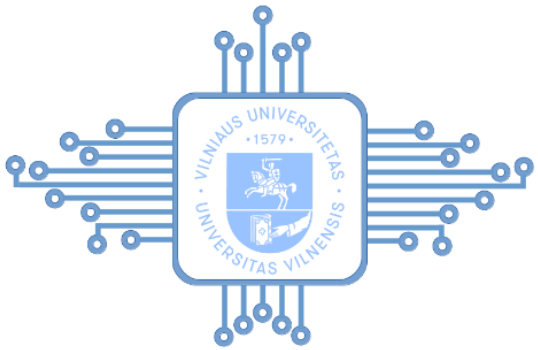
Linux 101

Assoc. prof., PhD Linas Bukauskas
linas.bukauskas@mif.vu.lt



Institute of Computer Science
Vilnius University

September 18, 2020

Overview

Expected learning Outcomes

- get introductory knowledge to Linux operating system
- get essential Linux connectivity skills
- learn skills to identify the most important Linux assets
- learn skills to navigate inside
- basis knowledge for self study

Why learning Linux?

- Knowledge is transferable to other UNIX style OS

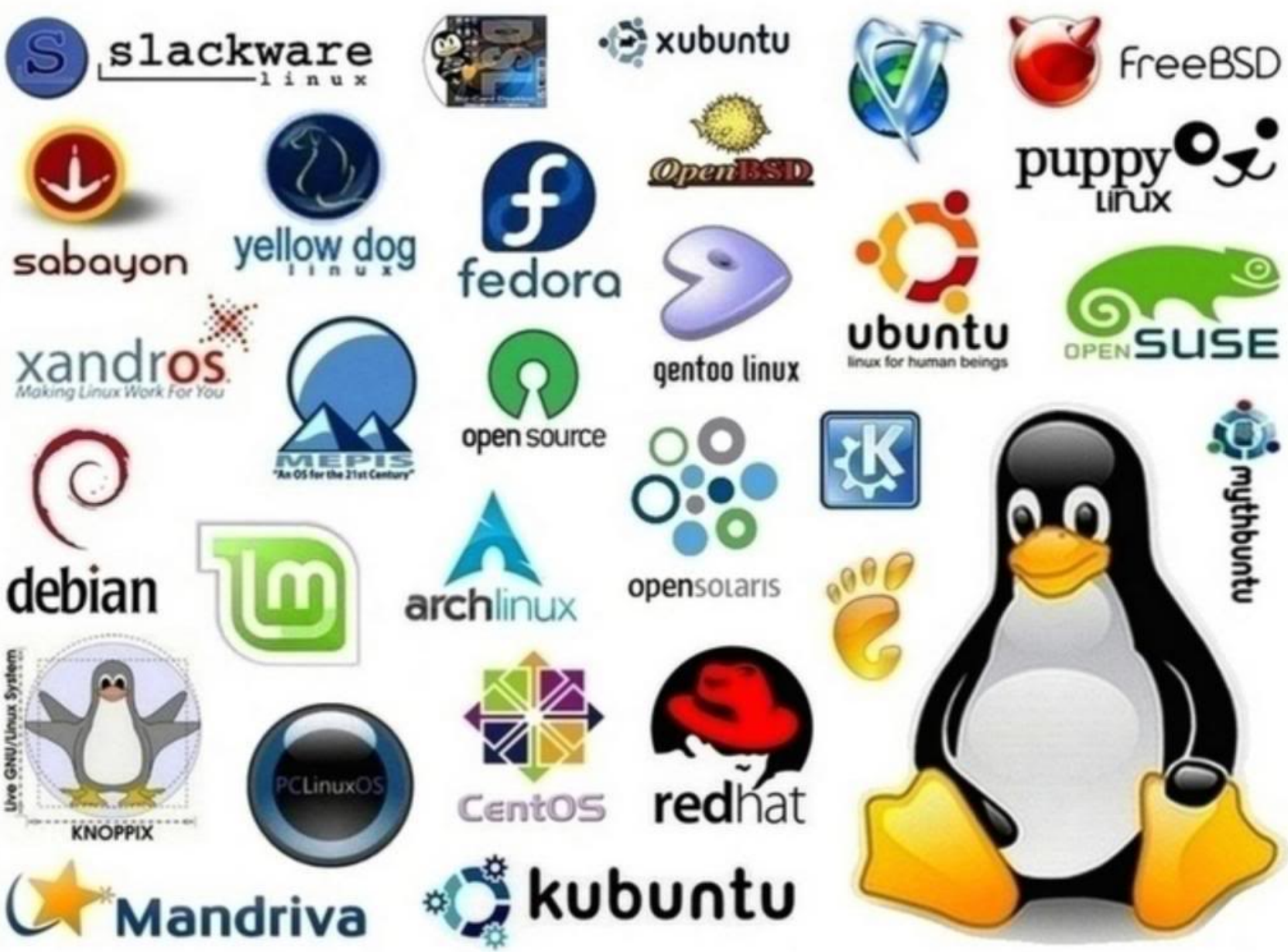
What is Linux?

