Overview

Introduction – Linux

- Command line basics – getting help
- The shell revisited: some features
- Navigating the file system
- File manipulation
- Text editing
- Various commands
- Archiving
- Groups, users, security
- Process control

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Introduction

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Operating system

- An operating system (OS) is system software that manages computer hardware, software resources, and provides common services for computer programs. (https://en.wikipedia.org/wiki/Operating_system)
  - Windows
    - Desktop systems
    - https://gs.statcounter.com/os-market-share/desktop/worldwide/
  - Linux
    - Server and supercomputing
  - MacOS
- Linux and Windows are based on foundations developed in the mid-1970s
- DOS, macOS and UNIX are proprietary, i.e., the source code of their kernel is protected

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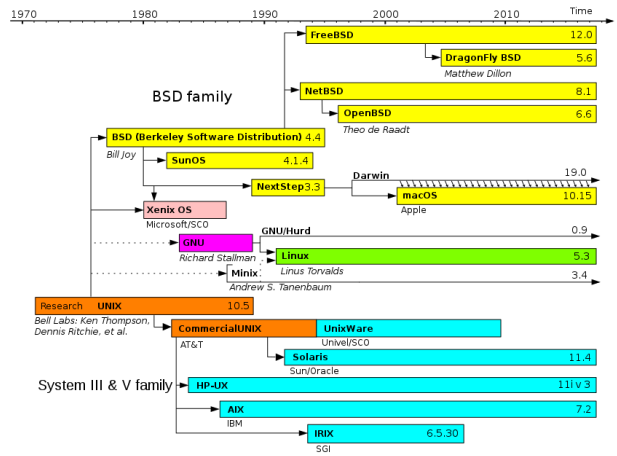
*nix time line



https://upload.wikimedia.org/wikipedia/commons/thumb/c/cd/Unix_timeline.en.svg/850px-Unix_timeline.en.svg.png

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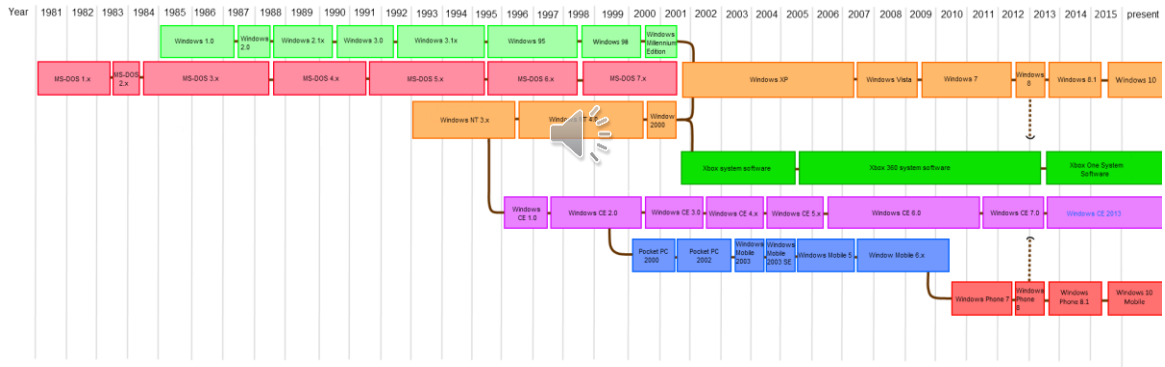
Windows time line



https://en.wikipedia.org/wiki/List_of_Microsoft_operating_systems#/media/File:Microsoft_timeline_of_operating_systems_2.png

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Some history

- UNIX: roots in Bell Labs (AT&T)
- 1985 Free Software Foundation (FSF) founded by Richard Stallman. Along with other programmers creates the tools needed to make a UNIX compatible OS
- 1985 Professor Andy Tanenbaum creates a UNIX like operating system based on System V Unix for the IBM PC & PC/AT computers. It is called Minix.
- 1989 Richard Stallman releases GPL and GNU software but lacks a free kernel.
- **1991** Building on the concepts in Minix, **Linus Torvalds** (Finnish college student) develops Linux along with help from other users on the web.

