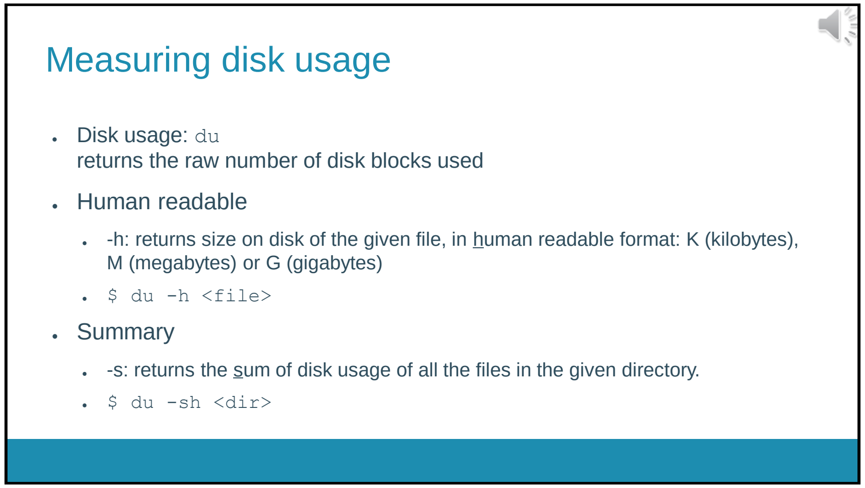
Outline

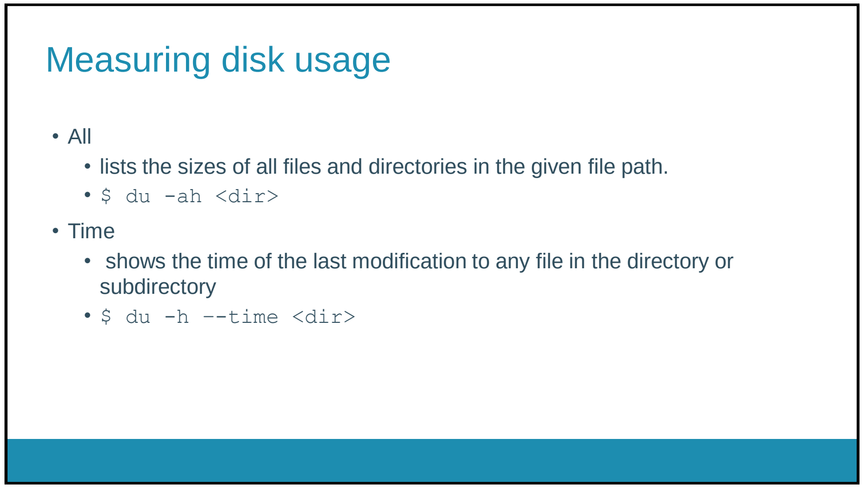
- Introduction - history
- Command line basics – getting help
- File system
- Working with files and directories
- More file handling
- The shell revisited
- ➢Monitoring resources

