

CO1507 Introduction To Networking **Linux OS**

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The Role of An Operating System

- To **Manage** resources:
 - CPU cores, threads, processes
 - Memory (RAM)
 - Files (Persistent storage)
 - Communication
 - Peripheral devices
- To enable resource **sharing**
- To provide users with **access** to programs, files, communication and peripheral devices
- To **hide** much of the detail from average users, whilst **enable access** to detail for developers, engineers, etc.

Process Management

- A program executes as a process, e.g. notepad, Firefox, Apache, MySQL
- Processes each have their own address space i.e. memory
- As a process executes, the CPU reads, and follows its instruction code
 - Read from, and write to its memory
 - Perform calculations, comparisons
 - To do many things, processes must take inputs, and send outputs
- I/O can be from:
 - User input e.g. keyboard/mouse or output to screen/printer etc.
 - Read from, write to, files and environment variables
 - Communicate with other processes e.g. inter process communication (IPC)
- When waiting for I/O, processes are put to sleep

The Kernel

The **kernel** (core of the OS) enables other processes to do special tasks (beyond working with their own address space) e.g.

- **STARTING** - the kernel finds executable code, checks for permissions, and admits a new process on the ready to run queue
- **STOPPING** - when finished, the kernel recovers process memory, and the process is terminated
- **INPUT** - helps processes to take in values from files, or keyboard, or **IPC** (e.g. network sockets)
- **OUTPUT** - helps processes to put values into files, or **IPC**, or to the screen
- **SCHEDULING** - chooses which process(s) to run next, then dispatches a ready process to running
- **TIME-SLICING** and **SWITCHING** - allows a process run for a time, interrupts and de-schedules it to ready; schedules another process, lets it run for a time

Linux

- Linux is a *free operating system (*free as in cost, free as in freedom)
 - Linux is not a commercial product, there is no definitive packaged version of it
 - Linux comes as a 'distribution' essentially a collection of software
 - Linux is supported by the free software foundation GNU public license
 - There are thousands of free applications for Linux under the GNU license
 - Just about every app can be swapped out for another
 - Imagine being able to uninstall the Windows 'start' menu and choose an alternate one
- ... An impossible dream maybe, but that's the Linux experience

Linux

- Linux is a 'UNIX-like' operating system
- Linux was written in 1991 by Linus Torvalds as his university final-year project
- UNIX is a commercial operating system developed by Bell Labs in the 1970s for mainframe computers requiring a multi-user operating system
- Linux is not the only implementation of a UNIX-like system, others include
 - BSD UNIX (Berkley Software Distribution) e.g. FreeBSD
 - mac OS (itself based upon BSD UNIX)
- UNIX-like operating systems are at the heart of Android (Linux based) and the Apple iOS mobile operating systems

Mac os:



Can you install this
5 year old program?

Nooooo, i can't! this
program is too old!

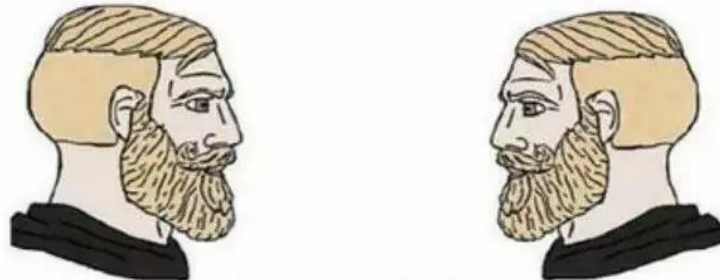
Windows:



Can you install this
25 year old program?

