Support de Cours

LINUX bases

LINUX : bases

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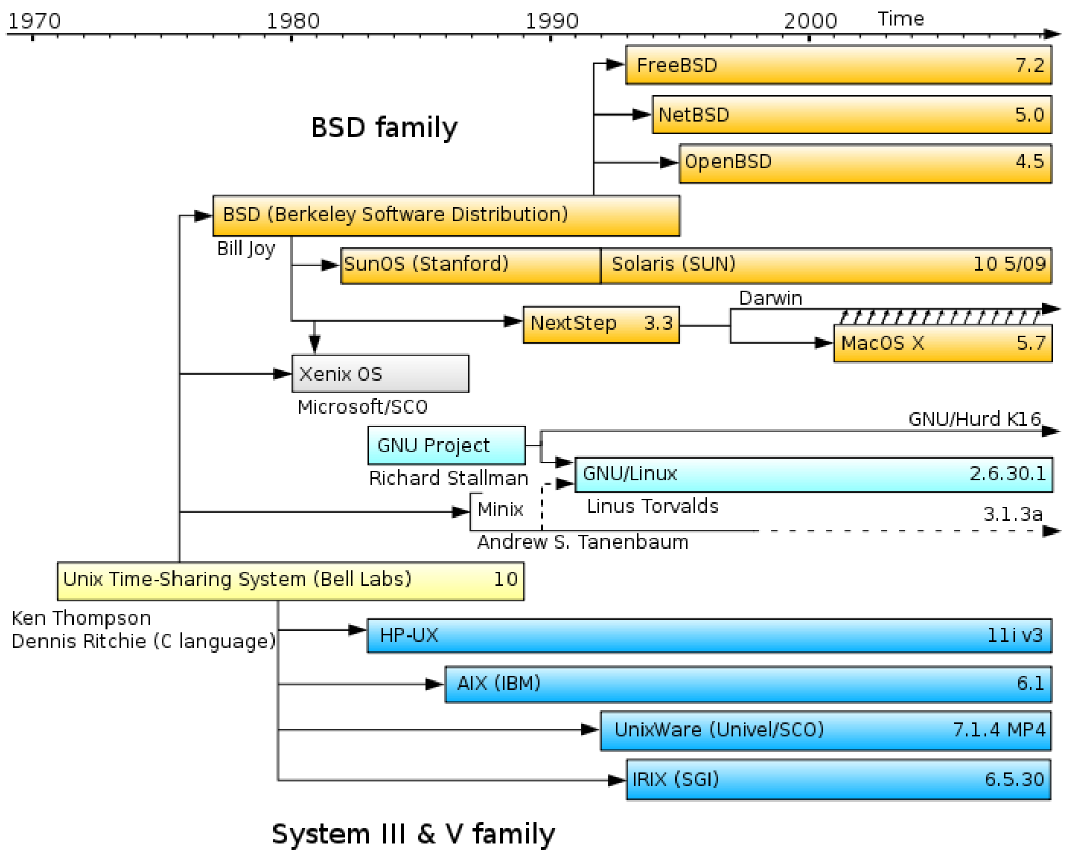
1 Introduction

1.1 History of Unix based systems

In 1969, the AT&T's Bell Laboratories in the United States conceived the Unix operating system. Unix led to the creation of Minix (an minimal Unix-like operating system, designed for education in computer science) and BSD (Berkeley Software Distribution), of which Mac OS X is derived.



In 1991 a finnish student called Linus Torvalds, frustrated by the licensing of MINIX limiting it to educational use only and preventing any commercial use, began to work on his own operating system, which eventually became the Linux kernel.

1.2 Definitions

Open source : the source code as well modified code must be made available (it does not mean that the distribution is free of charge, for example Redhat).

GNU : stands for Gnu is Not Unix, a free software, mass collaboration project, announced on September 27, 1983, by Richard Stallman at MIT. Early Linux kernel developers ported GNU code.

Flavours : implementations of Unix designed to work with different types of hardware, and having its own unique commands or features.

Distributions ("distros") : particular implementation of the Linux operating system, packaged with a set of applications and a user interface

Kernel : central OS component and the bridge between a software application and its data

Desktop environment : unified graphical interface for an operating system (you actually see when using a computer : how windows are drawn and managed, panels/taskbars, menus, file management, etc)

1.3 Characteristics and distributions

Below are some key characteristics of Linux, which contributed to its success:

- cross-platform
- multitask
- multiuser
- open source kernel and components
- many specialised distributions driven by developpers and user communities
- stability (modular by design, not monolithic)
- security (separation of administrative privileges from normal user privileges)
- file system based on a unified scheme (all directories are attached to the root directory)