Check disk space



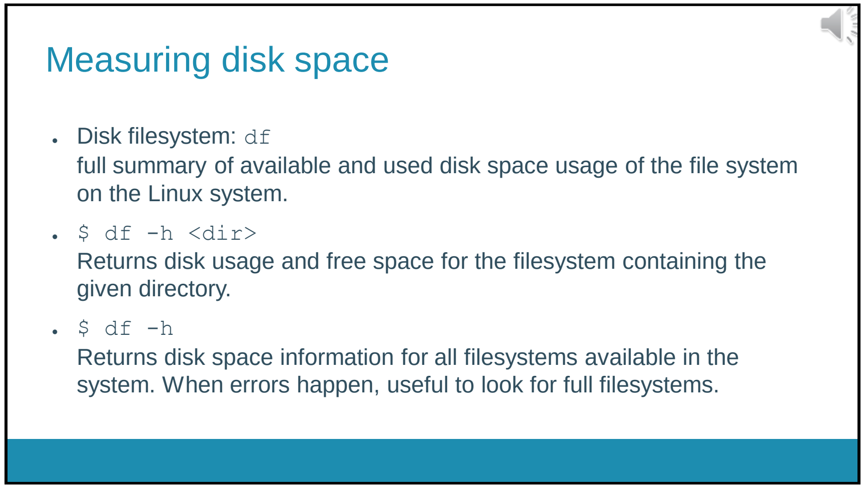
Measuring disk usage

- Disk usage: `du`
  returns the raw number of disk blocks used
- Human readable
  - -h: returns size on disk of the given file, in human readable format: K (kilobytes), M (megabytes) or G (gigabytes)
  - `$ du -h <file>`
- Summary
  - -s: returns the sum of disk usage of all the files in the given directory.
  - `$ du -sh <dir>`



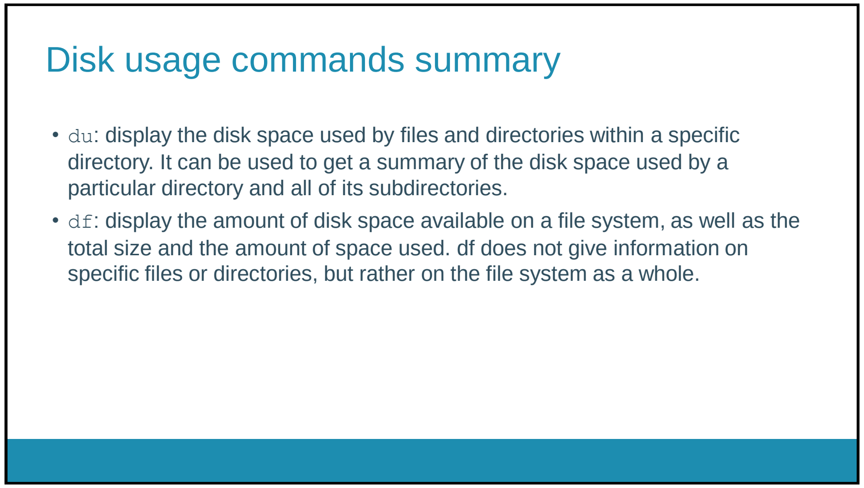
Measuring disk usage

- All
  - lists the sizes of all files and directories in the given file path.
  - `$ du -ah <dir>`
- Time
  - shows the time of the last modification to any file in the directory or subdirectory
  - `$ du -h --time <dir>`



Measuring disk space

- Disk filesystem: `df`
  full summary of available and used disk space usage of the file system on the Linux system.
- `$ df -h <dir>`
  Returns disk usage and free space for the filesystem containing the given directory.
- `$ df -h`
  Returns disk space information for all filesystems available in the system. When errors happen, useful to look for full filesystems.

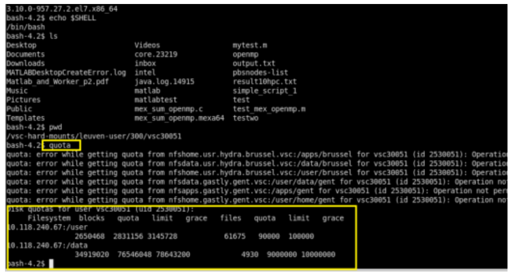


Disk usage commands summary

- `du`: display the disk space used by files and directories within a specific directory. It can be used to get a summary of the disk space used by a particular directory and all of its subdirectories.
- `df`: display the amount of disk space available on a file system, as well as the total size and the amount of space used. df does not give information on specific files or directories, but rather on the file system as a whole.

How much space do I have?