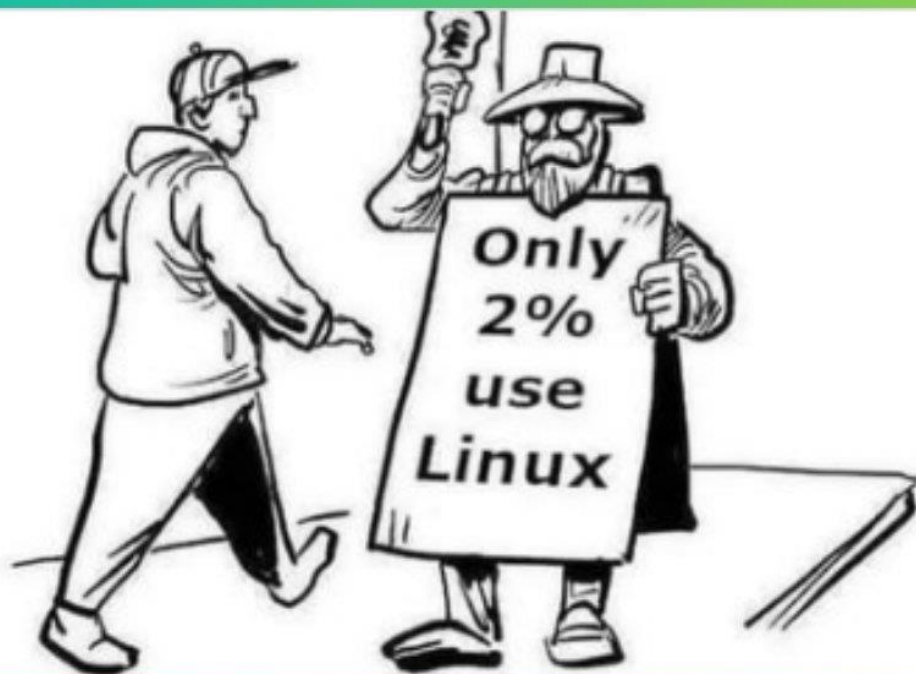
Yes, i can!
Installing... done!

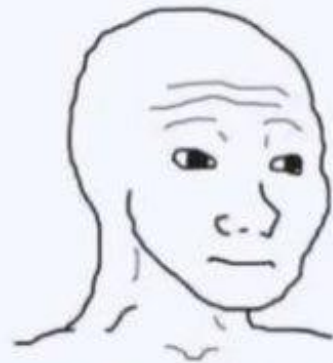
Linux



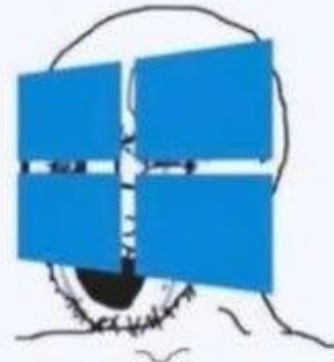
can you install this
25 year old
program