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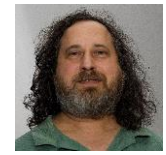
Some history

GNU project:

- Established in 1984 by **Richard Stallman** (goal: software should be free from restrictions against copying or modification in order to make better and efficient computer programs),
- GNU is a recursive acronym for "**G**NU's **N**ot **U**nix",



- Aim at developing a complete Unix-like operating system which is free for copying and modification,
- Companies make their money by maintaining and distributing the software, e.g. optimally packaging the software with different tools,
- Stallman built the first free GNU C Compiler in **1991**. But still, an OS was yet to be developed

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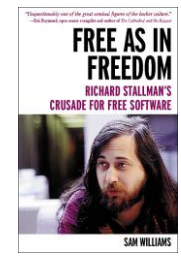
Open Source Software

- **Open Source Software (OSS)** generally refers to software for which the source code is available and which the licensing scheme permits the user to modify it and redistribute it in modified or unmodified form.
- **GNU copyleft (**www.gnu.org**)**
  - Nobody should be restricted by the software they use. There are four freedoms that every user should have:
  - the freedom to use the software for any purpose,
  - the freedom to change the software to suit your needs,
  - the freedom to share the software with your friends and neighbors, and
  - the freedom to share the changes you make.
  - When a program offers users all of these freedoms, we call it free software.



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Linux OS

- Linux is not a single operating system, but rather a large family of free and open source operating systems based on the Linux kernel.
- Different variants within this family are referred to as **Linux Distributions** (www.distrowatch.com) CentOS, Ubuntu, etc.
- There are two major components of Linux:
  - The **kernel** is the core of the Linux operating system:
    - Schedules processes and interfaces directly with the hardware.
    - It manages system and user I/O, processes, devices, files, and memory.
  - The **shell** is a text-only interface to the kernel.
    - Users input commands through the shell, and the kernel receives the tasks from the shell and performs them.
    - The shell works interactively (REPL).
    - Users *do not* interact with the kernel directly, it is done through the shell or a desktop environment.

(https://cvw.cac.cornell.edu/Linux/introduction)

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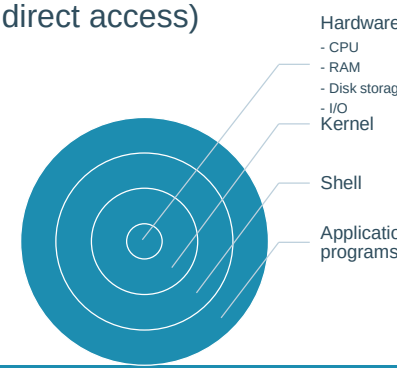
Linux kernel

- aka: executive, system monitor.
- Provides a layer between the computer hardware and user applications.
- Provides an interface for software to use hardware (no direct access)
- Planning and assigning:
  - memory, CPU, disk, etc.
  - security aspects
  - Fulfill user requests (system calls).
  - Filesystem, networking, ...



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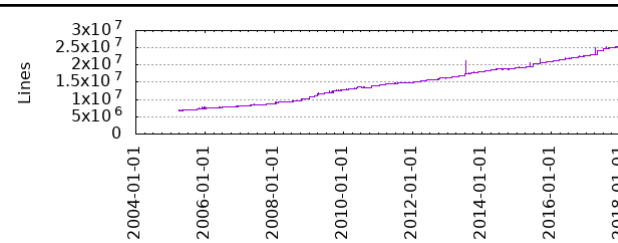
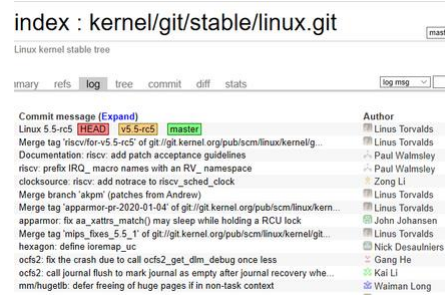
Linux kernel



- Lines of code

(https://www.phoronix.com/scan.php?page=news_item&px=Linux-Kernel-Commits-2017)

- Linux in 2020: 27.8 million lines of code in the kernel
https://www.theregister.co.uk/2020/01/06/linux_2020_kernel_systemd_code/



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Linux kernel

- File Management
  - Controls the creation, removal of files and provide directory maintenance
  - For a multiuser system, every user should have its own right to access files and directories
- Process Management
  - Multitask system: multiple programs can be executed simultaneously
  - When a program starts to execute, it becomes a *process.* The same program executing at 2 different times will become 2 different processes
  - Processes are managed by the kernel: creating, suspending, terminating
  - A process is protected from other processes and can communicate with the others