- `quota`: command to see all quotas for your directories are, if any



```
3.10.0-957.27.2.el7.x86_64
bash-4.2$ echo $SHELL
/bin/bash
bash-4.2$ ls
Desktop                       Videos                 mytest.m
Documents                     core.23219             openmp
Downloads                     inbox                  output.txt
MATLABDesktopCreateError.log  intel                  pbsnodes-list
Matlab_and_Worker_p2.pdf      java.log.14915         result10hpc.txt
Music                         matlab                 simple_script_1
Pictures                      matlabtest             test
Public                        mex_sum_openmp.c       test_mex_openmp.m
Templates                     mex_sum_openmp.mexa64  testwo
bash-4.2$ pwd
/vsc-hard-mounts/leuven-user/300/vsc30051
bash-4.2$ quota
quota: error while getting quota from nfshome.usr.hydra.brussel.vsc:/apps/brussel for vsc30051 (id 2530051): Operatio
quota: error while getting quota from nfsdata.usr.hydra.brussel.vsc:/data/brussel for vsc30051 (id 2530051): Operatio
quota: error while getting quota from nfshome.usr.hydra.brussel.vsc:/user/brussel for vsc30051 (id 2530051): Operatio
quota: error while getting quota from nfsdata.gastly.gent.vsc:/user/data/gent for vsc30051 (id 2530051): Operation no
quota: error while getting quota from nfsapps.gastly.gent.vsc:/apps/gent for vsc30051 (id 2530051): Operation not per
quota: error while getting quota from nfshome.gastly.gent.vsc:/user/home/gent for vsc30051 (id 2530051): Operation no
Disk quotas for user vsc30051 (uid 2530051):
     Filesystem  blocks   quota   limit   grace   files   quota   limit   grace
10.118.240.67:/user
                2650468  2831156 3145728           61675   90000  100000
10.118.240.67:/data
                34919020  76546048 78643200           4930  9000000 10000000
bash-4.2$
```

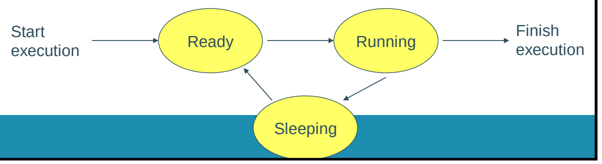
Process management

Process

- A program that is claimed to be executing is called a process
- Processes carry out tasks within the operating system.
- Several instances of the same program can run at the same time
- Processes are assigned a unique identifier which is used to monitor and control the process (PID)

Process

- A Linux process can be in one of the following states:
  - Running: the process is currently executing
  - Sleeping: the process is waiting for an event or resource
  - Stopped: the process has been stopped by a signal or command
  - Zombied: the process has completed execution but its parent process has not yet acknowledged its status.



ps

- **p**rocess **s**tatus: display running processes
  (cfr. Windows Task Manager ctrl-shift-esc)
- `$ps` Display the current user's processes
- `$ps -e` Display all processes running on the system
- `$ps -ef` Display detailed information about running processes
- `$ps -u [USER]` Display processes owned by the specified user
- `$ps -aux`

  a = show processes for all users
  u = display the process's user/owner
  x = also show processes not attached to a terminal

ps

```
  PID  TTY    STAT   TIME COMMAND
14748  pts/1  S      0:00 -bash
14795  pts/0  S      0:00 -bash
14974  pts/0  S      0:00 vi test1.txt
14876  pts/1  R      0:00 ps …
```

Process ID

Controlling Terminal name

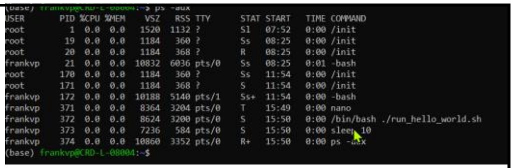
State:
S – Sleeping (waiting for input)
R – Running

