Linux & LPIC
Quick Reference Guide

Foreword

This guide stems from the notes I have taken while working with Linux and preparing the LPIC-1 certification. As such, it includes (almost) all topics of the LPIC-1 exam. This guide, which I started writing in 2013, is a work in progress and my aim is to update it periodically to make it as complete as possible. Please check the date in the right bottom corner of each page to ensure you're reading the latest version.

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Happy Linux hacking,

Daniele Raffo

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`hdparm`	Get/set disk parameters
`hdparm -g /dev/sda`	Display drive geometry (cylinders, heads, sectors) of /dev/sda
`hdparm -tT /dev/sda`	Perform benchmarks on the /dev/sda drive
`hdparm -p 12 /dev/hda`	Reprogram IDE interface chipset of /dev/sda to mode 4. Use with caution!

`lsdev`	List information about the system's hardware

`lspci`	List PCI devices
`lspci -d 8086:`	List all Intel hardware present. PCI IDs are stored in `/usr/share/misc/pci.ids` (Debian) or `/usr/share/hwdata/pci.ids` (Red Hat)

`lsusb`	List USB devices
`lsusb -d 8086:`	List all Intel USB devices present. USB IDs are stored in `/var/lib/usbutils/usb.ids`

`lsmod`	List loaded kernel modules
`insmod [module]`	Insert a module into the running kernel
`rmmod [module]`	Remove a module from the running kernel
`modinfo [module]`	Display information about a module
`modprobe`	Load/remove/list modules from the kernel

The Hardware Abstraction Layer (HAL) manages device files and provides plug-and-play facilities. The HAL daemon `hald` maintains the list of devices in a database.
udev creates the device nodes in `/dev/`. When a device is added, removed, or changes state, the kernel sends an uevent received by the `udevd` daemon.

`udevadm monitor` (Debian) `udevmonitor` (Red Hat)	Monitor uevents
`dbus-monitor`	Monitor messages going through a D-Bus message bus
`dbus-monitor --session`	Monitor session messages (default)
`dbus-monitor --system`	Monitor system messages

`dmesg [options]`	Print the logs of the kernel ring buffer
`dmesg -n 1`	Set the logging level to 1 (= only panic messages)

Almost all Linux commands accept the option `-v` (verbose), and many commands also accept the option `-vv` (very verbose).

/proc **pseudo filesystem**		
Directory	**Meaning**	**Equivalent command**
/proc/*n*/	Information about process with PID *n*	ps *n*
/proc/*n*/cmdline	Command line the process was launched by	
/proc/*n*/cwd	Working directory of process	
/proc/uptime	Time elapsed since boot	uptime
/proc/sys/	sysfs	
/proc/sys/kernel/	Kernel information and parameters	
/proc/sys/net/	Network information and parameters	
/proc/partitions	Drive partition information	
/proc/mounts	Mounted partitions	mount
/proc/devices	Drivers currently loaded	
/proc/modules	Kernel modules currently loaded	lsmod
/proc/bus	Buses (PCI, USB, PC Card...)	
/proc/ioports	I/O addresses in use	
/proc/dma	DMA channels in use	
/proc/interrupts	Current interrupts	
/proc/cpuinfo	CPUs information	
/proc/meminfo	Total and free memory	free
/proc/version	Linux version	uname -a

Boot sequence	
POST (Power-On Self Test)	Low-level check of PC hardware.
BIOS (Basic I/O System)	Detection of disks and hardware.
Chain loader GRUB (GRand Unified Bootloader)	GRUB stage 1 is loaded from the MBR and executes GRUB stage 2 from filesystem. GRUB chooses which OS to boot on. The chain loader hands over to the boot sector of the partition on which resides the OS. The chain loader may also load initrd, an initial ramdisk to be used as the initial root device during kernel boot.
Linux kernel	Kernel decompression into memory. Kernel execution. Detection of devices. Root filesystem is mounted on / in place of the initial ramdisk.
init	Execution of the first process (PID 1): `/sbin/init`
Startup	System loads startup scripts and runlevel scripts.
X Server	(Optional) The X Display Manager starts the X Server.

OS startup sequence (SysV)	Debian	Red Hat
At startup `/sbin/init` switches to the default runlevel specified in `/etc/inittab`:	`id:2:initdefault:`	`id:5:initdefault:`
The script for system initialization is then run:	`/etc/init.d/rcS`	`/etc/rc.d/rc.sysinit`
The script launches all services and daemons specified in the startup directories where *N* is the actual runlevel:	`/etc/rcN.d/`	`/etc/rc.d/rcN.d/`

The startup directories contain symbolic links to scripts in `/etc/init.d/` which are executed in numerical order. Links starting with K are called with argument `stop`, links starting with S are called with argument `start`.

```
lrwxrwxrwx.  1 root root   14 Feb 11 22:32 K88sssd -> ../init.d/sssd
lrwxrwxrwx.  1 root root   15 Nov 28 14:50 K89rdisc -> ../init.d/rdisc
lrwxrwxrwx.  1 root root   17 Nov 28 15:01 S01sysstat -> ../init.d/sysstat
lrwxrwxrwx.  1 root root   18 Nov 28 14:54 S05cgconfig -> ../init.d/cgconfig
lrwxrwxrwx.  1 root root   16 Nov 28 14:52 S07iscsid -> ../init.d/iscsid
lrwxrwxrwx.  1 root root   18 Nov 28 14:42 S08iptables -> ../init.d/iptables
```

To add or remove services at boot sequence (startup directories are updated accordingly):	`update-rc.d [service] defaults`
	`update-rc.d -f [service] remove`
		`chkconfig --add [service]`
		`chkconfig --del [service]`

Runlevel	Debian	Red Hat
0	Shutdown	
1	Single user mode	
2	Multi-user mode (default)	Multi-user mode without network
3	Multi-user mode	Multi-user mode with network
4	Multi-user mode	Unused, for custom use
5	Multi-user mode	Multi-user mode with network and X (default)
6	Reboot	