- **Linux** is a Unix clone written from scratch by Linus Torvalds with assistance from community.
- Unix is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T at Bell Labs.
- Linux strive to be portable operating system interface (POSIX) compliant among operating systems.
- Linux can be found on Servers, desktops, mobile devices (i.e. Android phone and the Kindle), network components and IoTs.

Main Philosophy

- Most of system assets are treated as a **file** or a stream of data
- **Output** of one program **is** the **input** to the other program
- multitasking, multi-user operating system, with built-in networking and **service processes** known as **daemons**.
- Multilayered Security (system call vs. user-land calls)

Many Linux Flavours



How and What Linux to choose?

Linux distribution is:

- the kernel (the latest 5.8.9 http://kernel.org)
- number of core software tools for file-related operations (`/bin/`, `/sbin/`)
- user/group management (`/usr/sbin/user{add|del|mod}`)
- software package management (`apt`,`dpkg`, `rpm`, `yum`, `dnf`, `pacman`, `portage` ...).

How to choose :)?

- Follow your expectation, experience or applications path [1]

Small programs that excel on one thing

- Process management: `ps`, `top`, `kill`, `killall`, `fg`, `bg`
- Network: `ssh`, `scp`, `ping`, `telnet`, `nslookup`, `wget`
- Shells: `bach`, `tcsh`, `alias`, `watch`, `clear`, `history`, `chsh`, `echo`, `set`, `setenv`, `xargs`
- System Information: `w`, `whoami`, `man`, `info`, `which`, `free`, `echo`, `date`, `cal`, `df`, `free`, `man`, `info`
- Command Information: `man`, `info`
- Symbols: `|`, `>`, `>>`, `<`, `&`, `>&`, `2>&1`, `;`, `~`, `.`, `..`, `$!`, `!:<n>`, `!<n>`
- Filters: `grep`, `egrep`, `more`, `less`, `head`, `tail`
- Hotkeys: `<ctrl><c>`, `<ctrl><d>`
- File System: `ls`, `mkdir`, `cd`, `pwd`, `mv`, `ln`, `touch`, `cat`, `file`, `find`, `diff`, `cmp`, `/net/<hostname>/<path>`, `mount`, `du`, `df`, `chmod`, `find`

Small programs that excel on one thing (cont.)

- Line Editors: `awk`, `sed`
- File Editors: `cat`, `pico`, `nano`, `vim`, `gvim`, `emacs`
- Process Management: `ps`, `top`, `kill`, `killall`, `fg`, `bg`

Connecting to Linux host

- From Linux/Mac:
  - Open terminal emulator and use:
    `> ssh user@host.domain`
- From MS Windows:
  - The most common way is to use Putty [2] (See tutorial example)