Total CPU usage

Name of executable/command

- For the example above, both bash processes, which are the shell of both terminals, are waiting for the input of user. They must be in the sleeping state
- The vi process, which is an editor, is also waiting for the input of user. Hence it is also in sleeping state
- When ps reporting the processes in the system, it is the only process that is running. Hence it is in running state

ps -aux



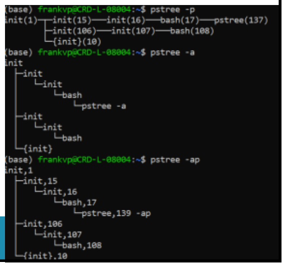
```
(base) frankvp@CRD-L-08004:~$ ps -aux
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.0   1520  1132 ?        Sl   07:52   0:00 /init
root        19  0.0  0.0   1184   360 ?        Ss   08:25   0:00 /init
root        20  0.0  0.0   1184   368 ?        R    08:25   0:00 /init
frankvp     21  0.0  0.0  10832  6036 pts/0    Ss   08:25   0:01 -bash
root       170  0.0  0.0   1184   360 ?        Ss   11:54   0:00 /init
root       171  0.0  0.0   1184   368 ?        S    11:54   0:00 /init
frankvp    172  0.0  0.0  10188  5140 pts/1    Ss+  11:54   0:00 -bash
frankvp    371  0.0  0.0   8364  3204 pts/0    T    15:49   0:00 nano
frankvp    372  0.0  0.0   8624  3200 pts/0    S    15:50   0:00 /bin/bash ./run_hello_world.sh
frankvp    373  0.0  0.0   7236   584 pts/0    S    15:50   0:00 sleep 10
frankvp    374  0.0  0.0  10860  3352 pts/0    R+   15:50   0:00 ps -aux
(base) frankvp@CRD-L-08004:~$
```

- More fields:

- USER: The effective user (the one whose access we are using)
- PID: Process ID
- %CPU: CPU time used divided by the time the process has been running
- %MEM: Ratio of the process's resident set size to the physical memory on the machine
- VSZ: Virtual memory usage of the entire process
- RSS: Resident set size, the non-swapped physical memory that a task has used
- TTY: Controlling terminal associated with the process
- STAT: Process status code
- START: Start time of the process
- TIME: Total CPU usage time
- COMMAND: Name of executable/command

pstree

- Shows the running processes as a tree, making the output more visually appealing.
- The root of the tree is either init or the process with the given pid.
- Options
  - -a: To include command line arguments in output
  - -p: display PIDs for each process name
  - -u: who is the owner/user of a process



```
(base) frankvp@CRD-L-08004:~$ pstree -p
init(1)─┬─init(15)───init(16)───bash(17)───pstree(137)
        ├─init(106)───init(107)───bash(108)
        └─{init}(10)
(base) frankvp@CRD-L-08004:~$ pstree -a
init
  ├─init
  │   └─init
  │       └─bash
  │           └─pstree -a
  ├─init
  │   └─init
  │       └─bash
  └─{init}
(base) frankvp@CRD-L-08004:~$ pstree -ap
init,1
  ├─init,15
  │   └─init,16
  │       └─bash,17
  │           └─pstree,139 -ap
  ├─init,106
  │   └─init,107
  │       └─bash,108
  └─{init},10
```

Process state codes

- R: running or runnable (waiting for the CPU to process it)
- S: Interruptible sleep, waiting for an event to complete, such as input from the terminal
- D: Uninterruptible sleep, processes that cannot be killed or interrupted with a signal, usually to make them go away you have to reboot or fix the issue
- Z: Zombie, are terminated processes that are waiting to have their statuses collected
- T: Stopped, a process that has been suspended/stopped

kill

- Sends an abort signal to the given processes. Lets processes save data and exit by themselves. Should be used first.
- `$ kill <pid>`
  Example:
  `$ kill 3039 3134 3190 3416`
- `$ kill -9 <pid>`
  Sends an immediate termination signal. The system itself terminates the processes. Useful when a process is really stuck.

