GNU/LINUX TUTORIAL

PART II: USERS, PERMISSIONS, PROCESSES, FILE TREE

§5: USERS AND GROUPS

- Commands are executed by **users**.
- Each user may belong to **groups**.
- `root` is the most powerful user.
- `sudo` command allows to execute other commands as `root`.
- Special users and groups may exist to run software.

WHO AM I? 😦

```
user@cosmos:~$ whoami
user
```

```
user@cosmos:~$ id
uid=1000(user) gid=1000(user) groups=1000(user),27(sudo)

user@cosmos:~$ id root
uid=0(root) gid=0(root) groups=0(root)
```

- Each user has
  - numeric **User ID** (**UID**),
  - home directory, e.g. `/home/user`,
  - login shell, e.g. `/bin/bash` or `/usr/sbin/nologin` if disabled.
- `root` has UID 0.

- Each group has numeric **Group ID** (**GID**).
- `sudo` group: those who can run `sudo`.

MANAGING PASSWORDS 🔑

```
user@cosmos:~$ passwd
Changing password for user.
Current password:
New password:
Retype new password:
passwd: password updated successfully
```

CHANGING ROOT PASSWORD 🗝️

```
user@cosmos:~$ sudo passwd root
New password:
Retype new password:
passwd: password updated successfully

user@cosmos:~$ su
Password:
root@cosmos:/home/user# exit
exit
user@cosmos:~$
```

MANAGING USERS 🧰

Command	Action
`useradd --create-home --shell /bin/bash newuser`	add user
`groupadd newgroup`	add group
`passwd newuser`	set password
`sudo usermod -aG sudo newuser`	add to `sudo` group
`su newuser`	login as `newuser`
`userdel newuser`	delete `newuser`

WHERE USERS AND PASSWORDS ARE?

- `/etc/passwd` : list of users.

  Can be accessed by everyone.
- `/etc/group` : list of groups.

  Can be accessed by everyone.
- `/etc/shadow` : list of users and hashes of their passwords.

  Can be accessed by `root`.

PRACTICE 💪

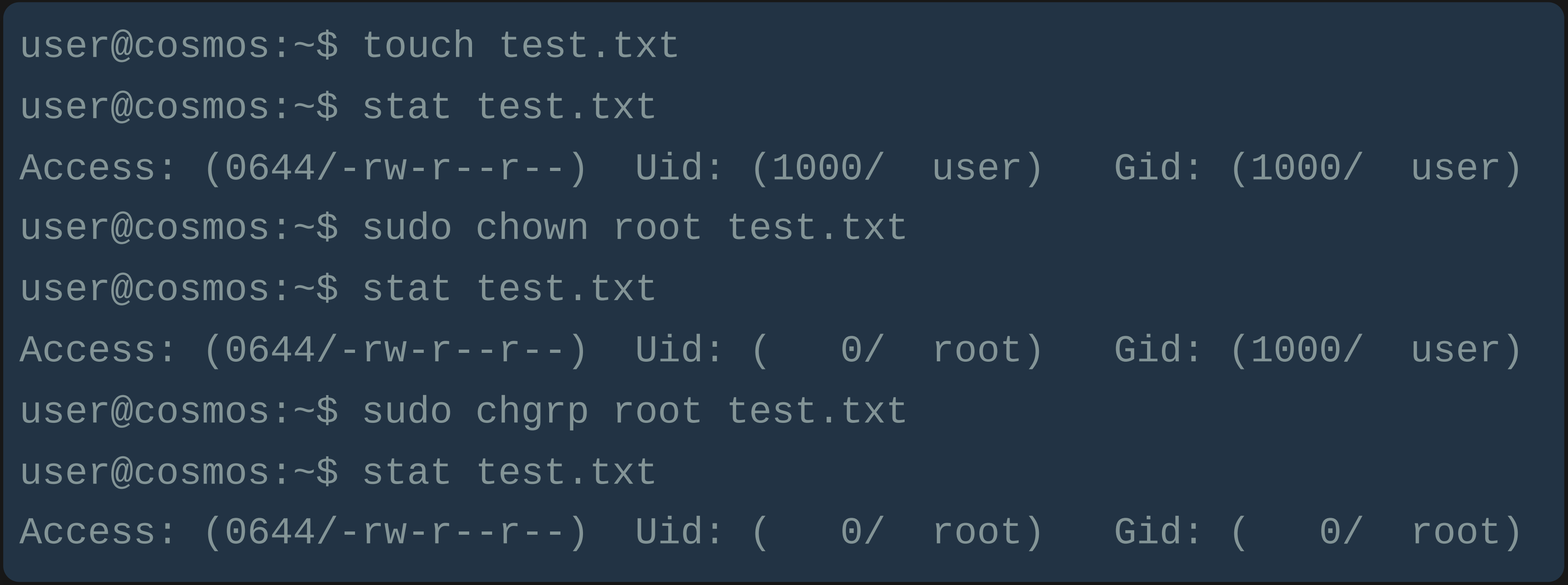
- Check `/etc/passwd`, `/etc/group`, and `/etc/shadow`.
- Create a new user with home directory and setup their password.
- Add user to the `sudo` group.
- Check `/etc/passwd`, `/etc/group`, and `/etc/shadow` again.
- Login as that user with `su`.
- Exit shell with `exit`.
- Delete the new user.