Login Screen

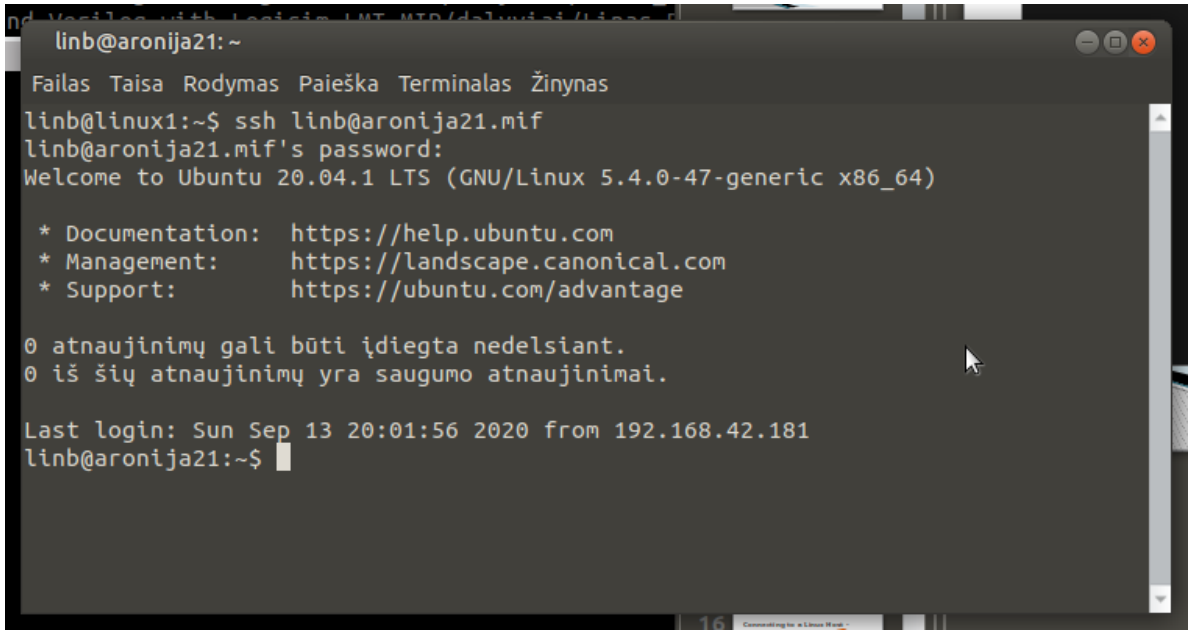


Figure 2: Login Screen

What can you learn from the screen?