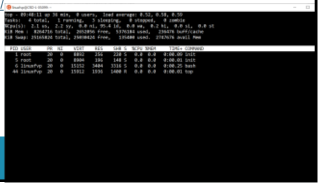
kill

- Suspend a process by sending STOP signal
- `kill -STOP <PID>`
- To resume the process, you'd have to use the CONT flag with the kill command
- `kill -CONT <PID>`

top

- Displays a real-time system status summary. The output displays the amount of system memory(RAM) used for different purposes, percentage of CPU being utilized, swap memory, and other information.
- Press ‘z‘ option will display the running process in color which may help you to identify the running process easily.
- Press ‘f’ to edit the columns, press space bar to select/deslect

http://www.thegeekstuff.com/2010/01/15-practical-unix-linux-top-command-examples/

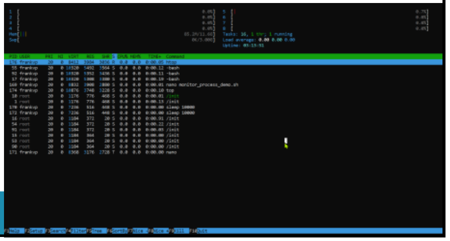


```
top - 09:48:11 up 36 min,  0 users,  load average: 0.52, 0.58, 0.59
Tasks:   4 total,   1 running,   3 sleeping,   0 stopped,   0 zombie
%Cpu(s):  2.1 us,  2.2 sy,  0.0 ni, 95.4 id,  0.0 wa,  0.2 hi,  0.0 si,  0.0 st
KiB Mem :  8264716 total,  2652056 free,  5376184 used,   236476 buff/cache
KiB Swap: 25165824 total, 25030424 free,   135400 used.  2747676 avail Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
    1 root      20   0    8892    156    220 S   0.0  0.0   0:00.09 init
    5 root      20   0    8904    196    148 S   0.0  0.0   0:00.01 init
    6 linuxfvp  20   0   15152   3404   3316 S   0.0  0.0   0:00.25 bash
   44 linuxfvp  20   0   15912   1936   1400 R   0.0  0.0   0:00.01 top
```

htop

- Displays the data in a more informative and interactive manner.
- The process names are more descriptive and the mouse integration is an extra feature that is not present with the ‘top’ command.
- Use the mouse to select various columns displayed on the terminal output.



```
  1  [                         0.0%]   5  [|                        0.7%]
  2  [                         0.0%]   6  [                         0.0%]
  3  [                         0.0%]   7  [                         0.0%]
  4  [                         0.0%]   8  [                         0.0%]
  Mem[|||              85.2M/11.6G]   Tasks: 16, 1 thr; 1 running
  Swp[                      0K/3.00G]   Load average: 0.00 0.00 0.00
                                        Uptime: 03:13:51

  PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command
  176 frankvp    20   0  8412  3984  3036 R  0.0  0.0  0:00.05 htop
   55 frankvp    20   0 10520  5492  3564 S  0.0  0.0  0:00.12 -bash
   92 frankvp    20   0 10520  5352  3436 S  0.0  0.0  0:00.11 -bash
   17 frankvp    20   0 10320  5308  3380 S  0.0  0.0  0:00.19 -bash
  169 frankvp    20   0  8832  3908  3080 S  0.0  0.0  0:00.01 nano monitor_process_demo.sh
  174 frankvp    20   0 10876  3748  3228 S  0.0  0.0  0:00.10 top
   10 root       20   0  1176   776   468 S  0.0  0.0  0:00.01 /init
    1 root       20   0  1176   776   468 S  0.0  0.0  0:00.13 /init
  170 frankvp    20   0  7236   516   448 S  0.0  0.0  0:00.00 sleep 10000
  172 frankvp    20   0  7236   516   448 S  0.0  0.0  0:00.00 sleep 10000
   16 root       20   0  1184   372    20 S  0.0  0.0  0:00.91 /init
   54 root       20   0  1184   372    20 S  0.0  0.0  0:00.22 /init
   91 root       20   0  1184   372    20 S  0.0  0.0  0:00.03 /init
   15 root       20   0  1184   364    20 S  0.0  0.0  0:00.00 /init
   53 root       20   0  1184   364    20 S  0.0  0.0  0:00.00 /init
   90 root       20   0  1184   364    20 S  0.0  0.0  0:00.00 /init
  171 frankvp    20   0  8368  3176  2728 T  0.0  0.0  0:00.00 nano

F1Help  F2Setup F3SearchF4FilterF5Tree  F6SortByF7Nice -F8Nice +F9Kill  F10Quit
```