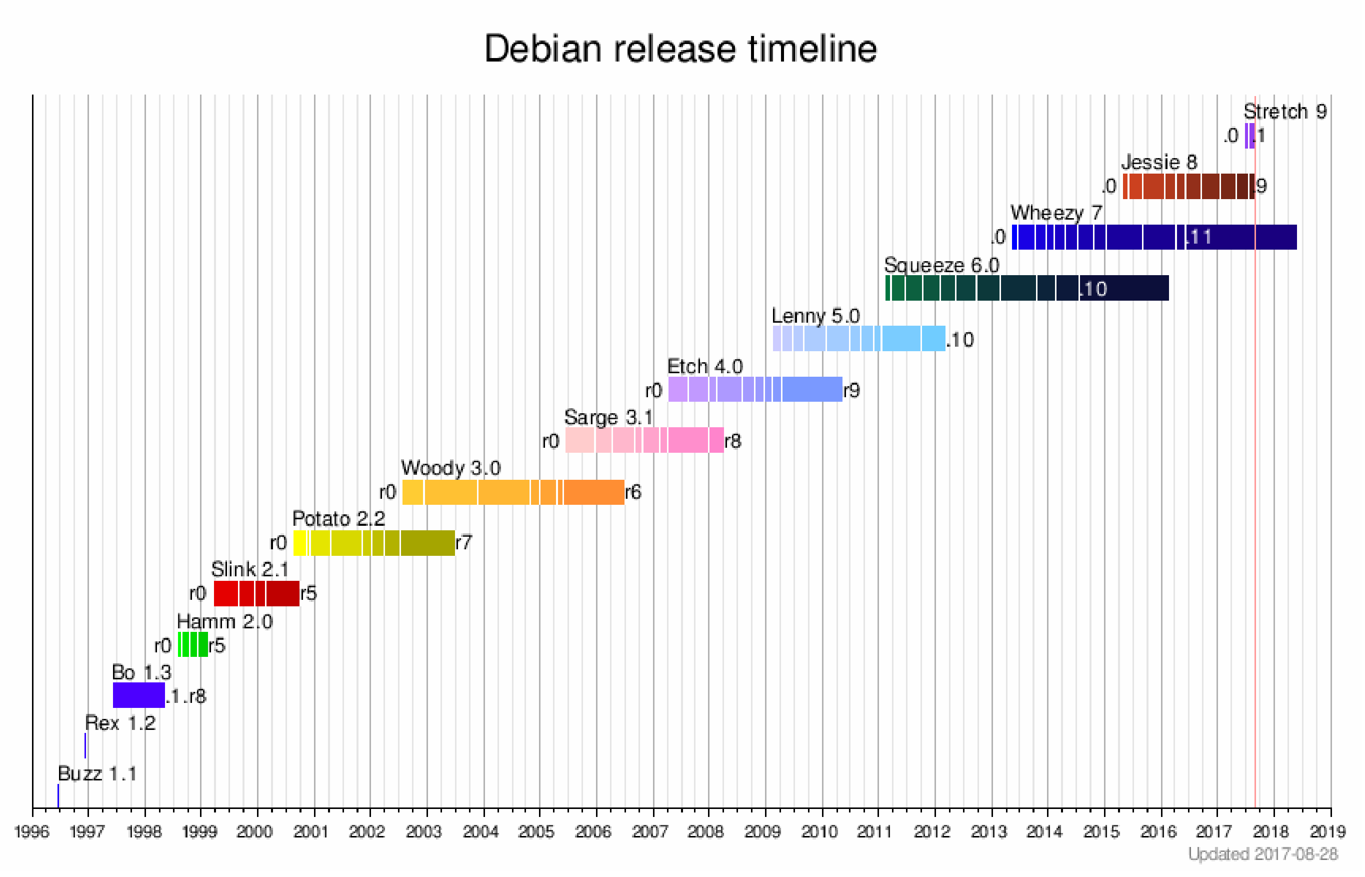
There are currently over six hundred Linux distributions. All are derivatives from 3 base distributions :

- Red Hat
- Slackware
- Debian

Some are commercially-backed distributions, such as Fedora (Red Hat), openSUSE (Novell), Ubuntu (Canonical Ltd.), and Mandriva Linux (Mandriva), and others are entirely community-driven distributions, such as Debian and Gentoo. Distributions have small variations in file structure and also differ by the type of packets (Debian packets are *.deb, Slackware packets need to be compiled, RedHat packets are *.rpm)

See : http://en.wikipedia.org/wiki/Linux_distribution

Debian is often considered one of the most stable version of Linux : indeed testing packets between each release takes more time than other distributions (2-3 years).



Debian versions are named after Toy Story characters.

See also : [what's new in Debian 9]()

2 Installation of Debian

2.1 Options

We will choose the following options to install Debian :

- graphic install or install (same screens, graphic install is prettier but it does not install a desktop environment)
- leave domain empty
- provide credentials
- choose entire disk (not LVM : logical volume management, flexible volumes)
- select Guided Partitioning, all in once partition
- In some cases, you might want these volumes to be located on separate partitions. Motivation in partitionning is to separate logs (so they don't fill the hard disk) and the users home folder so that the system can be reinstalled without affecting user files.
- keep default size calculated by the installer
- Note that the installer creates 1 primary partitions (number 1) and the others are logical partitions (numbering starts at 5 since there could be 3 more primary partitions). B means boot partitions. The default file system is ext4.
- packet manager: choose France and ftp.fr.debian.org
- leave proxy blank
- for a server: uncheck graphic environment and print server, leave only “standard system utilities”
- GRUB : yes, install on /dev/sda

2.2 File system : directory structure

The majority of these directories exist in all UNIX operating systems and are generally used in much the same way. In bold are the most important.

```
ls -l /
```

/	primary hierarchy, root directory of the entire file system
/bin	Essential command binaries
/boot	boot files
/dev	devices
/etc	Host-specific system-wide configuration files
/home	Users' home directories
/lib	Libraries
/mnt	mount points for file systems
/media	mount points for removable drives (CD; USB key; ext HD...)
/opt	Optional application software packages (empty by default)
/proc	Virtual filesystem documenting kernel and process status
/root	Home directory for the root user.
/sbin	Essential system binaries (admin commands like ifconfig etc)
/sys	System components
/srv	Site-specific data (empty by default)
/tmp	Temporary files (cleared after a reboot)
/usr	Secondary hierarchy for read-only user data (majority of utilities and applications)
/usr/bin	Non-essential command binaries (used by all users)
/usr/sbin	Non-essential system binaries (e.g daemons for various network services)
/var	variable files : logs, and application files (spool, databases, website files)

2.3 Navigation

Login with the normal user created during installation: the prompt gives some information about the user and the current folder :

```
username@computername:~$
```

~ : represents user home folder (current location)
$: simple user
# : root

Switch user using the command `su <username>`. Note that if you are logged in as a normal user, it will switch by default to root if no username is provided. Type `exit` to disconnects session (or return to the previously open session if you have used the command `su`.

`echo $HOME` : outputs path of user's home folder

All users have their folder in /home except root (/root)

Moving between folders with the command `cd`

`cd ../..`	goes up two levels
`cd -`	back to previous folder
`cd ~`	go to user home folder
`cd /home`	absolute path
`cd foldername`	relative path

Listing directory content with the command `ls`

`ls -al /etc`	
`ls -al /etc | more`	
`ls -al /etc | less`	(can scroll up and down; q to exit)
`ls -l /etc > file1`	(outputs result of the cmd into the file)

`pwd`	print working directory

Arrows up and down => command recall
Tab => completion (or choice if ambiguous).
ALT + F1-6 : separate virtual consoles by pressing etc..