- From `linux1.mif` login to `aronija21.mif`

Login Screen

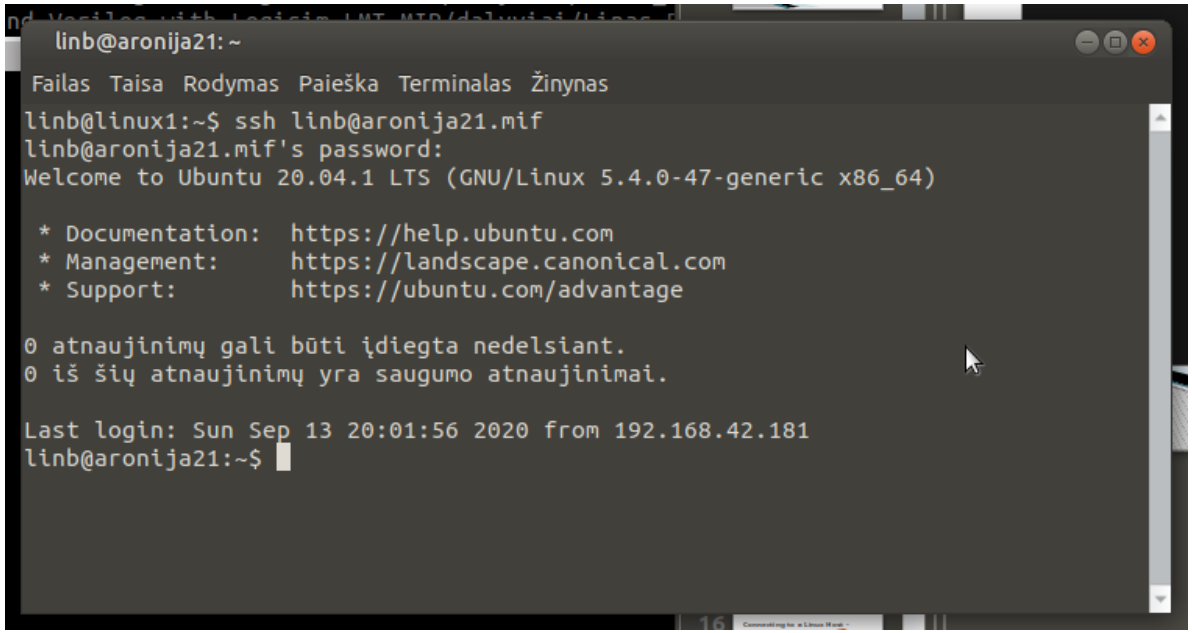


Figure 2: Login Screen

What can you learn from the screen?

- From `linux1.mif` login to `aronija21.mif`
- User `linb` is connecting to remote machine

Login Screen

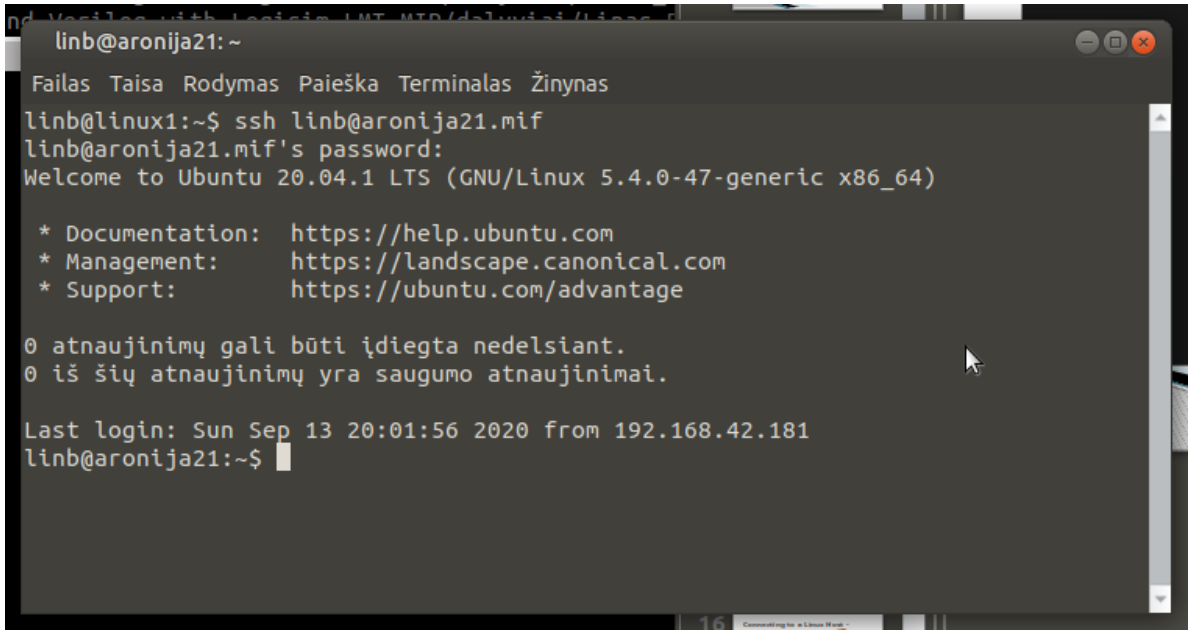


Figure 2: Login Screen

What can you learn from the screen?

- From `linux1.mif` login to `aronija21.mif`
- User `linb` is connecting to remote machine
- Remote Linux is: `Ubuntu 20.04.1 LTS` and kernel is ver. `5.4.0-47`

Login problems?