`runlevel`
`who -r`
	Display the previous and the current runlevel

`init [runlevel]`
`telinit [runlevel]`
	Change runlevel

`init 0`
`shutdown -h now`
`halt`
	Halt the system

`init 6`
`shutdown -r now`
`reboot`
	Reboot the system

`shutdown -h 16:00 "System halt at 4 PM"`	Halt the system at 4 PM and issue a warning message to all logged in users

Filesystem Hierarchy Standard (FHS)	
`/bin`	Essential command binaries
`/boot`	Bootloader files (kernel, initrd...)
`/dev`	Devices and partitions
`/etc`	System configuration files
`/home`	Home directories for users
`/lib`	Libraries for the binaries in `/bin` and `/sbin`, kernel modules
`/media`	Mount points for removable media
`/mnt`	Mount points for temporary filesystems
`/opt`	Optional application software packages
`/proc`	Virtual filesystem providing kernel and processes information
`/root`	Home directory for root
`/sbin`	Essential system binaries
`/srv`	Data for services provided by the system
`/tmp`	Temporary files
`/usr`	User utilities and applications
`/usr/bin`	Non-essential command binaries (for all users)
`/usr/lib`	Libraries for the binaries in `/usr/bin` and `/usr/sbin`
`/usr/sbin`	Non-essential system binaries (daemons and services)
`/usr/src`	Source code
`/var`	Variable files (logs, caches, mail spools...)

Linux-supported filesystems	
ext2	Linux filesystem
ext3	ext2 with journaling (the journal logs changes before committing them to the filesystem; ensures faster recovery and less corruption in case of a crash)
ext4	Linux journaling filesystem
reiserfs	Journaling filesystem
fat32	MS-Windows FAT filesystem
iso9660	CD-ROM filesystem
cramfs	Compressed RAM disk

`/dev/hda, /dev/hdb, ...`	first, second, ... IDE hard drive
`/dev/sda, /dev/sdb, ...`	first, second, ... SATA hard drive
`/dev/sda1, /dev/sda2, ...`	first, second, ... partition of the first SATA drive

Partitioning limits for Linux:

Max 4 primary partitions per hard disk, or 3 primary partitions + 1 extended partition	Partition numbers: 1-4
Max 11 logical partitions per hard disk (inside the extended partition)	Partition numbers: 5-15

Required partitions for Linux:

/	root containing the whole Linux distribution
swap	virtual memory used as RAM extension

The Logical Volume Manager permits disk hotswapping, partition resizing, dynamic logical volume assignment, backup via snapshots.
The superblock contains information relative to the filesystem (filesystem type, size, status, metadata structures...).
The Master Boot Record (MBR) is a 512-byte program located in the first sector of the hard disk; it contains information about hard disk partitions and has the duty of loading the OS.

`fdisk -l [device]`	List the partition table
`fdisk [device]`	Disk partitioning interactive tool
`cfdisk`	Text-based UI for fdisk
`gparted`	Graphical UI for fdisk in GNOME
`partprobe`	Notify the OS of partition table changes (without needing to reboot)
`mkfs -t [fstype] [device]`	Create a filesystem of specified type on a partition
`mke2fs /dev/sda`	Create a ext2 filesystem on first SATA drive
`mke2fs -j /dev/sda`	Create a ext3 filesystem (with journaling) on first SATA drive
`mkswap [options] [device]`	Create a swap filesystem on a partition
`swapon [options] [device]`	Enable a swap partition
`swapoff [options] [device]`	Disable a swap partition
`mount /dev/sda /mnt`	Mount a filesystem to mount point `/mnt` (mount directory must exist)
`mount`	Print the currently mounted filesystems
`df`	Report filesystem disk space usage

Boot manager

GRUB (Grand Unified Bootloader) is the standard bootloader on modern Linux distros, which may use either version: GRUB Legacy or GRUB 2.
Older Linux distros used LILO (Linux Loader) instead.

GRUB Stage 1 (446 bytes), as well as the partition table (64 bytes) and the boot signature (2 bytes), is stored in the 512-byte MBR. It accesses the GRUB configuration and commands available on the filesystem.

`grub-install /dev/sda`	Install GRUB on first SATA drive

GRUB Legacy configuration file (`/boot/grub/menu.lst` or `/boot/grub/grub.conf`)

```
timeout 10  # Boot the default kernel after 10 seconds
default 0   # Default kernel is 0

# Section 0: Linux boot
title   Debian     # Menu item to show on GRUB bootmenu
root    (hd0,0)    # root filesystem is /dev/hda1
kernel  /boot/vmlinuz-2.6.24-19-generic root=/dev/hda1 ro quiet
splash
initrd  /boot/initrd.img-2.6.24-19-generic

# Section 1: Windows boot
title   Microsoft Windows XP
root    (hd0,1)   # root filesystem is /dev/hda2
savedefault
makeactive        # set the active flag on this partition
chainloader +1    # read 1 sector from start of partition and run
```

Common kernel parameters:

`root=`	Defines filesystem root
`ro`	Mount read-only on boot
`quiet`	Disable most log messages
`debug`	Enable kernel debugging

GRUB 2 configuration file (`/boot/grub/grub.cfg`)

```
# Linux Red Hat
menuentry "Fedora 2.6.32" {    # Menu item to show on GRUB bootmenu
set root=(hd0,1)               # root filesystem is /dev/hda1
linux /vmlinuz-2.6.32 ro root=/dev/hda5 mem=2048M
initrd /initrd-2.6.32
}

# Linux Debian
menuentry "Debian 2.6.36-experimental" {
set root=(hd0,1)
linux (hd0,1)/bzImage-2.6.36-experimental ro root=/dev/hda6
}

# Windows
menuentry "Windows" {
set root=(hd0,2)
chainloader +1
}
```

