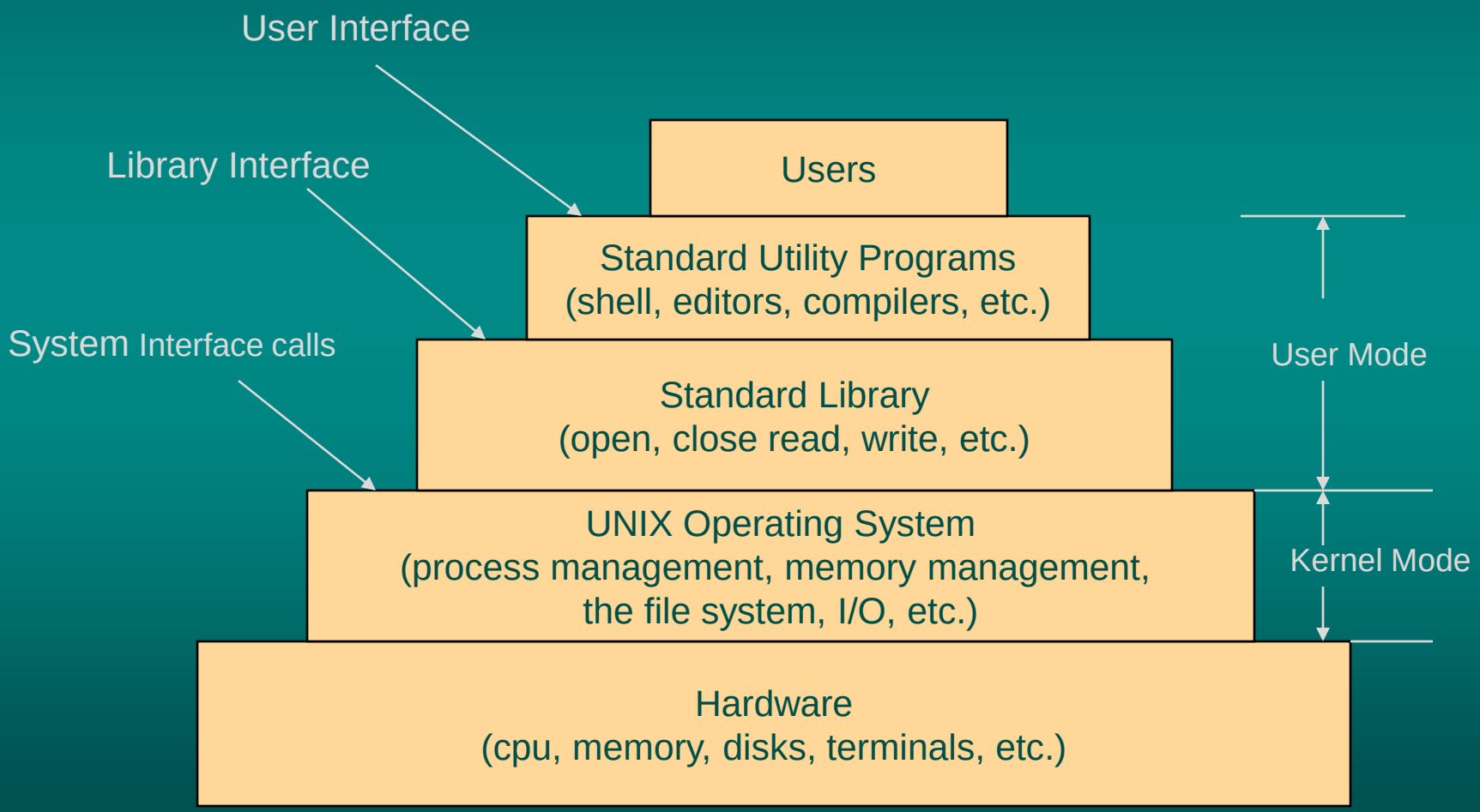
FreeBSD

Hewlett-Packard: HP-UX

Apple: OS X (Darwin)

…

Layers in the UNIX System



UNIX Structure

The ***kernel*** is the core of the UNIX system, controlling the system hardware and performing various low-level functions. The other parts of the UNIX system, as well as user programs, call on the kernel to perform services for them.

UNIX Structure

The ***shell*** is the command interpreter for the UNIX system. The shell accepts user commands and is responsible for seeing that they are carried out.

UNIX Structure

Over two hundred ***utility*** programs or ***tools*** are supplied with the UNIX system. These utilities (or commands) support a variety of tasks such as copying files, editing text, performing calculations, and developing software.