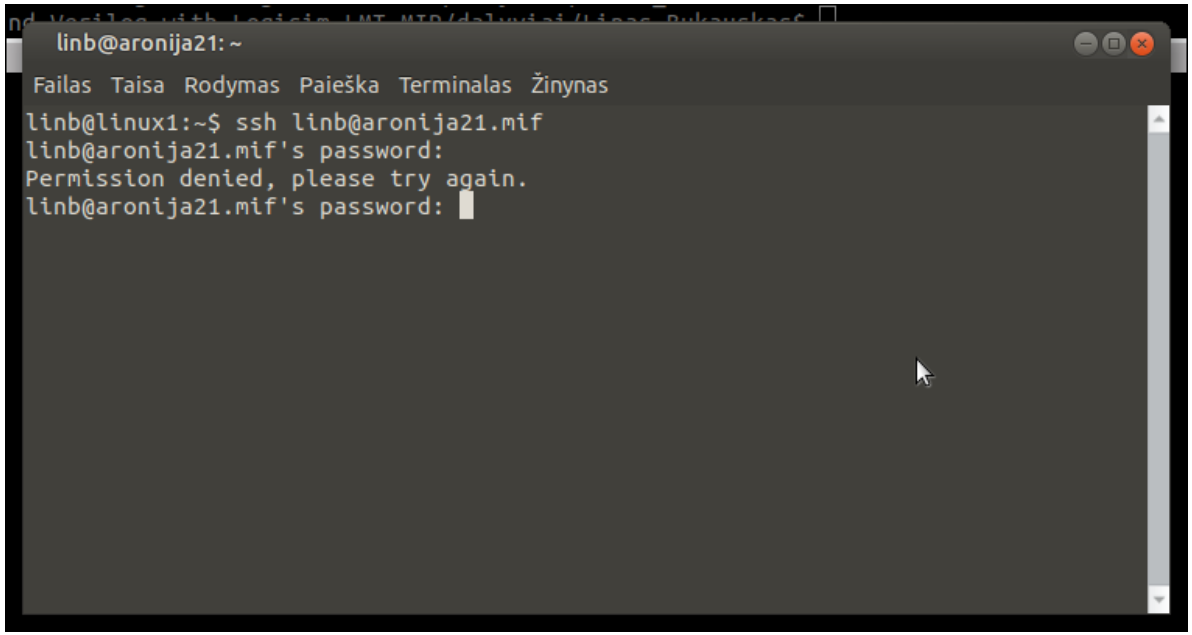


Figure 3: Login Error

- Failure to login caused by wrong password

Typical Root Catalog Structure

- After successful login issue commands:
  `cd / <enter>`
  `ls <enter>`

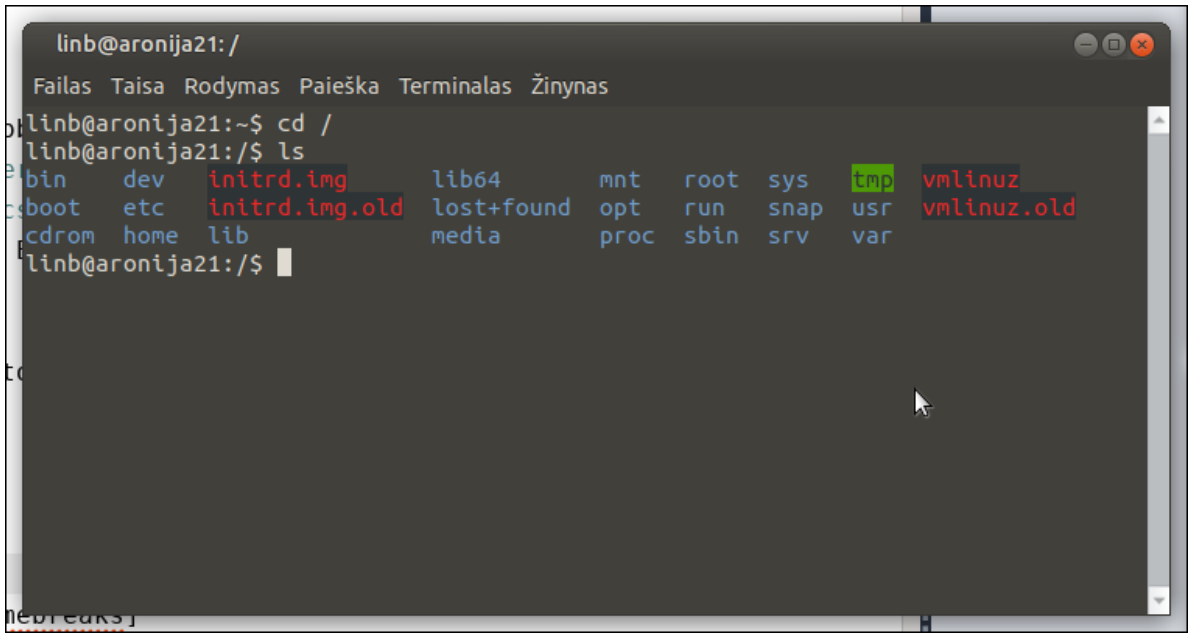


Figure 4: Root Tree Catalog

- Alternatively use: `tree -L 1 /` to list the file structure tree

notice "/" is the root of the file system on Linux

File System Structures

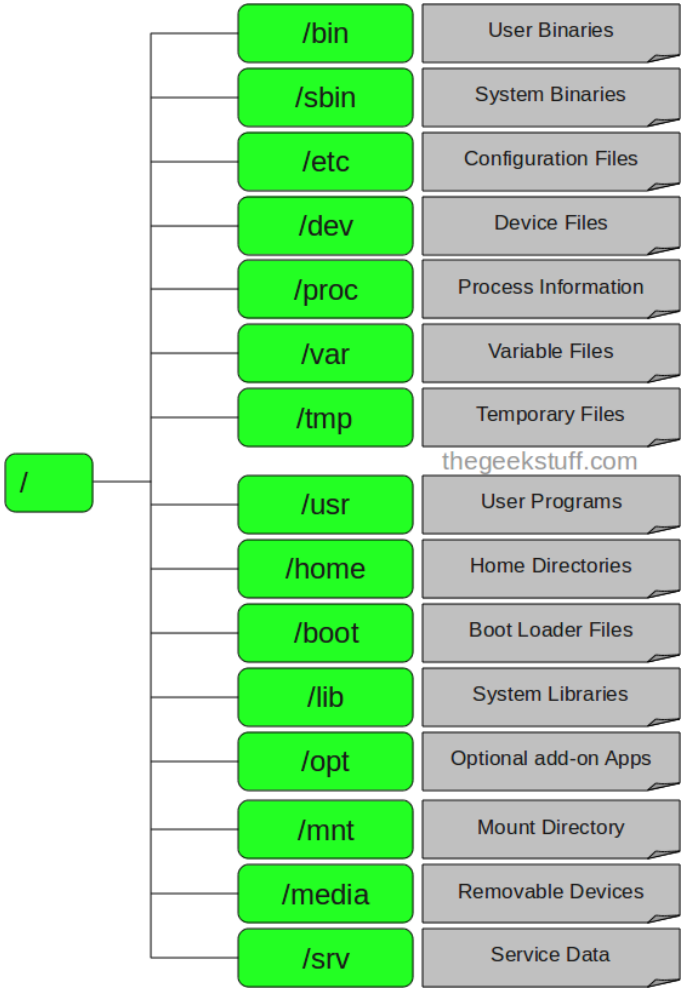


Figure 5: File catalogue structure. Ref. The Geek Stuff

File System Structures Explained

- `/bin` is the directory that contains binaries, that is, some of the applications and programs you can execute. More `bin` directories in other parts of the file system tree might be found.
- The `/boot` directory contains files required for starting your system. DO NOT TOUCH THIS! Messing up one of the files in here, may cause failure to boot.
- `/dev` contains device files registered by the kernel. Many of these are generated at boot time or even on the fly. For example try `ls -al /dev/` or `cat /proc/devices`
- `/etc` "et cetera" catalogue is for system and application configuration files. For examples, try `ls /etc/`
- `/home` is where you will find your users personal directories. In my case, under /home there are two directories: `/home/birute`, which contains all user-land stuff;

File System Structures Explained (cont.)