it's already
installed





hey can i uninstall edge



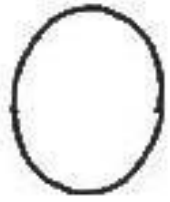
NOOO!!! YOUR SYSTEM WILL
BREAK



im going to uninstall the
bootloader



go ahead lol



WSL



SteamOS



Ubuntu



Fedora



Debian



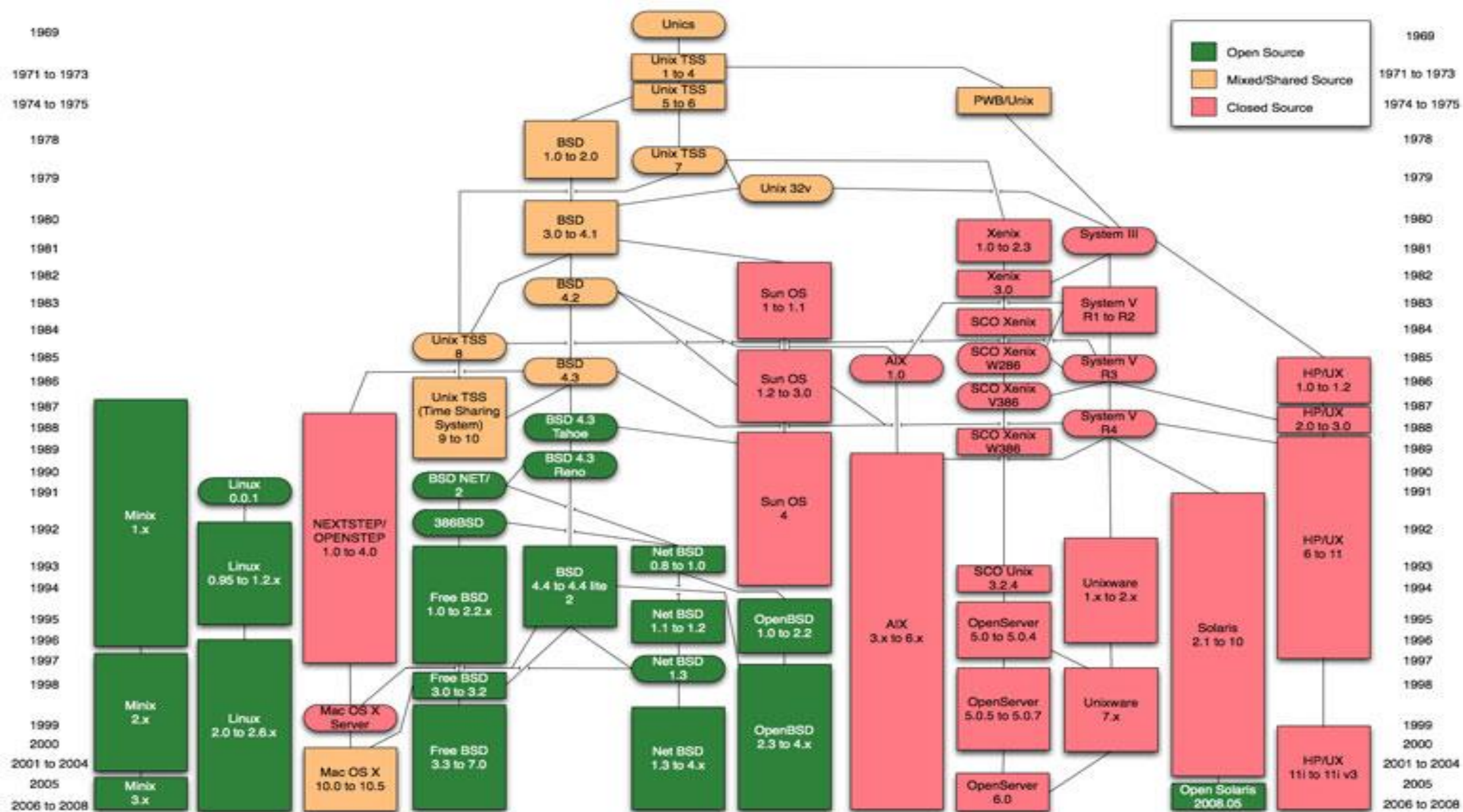
Arch



Gentoo



Linux
From
Scratch



X WINDOWS

- UNIX was a command line interface driven operating system
- Originally used by dumb terminals exchanging characters to and from a mainframe
- X-Windows released in 1985 is a GUI protocol which sits on top simplifying operation
- Implements Windows, Icons, Menus, and Pointers (WIMP) similar to Windows or Mac
- There are many different 'window managers' for Linux
 - **Ubuntu** uses a modified version of **Gnome3**, whereas **Kubuntu** uses **KDE Plasma**
 - **Lubuntu** uses **LXQt** a lightweight window manager – good for low resource systems / VMs
 - There's also Mate, LXDE, XFCE, Cinnamon and countless others