3 Command line basics

3.1 Files and folders manipulation

Create a file:
creates an empty file if it does not exist, updates the timestamp if the file exists
`touch <filename>`

You can send the result of a command into a file as follows :
For example : `echo "hello" > thatsme1`
`whoami > thatsme2` (`whoami` displays the name of the current user)

Display the content of a file:

`cat`	displays the contents of one or more files to screen (concatenate)
`tac`	same as cat but reverse
`more`	paginates output (stops and wait, next with spacebar)
`less`	paginates output (scroll with arrows)

Practice : experiment the commands, display the output of two files at once.
Display the content of a long file (for example `#less /var/log/user.log`)

Display the beginning or the end : `head` and `tail`

Example : copy /etc/passwd to the root user home folder and show 10 first lines or 5 last lines

```
#cd ~
#cp /etc/passwd .
#head -10 passwd
#tail -5 passwd
```

The command `tail` is particularly useful to display the most recent entries of log files. These two commands can be combined to display for example the 14th line of the file :

```
#head -14 passwd | tail -1
```

Sort the content of a file : `sort`

In order to test it, we need to create a file with several lines including a duplicated line.

```
$echo david > file1
$echo bernard >> file1
$echo arthur >> file1
$echo bernard >> file1
```

Note that >> appends a file while > would overwrite any existing content.

`$sort file1`	compare the output with `cat`
`$sort -u file1`	displays unique entries only

Create a folder: `mkdir <folder_name>`
It is possible to create to folders at once :

at the same level:	`mkdir folder1 folder2`
nested:	`mkdir -p folder1/folder2`

Delete a file or a folder: `rm <file_or_folder>`
Note that a folder must be empty. If not, you have to use the -R option (Recursive) to delete the folder AND its content. When deleting from the command line, files cannot be retrieved. Examples:

```
rm -R <foldername>
rm -R file*
```

(* is the wildcard for any number of characters, while ? matches ONE character only)

copy a file or a folder : `cp <source> <destination>`

Example:

```
cp -R folder1 folder2
```
(copies folder1 inside folder2)

Rename or move files or directories: `mv`

If the destination does not exists, it moves and renames with the destination name. Renaming is equivalent to moving to the same location under a new name. Examples:

```
mv oldname newname
mv folder1/folder2 folder2/folder3
mv ../folder1 .
```
(moves folder1 located one level up to current folder)

Exercise :

create a folder 2008 and a folder 2009
in each folder; create subfolders for 3 first months
in each subfolder create a file
rename 2008 as 2009 and 2009 as 2010
delete march 2010
create folder save in /tmp
copy 2009 and 2010 in /tmp/save

3.2 Help and system information

You can **display the system information** (version and name of the Linux distribution) using :

`uname -r`	(kernel version : always even numbers. Odd numbers are test versions)
`cat /etc/issue`	(system info: Debian GNU/Linux 6.0)

To **get help** ("manual") about a command, type `man <command>`

If you forget a command, you can search for a manual that contains a word using `man -K <word>` or alternatively `-k` to get a list of manual pages with that keyword in their short description only.

Terminology : in a command like `man -K [-M path] keyword`

`man` is the command, `-K` is the option or switch and `keyword` is the argument. Options and arguments are both parameters. Square brackets are used to indicate [optional] parameters. The argument is sometimes provided between < and > signs.

Unsure how to use the `man` command : try `man man`

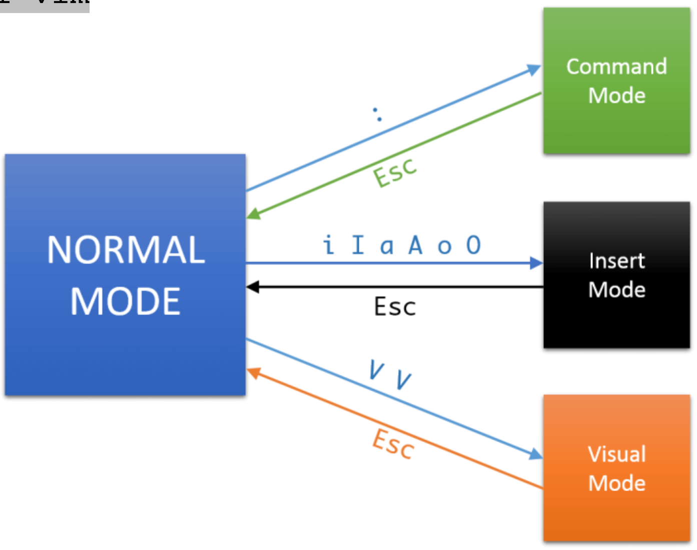
3.3 Text edition : introduction to vim

vim stands for VI iMproved (vi = Visual Interface) : a text editor using commands as opposed to menus like in windows' notepad. Other Linux text editors include *nano* (^ corresponds to ctrl) and *emacs*.

To install vim, type : `#apt-get install vim`
To open a file, type: `vim <filename>`

Vim works with different **modes**.

ESC takes you back to normal mode



Normal mode commands include :

to simply quit	`:q`
to force quit	`:q!`

to save and quit	`:wq`
to force save-quit	`:wq!` or `:x`

! can be used in conjuction with w to save a file which is read-only. It is strongly recommended to always cleanly exit vim using `:wq` otherwise there remains a swp temporary file.

w	Move to the start of the next word
e	Move to the end of the next word
ˆ	Move to the first word of the current line
$	Move to the end of the line
x	Delete the character under the cursor (delete=cut, p=paste)
dw	Delete from the current position to the end of the word
dd	Delete the current line.
u	Undo the last command
U	Undo all change to the current line

Visual mode allows you to highlight and copy some text:

y	copy
wy	copy word (position cursor on 1st character)
yy	copy line

Insertion keys are the following :

a	Append to the right of the cursor
A	Append at the end of the line
i	Insert text to the left of the cursor
I	Insert text to the left of the first non-blank character on current line
o	Open a new line below the current line and insert text
O	Open a new line above the current line and insert text

Vim includes a **tutorial**, type : `vimtutor` (and read until 4.2 included)

Practice : enable highlighting and line numbering options. Open or create a file, type the commands:

```
:syntax on
```

```
:set nu
```

To make the above options permanent, we need to create a configuration file in user's home folder :

`vim .vimrc` (we create a hidden file by starting its name with a dot)

To enable colour and line numbering option for the root user, copy .virmc to the root user home folder

```
$su root
```

`#cp .virmc ~`

To **search and replace**: `:%s/<word to search>/<word to replace>/gc`
(% specifies all document, s search, g=all instances, c=confirm)