- `/lib` is where dynamic/static libraries for software. Libraries are files containing code that your applications can use. They contain snippets of code that applications use to draw windows on your desktop, control peripherals, or send files to your hard disk.
- `/media` directory is where external storage might be automatically mounted when you plug in new devices.
- `/mnt` directory, is where you would manually mount storage devices or partitions.
- `/opt` directory is often where software you compile (that is, you build yourself from source code and do not install from your distribution repositories). `/opt/bin` and `/opt/lib` might have structure for binaries and libraries.
- `/usr/local/` Applications and libraries when software gets installed, there will also be `/usr/local/bin` and `/usr/local/lib` directories.

File System Structures Explained (cont.)

- `/proc`, like `/dev` is a virtual directory maintained by the kernel. It contains information about your computer, such as information about your CPU and the kernel your Linux system is running. You can learn about each file `ls /proc/` by for example using `cat /proc/cpuinfo`
- `/root` is the home directory of the SUPERUSER (also known as the GOD or Administrator) of the system.
- `/run` is another new directory. System processes use it to store temporary data for their own reasons.
- `/sbin` is similar to `/bin`, but it contains applications that only the superuser (hence the initial **s**bit) will need. You can use `sudo` command that temporarily elevates permissions. For example, `sudo rm -rf /bin` will permanently criple the system :)
- `/usr` contains a mish-mash of directories which in turn contain applications, libraries, documentation, wallpapers, icons and a long list of other stuff that need to be shared by applications and services.

File System Structures Explained (cont.)

- `/sys` is another virtual directory like `/proc` and `/dev` and also contains information from devices connected to your computer.
- `/tmp` contains temporary files, usually placed there by applications that you are running. Most often `/tmp` catalog gets cleaned up after reboot or a certain clean up operations.
- `/var` was originally given its name because its contents was deemed variable. For example, `/var/log` are files that register events that happen on the system. If something fails in the kernel, it will be logged in a file in `/var/log`. Try command: `grep Fail /var/log/auth.log` shall list failed attempts for authentication.

System Information

uname -a	Display Linux system information
uname -r	Display kernel release information
lsb_release -a	Show installe linux version
lsblk	Show block devices
time	Show how long the system has been running + load
hostname	Show system host name
hostname -I	Display the IP addresses of the host
last reboot	Show system reboot history
date	Show the current date and time
cal	Show this month's calendar
w	Display who is online
whoami	Who you are logged in