This course will only attempt to introduce a limited number of these utilities or tools!

Unix vs. Linux

- Age
  - Unix: born in 1970 at AT&T/Bell Labs
  - Linux: born in 1992 in Helsinki, Finland
- Sun, IBM, HP are the 3 largest vendors of Unix
  - These Unix flavors all run on custom hardware
- Linux is FREE! (Speech vs. Beer)
  - Linux was written for Intel/x86, but runs on many platforms

Unix vs. Linux

- UNIX is called the mother of operating systems which laid out the foundation to Linux.
- There is not much difference between UNIX and Linux.
- Though they might seem different, at core, they are essentially the same.
- the commands used on both the operating systems are usually the same.
- **Linux is a clone of UNIX**. So learning one is same as learning another.

Unix vs. Linux

- Unix is designed mainly for mainframes and is in enterprises and universities
- You may have to pay for a Unix kernel
- Linux is fast becoming a household name for computer users , developers and server environment.
- Linux Kernel is free.

Linux Distributions

- versions/ types /kinds of Linux operating system are called Distributions.
- To prevent hacking attempts, many organizations keep their Linux operating systems private.
- Many others, make their variations of Linux available publicly so the whole world can benefit at large.

- There are hundreds of Linux operating systems or Distributions available these days.
- Many of them are designed with a specific purpose in mind.
  - E.g to run a web server or to run on network switches like routers, modems etc.
- The latest example of one of the most popular smartphone based Linux Distribution is Android!

Popular Linux Distributions

Linux Distribution	Name	Description
	Arch	This Linux Distro is popular amongst Developers. It is an independently developed system .It is designed for users who go for a do-it-yourself approach.
	CentOS	It is one of the most used Linux Distribution for enterprise and web servers. It is a free enterprise class Operating system and is based heavily on Red Hat enterprise Distro.
	Debian	Debian is a stable and popular non-commercial Linux distribution. It is widely used as a desktop Linux Distro and is user-oriented. It strictly acts within the Linux protocols.
	Fedora	Another Linux kernel based Distro, Fedora is supported by the Fedora project, an endeavor by Red Hat. It is popular among desktop users. Its versions are known for their short life cycle.
	Gentoo	It is a source based Distribution which means that you need to configure the code on your system before you can install it. It is not for Linux beginners, but it is sure fun for experienced users.

Popular Linux Distributions

	**LinuxMint**	It is one of the most popular Desktop Distributions available out there. It launched in 2006 and is now considered to be the fourth most used Operating system in the computing world.
	**OpenSUSE**	It is an easy to use and a good alternative to MS windows. It can be easily set up and can also run on small computers with obsolete configurations.
	**RedHat enterprise**	Another popular enterprise based Linux Distribution is Red Hat Enterprise.It has evolved from Red Hat Linux which was discontinued in 2004. It is a commercial Distro and very popular among its clientele.
	**Slackware**	Slackware is one of the oldest Linux kernel based OS's. It is another easy desktop Distribution. It aims at being a 'Unix like' OS with minimal changes to its kernel.
	**Ubuntu**	This is the third most popular desktop operating system after Microsoft Windows and Apple Mac OS. It is based on the Debian Linux Distribution and it is known for its desktop environment.