Is not meant to be edited manually.
Instead, you must edit:
`/etc/grub.d/`
`/etc/default/grub`
and then run `update-grub`

The runtime loader `ld.so` loads the required libraries of the program into RAM, searching in this order:

`LD_LIBRARY_PATH`	Environment variable specifying the list of directories where libraries should be searched for first
`/etc/ld.so.cache`	Cache file
`/lib` and `/usr/lib`	Default locations for shared libraries

`/etc/ld.so.conf`	Configuration file used to specify other shared library locations (other than the default ones `/lib` and `/usr/lib`)
`ldconfig`	Create a cache file `/etc/ld.so.cache` of all available dynamically linked libraries. To be run when the system complains about missing libraries
`ldd [program or lib]`	Print library dependencies

Package management		Debian	Red Hat
Low-level tools	Install a package file	`dpkg -i package.deb`	`rpm -i package.rpm`
	Remove a package	`dpkg -r package`	`rpm -e package`
	Upgrade a package (and remove old versions)		`rpm -U package.rpm`
	Upgrade a package (only if an old version is already installed)		`rpm -F package.rpm`
	List installed packages and their state	`dpkg -l`	`rpm -qa`
	List the content of an installed package	`dpkg -L package`	`rpm -ql package`
	List the content of a package file	`dpkg -c package.deb`	`rpm -qpl package.rpm`
	Show the package containing a specific file	`dpkg -S file`	`rpm -qf file`
	Reconfigure a package	`dpkg-reconfigure package`	
	Install a package source file		`rpm -i package.src.rpm`
	Compile a package source file		`rpm -ba package.spec`
High-level tools (can install remote packages, automatically solves dependencies)	Install a package	`apt-get install package`	`yum install package`
	Remove a package	`apt-get remove package`	`yum remove package`
	Upgrade an installed package		`yum update package`
	Upgrade all installed packages	`apt-get upgrade`	`yum update`
	Upgrade all installed packages and handle dependencies with new versions	`apt-get dist-upgrade`	
	Get the source code for a package	`apt-get source package`	
	Check for broken dependencies and update package cache	`apt-get check`	
	Fix broken dependencies	`apt-get install -f`	
	Update information about available packages	`apt-get update`	
	List all available packages		`yum list`
	Search for a package	`apt-cache search package`	`yum search package`
	Show package dependencies	`apt-cache depends package`	`yum deplist package`
	Show package records	`apt-cache show package`	`yum list package`
	Show information about a package	`apt-cache showpkg package`	`yum info package`
	Update information about package contents	`apt-file update`	
	List the content of an uninstalled package	`apt-file list package`	
	Show the package containing a specific file	`apt-file search file`	`yum provides file`
	Add a CD-ROM to the list of available sources	`apt-cdrom add`	
	Download package and resolve dependencies		`yumdownloader --resolve package`
	List the URLs that would be downloaded		`yumdownloader --urls package`
Text-based UI or graphical tools	Manage packages and dependencies	`aptitude`	
		`dselect`	
Other tools	Convert a RPM package to DEB and installs it. May break the package system!	`alien -i package.rpm`	
	Convert a RPM package to cpio archive		`rpm2cpio package.rpm`
Miscellaneous information	List of available sources	`/etc/apt/sources.list`	`/etc/yum.repos.d`
	Package format	compressed with `ar` (package `binutils`)	compressed with `cpio`

`man 7 [command]`	Show manpage 7 for a command
`man man`	Show information about manpages' content: 1 Executable programs or shell commands 2 System calls (functions provided by the kernel) 3 Library calls (functions within program libraries) 4 Special files 5 File formats and conventions 6 Games 7 Miscellaneous 8 System administration commands (usually only for root) 9 Kernel routines

`cd [directory]`	Change to the specified directory
`cd -`	Change to the previously used directory
`pwd`	Print the current directory you are in

`history`	Show the history of command lines executed up to this moment. Commands prepended by a space will be executed but won't show up in the history. Once you logout from Bash, history is saved into `~/.bash_history`
`!`*n*	Execute command number *n* in the command line history
`history -c`	Delete command line history

`uname -a`	Print system information

`vlock` `away`	Lock the virtual console (terminal)

Bash shortcuts	
`.`	Current directory
`..`	Parent directory
`~`	Home directory of current user
`~jdoe`	Home directory of user jdoe

Text streams

cat myfile	Print a text file
cat myfile1 myfile2 > myfile3	Concatenate text files
head myfile head -n 10 myfile	Print the first 10 lines of a text file
tail myfile tail -n 10 myfile	Print the last 10 lines of a text file
tail -f myfile	Output appended data as the text file grows; useful to read logs in realtime
tac myfile	Print a text file in reverse, from last line to first line
fmt -w 75 myfile	Format a text file so that each line has a max width of 75 chars
pr myfile	Format a text file for a printer
nl myfile	Prepend line numbers to a text file
wc myfile	Print the number of lines, words, and bytes of a text file
join myfile1 myfile2	Join lines of two text files on a common field
paste myfile1 myfile2	Merge lines of text files
split -l 1 myfile	Split a text file into 1-line files (named xaa, xab, xac, ...)
uniq myfile	Print the unique lines of a text file, omitting consecutive identical lines
sort myfile	Sort alphabetically the lines of a text file
expand myfile	Convert tabs into spaces
unexpand myfile	Convert spaces into tabs
od myfile	Dump a file into octal
cut -d: -f3 myfile	Cut the lines of a file, considering : as the delimiter and printing only the 3rd field
cut -d: -f1 /etc/passwd	Print the list of user accounts in the system
sed s/foo/bar/ myfile	Replace the first occurrence of foo with bar (Stream Editor)
sed s/foo/bar/g myfile	Replace all occurrences of foo with bar
tr a-z A-Z <myfile tr [:lower:] [:upper:] <myfile	Convert all lowercase into uppercase in a text file (Translate characters)
tr -d 0-9 <myfile tr -d [:digit:] <myfile	Delete all digits from a text file

Processes

Any application/program/script that runs on the system is a process. Signals are used for inter-process communication. Each process has an unique PID (Process ID) and a PPID (Parent Process ID); when a process spawns a child, its PID is assigned as the child's PPID.
The `/sbin/init` process, run at bootup, has PID 1; is the ancestor of all processes and becomes the parent of any orphaned process.
When a child process dies, its status becomes EXIT_ZOMBIE and a SIGCHLD is sent to the parent. The parent should then call the `wait()` system call to read the dead process' exit status and other info; until that moment, the child stays zombie.