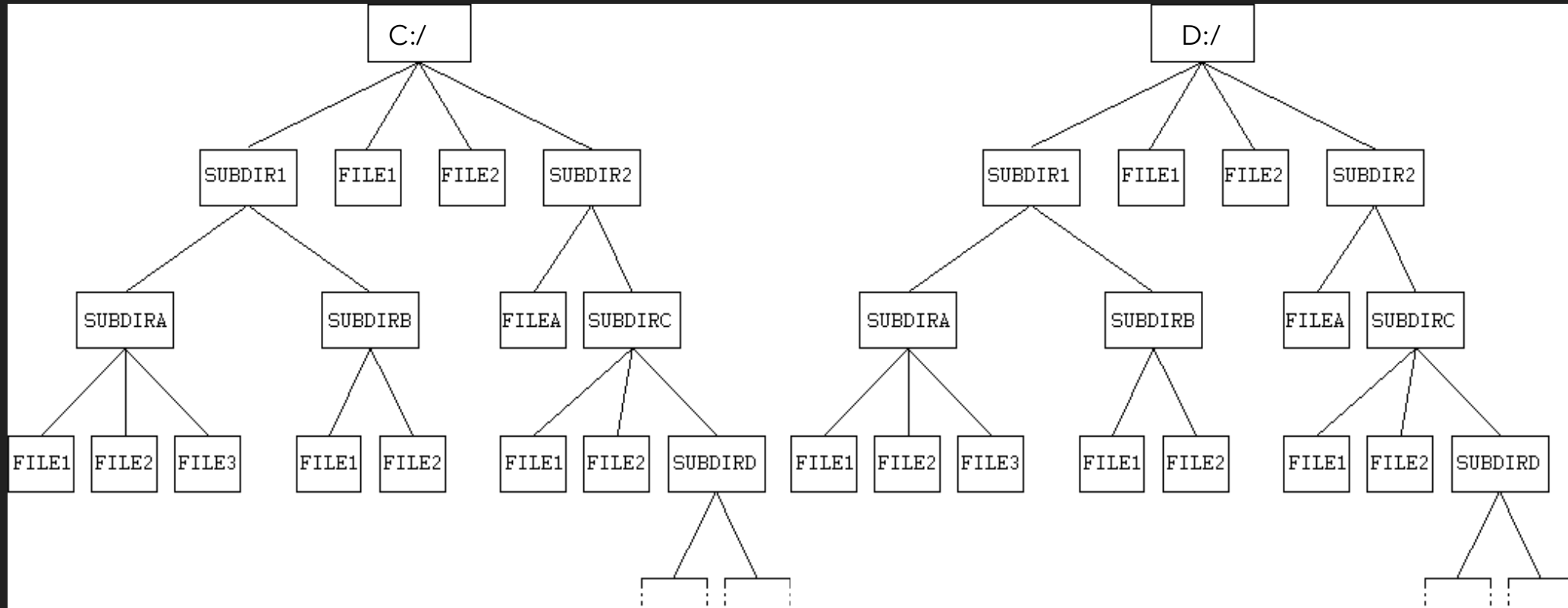
Why Linux?

- Linux is the most used server operating system
- Linux is used in many niche areas such as OSs for NAS servers, Firewalls, Media Centres, Raspberry Pi. etc.
- Many cyber security and forensic analysis tools are most frequently Linux based
- Thousands of pieces of software, many of which rival commercial products, which are free
- Even if you are a gamer the future is bright for gaming on Linux thanks to technology such as Valve's 'Proton' enabling many AAA titles to run on Linux