The Best Linux Distribution

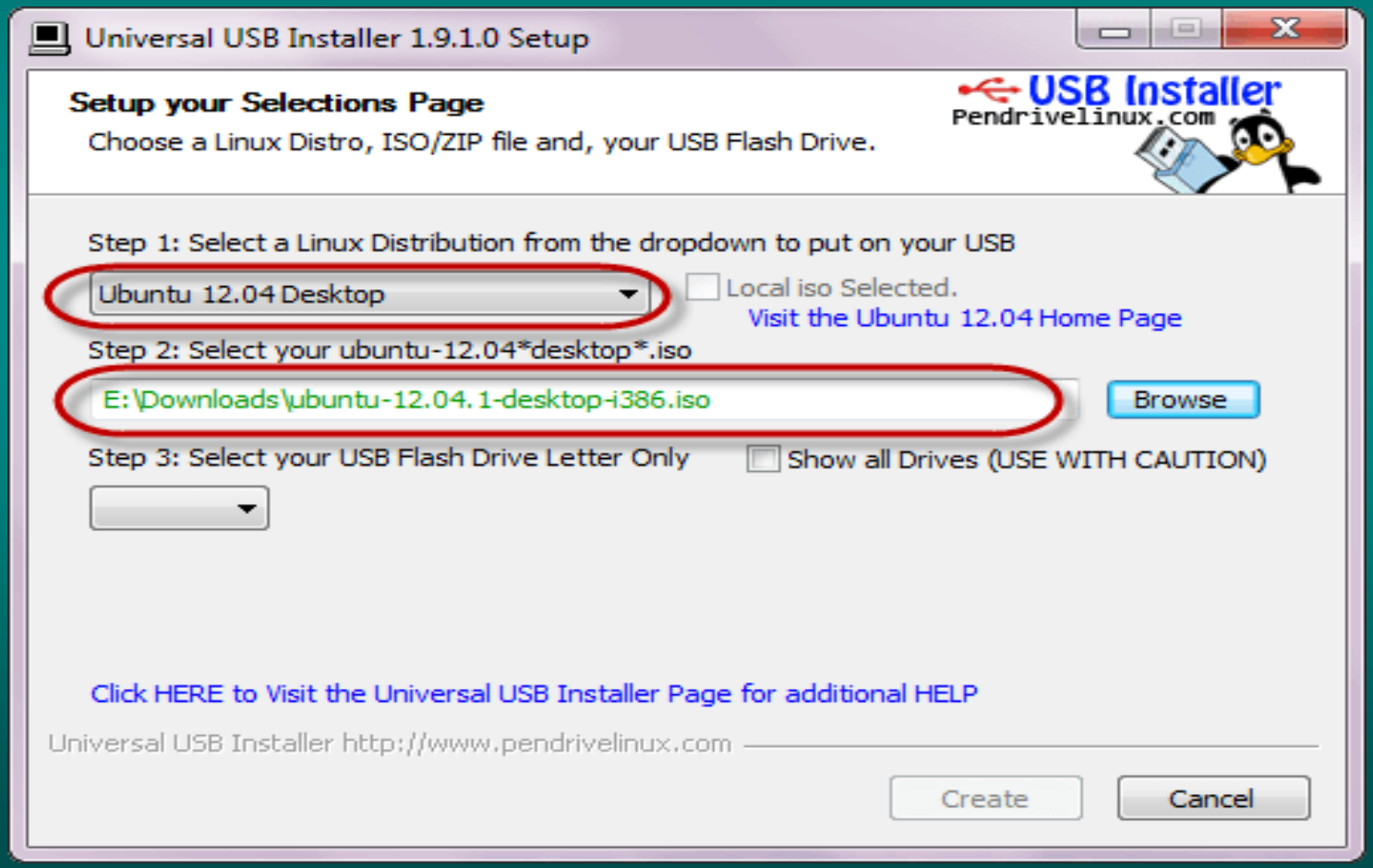
- Best is relative.
- Each Linux distribution is built for a specific purpose built to meet the demands of its target users.
- The desktop Distributions are available for free at their respective websites.
- Each one of them offers it's own unique design, applications and security.
- We will be using Ubuntu for our learning purpose
  - it's easy for a beginner to understand.

Installing Linux (Ubuntu)

- **USB stick**
  - one of the easiest methods of installing Linux on your computer.
  - Follow the steps.
    - Download the .iso or the OS files on your computer from http://www.ubuntu.com/download/desktop.
    - Download free software like 'Universal USB installer to make a bootable USB stick.
    - Boot your computer through it and follow the instructions as they come

Installing Linux (Ubuntu)

- **USB stick**



Installing Linux (Ubuntu)