jobs

- Each process is assigned a unique identifier called a process ID (PID). The PID can be used to refer to the process and perform actions on it, such as suspending or terminating it.
- A job is a process that is either running in the foreground or the background. The foreground is the active window in the terminal, and the background is any process that is running but not actively being used in the terminal.
- By default, when you run a command in the terminal, it runs in the foreground. You can tell that a process is running in the foreground because it displays output and you cannot enter any more commands until it finishes.

jobs

- A running program launched from the shell is known as a **job**.
  - is started from the command line
  - runs until the program completes its task.
- Each job is always in one of three states:
  - Foreground: Running, with control of the terminal. (default)
  - Background: Running, but not able to read from the terminal.
  - Stopped: Waiting to be resumed.
- A Linux **job** refers to a task that is executed in the foreground or background of a shell session, while a Linux **process** refers to an instance of a running program in the operating system. A job can consist of one or multiple processes.

commands

- There are several commands that are used to control processes:
  - `jobs` - an alternate way of listing your own processes in background or suspended
  - `bg` - put a process in the background
  - `fg` - put a process in the foreground
  - `ps` - list the processes running on the system

jobs

- Run a command, if you need to free up the terminal, you can stop the process. Ctrl-z stops a process

```
sleep 10000
^Z
```

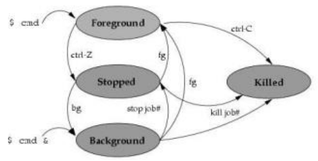
- Get a list of jobs in the background: `jobs`

```
jobs -l
```

Option `-l` shows info on the process id

- Bring a job back to the foreground: `fg` multiple stopped jobs, specify the job ID

```
fg 2
```



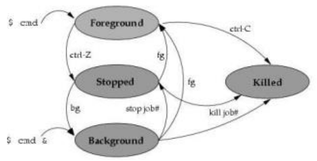
https://www.baeldung.com/linux/foreground-background-process#:~:text=A%20process%20that%20connects%20to,is%20called%20a%20background%20job.

jobs

- Run a stopped command in the background
- Get a list of jobs in the background: `jobs`

```
jobs -l
```

- Bring a job to the background: `bg` multiple stopped jobs, specify the job ID
- `bg 2`
- Check with `jobs`: the process is in the background, but running instead of being stopped.



https://www.baeldung.com/linux/foreground-background-process#:~:text=A%20process%20that%20connects%20to,is%20called%20a%20background%20job.

jobs

- Run a command, 2 ways to execute
  - Foreground Processes
    - depend on the user for input
    - also referred to as interactive processes
    - A process that connects to the terminal is called a foreground job. A job is said to be in the foreground because it can communicate with the user via the screen and the keyboard.
  - Background Processes
    - If the background job requires interaction with the user, it will stop and wait until establishing a connection to the terminal. Referred to as non-interactive or automatic processes
    - Daemons: special type of background processes that start at system startup and keep running forever as a service; they don't die.

&

- **&** is a command line operator that instructs the shell to start the specified program in the background.
  - This allows you to have more than one program running at the same time without having to start multiple terminal sessions.
  - Starting a process in background: add & at the end of your line:

```
$ sleep 10000 &
```