What is Linux?

- A computer **operating system (OS)**.
- Based on the **UNIX** OS (a major server OS).
- **Free** and **open source** software (FOSS).
- Available **free of cost**.
- Runs on **nearly every hardware platform**:
  - mainframes, PCs, cell phones, embedded processors
- Vast choice of **versions and interfaces**.
- Basis for much modern technology.

Linux??

- “But I have never heard of Linux.”
- “Nobody uses Linux.”
- “Everyone runs Windows.”
- “Linux is too hard for anyone but computer scientists to use.”
- “Linux is not more secure, there's simply no malware for it because it is so unimportant.”
- **Actually, you are probably using Linux without even being aware you are!**

Are You Using Linux?

- **Desktop OS**
  - many **distributions**: Ubuntu, RedHat, etc.
  - while not as common as Windows/Mac, just as functional, available for free, and more flexible

Are You Using Linux?

- **Cell phones, Tablets, Netbooks**
  - **Android** and **Chrome OS** are both Linux based
  - Use a Linux **kernel** with particular environments
Are You Using Linux?

- Routers and other Network Gear
  - many network devices run Linux
  - projects like DD-WRT are based on Linux

- NAS (Network Attached Storage) devices
  - most run Linux

- Multimedia devices
  - many run Linux

- Plug Computers and Single-Board Computers
  - SheevaPlug, CloudPlug, etc.
  - Raspberry Pi, Arduino, etc.
  - typically run Linux
Are You Using Linux?

- "Internet of Things"
  - kitchen appliance, light switches, etc.
  - many run Linux (e.g., Belkin WeMo CrockPot)

Are You Using Linux?

- Steam Machine
  - Valve's new gaming device
  - SteamOS is a Linux distro

Are You Using Linux?

- Movies
  - virtually all CGI (Computer-Generated Imagery) in movies is now done with Linux renderfarms
  - much desktop animation also uses Linux
  - Shrek was the first animated movie made using only Linux

Are You Using Linux?

- Web servers
  - Google, Amazon, Facebook, etc. run on Linux systems, as do an estimated 30% of all websites
  - Google runs in excess of two million Linux servers!
Are You Using Linux?

**Cloud Computing**
- Linux serves as the base OS for many cloud servers
- e.g., Linux **hypervisors** run **virtual machines**
- **Amazon Web Services (AWS)** runs on a few hundred thousand Linux servers:
  - **Amazon Elastic Compute Cloud (EC2)** runs guest OS's run in virtual machines
  - **Amazon Simple Storage Service (S3)**

**In-Vehicle Infotainment (IVI) systems**
- multiple groups are developing Linux (or Android) IVI frameworks
- e.g., GENIVI, Automotive Grade Linux, Android Auto
- GM and Toyota are selling cars with Linux-based infotainment systems

Other Uses of Linux

**Supercomputers**
- 98% of the top 500 supercomputers in the world run some version of Linux (TOP500.org)

**Rockets and spacecraft**
- SpaceX runs Linux from desktops to spacecraft
Linux!

- So in reality, Linux is now a critically important and very heavily used operating system.
- Many modern technologies would not exist without Linux (e.g., Google, Android, cheap routers and media players, and on and on).
- Linux' importance will only increase as:
  - “mobile OS's” grow in use
  - ever more devices contain powerful processors
  - “Internet of things” becomes a reality
  - more computing moves “to the cloud”

Most Used OS?

- Question: What OS is used on the most number of computing devices in the world today?
- Not an easy question to answer, actually: how count desktop PC vs server, PC vs phone, PC vs multi-thousand core super computer??
- Traditionally, firms have tracked PC and server purchases based on OS at purchase, but Linux is freely downloadable and installable.

Most Used OS?

- E.g., instructor has several PCs that would be counted as “Windows machines” but run Linux.
- So Linux desktop/server usage is always undercounted by firms that track OS's.
- In fact, likely answer to question is: Linux!
- “Linux” being: servers running Linux + desktops running Linux + embedded systems (networking and other gear) + Android phones/tablets + Chrome OS.

Most Used OS?

- End of 2014: estimated one billion Android smartphones/tablets in use.
- Windows does continue to dominate desktop.
- Estimated “PCs”: 1.6 billion, with maximum 90% (~1.4 billion) running Windows.
- Android devices are growing at a much faster rate than PCs, so if not Linux today, just wait a while!
What is an Operating System?

- An **OS** is a *layer of software* that sits between users/programs and the bare computer hardware.
- Makes the hardware much **easier to use**.
- Allows programs to run **safely & efficiently**:  
  - controls memory and CPU use by each program  
  - allows multiple programs to run “simultaneously”  
  - prevents programs from interfering with one another  
  - allows users to store files (provides *filesystem*)  
  - controls access to files, printers, etc.

What is an OS? (contd.)

- What most people think of as an “operating system” is actually the OS plus more:  
  - **application software**: allows users to get things done  
  - **GUIs/window managers**: graphical interface to OS  
  - **Shells**: the *command line* interface to OS  
  - **libraries**: higher level programming interface  
  - the **kernel**: the OS core  
  - **device drivers**: interface between kernel and hardware

What is an OS? (contd.)

- These components are arranged in *layers*:

Linux History

- Linux began as project by Finnish computer science graduate student **Linus Torvalds** to create a **UNIX-like** OS he could use on PCs.
- Version 0.01 was made available during 1991.
- One of the first **Internet-based collaborative programming projects**.
- An important **FOSS** project.
- Linus continues to serve as the main director for Linux kernel development.
What is UNIX?