To **open several documents** in the same console (split viewport vertical or horizontal) type `:sv` or `:sp`
The commands can include a filename. To toggle windows, use CTRL-W

To **open several tabs**, type `:tabnew [filename]` and toggle using `:tabp` (previous) and `:tabn` (next). Close the tab using the command `:tabc` (close)

For **fun**, type `:help 42` and `:help!`

4 Network configuration

4.1 Basic commands

Display interfaces information:

```
ip a
```

For detailed help, type `ip a help`

Since Debian 9, the command `ip a` (short for `ip address`) replaces `ifconfig`

Display DNS configuration

the file */etc/resolv.conf* contains the list of DNS servers:

```
cat /etc/resolv.conf
```

Display gateway information:

```
ip route
```

Display computer name

```
Hostname
```

Interface naming convention

Debian 9 uses the firmware/BIOS provided index numbers and then PCI card slot numbers, producing names like `enp1s1` (ethernet) or `wlp3s0` (wlan). This naming convention replaces the former `eth0`.

To enable an interface :

```
#ifup <interface_name>
```
Example :
```
#ifup enp0s3
```

To disable an interface

```
#ifdown <interface_name>
```
Example :
```
#ifdown enp0s3
```

4.2 Automatic configuration (dhcp)

Edit the interfaces configuration file */etc/network/interfaces* :

```
#vim /etc/network/interfaces
```

```
# automatically enable the network card
# (at the same time as the network service at boot up)
auto lo enp0s3
#Loopback interface, do not modify
iface lo inet loopback

#brings up the interface when a cable is plugged in
allow-hotplug enp0s3

#Configuration of interface eth0 with DHCP
iface enp0s3 inet dhcp
```

To enable the configuration, restart the network service:

```
#service networking stop
#service networking start
```

Some services have a "`restart`" and a "`status`" option

To renew the DHCP lease or send an IP address request :

```
#dhclient
```

4.3 Manual configuration (static address)

Edit the interfaces configuration file */etc/network/interfaces* :

```
#vim /etc/network/interfaces
```

```
# Static Configuration of interface eth0
iface enp0s3 inet static
# Definition of the IP address
address 10.0.0.100
# Definition of the network mask
netmask 255.255.255.0
# Definition of the gateway
gateway 10.0.0.1
```

5 Managing users and groups

5.1 Listing users and user parameters

The list of users is contained in the file **/etc/passwd** which you can open with vim for viewing but not for editing (best done via specific commands). The format is the following (: is the separator):

```
root:x:0:0:root:/root:/bin/bash
john:x:1000:1000:john,,,:/home/john:/bin/bash
```

- john is the username (login)
- x indicates that the password is encrypted
- 1000:1000 is the uid:gid (user ID and primary Group ID) for the first user. Other users would have 1001, 1002 etc while 0:0 is the uid:gid for the superuser.
- john,,, the description (in this example the same as the user name)
- /home/john is the path of the user's home folder
- /bin/bash is the command line interpreter (here the Bash Shell). Shells include

sh	Bourne shell (written by Stephen Bourne)
bash	Bourne Again shell (replaces the sh shell)
ksh	Korn shell (Bell Labs)
ash	Almquist shell (used in resource-constrained environments)
dash	Debian Almquist shell - modern replacement for ash in Debian.

In the list of users, some accounts are only used for a service (daemon; bin; ...) for security reasons. For example, when you install Apache, it creates a service account www-data. This service account cannot open a session. When you create a website, www-data must be the owner of the website's files and folders.

Hashed passwords are stored in **/etc/shadow** (view only as root, also best not to modify this file as this done by commands).

toto:$6$dBNsAuty$OCvLto.HGjOpKKBrgVAdQX9QuyoAnM/FeAN2xevUXrE.q9jKtVTnHhOmt9GAEAHkGB01IM.qo4NP.rPhbLp5Z1:17508:0:99999:7:::

User login name

Reference of the Hash algorithm

Salt

Salt+Password hash

* means no password is set, user cannot open a session, ! means account is locked

Days since Epoch (01.01.1970) of last password change

Days until change allowed

Days before change required

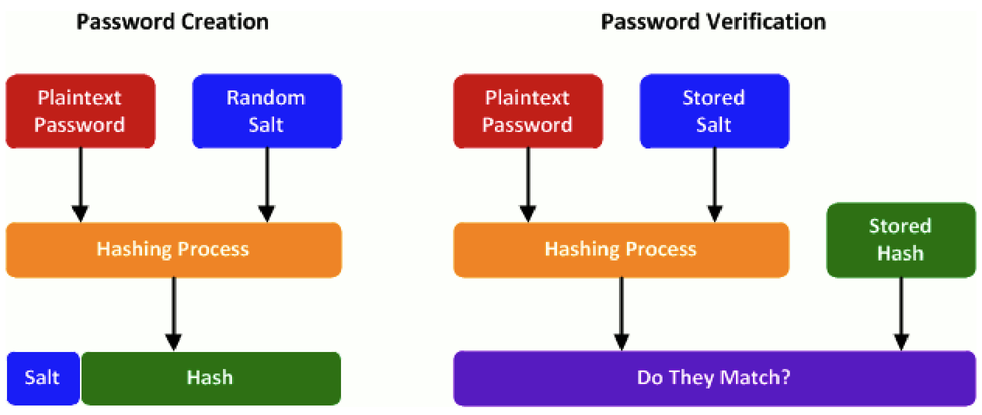
Days warning for expiration

Days before account inactive

Days since Epoch (01.01.1970) when account expires

Reserved

5.2 Authentication process



5.3 *Managing users and groups*

To **display information** about a user, including the groups to which it belongs:

```
id <username>
```

The output is as follows (note the default specific groups for audio, CD etc...)

```
uid=1000(user1) gid=1000(user1)
groups=1000(user1),24(cdrom),25(floppy),29(audio),30(dip),44(video),46
(plugdev)
```

Creating users is done thanks to the command:

```
#useradd -m -s <shell> <username>
```
or
```
#useradd -ms /<shell> <username>
```

Notes:

- the switch -s waits for an argument, for example /bin/bash, so you cannot type -sm)
- by default, the system sets /bin/sh as the shell
- the switch -m creates user home now (instead of at logon)

define a password (by default, accounts are locked: check /etc/shadows):

```
#passwd <username>
```

To **modify a user**, invoke the command (type `man usermod` for the many options)

```
#usermod <username>
```

When a user is created, it has a **default profile** copied from /etc/skel. If you want to add a configuration file to all users, add it to this folder. Example for the vim configuration:

```
#cd /etc/skel
#ls -al
#cp ~/.vimrc .
```

An alternative is to edit /etc/vim/.vimrc and either add a line or to uncomment (remove ") the appropriate line(s). This will affect all users.