`ps -ef` (UNIX options) `ps aux` (BSD options)	List all processes
`pstree`	Display all processes in hierarchical format
`top` `htop`	Monitor processes in realtime
`free`	Show the amount of free and used memory in the system
`vmstat`	Show virtual memory statistics
`uptime`	Show how long the system has been up, and the system load averages

`kill -9 1132`	Send a signal 9 (SIGKILL) to process 1132, killing it	
`killall -9 sshd`	Kill processes whose name is sshd	
`pgrep -u root sshd`	Show processes whose name is sshd and are owned by root	(`pgrep` and `pkill` accept the same options)
`pkill -9 -u root sshd`	Kill processes whose name is sshd and are owned by root	

`jobs`	List all jobs (i.e. processes whose parent is a Bash shell)
CTRL Z	Suspend a job, putting it in the stopped state (send a SIGTSTP)
`bg %1`	Put job #1 in the background (send a SIGCONT)
`fg %1`	Resume job #1 in the foreground and make it the current job (send a SIGCONT)
`kill %1`	Kill job #1

When a Bash shell is terminated cleanly via `exit`, its jobs will became child of the Bash's parent and will continue running.
When a Bash is killed instead, it issues a SIGHUP to his children which will terminate.

`nohup myscript.sh`	Prevent a process from receiving a SIGHUP (hence terminating) when its parent Bash dies

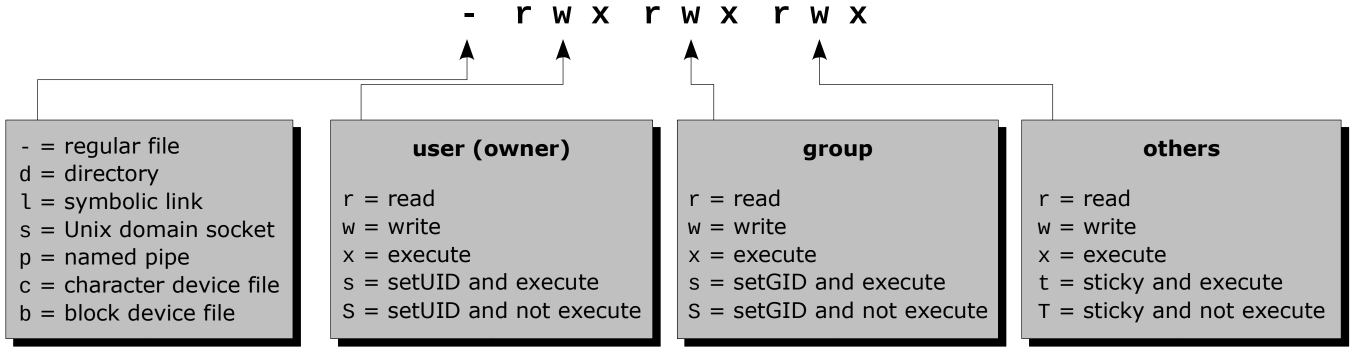
To each process is associated a niceness value: the lower the niceness, the higher the priority.
The niceness value ranges from -20 to 19, and a newly created process has a default niceness of 0.
Unprivileged users can modify a process' niceness only within the range from 1 to 19.

`nice -n -5 [command]`	Start a command with a niceness of -5 (if niceness is omitted, a default value of 10 is used)
`renice -5 [command]`	Change the niceness of a running command to -5

Most frequently used signals

Signal number	Signal name	Meaning
1	SIGHUP	Used by many daemons to reload their configuration
2	SIGINT	Interrupt, stop
9	SIGKILL	Kill unconditionally (this signal cannot be ignored)
15	SIGTERM	Terminate gracefully
18	SIGCONT	Continue execution
20	SIGTSTP	Stop execution

File permissions



- r w x r w x r w x

- = regular file
d = directory
l = symbolic link
s = Unix domain socket
p = named pipe
c = character device file
b = block device file

user (owner)

r = read
w = write
x = execute
s = setUID and execute
S = setUID and not execute

group

r = read
w = write
x = execute
s = setGID and execute
S = setGID and not execute

others

r = read
w = write
x = execute
t = sticky and execute
T = sticky and not execute

Permission	Octal value	Command	Effect on file	Effect on directory
Read	user: 400	`chmod u+r`	Can open and read the file	Can list directory content
	group: 40	`chmod g+r`		
	others: 4	`chmod o+r`		
Write	user: 200	`chmod u+w`	Can modify the file	Can create, delete, and rename files in the directory
	group: 20	`chmod g+w`		
	others: 2	`chmod o+w`		
Execute	user: 100	`chmod u+x`	Can execute the file (binary or script)	Can access the directory
	group: 10	`chmod g+x`		
	others: 1	`chmod o+x`		
SetUID (SUID)	4000	`chmod u+s`	Executable is run with the privileges of the file's owner	No effect
SetGID (SGID)	2000	`chmod g+s`	Executable is run with the privileges of the file's group	All new files and subdirectories inherit the directory's group ID
Sticky	1000	`chmod +t`	No effect	Only the file's or the directory's owner can delete or rename a file inside

`chmod 710 file`
`chmod u=rwx,g=x file`
	Set read, write, and execute permission to user; set execute permission to group

`chmod ug=rw file`
`chmod 660 file`
	Set read and write permission to user and group

`chmod +wx file`	Add write and execute permission to everybody (user, group, and others)
`chmod -R o+r file`	Add recursively read permission to others
`chmod o-x file`	Remove execute permission from others
`chown root file`	Change the owner of file to root
`chown root:mygroup file`	Change the owner of file to root, and the group of file to mygroup
`chgrp mygroup file`	Change the group of file to mygroup

The `chmod`, `chown`, and `chgrp` commands accept the option `-R` to recursively change properties of files and directories.