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Linux kernel

- Memory management
  - Memory in a computer is divided into main memory (RAM) and secondary storage (usually refer to hard disk)
  - Memory is small in capacity but fast in speed, and hard disk is vice versa
  - Data that are not currently used should be saved to hard disk first, while data that are urgently needed should be retrieved and stored in RAM
- Device drivers
  - Interfaces between the kernel and the BIOS (*basic input/output system*)
  - Different device has different driver

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Linux kernel

- Get the kernel version
  `uname -r`
- `uname -a` provides the information in the order
  - KERNEL-NAME NODENAME KERNEL-RELEASE KERNEL-VERSION
  - MACHINE PROCESSOR HARDWARE-PLATFORM OPERATING-SYSTEM

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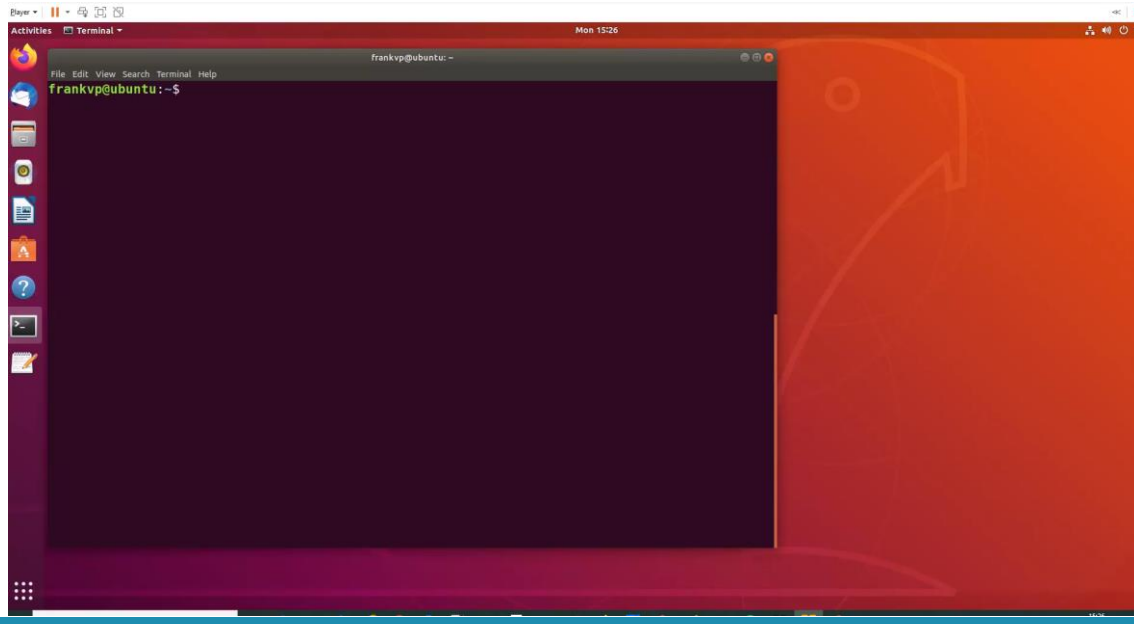

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Linux User Interface

- Traditional *nux (Linux, Unix) systems use **command line interface** (**cli** or text-based interface)
- User needs to type lines of command to instruct the computer to work, similar to Windows DOS command window
- Advantages:
  - Fast: few resources required
  - Reliable: some of these commands have been around for years. Commands change less frequently than the GUI counterparts. GUI counterparts often use these same commands under the hood.
  - Productivity: use the keyboard instead of navigating through a bunch of menus and screens with the mouse and tabbing back and forth between different applications
- Disadvantages:
  - Memorize the commands
  - Typing a command can be error prone

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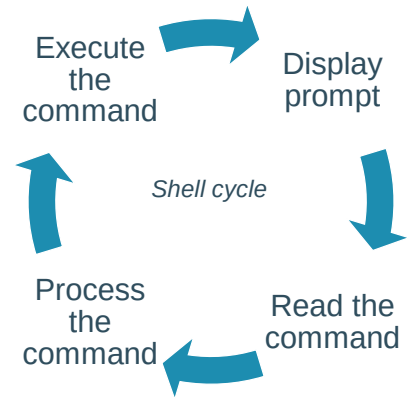
Linux shell

- A shell is an interface for accessing the underlying commands of an operating system.
- When you sign in at the command line or launch a terminal window on Linux, the system launches the shell program.
- Is the command line interpreter: a program that accepts input from a user (e.g. a command) and performs the requested task. (REPL)
- The shell's **prompt** identifies the type of shell being used



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Most popular shells

- There are several types of shells for Linux.
- Check it with
  `$ echo $SHELL`
- Change the shell with
  `chsh`