§6: FILE PERMISSIONS

- Permissions are important
  - for security reasons,
  - not to touch data you're not supposed to.
- Managed on three levels:
  - file owner,
  - file group,
  - everyone.

MANAGING OWNER AND GROUP ⚙️

- `chown <owner> <file>`
- `chgrp <group> <file>`



```
user@cosmos:~$ touch test.txt
user@cosmos:~$ stat test.txt
Access: (0644/-rw-r--r--)  Uid: (1000/  user)   Gid: (1000/  user)
user@cosmos:~$ sudo chown root test.txt
user@cosmos:~$ stat test.txt
Access: (0644/-rw-r--r--)  Uid: (   0/  root)   Gid: (1000/  user)
user@cosmos:~$ sudo chgrp root test.txt
user@cosmos:~$ stat test.txt
Access: (0644/-rw-r--r--)  Uid: (   0/  root)   Gid: (   0/  root)
```

PERMISSIONS ✅

	Permission	Regular files	Directories
`r`	read	read contents	list files inside
`w`	write	modify contents	create, rename, delete files
`x`	execute	execute	enter with `cd`

⚠️ Set `x` only on executable files (binaries, scripts) and directories.

REPRESENTED BY A NUMBER 🤖

Number	Binary	Permissions
`0`	`0b000`	`---`
`1`	`0b001`	`--x`
`2`	`0b010`	`-w-`
`3`	`0b011`	`-wx`
`4`	`0b100`	`r--`
`5`	`0b101`	`r-x`
`6`	`0b110`	`rw-`
`7`	`0b111`	`rwx`

FORMAT 🤖

```
user@cosmos:/usr/local/lib$ stat /usr/bin
Access: (0755/drwxr-xr-x)  Uid: (    0/   root)   Gid: (    0/   root)
         │ │  │ │  │  └── all: r-x
         │ │  │ │  └── group: r-x
         │ │  │ └── owner: rwx
         │ │  └── file type: (d)irectory
         │ └── 755 = rwxr-xr-x
   "sticky bit" = 0
```

FILE TYPES 🗂️

Character	Type
`-`	regular file
`d`	directory
`l`	symbolic link
`c`	character special device
`b`	block special device
`p`	FIFO
`s`	socket

EXAMPLES

- `777` = `rwxrwxrwx` : everything is permitted to everyone.
- `666` = `rw-rw-rw-` : permission of the beast, anyone can read and modify the file.
- `644` = `rw-r--r--` : owner can read and modify; others can read.
- `755` = `rwxr-xr-x` : directory is read-only, except for the owner.