`umask 022`	Set the permission mask to 022, hence masking write permission for group and others. Linux default permissions are 0666 for files and 0777 for directories. These base permissions are ANDed with the inverted umask value to calculate the final permissions of a new file or directory.

A Linux directory contains a list of structures, which are associations between a filename and an inode.
An inode contains file metadata: file type, permissions, owner, group, size, access/change/modification/deletion times, number of links, attributes, ACLs, and address where the actual file content (data) is stored.

`ls -i`	Show a listing of the directory with the files' inode numbers

	Hard link	Symbolic link or soft link
What it is	A link to an already existing inode	A path to a filename, like a shortcut
How to create it	`ln myfile hardlink`	`ln -s myfile symlink`
If original file is moved or deleted, is the link still valid?	Yes (because the link references the inode the original file pointed to)	No (the path now references a non-existent file)
Can link to a file in another filesystem?	No (because inode numbers make sense only within a determinate filesystem)	Yes
Can link to a directory?	No	Yes
Link permissions	Reflect the original file's permissions, even when these are changed	`rwxrwxrwx`
Link attributes	`-` (regular file)	`l` (symbolic link)
Inode number	The same as the original file	A new inode number

Find system files

`find / -name "foo*"`	Find all files, starting from the root dir, whose name start with foo
`find / -name "foo*" -print`	Find all files whose name start with foo and print their path
`find / -name "foo*" -exec chmod 700 {} \;`	Find all files whose name start with foo and apply permission 700 to all of them
`find / -name "foo*" -ok chmod 700 {} \;`	Find all files whose name start with foo and apply permission 700 to all of them, asking for confirmation before each file
`find / -perm -4000 -type f`	Find all files with SUID set (a possible security risk, because a shell with SUID root is a backdoor)
`find / -perm -2000 -type f`	Find all files with SGID set

`locate ls`
`slocate ls`
	Locate the command `ls` by searching the file index, not by actually walking the filesystem. The search is quick but will only held results relative to the last rebuilding of the file index (`/etc/updatedb.conf`)

`updatedb`	Build the file index (`/etc/updatedb.conf`)
`which command`	Locate a binary executable command within the PATH
`which -a command`	Locate all matches of `command`, not only the first one
`whereis command`	Locate the binary, source, and manpage files for `command`
`whereis -b command`	Locate the binary files for `command`
`whereis -s command`	Locate the source files for `command`
`whereis -m command`	Locate the manpage files for `command`
`file myfile`	Analyse the content of a file or directory
`type command`	Determine if `command` is a program or a shell builtin

Bash shell event	Files run	

When a login shell is launched	`/etc/profile`
	`~/.bash_profile`
	`~/.bash_login`
	`~/.profile`
		The shell executes the system-wide profile file, then the first of the 3 user files that exists and is readable

When a login shell exits	`~/.bash_logout`	
When a non-login shell is launched	`/etc/bash.bashrc` `~/.bashrc`	

`function myfunc { [commands] }`
`myfunc() { [commands] }`
	Define a function

`myfunc arg1 arg2 ...`	Call a function
`typeset -f`	Show functions defined in the current Bash session
`MYVAR=myvalue`	Set a variable
`unset MYVAR`	Delete a variable
`export MYVAR`	Export a variable so it can be seen by Bash child processes
`echo $MYVAR`	Print the value of a variable
`echo ${MYVAR:-mymessage}`	If variable exists and is not null, print its value, otherwise print a message
`echo ${MYVAR:+mymessage}`	If variable exists and is not null, print a message, otherwise print nothing
`set ${MYVAR:=myvalue}`	Set a variable only if it does not exist or is null
`set`	Display all Bash variables
`set -o`	Show the status of all Bash options
`set -o [option]`	Enable a Bash option
`set +o [option]`	Disable a Bash option
`env`	Display all environment variables
`alias ls='ls -lap'`	Set up a command alias
`alias`	Show current aliases
`\ls` `/bin/ls`	Run the non-aliased version of the command `ls`

Scripts must start with the shebang line `#! /bin/bash` indicating the location of the script interpreter.

Script execution	

`source myscript.sh`
`. myscript.sh`
	Script execution takes place in the same shell. Variables defined and exported in the script are seen by the shell when the script exits

`bash myscript.sh` `./myscript.sh` (file must be executable)	Script execution spawns a new shell

`command &`	Execute a command in the background
`command1; command2`	Execute command 1 and then command 2
`command1 && command2`	Execute command 2 only if command 1 executed successfully (exit status = 0)
`command1 || command2`	Execute command 2 only if command 1 did not execute successfully (exit status > 0)
`exit`	Terminate a script
`exit [n]`	Terminate a script with the specified exit status number. By convention, a 0 exit status is used if the script executed successfully, non-zero otherwise
`read MYVAR`	Read a variable from standard input
`read -n 8 MYVAR`	Read only max 8 chars from standard input
`read -t 60 MYVAR`	Read a variable from standard input, timing out after one minute
`read -s MYVAR`	Read a variable from standard input without echoing to terminal (silent mode)
`echo $MYVAR`	Print a variable on screen
`echo -n "mymessage"`	Print on screen without a trailing line feed