Shell	Prompt	Name	Note
sh	$	Bourne Shell	Default on some Unix systems
bash	$	Bourne Again Shell	Enhanced replacement for the Bourne shell Default on most Linux and Mac OS X systems
csh	%	C Shell	Default on many BSD systems
tcsh	>	TC Shell	Enhanced replacement for the C shell
ksh	$	Korn Shell	Default on AIX systems

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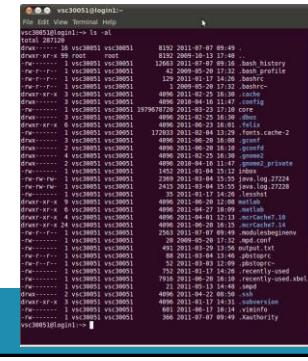
Command Line Interface: Beware!

- Common use on servers and HPC system
- Implicitly assumes that you know what your are doing. Don't be scared!
- Often there are no warnings with commands, no *undo*
- No recycle bin!
- If anything goes wrong, you can stop the command with **`ctrl+C`**



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Linux User Interface

- By adopting the X-Window technology, graphical user interface (GUI) is available for Linux.
- Uses pointing devices (e.g. mouse) to control the system, similar to Microsoft's Windows
- Provide menu-driven and/or icon-driven interfaces
  - menu-driven: user is provided with a menu of choices. Each choice refers to a particular task
  - icon-driven: tasks are represented by pictures (icon) and shown to user. Click on an icon invokes one task
- Advantages:
  - No need to memorize commands. Always select task from menus or icons
- Disadvantages:
  - Slow and require certain resource for its implementation
  - Suitable for general users and systems, such as PC

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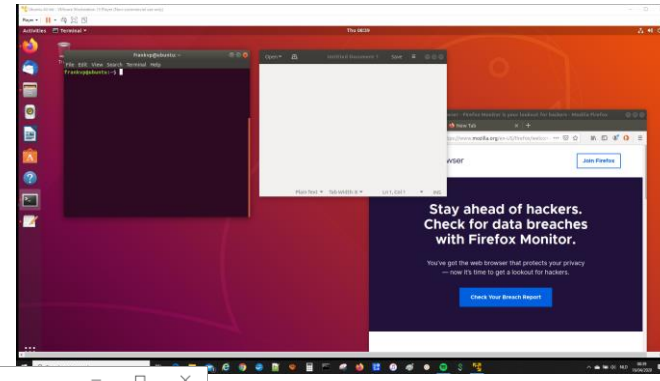
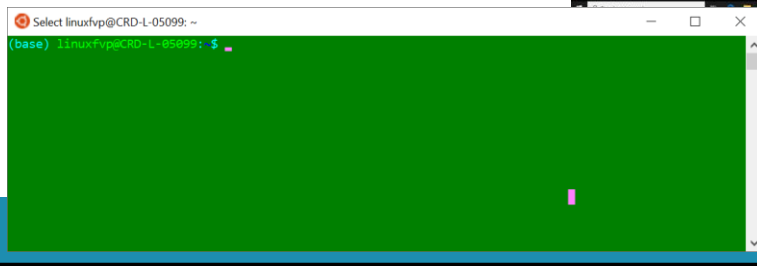
Linux User Interface





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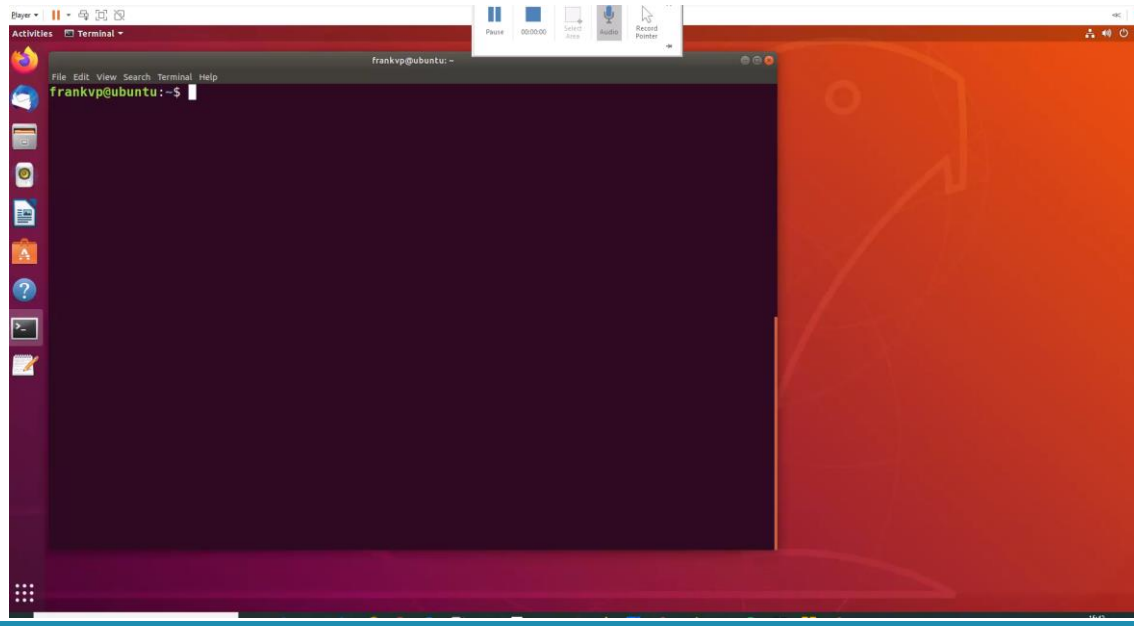