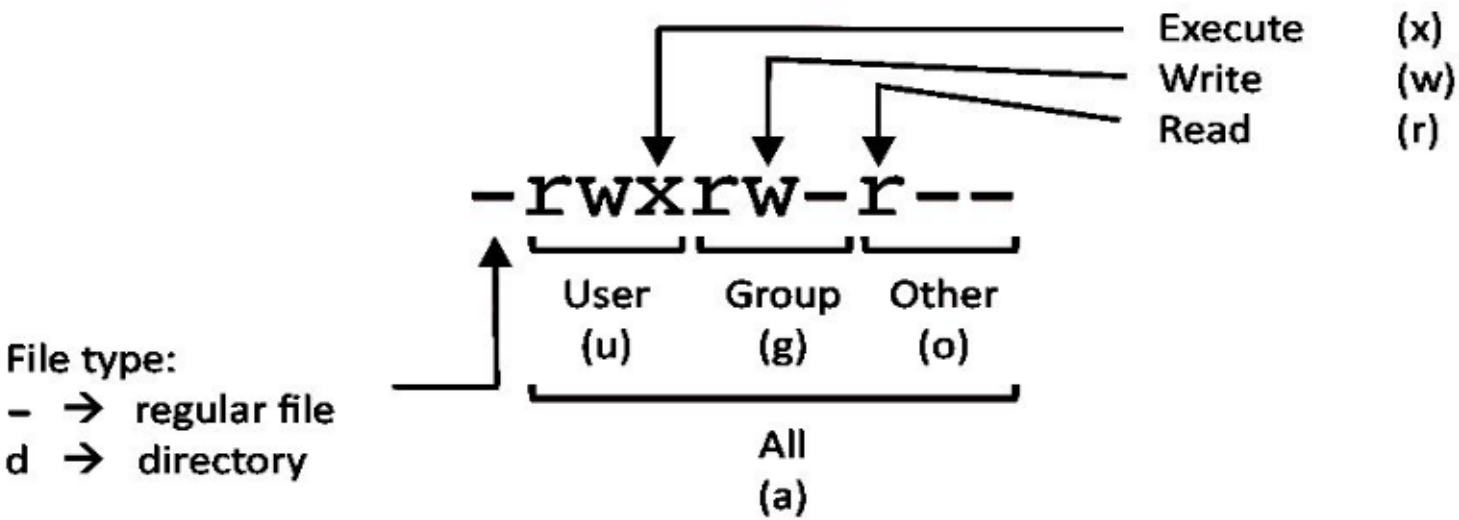
Hardware information

dmesg	Display messages in kernel ring buffer
cat /proc/cpuinfo	Display CPU information
cat /proc/meminfo	Display memory information
free -h	Display free and used memory
	(-h for human readable,-m for MB, -g for GB)
lspci -tv	Display PCI devices
lsusb -tv	Display USB devices
dmidecode	Display DMI/SMBIOS (hw info) from the BIOS
hdparm -i /dev/sda	Show info about disk sda
hdparm -tT /dev/sda	Perform a read speed test on disk sda
badblocks -s /dev/sda	Test for unreadable blocks on disk sda

Performance and statistics

top	Display and manage the top processes
htop	Interactive process viewer (top alternative)
mpstat 1	Display processor related statistics
vmstat 1	Display virtual memory statistics
iostat 1	Display I/O statistics
tail 100 /var/log/messages	Display the last 100 syslog messages (Use/var/log/syslog for Debian based systems)
tcpdump -i eth0	Capture and display all packets on interface eth0
tcpdump -i eth0 'port 80'	Monitor all traffic on port 80 (HTTP)
lsof	List all open files on the system
lsof -u user	List files opened by user
free -h	Display free and used memory (-h for human readable, -m for MB, -g for GB)
watch df -h	Execute "df -h", showing periodic updates

File Permissions



PERMISSION			EXAMPLE	
U	G	W		
rwx	rwx	rwx	chmod 777 filename	# Use sparingly!
rwx	rwx	r-x	chmod 775 filename	
rwx	r-x	r-x	chmod 755 filename	
rw-	rw-	r--	chmod 664 filename	
rw-	r--	r--	chmod 644 filename	

- Try using `chmod ugo+rwx` invariant

File handling

ls -al	List all files in a long listing (detailed) format
pwd	Display the present working directory
mkdir directory	Create a directory
rm file	Remove (delete) file
rm -r directory	Remove the directory and its contents recursively
rm -f file	Force removal of file without prompting
rm -rf directory	Forcefully remove directory recursively
cp file1 file2	Copy file1 to file2
touch file	Create an empty file or update the access and modification times of file
cat file	View the contents of file
less file	Browse through a text file
head file	Display the first 10 lines of file
tail file	Display the last 10 lines of file
tail -f file	Display the last 10 lines of file and "follow" the file as it grows.

Process management

ps	Display your currently running processes
ps -ef	Display all the currently running processes on the system
ps -ef — grep processname	Display process information for processname
top	Display and manage the top processes
htop	Interactive process viewer (top alternative)
kill pid	Kill process with process ID of pid
killall processname	Kill all processes named processname
program	Start program in the background
bg	Display stopped or background jobs
fg	Brings the most recent background job to foreground
fg n	Brings job n to the foreground

Pattern search

grep pattern file	Search for pattern in file
grep -r pattern directory	Search recursively for pattern in directory
locate name	Find files and directories by name
find /home/john -name 'prefix*'	Find files in /home/john that start with "prefix"
find /home -size +100M	Find files larger than 100MB in /home

Practical stydy

- Thank you!
- During self study time can help you on MSTeams.

References

[1] Linux Training Academy, *Choosing a linux distribution*, 2020. [Online]. Available: https://www.linuxtrainingacademy.com/choosing-a-linux-distribution/.

[2] Simon Tatham's, *Putty home page*, 2020. [Online]. Available: https://www.chiark.greenend.org.uk/~sgtatham/putty/.