``MYVAR=`date` ``
`MYVAR=$(date)`
	Assign to a variable the output resulting from a command

`zenity`	Display GTK+ graphical dialogs for user messages and input

Bash built-in variables	
`$0`	Script name
`$1, $2, ...`	First, second, ... argument passed to the script or function
`$#`	Number of arguments passed to the script or function
`$?`	Exit status of the last executed command

Flow control

```
test $MYVAR = "myvalue" && mycommand
[ $MYVAR = "myvalue" ] && mycommand
if [ $MYVAR = "myvalue" ]; then mycommand; fi
```

Perform a test; if it holds true, the command is executed

Test operators

Integer operators

`-eq`	Equal to
`-ne`	Not equal to
`-lt`	Less than
`-le`	Less than or equal to
`-gt`	Greater than
`-ge`	Greater than or equal to

String operators

`-z`	Is zero length
`-n` or nothing	Is non-zero length
`=` or `==`	Is equal to
`!=`	Is not equal to
`<`	Is alphabetically before
`>`	Is alphabetically after

File operators

`-e` or `-a`	Exists
`-d`	Is a directory
`-b`	Is a block special file
`-c`	Is a character special file
`-f`	Is a regular file
`-r`	Is readable
`-w`	Is writeable
`-x`	Is executable
`-s`	Is non-zero length
`-u`	Is SUID
`-g`	Is SGID
`-k`	Is sticky
`-h`	Is a symbolic link

Expression operators

`-a`	Logical AND
`-o`	Logical OR
`!`	Logical NOT
`\(   \)`	Priority

`expr $MYVAR = "39 + 3"`	Evaluate an expression; the variable will hold the value 42
`expr [string] : [regex]`	Return the length of the substring matching the regex
`expr [string] : \([regex]\)`	Return the substring matching the regex

Evaluation operators

`=`	Equal to
`!=`	Not equal to
`<`	Less than
`<=`	Less than or equal to
`>`	Greater than
`>=`	Greater than or equal to

`+`	Plus
`-`	Minus
`\*`	Multiplied by
`/`	Divided by
`%`	Remainder

`string : regex`
`match string regex`
	String matches regex

`substr string position length`	Substring
`index string chars`	Index of any chars in string
`length string`	String length

Tests

```
if [test 1]
then
   [command block 1]
elif [test 2]
then
   [command block 2]
else
   [command block 3]
fi
```

```
case $VAR in
   [pattern 1]) [command 1] ;;
   [pattern 2]) [command 2] ;;
   *) [command 3]
esac
```

Loops

```
while [test]
do
   [command block]
done
```

```
for $I in [list]
do
   [command operating on $I]
done
```

`break`	Terminate a loop
`continue`	Jump to the next iteration

SQL syntax

USE MyDatabase;	Choose which database to use
SHOW DATABASES;	Show all existing databases
SHOW TABLES;	Show all tables from the selected database
DESC tableCustomers;	Describe the columns of a table
SELECT * FROM tableCustomers;	Select all columns from the table
SELECT * FROM tableCustomers ORDER BY columnLastname LIMIT 5;	Select only the first 5 records of customers as ordered by last name

SELECT columnFirstname, columnLastname FROM tableCustomers WHERE
columnZipcode = 00123;
	Select only first and last name of customers whose zip code is 00123

SELECT columnCustomerID, SUM(columnSalary) FROM tablePayments
GROUP BY columnCustomerID;
	Select all salary payments grouped by customer ID, summed up

SELECT tableCustomers.columnLastname, tablePayments.columnAmount
FROM tableCustomers, tablePayments WHERE
tableCustomers.columnCustomerID = tablePayments.columnCustomerID;
	Perform a join by selecting data from two tables that are linked

INSERT INTO tableCustomers
(columnFirstname,columnLastname,columnDOB)
VALUES (Arthur,Dent,1959-08-01);
	Insert new data

UPDATE tableCustomers SET columnCity = 'London' WHERE
columnZipcode = 00789;
	Modify data

SHOW GRANTS FOR 'user'@'localhost';	Show permissions for a user
GRANT ALL PRIVILEGES ON MyDatabase.* TO 'user'@'localhost';	Grant permissions to a user
REVOKE ALL PRIVILEGES FROM 'user'@'localhost';	Revoke permissions from a user
SELECT Host,User FROM mysql.user;	List MySQL users
CREATE USER 'user'@'localhost' IDENTIFIED BY 'p4ssw0rd';	Create a MySQL user
SET PASSWORD FOR 'user'@'localhost' = PASSWORD('p4ssw0rd');	Set a password for a MySQL user

MySQL command line syntax

mysql -u root -p	Login to MySQL as root, prompting for the password
mysql -u root -ps3cr3t	Login to MySQL as root with password s3cr3t
mysql -u root -p -e 'CREATE DATABASE NewDatabase'	Create a new database by passing a SQL command to MySQL
mysql -u root -p NewDatabase < newdb.sql	Create a new database from an external file (.sql files are composed of SQL commands)
mysqldump -u root -p MyDatabase > backup.sql	Backup a database on an external file

Display Managers

Display Manager		Configuration files		Display Manager greeting screen
xdm	X Display Manager	/etc/x11/xdm/Xaccess	Control inbound requests from remote hosts	Defined in /etc/x11/xdm/Xresources by the following line: xlogin*greeting: Debian GNU/Linux (CLIENTHOST)
		/etc/x11/xdm/Xresources	Configuration settings for X applications and the login screen	
		/etc/x11/xdm/Xservers	Association of X displays with local X server software, or with X terminals via XDMCP	
		/etc/x11/xdm/Xsession	Script launched by xdm after login	
		/etc/x11/xdm/Xsetup_0	Script launched before the graphical login screen	
		/etc/x11/xdm/xdm-config	Association of all xdm configuration files	
gdm	GNOME Display Manager	/etc/gdm/gdm.conf or /etc/gdm/custom.conf		Configured via gdmsetup
kdm	KDE Display Manager	/etc/kde/kdm/kdmrc		Configured via kdm_config

