Outline

➤Introduction - history

- Command line basics getting help
- File system
- Working with files and directories
- More file handling
- · The shell revisited
- Monitoring resources

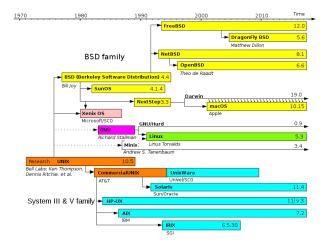
Some background



- An operating system (OS) is system software that manages computer hardware, software resources, and provides common services for computer programs.

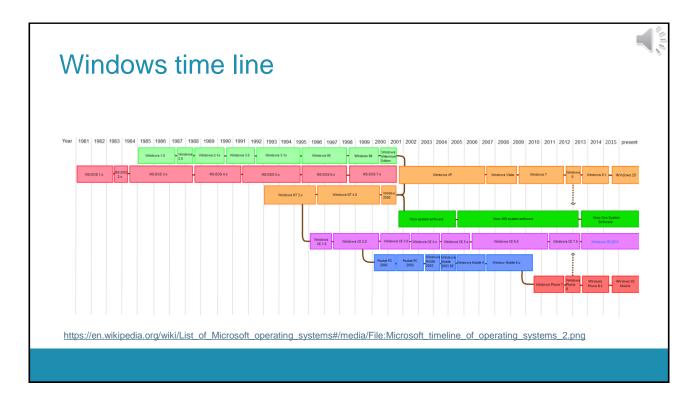
 (https://en.wikipedia.org/wiki/Operating_system)
 - Windows
 - · Desktop systems
 - https://gs.statcounter.com/os-market-share/desktop/worldwide/
 - Linux
 - · Server and supercomputing
 - MacOS
- · Linux and Windows are based on foundations developed in the mid-1970s
- DOS, macOS and UNIX are proprietary, i.e., the source code of their kernel is protected

*nix time line



 $\underline{\text{https://upload.wikimedia.org/wikipedia/commons/thumb/c/cd/Unix_timeline.en.svg/850px\cdot Unix_timeline.en.svg.png}$





Some history

- .
- UNIX: roots in Bell Labs (AT&T) (https://www.bell-labs.com/about/history/innovation-stories/50-years-unix/#gref)
- 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.



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 "GNU's Not Unix",



- 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

OS, kernel, shell, etc.



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- Read Evaluate Print Loop).
 - · Users do not interact with the kernel directly, it is done through the shell or a desktop environment.

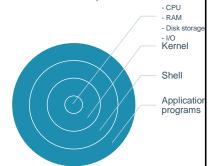
(https://cvw.cac.cornell.edu/Linux/introduction)

Linux kernel



Hardware

- 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, ...



Linux kernel **Lines of code **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/



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



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



Linux kernel

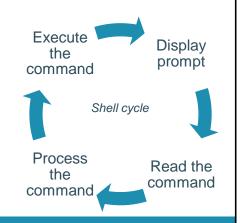
Get the kernel version

uname -r

- uname -a provides the information in the order
 - KERNEL-NAME NODENAME KERNEL-RELEASE KERNEL-VERSION
 - MACHINE PROCESSOR HARDWARE-PLATFORM OPERATING-SYSTEM

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 - readeval-print loop)
- The shell's **prompt** identifies the type of shell being used



Most popular shells



• Check it with \$ echo \$SHELL

• Change the shell with chsh

File:check_shell.sh

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



CLI



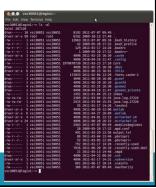
Linux User Interface

- 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



Command Line Interface: Beware!

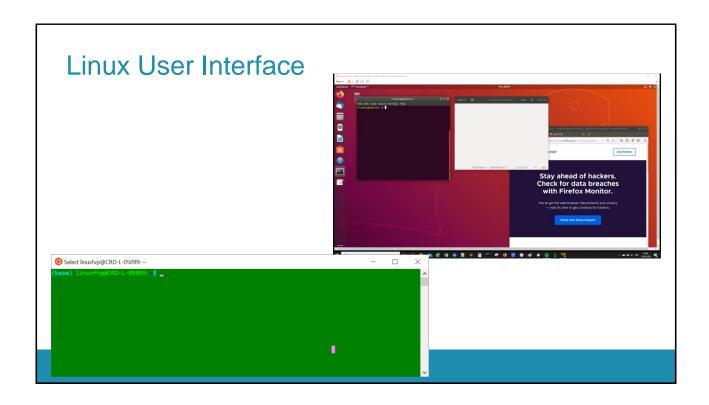
- · Common use on servers and HPC system
- Implicitly assumes that you know what you are doing. Don't be scared!
- Often there are no warnings with commands, no undo
- · No recycle bin!
- If anything goes wrong, you can stop the command with ctrl+C





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 requires resources for its implementation
 - · Suitable for general users and systems, such as PC use



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: who ami
- 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



- 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 the 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.

HPC

```
(x) (A) (x)
                                                                           Mate Terminal
                                                                                                                                                                                                                                                  Mate Terminal
File Edit View Search Terminal Help
                                                                                                                                                                        File Edit View Search Terminal Help
                                                Apr 16 08:00 (10.118.224.28)
Apr 14 21:16 (:1003)
Apr 16 08:03 (2a02:1811:d16:4c00:71b9:bb3c:311
Apr 10 21:05 (:1015)
Apr 13 02:27 (:1032.0)
Apr 15 10:36 (:1016.0)
Apr 15 10:39 (10.118.224.28)
Apr 14 13:57 (10.118.224.28)
Apr 15 15:57 (:1025)
Apr 14 14:19 (10.118.224.28)
Apr 15 16:17 (:1010)
Apr 14 16:05 (:1015)
Apr 15 16:57 (:1025)
Apr 15 15:017 (:1010)
Apr 14 15:09 (:1047)
Apr 15 15:73 (:1035.0)
Apr 15 10:17 (:1010)
Apr 14 15:00 (:1047)
Apr 15 10:17 (:1010)
Apr 14 16:54 (:1047)
Apr 15 10:17 (:1010)
Apr 16 08:818 (:1006)

Apr 16 08:818 (:1006)
tier2-p-login-3
bash-4.2$ whoami
bash-4.2$ who
vsc33412 pts/1
vsc30760 pts/24
vsc33476 pts/31
 vsc33562 pts/4
vsc32242 pts/20
vsc33355 pts/0
vsc33313 pts/37
vsc30539 pts/39
vsc32456 pts/44
vsc31953 pts/45
 vsc32448 pts/19
vsc32366 pts/46
 /sc32448 pts/10
 x0090231 pts/47
vsc33355 pts/86
   sc33397 pts/26
vsc32101 pts/30
vsc32448 pts/6
vsc31402 pts/5
vsc32319 pts/49
```