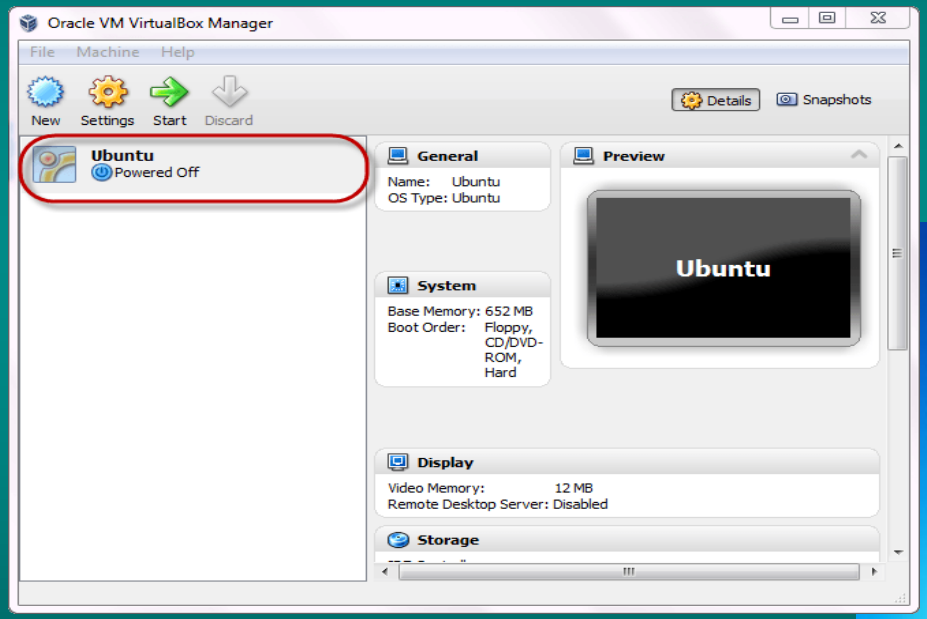
- **Live Cd**
  - Download the .iso or the OS files onto your computer from http://www.ubuntu.com/download/desktop.
  - Burn the files on a CD .
  - Boot your computer through the optical drive and follow the instructions as they come.

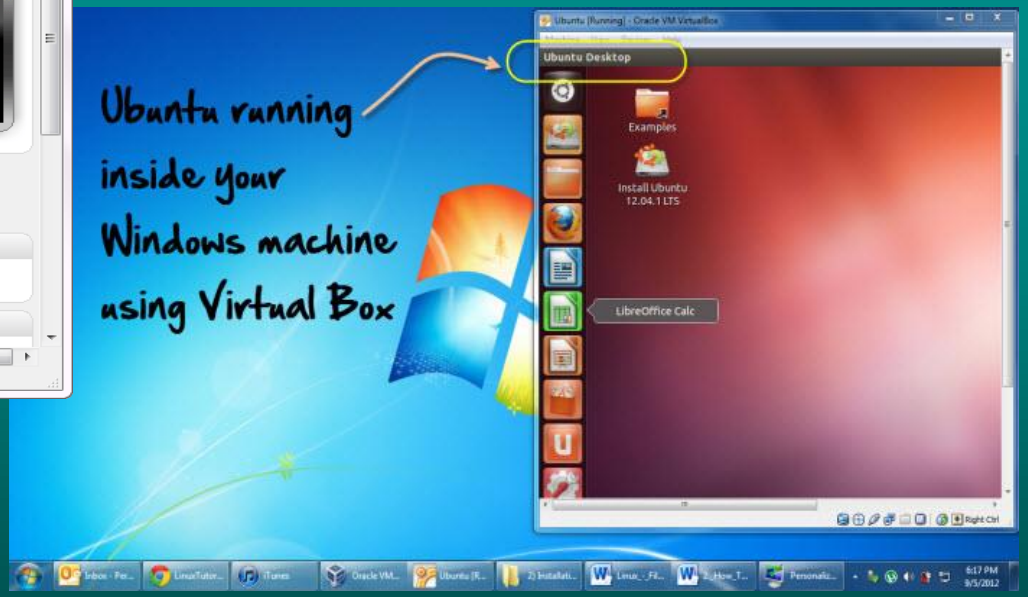
Installing Linux (Ubuntu)

- **Virtual installation**
  - Download and install Oracle VM on your computer.
  - Click on new on the VM tool bar. Enter the VN Name and OS Type.
  - Follow the instructions. You will see Ubuntu configured in your VM.
  - Double click on it . Ubuntu will load as a separate machine while you are working on Windows

Installing Linux (Ubuntu)