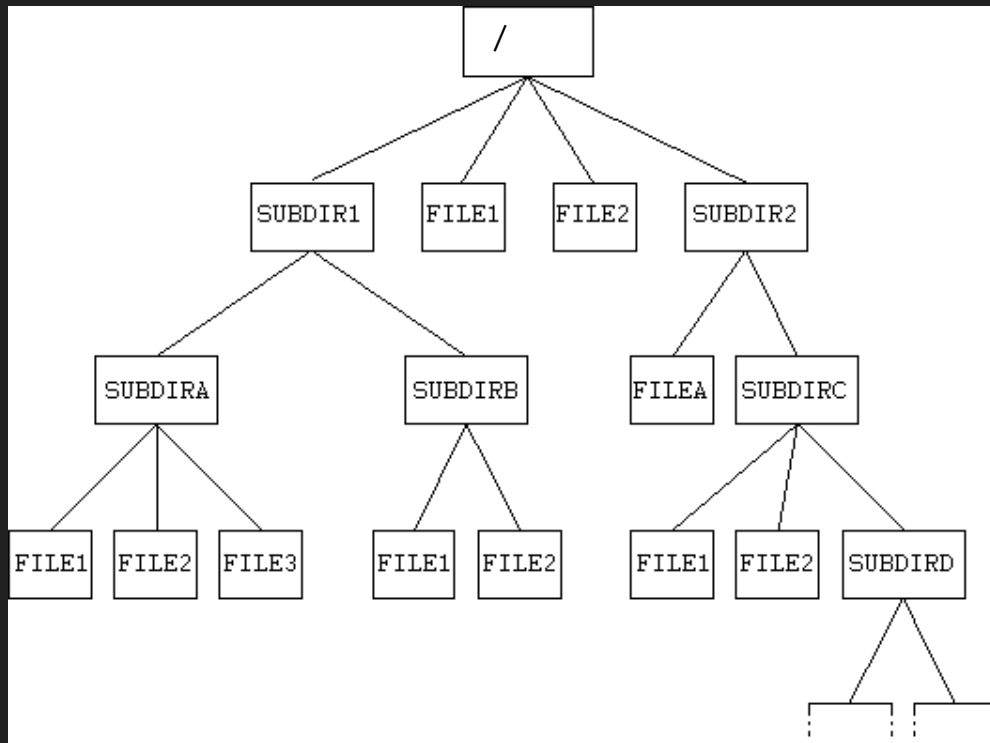
Linux Directory Structure

- In Windows, every disc or partition of a disc is 'mounted' to an indicator marked with a letter of the alphabet
 - e.g. 'C:\' is the primary hard disc partition
- However, under Linux there is one overarching hierarchy everything begins at root ('/') where the primary hard drive partition is also mounted
- Anything and everything else can be 'mounted' within this file hierarchy
- E.g. /media/jonathan/usb-stick
- Mounting can be done manually, though modern utilities do it for you automatically mimicking Windows or Mac

Windows Directory Structure



Linux Directory Structure



- / is the root directory
- Each user has a home directory located at /home/username
- This is just like Windows C:\users\username
- All the mount points for physical drives and partitions are defined in the file /etc/fstab and can be edited manually

Linux File system

/bin	Common programs, shared by the system, the system administrator and the users.
/boot	The startup files and the kernel, vmlinuz. In some recent distributions also grub data. Grub is the GRand Unified Boot loader and is an attempt to get rid of the many different boot-loaders we know today.
/dev	Contains references to all the CPU peripheral hardware, which are represented as files with special properties.
/etc	Most important system configuration files are in /etc, this directory contains data similar to those in the Control Panel in Windows
/home	Home directories of the common users.
/initrd	(on some distributions) Information for booting. Do not remove!
/lib	Library files, includes files for all kinds of programs needed by the system and the users.
/lost+found	Every partition has a lost+found in its upper directory. Files that were saved during failures are here.
/misc	For miscellaneous purposes.
/mnt	Standard mount point for external file systems, e.g. a CD-ROM or a digital camera.
/net	Standard mount point for entire remote file systems
/opt	Typically contains extra and third party software.
/proc	A virtual file system containing information about system resources. More information about the meaning of the files in proc is obtained by entering the command man proc in a terminal window. The file proc.txt discusses the virtual file system in detail.
/root	The administrative user's home directory. Mind the difference between /, the root directory and /root, the home directory of the root user.
/sbin	Programs for use by the system and the system administrator.
/tmp	Temporary space for use by the system, cleaned upon reboot, so don't use this for saving any work!
/usr	Programs, libraries, documentation etc. for all user-related programs.
/var	Storage for all variable files and temporary files created by users, such as log files, the mail queue, the print spooler area, space for temporary storage of files downloaded from the Internet, or to keep an image of a CD before burning it.

Relative Vs Absolute Paths

```
$cd Documents
```

This command only does what you want **IF** 'Documents' exists inside your **present working directory**

```
$cd /home/username/Documents
```

This command (providing you got the folder names right) works from anywhere

Notice that absolute paths **ALWAYS** begin with a slash '/'