To **create, delete or edit a group**, the commands are the following, respectively:

```
#groupadd <groupname>
#groupdel <groupname>
#groupmod <groupname>
```

The file /etc/group **lists all groups** (while /etc/passwd only shows the primary groups). When creating a user, a group that has the same name is automatically created.

To assign a primary group to a user : use the `usermod` command with the g option:

```
#usermod -g primary_group username
```

To **make users members of a secondary group**, use `a` for add and `G` for secondary group :

```
#usermod -aG group1,group2 username
```

5.4 Pipe for command input/output (applied to user management)

The symbol | is called pipe and **redirects** output of the first command into the second (in the example below it sends the output of `cat` into `grep`). The `grep` command returns all line in the file that contains a pattern. For example:

`cat /etc/passwd	grep <user>`	display only the line about one user

It is possible to define if the line should start (^) or finish ($) by the pattern. These symbols are part of Regular Expressions (regex), a complex but very precise, powerful and flexible method for matching strings of text. For example :

`cat /etc/passwd	grep ^us`	outputs all users who's name stars by "us"
`cat /etc/passwd	grep false$`	outputs users with not shell assigned

The following commands are more example of solutions to check system users and groups (note the possible switches for the "count" command `wc` : -l (line) -w (word) -m (character):

`who	grep root`	shows sessions that are open by root
`who	wc -l`	shows number of open sessions (connected users)
`wc -l /etc/group`	shows the number of groups
`cat /etc/group	wc -l`	same as above

The `cut` command is useful to display only a section of a line. The -d switch stands for "delimiter", which is a colon in the passwd field. The -f specifies the field numbers. The following commands display respectively: only the 3rd field (user ID), the 3rd and the 5th, from the 3rd to the 5th :

```
#cat passwd | grep <user> | cut -d ":" -f3
#cat passwd | grep <user> | cut -d ":" -f3,5
#cat passwd | grep <user> | cut -d ":" -f3-5
```

Exercise:

show number of users :

show connected users : OR

show main group id of first user created :

show groups of current user:

6 Permissions and ownership

6.1 Understanding permissions in Linux

To display the permissions on a file (or folder), type the command `ls -al`

```
-rwxrw-rw- 1 user1 user1  721 Jun 21 09:15 file1
drwxr-xr-x  2 user1 user1 4096 Jun 21 19:25 Pictures
```

The first block is for the user, the second for the primary group, the third for others. Every file has an owner (here user1). The letters represent the actual permissions, and each have a corresponding value :

r	read	4
w	write	2
x	execute	1
d	directory	(always has x : a folder must be executable)

Folder default permissions are	`755 (drwxr-xr-x)`
File default permissions are	`644 (-rw-r--r--)`

6.2 Changing permissions

If you create a file that contains some commands that you want to execute, you will need to make the files executable (a normal file is by default not executable). For example, create file in a user's home folder using vim, and type `whoami` in the file.

– Check the permissions :	644
– Try to execute the file (./<filename>):	“permission denied”
– Change permissions:	`$chmod u+x <filename>`
– Check the permissions :	now rwxr--r-- (744)

This is one possibility to change permissions (r, w, x), by adding (+) or removing (-) the right of the user (u) or the group (g) or others (o) or all (a). Instead of u in this example, you could type g, o or a (all). This is method uses the symbolic notation. Alternatively, you could set the permissions using the numeric notation : `chmod 744 <filename>`

In Linux, a file is created with the creator's permissions, it does not inherit the folder's permissions. To apply the same permissions to all sub-folders, use the recursive switch -R.

6.3 Ownership

In this example, the owner of file1 is user1 who belongs to the group user1 (see 4.2, when a user is created, it is automatically member of a group of the same name).

```
-rwxrw-rw- 1 user1 user1  721 Jun 21 09:15 file1
```

To change owner, type the command `#chown <user:group> <file_or_folder>`
Note that if you only specify one parameter instead of user:group, then user is considered.

Exercise: (see folders. Exercise 3_)

note : check group with id command

As a conclusion, here's a final note about permissions:

7 Disks and partitions

So that we can add hard-drives, we will first stop the virtual machine by typing either of the following:

```
#halt
```

7.1 List partitions and disks

Add two hard disks (default options) from the VM settings. Then restart the VM and type the command that will list the available hard drives and partitions.

```
#fdisk -l
```

```
Disk /dev/sda 16.6 GB, 16610492416 bytes
[...]
Device      Boot        Start       End         Blocks      Id    System
/dev/sda1   *           1           43          340992      83    Linux
/dev/sda2               43          1958        15384577    5     Extended
/dev/sda5               43          737         5573632     83    Linux
/dev/sda6               737         1070        2675712     83    Linux
/dev/sda7               1070        1181        886784      82    Linux swap / Solaris
/dev/sda8               1181        1229        389120      83    Linux
/dev/sda9               1230        1958        5855232     83    Linux
Disk /dev/sdb: 1073 MB, 1073741824 bytes
[...]
Disk /dev/sdb doesn't contain a valid partition table
Disk /dev/sdc: 1073 MB, 1073741824 bytes
[...]
Disk /dev/sdc doesn't contain a valid partition table
```

The first disk is called sda, the second disk sdb etc...

The first partition of the first disk is sda1

The new hard disk are not partitioned.

The column “system” tells the file system used when the partition was formatted. Other file system include : NTFS, FAT32 (VFAT is the Linux equivalent), EXT2, EXT3 (default), EXT4, HFS (Mac), ISO9660 (CDs). Type `man fs` for more information.

7.2 Create the partition

Linux provides a graphical utility to partition a disks:

```
#cfdisk <disk_id>
```
(disk_id = /dev/sd?)