- One of the first multiprocess/multitasking OS's.
- One of the first multi-user OS's (means multiple users at the same time).
- One of the first portable OS's (written in C).
- One of the first network OS's (origin of sockets).
- Modern UNIXes©:
  - Solaris, AIX (IBM), HP-UX, Mac OS X
- Dominant on servers before Linux matured.

What is FOSS?

- FOSS: Free and/or Open Source Software (also FLOSS: Free/Libre/Open Source Software)
- Free software:
  - free as in “free speech” vs. “free beer”
  - freedom to use, copy, distribute, and modify
- Open Source Software:
  - source code (original program) is available to users
- Note that some software is free (to use/copy) but not open source.

What is FOSS? (contd.)

- vs. Proprietary, Closed Source Software:
  - restrictions on use (e.g., EULAs)
    - how many instances can run, what machines or OS's can run on, need for activation, reverse engineering illegal
    - binary/executable only–cannot examine/modify code
- Genesis of FOSS movement:
  - GNU project
  - begun in 1984 by Richard Stallman of MIT
  - goal was to build a free complete UNIX-like system
  - much software in a Linux distribution is from GNU

What is a Linux Distribution?

- Most people install a Linux distribution.
- A distribution is a packaging of:
  - Linux (kernel) + device drivers
  - shells (bash, csh, etc.)
  - GUI (X11, Xfree, X.org)
  - window managers (KDE, Gnome, etc.)
  - boot managers (LILO, GRUB)
  - application software
  - installation and maintenance tools
What is a Distribution? (contd.)

- Many Linux distributions are available:
  - e.g., Ubuntu, Mint, Mageia, RedHat, CentOS, Fedora, OpenSUSE, Debian, Kubuntu, Slackware, Gentoo, Arch, Puppy, MEPIS, PCLinuxOS, Knoppix, etc.
  - good overview site: DistroWatch.com
- Distributions can differ in many ways:
  - interface (look and feel), target users, software selection, packaging method, release cycle, installation and maintenance tools, security emphasis, desktop vs. server focus, licenses, support methods, cost, hardware optimization, etc.

Why Use Linux?

- Many distributions are available completely free (as in “free beer”) for downloading from Internet.
- Avoids giving money to Microsoft/Apple.
- Freedom from restrictive licenses (no need to activate, can install on multiple machines, etc.).
- Supporting and participating in FOSS.
- More control over upgrades, security patches, etc.
- Package management systems make large amounts of software easy to find, install, update.

Why Use Linux? (contd.)

- Administration to keep secure and up-to-date requires much less effort than with Windows.
- More flexible than Windows/Mac:
  - can recompile/specialize kernel
  - runs on many platforms and reads many filesystems
  - many distributions with different goals and looks
  - multiple GUIs (desktop environments) available
    - e.g., KDE, GNOME, Unity, Cinnamon, etc.
  - window managers highly customizable
  - large amounts of FOSS software free to install

KDE Desktop
Why Use Linux? (contd.)

• Generally highly stable and easy to fix:
  – Linux servers often run for months without rebooting
  – software installation or configuration changes almost never require rebooting (mainly just kernel updates)
  – configuration done via text files (vs. “registry”), so easily viewed/changed
  – don't need to buy “registry cleaning” software and the like just to maintain your system
  – GUI issues often don't affect kernel so can simply restart GUI and go on running

Why use Linux? (contd.)

• More secure than Windows:
  – immune to Windows malware, Linux malware rare
  – do not need to run virus scanning software
  – user privileges/permissions limit damage
  – limited integration/automation among applications
  – all applications separate from OS (unlike IE)
  – system and app patches available via package system
  – remote exploits rare (most patches for local exploits)
  – powerful firewall built into Linux kernel
  – much security software included

Why Use Linux? (contd.)

• More sophisticated networking capabilities:
  – routing and NAT capabilities built in
  – distros include many free servers (e.g., SSH, Apache)
  – remote access/control via SSH, VNC, or X11
  – encrypted access via SSH/SFTP
  – can mount remote filesystems (e.g., NFS, SMB)
  – understands all open network standards (e.g., IPv6, IPP, etc.) as well as many proprietary/closed
  – many applications network aware (e.g., Konqueror)
Why Use Linux? (contd.)

- Can **interoperate** in mixed OS networks:
  - **Samba** can read and serve Windows file and print shares (using SMB/CIFS)
  - kernel supports SMB and NFS network filesystems
  - **CUPS** handles every network print server protocol
  - **Office suites** can read most MS Office documents

Why Not Use Linux?

- Windows software does not run on Linux and much of the software you now use is not available for Linux (e.g., Office, Photoshop).
- Some multimedia formats are available only for Windows (e.g., browser plugins, WM/DRM).
- Almost no hardware comes with Linux drivers or instructions for installing under Linux.
- Linux can require more technical expertise to set up and use certain hardware and software.

Why Not Use Linux? (contd.)

- Some new hardware may not have Linux drivers.
- Difficult to get Linux preinstalled, so must install (not too difficult but “scary” for many people).
- Support staff generally ignorant of Linux so cannot use “traditional channels” for support.
- Many businesses require use of MS products.
- May be harder to exchange some files.
- Availability of games more limited.