File Permissions

```
jonathan@jonathan-virtual-machine: ~  
drwx----- 4 jonathan jonathan 4096 Mar  6 10:58 .gnome2  
drwxrwxr-x 2 jonathan jonathan 4096 Mar 19 09:13 .gstreamer-0.10  
-rw-rw-r-- 1 jonathan jonathan 152 Apr  2 09:52 .gtk-bookmarks  
dr-x----- 2 jonathan jonathan  0 Apr  2 09:52 .gvfs  
-rw----- 1 jonathan jonathan 5850 Apr  2 09:52 .ICEauthority  
drwxrwxr-x 2 jonathan jonathan 4096 Mar 20 10:06 JonathansFiles  
drwxr-xr-x 3 jonathan jonathan 4096 Mar  6 10:58 .local  
drwx----- 3 jonathan jonathan 4096 Mar  6 10:59 .mission-control  
drwx----- 4 jonathan jonathan 4096 Mar 17 11:50 .mozilla  
drwxr-xr-x 2 jonathan jonathan 4096 Mar  6 10:58 Music  
drwxr-xr-x 3 jonathan jonathan 4096 Mar 20 09:40 .openarena  
drwxr-xr-x 2 jonathan jonathan 4096 Mar 19 10:20 Pictures  
-rw-rw-r-- 1 jonathan jonathan 425 Mar 20 13:06 ping.txt  
-rw-r--r-- 1 jonathan jonathan 675 Mar  6 10:53 .profile  
drwxr-xr-x 2 jonathan jonathan 4096 Mar  6 10:58 Public  
drwx----- 2 jonathan jonathan 4096 Apr  2 09:29 .pulse  
-rw----- 1 jonathan jonathan 256 Mar  6 10:58 .pulse-cookie  
drwxr-xr-x 2 jonathan jonathan 4096 Mar  6 10:58 Templates  
drwx----- 3 jonathan jonathan 4096 Mar 19 12:25 .thumbnails  
drwxr-xr-x 2 jonathan jonathan 4096 Mar  6 10:58 Videos  
-rw----- 1 jonathan jonathan  69 Apr  2 09:52 .Xauthority  
-rw----- 1 jonathan jonathan 10653 Apr  2 09:56 .xsession-errors  
-rw----- 1 jonathan jonathan 3568 Apr  2 09:52 .xsession-errors.old  
jonathan@jonathan-virtual-machine:~$
```

The command `ls -l` provides detailed file listing including details such as the owner's username the date and time created/modified etc.

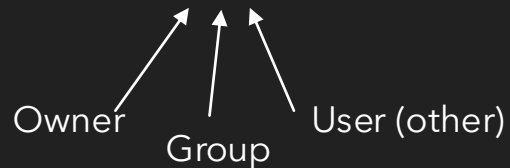
The string on the left of 10 characters defines the permissions

Read ('r') Write ('w') and Execute ('x') privileges can be defined for the file owner, the members of the group policy, and all others

Modifying File Permissions

- The command **chmod** is used to modify file permissions
- You need to be **root** or super user to be allowed to use it on a file or folder you don't own (for security reasons)
- **chmod** uses numeric codes to represent permissions

Take the example command **chmod 777 filename**



- This would give **read**, **write**, and **execute** privileges to all 3 'users'
- 7 just means **read**, **write** and **execute**. (i.e. all 3 privileges)

The numbers are OCTAL e.g. 7 = 111, 4 = 100, 5 = 101 and so on..

Octal (hint: think 3 bits of binary)

#	Permission	rwX
7	full	111
6	read and write	110
5	read and execute	101
4	read only	100
3	write and execute	011
2	write only	010
1	execute only	001
0	none	000

- Example: I want the owner to have all privileges, read-only access for group users, and no access at all for others, the command would be: `chmod 740 name_of_file`

Permission & chmod

```
jonathan:~/Documents> ls -l
total 80
-rw-rw-r--  1 jonathan jonathan   31744 Feb 21 17:56 intro Linux.doc
-rw-rw-r--  1 jonathan jonathan   41472 Feb 21 17:56 Linux.doc
drwxrwxr-x  2 jonathan jonathan    4096 Feb 25 11:50 course
```

-rw-rw-r--
drwxrwxr-x

File types

permissions

Symbol	Meaning
-	Regular file
d	Directory
l	Link
c	Special file
s	Socket
p	Named pipe
b	Block device

Permission & chmod

- `-rwxrwxrwx`
- Owner Group Others Or in binary `11111111`
- Or as 3 decimals.. (for use with **chmod**) `777`

```
-rw-r--r--  1  jonathan  jonathan  4096  Mar   10  11:27  file.txt
```

- **jonathan** is owner
- **jonathan** is group name
- **jonathan** has **read**, and **write** privileges
- **Group** members have **read-only** access
- **Others** have **read-only** access

User Types

Root User

- A special kind of user account which holds **permissions** to alter programs or services in Linux
- This kind of user account is used for **system admin** only
- They can control and limit the access of another users
- Care must be taken before performing each modification, if anything goes wrong, no option left other than crash of Kernel
- Take extreme care if logged in as **root** - some distributions of Linux are configured to not permit direct login as root as it's risky