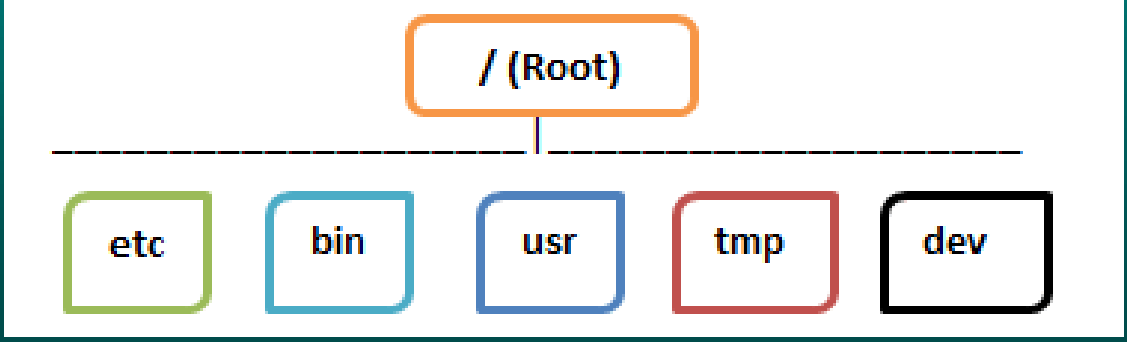
- Virtual installation





Linux Vs Windows

- Microsoft Windows
  - files are stored in folders under different data drives like C: D: E: .
- Linux
  - files are ordered in a tree structure starting with the root directory
  - The root directory can be considered as the start of the file system and it further branches out various other subdirectories.
  - The root is denoted with a forward slash
- Unix general file system:



Types of Files

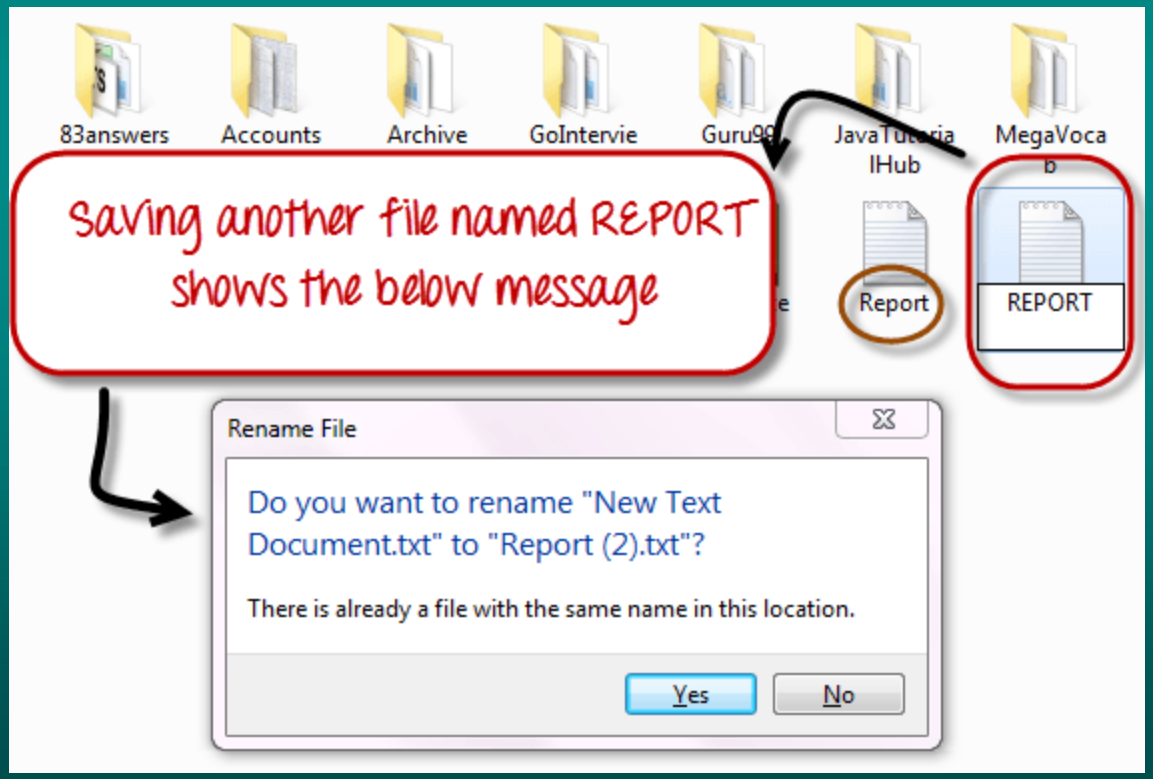
- **In Linux and UNIX, everything is a file.**
  - Directories are files, files are files, and devices like Printer, mouse, keyboard etc.are files
  - All file types have permissions, which allow a user to read, edit or execute (run) them. This is a powerful Linux/Unix feature. Access restrictions can be applied for different kinds of users, by changing permissions
- **General Files**
  - image, video, program or text.
  - They can be in ASCII or a Binary format.
  - They are the most commonly used files by Linux Users
- **Directory Files**
  - warehouse for other file types (similar to folders in Windows)
- **Device Files:**
  - CD-ROM, hard drives etc
  - All device files reside in the directory /dev/