`/etc/init.d/xdm start`	Start the X Display Manager (gdm or kdm are started in a similar way)
`xorgconfig`	Configure X (text mode) (Debian)
`Xorg -configure`	Configure X (text mode) (Red Hat)
`xorgcfg`	Configure X (graphical mode) (Debian)
`system-config-display`	Configure X (graphical mode) (Red Hat)
`X -version`	Show which version of X is running
`xdpyinfo`	Display information about the X server
`xwininfo`	Display information about windows
`xhost + 10.3.3.3`	Add 10.3.3.3 to the list of hosts allowed to make X connections to the local machine
`xhost - 10.3.3.3`	Remove 10.3.3.3 from the list of hosts allowed to make X connections to the local machine
`mkfontdir`	Catalog the newly installed fonts in the new directory
`xset fp+ /usr/local/fonts`	Dynamically add the newly installed fonts in /usr/local/fonts to the X server
`xfs`	Start the X font server
`fc-cache`	Install fonts and build font information cache
`switchdesk gde`	Switch to the GDE Display Manager at runtime
`/etc/X11/xorg.conf`	Configuration file for X
`~/.Xresources`	Configuration settings for X applications, in the form `program*resource: value`
`$DISPLAY`	Environment variable defining the display name of the X server, in the form `hostname:displaynumber.screennumber`

/etc/inittab instructs init to launch XDM at runlevel 5:

```
x:5:respawn:/usr/X11R6/bin/xdm -nodaemon
```

/etc/sysconfig/desktop defines GNOME as the default Display Environment and Display Manager:

```
desktop= "gde"
displaymanager= "gdm"
```

X11 Forwarding - local execution of remote graphical applications

	Over telnet	Over ssh
On remote machine 10.2.2.2	export DISPLAY=10.1.1.1:0.0	/etc/ssh/sshd_config must specify X11Forwarding yes xauth must be installed
On local machine 10.1.1.1	xhost + telnet 10.2.2.2 xclock &	ssh -X 10.2.2.2 xclock &

User accounts

/etc/passwd – Users accounts

```
root:x:0:0:/root:/bin/bash
bin:x:1:1:/bin:/bin/bash
jdoe:x:500:100:John Doe,,555-1234,,:/home/jdoe:/bin/bash
  ①  ②  ③   ④            ⑤                ⑥         ⑦
```

① Login name

② Encrypted password (obsolete), or `x` if password is in `/etc/shadow`

③ UID – User ID (UID 0 is superuser; by convention UIDs 1-99 are system accounts, UIDs above are regular users)

④ GID – Default Group ID

⑤ GECOS field – Information about the user: Full name, Room number, Work phone, Home phone, Other

⑥ Home directory of the user

⑦ Login shell (can be set to `/bin/false` to prevent a user from logging in)

/etc/shadow – User passwords (file is readable only by root)

```
root:fZPe54/Kldu6D32pl0X/A:15537:0:99999:7:::
bin:*:15637:0:99999:7:::
jdoe:!hsp\8e3jCUdw9Ru53:15580:0:99999:7::15766:
 ①           ②            ③   ④   ⑤   ⑥⑦   ⑧   ⑨
```

① Login name

② Encrypted password (a `!` prefix if the account is locked), `*` if account is disabled, `!` or `!!` if no password

③ Date of last password change (in number of days since 1 January 1970)

④ Days before password may be changed; if 0, user can change the password at any time

⑤ Days after which password must be changed

⑥ Days before password expiration that user is warned

⑦ Days after password expiration that account is disabled

⑧ Date of account disabling (in number of days since 1 January 1970)

⑨ Reserved field

/etc/group – Group accounts

```
root:x:0:root
jdoe:x:501
staff:x:530:jdoe,asmith
  ①   ② ③      ④
```

① Group name

② Encrypted password, or `x` if password is in `/etc/gshadow`

③ GID – Group ID

④ Group members (if this is not their Default Group)

/etc/gshadow – Group passwords (file is readable only by root)

```
root::root:root
jdoe:!::
staff:0cfz7IpLhGW19i::root,jdoe
  ①         ②        ③    ④
```

① Group name

② Encrypted password, or `!` if no password set (default)

③ Group administrators

④ Group members

User management

`useradd -m jdoe`
`useradd -mc "John Doe" jdoe`
`useradd -ms /bin/ksh jdoe`
`useradd -D`
	Create a user account, creating and populating his homedir from `/etc/skel`
	Create a user account, specifying his full name
	Create a user account, specifying his login shell
	Show default values (specified in `/etc/login.defs`) for user account creation	

`usermod -c "Jonas Doe" jdoe`
`usermod -L jdoe`
`usermod -U jdoe`
	Modify the GECOS field of a user account
	Lock a user account
	Unlock a user account
		(`usermod` accepts many `useradd` options)

`userdel -r jdoe`	Delete a user and his homedir	
`chfn jdoe`	Change the GECOS field of a user	
`chsh jdoe`	Change the login shell of a user	

`passwd jdoe`
`passwd -l jdoe`
	Change the password of a user
	Lock a user account	

`chage -E 2013-02-14 jdoe`
`chage -d 13111 jdoe`
`chage -d 0 jdoe`
`chage -M 30 jdoe`
`chage -m 7 jdoe`
`chage -W 15 jdoe`
`chage -I 3 jdoe`
`chage -l jdoe`
	Change the password expiration date, locking the account at that date
	Change the date (in number of days since 1 January 1970) of last password change
	Force the user to change password at his next login
	Change the max number of days during which a password is valid
	Change the min number of days between password changes
	Change the number of days before password expiration that the user will be warned
	Change the number of days after password expiration before the account is locked
	List password aging information for a user	