User Types

System User / Administrator

- Created by the OS upon install. This type of user is like normal user but has more privileges and access to secure programs which the normal user doesn't
- Administrators or System users have access to the 'sudo' command and can "become" root for a temporary period

Normal User

- These are the users which have been created by the **Root** and has limited access to the resources and need permission from **Root** to access any secure resources and services
- Typically, would not have access to 'sudo' command

"sudo" Command

- **'sudo'** is a utility for UNIX-like computer operating systems that allows users to run programs with the security privileges of another user (normally the super user, or root)
- Its name is a concatenation of 'su' (substitute user) and 'do', to take action
- By default, the first user setup by Ubuntu Linux has access to this command (they are added to the 'sudoers' file)
- The accounts you created in the lab last week are admin accounts and are in the 'sudoers' list

Commands You Should Know

- **pwd** 'print working directory', this shows the working directory in the console e.g. the folder we are currently 'inside' or 'looking at'
- **ls** list shows the file and folders in the present working directory in the console
- **ls -l** list with the 'long' switch so we see more details on each file and folder
- **ls -a** list with the 'all' switch so we see all files even those marked as hidden
- **cd** change directory e.g. `cd Documents`

Commands You Should Know

- **rm** remove, i.e. delete
 - e.g. `rm cat.jpg`
- **rm -R** `rm` with the 'recursive' switch, you use this to remove folders which are not empty i.e. remove this, and everything within this
- **rmdir** remove an empty directory
- **mkdir** make a new directory
- **touch** updates the time stamp on a file, or creates the file if it doesn't already exist
- **cat** concatenate e.g. join and output to the console
 - `cat file.txt` would output all the characters to the screen

Common Console Utilities

- **more** and **less** both allow for pagination to allow easier browsing of long outputs that go off the top of the console window – less is an updated version of more
- **vim** is a console-based text editor but is rather difficult to use for beginners
- **nano** is a console-based text editor which is rather easier to use

Common Console Utilities

- **chmod** for changing file and folder permissions
- **chown** for changing file and folder ownership
- **adduser** for adding a user to the system
- **usermod** modify users add to groups, to sudoers list
- **groupadd** for creating a group
- **chgrp** changing the group a file or folder belongs in
- **passwd** change a password

Common Console Utilities

- **grep** **G**lobal **R**egular **E**xpression and **P**rint allows input to be searched for pattern matching within text files useful for searching long log files on a server
- **sort** sort alphabetically
- **wc** word count (can also be used to count lines)
- **ifconfig** like ipconfig for Windows shows details on network interfaces (NB **ifconfig** is no longer supplied with some Linux distributions, including Ubuntu)
- **ip address** the new way for bringing up details on networking interfaces in the latest versions of Ubuntu

Pipes are Redirects

- In the console we can take output that would otherwise be to the screen and send it elsewhere
- Out can be piped into another utilities input stream
- Piping is indicated by the bar character ' | '
 - E.g. `grep apple fruits.txt | less`
- In the example above 'grep' searches for the word 'apple' within fruits.txt and then pipes the output into the less pagination utility rather than straight to the screen

Redirecting

- We can also redirect the output to a text file
- Redirection is indicated by the more than character '>'
- E.g. `grep apple fruits.txt > searchResults.txt`
- In the example above `grep` searches for the word 'apple' within `fruits.txt` and then creates a new text file called `searchResults.txt` containing the output
- E.g. `grep orange fruits.txt >> searchResults.txt`
- In the example above `grep` searched for the word 'orange' within `fruits.txt` and then appends the already existing text file `searchResults.txt`

Wildcards

- ? Any single character, except a leading dot
- * zero or more characters, except a leading dot
- [] defines a class of characters
 - [1-9]
 - [abc]
- ! NOT
 - [!abc]
- "Wildcards" can be substituted for actual characters
- e.g. use the "*" to mean any or all
 - `rm *.jpg` will remove **ALL** files with the .jpg extension found in the present working directory
 - `rm *.*` will remove ALL files with any name and any extension (but not files without a dot)

Networking Utilities

- ip - a system tool for network administration
- ifconfig - for network interface configuration
- tcpdump - command line packet analyser
- nmap - network scanning tool used for network exploration, host discovery
- traceroute - displaying possible routes and measuring transit delays of packets
- ping - used to test the reachability of a host on an Internet Protocol network