For example:

```
#cfdisk /dev/sdb
```
select new > primary > size: default > write > yes (not y) > quit
check with `fdisk -l` : it now shows as partitioned

7.3 Format the new partition

We will format as EXT4, the default Linux file system.

```
#mkfs.ext4 <partition_id>
```
(partition_id = /dev/sd?#)

For example:

```
#mkfs.ext4 /dev/sdb1
```

Note the following lines in the output :

```
13052 blocks (5.00%) reserved for the super user
```

This allocated space is meant to let root connect and work in case a partition is filled. It is useful for system partition, but can recover space in other cases if ncessary.

```
This filesystem will be automatically checked every 30 mounts or 180 days
```

The system will automatically schedule checks (can be disabled)

7.4 Mount the new partition

So far, the partition is not accessible. We need to create a mount point (a folder), assign the correct permissions and mount the partition in this folder. Mount points should be located in the /mnt folder.

`#mkdir /mnt/disk1`	create mount point
`#mount -t  ext4 /dev/sdb1 /mnt/disk1`	mount the partition
`#df -h` or `#mount`	check the partitions that are mounted

We can now access the partition on the new hard disk in /mnt/disk1 and create a file.

7.5 Manage partitions

The command to unmount this partition is either `#umount /dev/sdb1` or `umount /mnt/disk1`
If the partition is not mounted, the folder /mnt/disk1 appears empty.

A partition mounted at the command line will not be accessible at the next boot up until we run the same command again. To automatically mount a partition at boot up, we need to edit a file :

```
#vim /etc/fstab
```

The file lists partitions as follows:

```
<file system> <mount point>   <type>  <options>       <dump>  <pass>
```

add a line with tabs as separators, for example :

```
/dev/sdb1       /mnt/disk1      ext4    defaults        0       2
```

Note that :

- for partitions created at installation, /dev/sdb? is represented by UUID
- there are possible options so that a partition could only used by one user
- errors=remount-ro means if error, mount in read only
- <pass> = mount order

To test, either reboot or ask system to mount partitions in fstab that are not already mounted using :

```
#mount -a
```

Display disk usage :

`du -sh`	disk used
`df -h`	disk free

(s = sum otherwise would list all files)

Exercice : configure /etc/fstab to automatically mount the second disk

8 Archived and compressed files

8.1 Archiving and compressing

An archive is a collection of files within a single file uncompressed (commonly called a tar file or tarball). The command to archive is tar (which stands for tape archive). It is handy to these archive files the .tar extension. For example, the following command would bundle all the .doc files in the current directory into the alldocs.tar file (switches : c= create, v=verbose, f expects a filename and should be placed last).

```
tar -cvf alldocs.tar *.doc
```

If you omit the file(s) or folder to archive, the command returns a message :

`tar -cvf <archive_name>`	Cowardly refusing to create an empty archive

The `gzip` program compresses a single file. One important thing to remember about `gzip` is that, unlike tar, it replaces your original file with a compressed version. The extension .gz is automatically given to the compressed file.

`gzip report.doc`	(compresses report.doc into report.doc.gz)
`gzip -r <directory>`	(compresses every file in the the directory)
`gzip alldocs.tar`	(compresses an archive, creates a tar.gz file)

It is possible to combine archiving and compressing thanks to the `-z` switch of the `tar` command. The switch `P` is optional and indicates that absolute paths should be used. It is recommended to provide a meaningful extension to compressed archives, for example tgz or tar.gz.

```
tar -cvPzf <archive_name> <files_or_folders_to_archive>
```

If you provide the files or folder name using the absolute path, and you omit the -P, the systems gives a warning :`Removing leading `/' from member names`

8.2 Checking the archive content

The command tar with the `t` (list) switch allows you to check content of archive. Note that the `tar` command accepts that you omit the – before the switches.

```
tar tvf <archive_name>
```

8.3 Decompressing / restoring

You can decompress the a file that was compressed with the `gzip` command. For example, the command below will return the file report.doc.gz to its original state report.doc.

```
gunzip report.doc.gz
```

The command `tar` with the `-x` switch will restore an archive. Without the P switch, restore will use the relative path, meaning you have to be in the right folder.

```
tar -xPvzf <archivename>
```

It is possible to partially restore archive by providing the path.

```
tar -xPvzf <archive> </path/of/data/to/restore>
```

Exercises :

1/ Create a user with the correct option to create the home directory : archive, delete and restore it.

2/ create user Bob, and in his home folder create folder1 and add a file in this folder
backup Bob's home folder using tar to /mnt/disk1/backup
delete folder1
restore folder1

Notes about the correction:

`;`	runs two commands in one line, no matter what is the output of the first command
`&&`	runs the second command only if there is no error in first one, based on the return code
`||`	runs second command only if error in first command

`echo $?`	gives return value of last command (0 no error)

`1> /dev/null`	sends the standard output to the null device (“black hole”), i.e. no output displayed
`2> /dev/null`	sends any error to the null device (“black hole”), i.e. no error displayed

see : http://en.wikipedia.org/wiki/Redirection_%28computing%29

9 Managing processes

9.1 *Listing running processes*

There are various ways to display the list of all running processes :

`top`	lists all processes in realtime as well as system resources
`pstree`	displays process tree (note that init is the first process)
`ps -ef`	displays processes with PPID
`ps -aux`	displays processes with CPU and memory usage

PID = Process ID (numbered by order of creation)
PPID = Parent Process ID

If you want to monitor system resources real time, you can use an application called saidar :

```
#apt-get install saidar
#saidar -c
```

`uptime`	displays how long the system has been running

Exercise : launch vim and find its process ID using the command grep

9.2 *Stopping a process*

In case an application hangs, you can stop the related process with the command `kill` followed by the process ID :

`kill <PID>`	unless logged as root, you can only kill process that you started

This command sends a signal to a process, by default 15 (TERM) which asks the application to terminate. Should this signal fail, you can use 9 (KILL) which cannot be blocked. To stop all processes with the same name as oppposed to stopping according to user or pid, use the following commands :

```
#killall <process_name>
#pkill <process_name>
```

Exercise : install Lynx (text mode web browser), launch it and kill it

```
#apt-get install lynx
#lynx <ulr>
```

10 Symbolic links

A symbolic link (also called symlink or soft link) is a special type of file that contains a reference to another file or directory. The command to create a symbolic links is the following (note that <link_name> must not be an existing file or folder). It is recommended to use absolute paths. The command `ls -l` shows symbolic link with an arrow pointing to the actual folder or file.

```
ln -s <source_file_or_folder> <link_name>
```

Symbolic links are particularly useful if a partition is running out of disk space and it is fully transparent for the user and for the system alike. For example, suppose a server has a partition for /etc, /lib, /root and /var that has become too small, and another with /home that has plenty of space. It is possible to create a symbolic link so that /var points to /home/var :

1/ stop processes of applications creating logs

2/ type the commands:

```
#cp -pR /var /home/var
#rm -R /var
#ln -s /home/var /var
```

(-p switch to copy keeping ownership)

3/ restart the processes

To remove symbolic, type :

```
rm <link_name>
```

Note that there is no switch -R as it only deletes the links, not the content of actual folder. If you remove or rename the actual folder (source), the symbolic link remains but points to nothing.