REAL EXAMPLES 📂

File	Permissions	
`/etc/passwd`	`0644`	`-rw-r--r--`
`/bin/bash`	`0755`	`-rwxr-xr-x`
`/tmp`	`1777`	`drwxrwxrwt`
`/home`	`0755`	`drwxr-xr-x`
`/home/user`	`0755`	`drwxr-xr-x`

CHANGING PERMISSIONS 🖍️

```
user@cosmos:~$ touch test.txt
user@cosmos:~$ stat test.txt
Access: (0644/-rw-r--r--)  Uid: (1000/   user)   Gid: (1000/   user)
user@cosmos:~$ chmod +x test.txt
user@cosmos:~$ stat test.txt
Access: (0755/-rwxr-xr-x)  Uid: (1000/   user)   Gid: (1000/   user)
user@cosmos:~$ chmod 666 test.txt
user@cosmos:~$ stat test.txt
Access: (0666/-rw-rw-rw-)  Uid: (1000/   user)   Gid: (1000/   user)
```

WHAT IS THE DEFAULT? 🤔

- `umask` : print file mode mask.
- `umask 022` : set file mode mask.
- Default permissions:
  - `666` - `umask` for regular files,
  - `777` - `umask` for directories.

```
user@cosmos:~$ umask
0022
user@cosmos:~$ touch test.txt
user@cosmos:~$ mkdir test
user@cosmos:~$ ls -1l
drwxr-xr-x 1 user user 0 Aug  8 20:11 test
-rw-r--r-- 1 user user 0 Aug  8 20:11 test.txt
```

Remember: `chmod`, `chown`, `chgrp`.

§7: PROCESSES

- Each process has its unique Process ID (PID).
- `pidof {name}` (e.g. `pidof bash`) finds PIDs by name.

PS: PROCESS INFO 📝

- `sudo apt install procps` : utilities for working with processes.

Command	Action
`ps`	list current processes
`ps -e`	list all processes
`ps -C bash`	processes with command `bash`
`ps -U root`	processes run by `root` user
`pstree`	process tree

MONITORING PROCESSES 👁️

- `top`

```
top - 19:57:02 up  4:24,  0 users,  load average: 3.86, 1.34, 0.61
Tasks: 120 total,   1 running, 118 sleeping,   1 stopped,   0 zombi
%Cpu(s): 70.3 us, 11.7 sy,  0.0 ni,  6.4 id,  0.8 wa,  0.0 hi,  0.1
MiB Mem :   6603.6 total,   6592.3 free,      5.1 used,      6.2 bu
MiB Swap:      0.0 total,      0.0 free,      0.0 used.   6598.5 av

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME
20995 abeshen+  20   0 7894004   2.2g 297812 S 305.7  34.0   2:44.6
21501 abeshen+  20   0 2475216  55784  26788 S  23.0   0.8   0:00.6
21495 abeshen+  20   0 2475216  52100  26660 S  22.0   0.8   0:00.6
  499 abeshen+  20   0   72268  28936   8140 S   1.7   0.4   2:16.5
```

KILL 🔪

Command	Action
`kill {pid}`	sends `SIGTERM`
`killall {name}`	sends `SIGTERM`
`kill -KILL {pid}`	sends `SIGKILL`
`killall -KILL {name}`	sends `SIGKILL`

- `SIGTERM` asks process politely to terminate.
- `SIGKILL` kills the process (e.g. when not responding)

EXAMPLE 🔪

- Run `less /etc/passwd`.
- Press `C-z`.
- Check `top`.
- Try `killall less`.
- Check `top` again.
- Try `killall -KILL less`.

§8: FILE SYSTEM

WHAT'S IN THE ROOT /? 🤨

```
user@cosmos:~$ ls -p /
bin/   dev/   home/  lib64/  mnt/  proc/  run/
srv/   tmp/   var/   boot/   etc/  lib/   media/
opt/   root/  sbin/  sys/    usr/
```

- Linux distributions more or less follow the **Filesystem Hierarchy Standard**.