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Someone is doing something somewhere

- Linux is a multiuser OS
  - Allows multiple users to use the resource of a computer at the same time
  - Before you can do anything, you have to log in.
    - This can be either a graphical or a nongraphical prompt.
      - Linux desktop: you are likely to see a graphical environment.
      - A server: you'll just see a shell login prompt.
- Check who you are on the computer: `whoami`
- List the users logged on with: `who`
- What is the machine you are working on: `hostname`
- What is the directory you are working in: `pwd`
- What time is it: `date`

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Useful commands

- Clear the contents of the current screen
  `$ clear`
- `$ logout`
  - The logout command logs your account out of the system (in a text mode).
  - This will end your terminal session and return to the login screen.
  - Some systems may have a file called `.logout` or `.bash_logout` in each user's home directory.
- `$ exit`
  - Exit the current shell. The `exit` command is similar to the `logout` command with the exception that it does not run the logout script located in the user's home directory.

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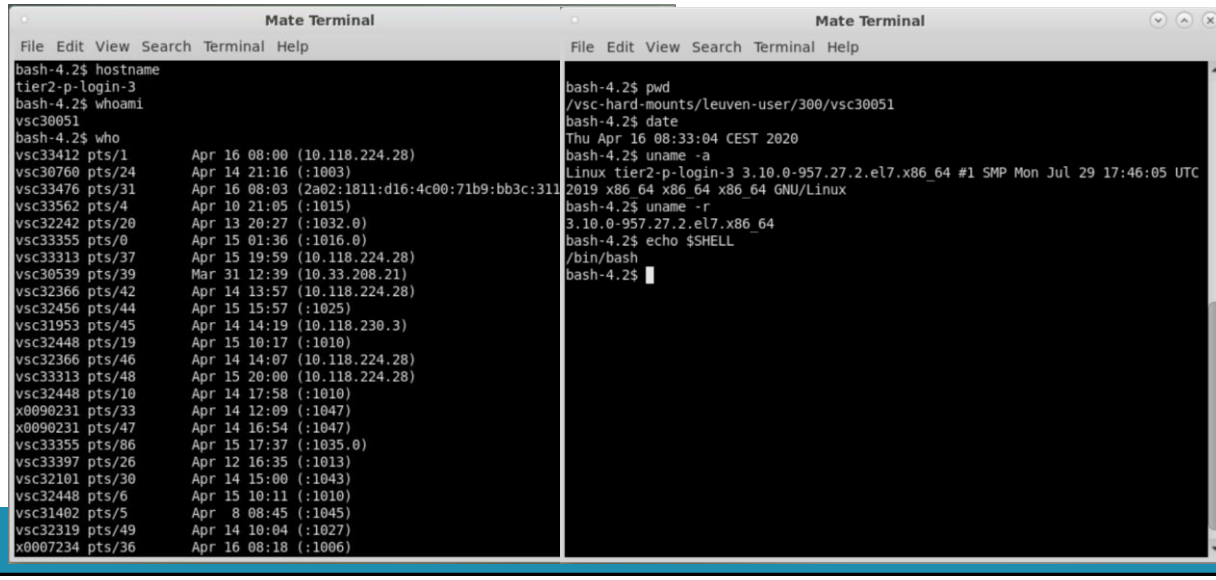
HPC



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Hands-on 1

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