11 Schedules jobs

11.1 Examples of configuration

Cron is a time-based job scheduler common to all Unix-based systems. Cron enables users and administrators to schedule jobs (commands or shell scripts) to run periodically at set times or dates. This utility is driven by a configuration file called crontab located in /etc.

In the example below, the script would run on a weekly basis at 6:47am every Sunday.

```
#vim /etc/crontab
 m          h     dom         mon         dow         user        command
47          6     *           *           7           root        /path/script
```

m : minute
h: hour
dom : day of month
mon : month
dow : day of week
* = any

Examples :

5th of June at 13:26

```
m    h    dom  mon  dow  user  command
26   13   5    6    *
```

any Friday 13th, at 13:13

```
m    h    dom  mon  dow  user  command
13   13   13   *    5
```

any working day of the week in July and May

```
m    h    dom  mon  dow  user  command
*    *    *    5,7  1-5
```

Note : it is recommended to point the entry in the crontab file to a script rather than typing the actual command. This also allows for testing the script prior to creating the scheduled job.

11.2 Application to automated backup

Below is how you would plan a backup of the /home folder to /mnt/disk1 using the command tar:

```
#cd /root
#vim home_backup
```

type the command : `tar cvPzf /mnt/disk1/backup/home.tgz /home`

make this file executable (chmod u+x)
test script before configuring crontab
add script to crontab and configure it 5 or 10 minutes ahead of the current time

```
45 10   * * *   root    /root/home_backup
```

Doing so however means that each daily backup will overwrite the previous one. This can be avoided by including the date in the file name using the command `date` between back-quotes :

```
/mnt/disk1/backup/`date +%Y_%m_%d`_home.tgz
```

Swapping `%Y_%m_%d` is possible but in general, providing the year first makes it easier to sort as files will appear by default in the actual order when listed with the command `ls`.

For a more elaborate script, see the file cron_ex

12 System event logs (syslog)

Syslog is a standard for logging program messages. The program rsyslog is available for a number of Unix systems and Linux distributions. It uses the configuration file rsyslog.conf. Logs are store in /var/log

```
ls -l /var/log
-rw-r----- 1 root        adm              0 Jun 21 18:36 mail.err
-rw-r----- 1 root        adm              0 Jun 21 18:36 mail.info
-rw-r----- 1 root        adm              0 Jun 21 18:36 mail.log
-rw-r----- 1 root        adm              0 Jun 21 18:36 mail.warn
```

The directory listing for the `mail` service show that its logs are set with different security levels.

0 - Emergency (emerg)
1 - Alerts (alert)
2 - Critical (crit)
3 - Errors (err)
4 - Warnings (warn)
5 - Notification (notice)
6 - Information (info)
7 - Debug (debug)
* - any

These security levels are set in the configuration file along with the "facilities" which loosely relate to system processes. Some facilities log all types of events into one log file.

`#vim /etc/rsyslog.conf` (go to line 54)

```
kern.*       -/var/log/kern.log          (any kernel related event is logged in kern.log)
mail.err      /var/log/mail.err          (mail errors logged in a specific file)
```

auth	- authentication (login) messages
cron	- messages from the memory-resident scheduler
daemon	- messages from resident daemons
kern	- kernel messages
lpr	- printer messages
mail	- messages from Sendmail
user	- messages from user-initiated processes/apps
syslog	- messages from the syslog process itself

You can display the last 20 lines of some of the files, for example the authentication log :

```
#tail -20 /var/log/auth.log
```

13 Installing applications

13.1 Using apt-get and the repositories

Every Linux distribution has its own way of packaging software. For example, Red Hat uses .rpm packages to install software and Debian uses .deb packages. These packages are made available in a public repository where they are organized in a special directory tree. Depending on the location / country provided at installation, the system will set certain repositories as preferred. In a typical installation, you would first if necessary add a repository, then update the packet list, update the packets and only then install:

`#vim /etc/apt/sources.list`	list repository in use
`#apt-get update`	update the packet list (resynchronize)
`#apt-get upgrade`	update packets
`#apt-get install <packetname>`	install a packet
`#apt-cache search <name>`	search packets
`#apt-get remove <packetname>`	remove a packet (uinstall)
`#apt-get remove --purge <packetname>`	remove a packet including config files

The graphical interface (synaptic) also uses `apt-get`. Note that there an alternative to `apt-get` called `aptitude`. It is recommended to always use either `apt-get` or `aptitude`.

I you install, then uninstall, and later reinstall, the system does not need to download again, it will the packets stored locally. It is also possible to manually download .deb files but this is not recommended as you will then have to manually update the applications.

`wget` download item from webpage
(a gpg key a identification key system people use to "sign" files so you can check their authenticity)

13.2 Installing using source files

Generally you would get the source files for a Linux software in the tarball format (.tgz) This file has to be uncompressed into any directory using tar command. The software installation is then done in 3 steps : configure, make, make install.

The **configure** script basically consists of many lines which are used to check some details about the machine on which the software is going to be installed. The main job of the configure script is to create a file called ' Makefile '

The **make** utility compiles all your program code. It creates the executables using the directions present in the Makefile and proceed with the installation.

But when type **make install** (you run make with install as the parameter), the make utility searches for a label named install within the Makefile, and executes only that section of the Makefile. The install section happens to be only a part where the executables and other required files created during the last step (i.e. make) are copied into the required final directories on your machine.