Dir	Contents	Dir	Contents
`/bin`	basic bins	`/proc`	process info
`/boot`	bootloader	`/root`	root home
`/dev`	devices	`/run`	run-time data
`/etc`	configuration	`/sbin`	system binaries
`/home`	home dirs	`/srv`	data served
`/lib(64)`	libs	`/sys`	system info
`/media`	removable media	`/tmp`	temporary files
`/mnt`	mounted fs	`/usr`	user shareable, read-only data
`/opt`	addon pkgs	`/var`	variable data

BINARIES ⚙️

```
├── 📂 bin     ← essential binaries available to all users
│   ├── ⚙️ bash      ← some basic commands
│   ├── ⚙️ date
│   ├── ⚙️ mv
│   ├── ⚙️ rm
│   ├── ⚙️ tar
│   └── ...
│
├── 📁 sbin  ← system binaries available to root
│              (boot, recovery, etc.)
│
```

LIBRARIES 📚

```
├── 📁 lib        ← libraries: shared objects = SO,
├── 📁 lib64        kernel modules, etc.
│                   (like DLLs in W*ndows)
└── 📂 usr
    ├── 📁 lib        ← user libraries
    │
    └── 📂 local
        │
        └── 📁 lib
```

HOME DIRECTORIES 🏡

```
├── 📂 home    ← user home directories
│   ├── 📁 user    (user's data, installations, configurations)
│   └── ...
│
└── 📁 root    ← root's home
```

DEVICES 🌟

DEVFS MANAGED BY KERNEL

```
└── 📂 dev    ← device files
    ├── 🌟 null       ← null-device (discards data)
    ├── 📂 pts
    │   ├── 🌟 0      ← pseudoterminal connected to standard input
    │   └── ...
    │
    ├── 🌟 random     ← (pseudo)random byte source, blocks when out
    ├── 🌟 tty        ← current console (TeleTYpewriter)
    ├── 🌟 urandom    ← (pseudo)random byte source, non-blocking (un
    ├── 🌟 zero       ← provides zero-characters 0x00
    └── ...
```

INFO MANAGED BY KERNEL 📝

```
├── 📂 proc    ← processes
│   ├── 📝 cpuinfo    ← CPU info
│   ├── 📝 meminfo    ← memory info
│   ├── 📝 version    ← kernel version
│   │
│   └── 📂 {pid}    ← directory attached to process ID
│       ├── 📝 cmdline    ← command that started the process
│       ├── 📝 cws        ← symlink to the current working dir
│       ├── 📝 environ    ← environment variables
│       ├── 📝 exe        ← symbolic link to the executable
│       ├── 📝 fg         ← directory with file descriptors
```

TEMPORARY DATA ⏳

```
├── 📁 run   ← run-time variable data; cleared on boot
│
└── 📁 tmp   ← temporary files,
               may be created by everyone,
               don't persist
```

/USR 👥

```
└── 📂 usr    ← data shared between users
    ├── 📁 bin
    ├── 📁 include    ← C header files
    ├── 📁 lib
    ├── 📂 local    ← locally installed software
    │   ├── 📁 bin
    │   ├── 📁 include
    │   ├── 📁 lib
    │   ├── 📁 share
    │   ├── 📁 src
    │   └── ...
```

OTHER STUFF 🔮

```
├── 📁 etc    ← 'etcetera'; host-specific configuration files
│
├── 📁 opt    ← additional software packages
│
├── 📁 srv    ← data served by the system
│
└── 📂 var    ← variable data
    ├── 📁 cache
    ├── 📁 lock
    ├── 📁 log
    ├── 📁 mail
```

BOOT AND FILE SYSTEMS 🤖

```
├── 📁 boot  ← boot loader files
│
├── 📁 media   ← mount points for removable devices
│
└── 📁 mnt     ← mount points for other file systems
```

EXPLORE IT YOURSELF! 💪

- Read `cpuinfo`, `meminfo`, `version` inside `/proc` as regular files.
- For a process with some ID, explore `/proc/{pid}`.
- What's the difference between `/bin` and `/usr/bin`?
- Check out `/var/log/apt/history.log`.

NEXT TIME

- IO redirection and pipelines.
- Pattern matching, alisases, variables, `$PATH`.
- Anatomy of scripts: shebang.