Users in Linux

- **Regular User**
  - created for you when you install Ubuntu on your system.
  - All your files and folders are stored in /home/ which is your home directory.
  - As a regular user, you do not have access to directories of other users.
- **Root User**
  - created at the time of installation.
  - The root account is a super user who can access restricted files, install software and has administrative privileges.
- **Service user**
  - Linux is widely used as a Server Operating System.
  - Services such as Apache, Squid, mail, etc. have their own individual service accounts.
  - Having service accounts increases security of your computer.
  - Linux can allow or deny access to various resources depending on the service.
- **Note**:
  - You will not see service accounts in Ubuntu Desktop version.
  - Regular accounts are called standard accounts in Ubuntu Desktop

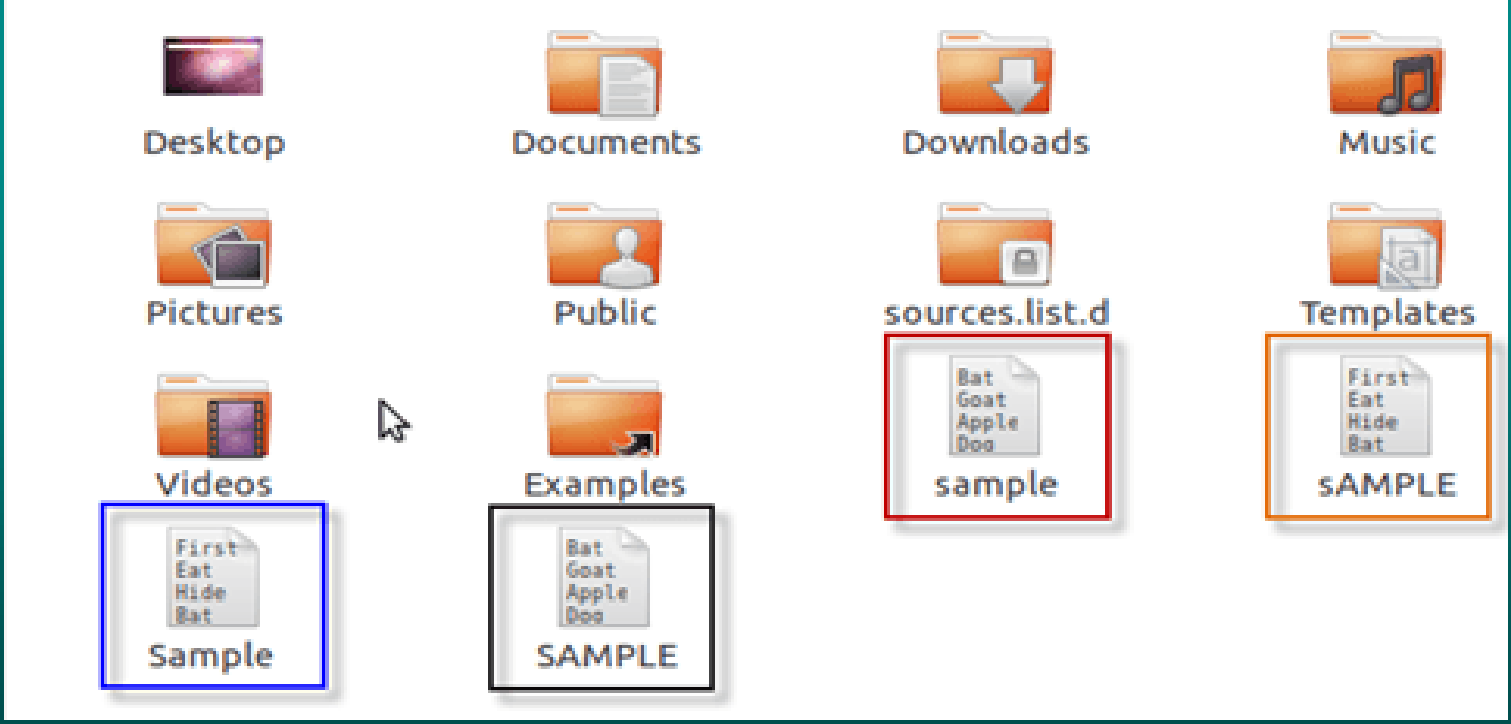
File Name Convention

- In Windows, you cannot have 2 files with the same name in the same folder.



File Name Convention

- in Linux, you can have 2 files with the same name in the same directory, provided they use different cases



File Name Convention

- important Linux Directories and short description of what they contain.