Note that this procedure is more complex than using `apt-get` or `aptitude`, and only applies to software not available from a repository (e.g. recent updates, test versions) and for other specific needs as well as Slackware-type distributions.

14 Web server Apache

Apache is the web server software that played a key role in the initial growth of the Web. Apache is an Open-Source software designed to work on Unix like systems, although a Windows version does exist.

Apache is used by 42% of the top million busiest sites (its growing and also OpenSource competitor nginx represents another 30%, and Microsoft 10%).
For more statistics regarding the market share of various web servers, please refer to :
https://news.netcraft.com/archives/2017/02/27/february-2017-web-server-survey.html

14.1 Installation

```
#apt-get install apache2
```

Once installed, enter the IP of your server in a web browser and you should see a message "It works".
This is the default website.

14.2 Configuration files

The main configuration file of Apache `is /etc/apache2/apache2.conf`. This file is only edited when global changes in the server configuration are required.

The various websites have their own respective configuration files stored in `/etc/apache2/sites-available.` This directory `/etc/apache2/sites-available` contains the list of websites that are available, but not necessarily enabled.

The directory `/etc/apache2/sites-enabled` contains the list websites that are enabled. When a website is enabled, a symbolic link is created in `/etc/apache2/sites-enabled` pointing to the configuration file located in `/etc/apache2/sites-available`

At installation of Apache, a default website is created with a basic configuration.
`vim /etc/apache2/sites-available /000-default.conf`

```
# the * means any IP, 80 is the port number
<VirtualHost *:80>
        #ServerName www.example.com
        ServerAdmin webmaster@localhost
        #DocumentRoot is the location of the website's content
        DocumentRoot /var/www/html

        #LogLevel info ssl:warn
        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

</VirtualHost>
```

If you wish to host only one website, the easiest is to edit the default website configuration file and place the website's files in the default folder `/var/www`.

14.3 Setting up additional websites

In order to host several websites on the same server, there must be a parameter to distinguish them:

- Port number (implies that the user knows which port and specifies it in the URL)
- IP address (on a multihomed server, a website can be configured to respond to one IP address)
- ServerName : this directive specifies the address of the website, it requires that an alias is created in the DNS zone (typically www). The website will only respond to request corresponding to the ServerName parameter (for example www.linux .corp). This is the most practical way.

Copy the configuration file of the default website and to edit this copy:

```
#cp /etc/apache2/sites-available/000-default.conf /etc/apache2/sites-available/linux.corp.conf
```

The file can take any name but it is recommended to choose a meaningful filename (for example the actual website name : linux.corp.conf) in order to easily identify the various configuration files when there are several websites.

Next, you need to create a root folder for the website. The recommended location is /var :

```
#mkdir /var/www/linux.corp
```

The owner of this folder should be the Apache service account named www-data instead of root:

```
#chown -R www-data:www-data /var/www/linux.corp
```

We can now edit the website configuration file :

```
#vim /etc/apache2/sites-available/linux.corp
```

```
# the * means any IP, 80 is the port number
<VirtualHost *:80>
        # uncomment and edite the ServerName directive
        ServerName www.linux.corp
        ServerAdmin webmaster@localhost
        #DocumentRoot is the location of the website's content
        DocumentRoot /var/www/linux.corp

        #LogLevel info ssl:warn
        ErrorLog ${APACHE_LOG_DIR}/error.log
        CustomLog ${APACHE_LOG_DIR}/access.log combined

</VirtualHost>
```

You can now enable the website with the following command :

```
#a2ensite <name_of_website_config_file>
```

Note that a symbolic link has been created in the folder /etc/apache2/sites-enabled
Example :

```
#a2ensite linux.corp.conf
```

The following command allows you to disable a website (it removes the symbolic link):

```
#a2dissite linux.corp.conf
```

To validate the configuration changes, you have to reload (not restart!) the Apache service.

```
#service apache2 reload
```

A 'www ' alias (or an A record) pointing to the Apache server has to be created on the DNS server in charge of the domain. Finally, create a file called index.html in the website root folder, and test if you can display the webpage using a web-browser.

14.4 Troubleshooting tips

- start by checking the name resolution with a ping on the alias:
`#ping www.linux.corp`

- check if the `ServerName` directive in the website configuration file is correct

- empty the web-browser cache

- empty the local computer DNS cache (on windows : ipconfig /flushdns).

- under Gnome, try Iceweasel if you cannot display the site using Epiphany

- you can always try with Lynx ...

15 Appendix

15.1 Finding a file

```
find <path> -iname <item_to_find>
```

(iname = not case sensitive)
can use wildcards * and ?

15.2 Forward display through SSH

X11-forwarding allows you to send the display of a graphic program or utility to a remote client over SSH. You can install an app on a Debian server, which will use its resources to execute it, but the display will be sent to a remote client (for example a Windows desktop). For more info, see :
http://en.wikipedia.org/wiki/X_Window_System

- **on windows : install xming**

http://sourceforge.net/projects/xming/files/
(select putty portable if so)

- **on debian**

install the following packets : `x11-common x11-apps xauth`
install the app for which you wish to forward the display to windows (eg `iceweasel`)
open `/etc/ssh/sshd_config` and ensure you have `X11Forwarding yes`

- **configure putty**

expand SSH > X11
tick "enable X11 forwarding"
set X display location to localhost:0.0
leave protocol on MIT-Magic-Cookie

- **test**

open a SSH connection with putty
launch the app with the bash command
alternatively you can test with an app of the X11-apps package
(see https://packages.debian.org/hu/wheezy/x11-apps)

- **in case of error** `"Missing charsets in String to FontSet conversion"`

install xming-fonts on windows
http://sourceforge.net/projects/xming/files/Xming-fonts/

15.3 Streamline editor (sed)

The command sed allows you to modify a file without opening it. Used with REGEX, it’s a powerful but complex command.

Example :

```
sed 's/day/night/g' <originalfile > newfile
```

This command will subsitute (s) globally (g) all instances of day into night in originalfile and saves the result as newfile

```
sed -i 's/day/night/g' filetofix.txt
```

the option -i stands for “inline” as it will overwrite the original file, so you can do the job "on the fly"

A note about REGEX (regular expressions) :

. stands for a single character

[x|y] will match x and y

the backslash is to escape, that is to tell sed that the character that follows is to be interpreted literaly.

https://wiki.debian.org/Tutorials/Sed