`groupadd staff`	Create a group	
`groupmod -n newstaff staff`	Change a group name	
`groupdel staff`	Delete a group	

`gpasswd staff`
`gpasswd -a jdoe staff`
`gpasswd -d jdoe staff`
`gpasswd -A jdoe staff`
	Set or change the password of a group
	Add a user to a group
	Delete a user from a group
	Add a user to the list of administrators of the group	

`adduser`
`deluser`
`addgroup`
`delgroup`
	User-friendly front-ends for user and group management (Debian)	

`who am i`
`whoami`
	Print your effective user ID	

`who` `w`	Print the list of users logged into the system Print the list of users logged into the system, and what they are doing	

`su jdoe`
`su -c "fdisk -l"`
	Run a shell as the specified user. If user is not specified, assume root
	Pass a single command to the shell	

`su -`
`su -l`
	Ensure that the spawned shell is a login shell, hence running login scripts and setting the correct environment variables. Recommended option	

`sudo fdisk -l`
`sudo -ujdoe fdisk -l`
	Run a command as root. Sudo commands are logged via syslog
	Run a command as another user	

`sudoedit /etc/passwd`
`sudo -e /etc/passwd`
	Edit a protected file. It is recommended to use this instead of allowing users to sudo text editors as root, which is a security problem if the editor spawns a shell	

`visudo`	Edit `/etc/sudoers`, the configuration file that specifies access rights to sudo	
`/var/log/auth.log`	Log containing user logins and authentication mechanisms	
`/etc/nologin`	If this file exists, `login` and `sshd` deny login to the system	

cron – repeated scheduled execution

```
/etc/crontab
# m  h  dom mon dow  user  command
  25 6   *   *   1   root  myscript.sh
```

m = minutes
h = hours
dom = day of month (1-31)
mon = month (1-12 or jan-dec)
dow = day of week (0-7 or sun-sat; 0=7=Sunday)
	`25    6  *  *    1` = every Monday at 6:25 AM
	`*/5  16  *  *    *` = from 4:00 to 4:55 PM every 5 mins, everyday
	`0,30  7 25 12    *` = on 25th December at 7:00 and 7:30 AM
	`3    17  *  *  1-5` = at 5:03 PM everyday, from Monday to Friday

The crond daemon checks the /etc/crontab system-wide file every minute and executes command as user at the specified times.
Each user may also set his own crontab scheduling, which will result in a file /var/spool/cron/[user]. A user' crontab file has the same format, except that the user field is not present.

```
/etc/anacrontab
# period  delay  job-identifier  command
  7       10     cron-weekly     myscript.sh
```

period	= period in days
delay	= delay in minutes
job-identifier	= job identifier in anacron messages

Anacron jobs are run by crond, and permit the execution of periodic jobs on a machine that is not always running, such as a laptop.
If the job has not been executed in the last period, the system waits for delay and then executes command.

If /etc/cron.allow exists, only users listed therein can access the service.
If /etc/cron.deny exists, all users except those listed therein can access the service.
If none of these files exist, all users can access the service.

`crontab -e`	Edit your user crontab file
`crontab -l`	List the contents of your crontab file
`crontab -e -u jdoe`	Edit the crontab file of another user (only root can do this)

`/etc/cron.hourly`
`/etc/cron.daily`
`/etc/cron.weekly`
`/etc/cron.monthly`
	Scripts placed in these directories will be automatically executed with the specified periods

at – scheduled execution once

If /etc/at.allow exists, only users listed therein can access the service.
If /etc/at.deny exists, all users except those listed therein can access the service.
If none of these files exist, no user except root can access the service.

`at 5:00pm tomorrow myscript.sh`
`at -f mylistofcommands.txt 5:00pm tomorrow`
`echo "rm file" | at now+2 minutes`
	Execute a command once at the specified time (absolute or relative)

`at -l`
`atq`
	List the scheduled jobs

`at -d 3`
`atrm 3`
	Remove job number 3 from the list

Locale environment variables		
LANG LANGUAGE	Language, stored in `/etc/default/locale` . When scripting, you should set `LANG=C` because this specifies the minimal locale environment for C translation, and guarantees a standard collation and formats for the execution of scripts	These locale variables are in the format `[language]_[territory].[encoding]` e.g. `en_US.UTF-8` The list of supported locales is stored in `/usr/share/i18n/SUPPORTED`
LC_CTYPE	Character classification and case conversion	
LC_NUMERIC	Non-monetary numeric formats	
LC_TIME	Date and time formats	
LC_COLLATE	Alphabetical order	
LC_MONETARY	Monetary formats	
LC_MESSAGES	Language and encoding of system messages and user input	
LC_PAPER	Paper size	
LC_NAME	Personal name formats	
LC_ADDRESS	Geographic address formats	
LC_TELEPHONE	Telephone number formats	
LC_MEASUREMENT	Measurement units (metric or others)	
LC_IDENTIFICATION	Metadata about locale	
LC_ALL	Special variable overriding all others	

`locale`	Show locale environment variables
`locale-gen it_IT.UTF-8`	Generate a locale by compiling a list of locale definition files
`apt-get install manpages-it language-pack-it`	Install a different locale (system messages and manpages)
`iconv -f IS6937 -t IS8859 myfilein > myfileout`	Convert a text file from a codeset to another

ISO/IEC-8859 is a standard for 8-bit encoding of printable characters.
The first 256 characters in ISO/IEC-8859-1 (Latin-1) are identical to those in Unicode.
UTF-8 encoding can represent every character in the Unicode set, and was designed for backward compatibility with ASCII.

System time

`tzselect`
`tzconfig`
`dpkg-reconfigure tzdata` (Debian)
	Set the timezone, stored in `/etc/timezone`

Timezone is also set as a symbolic link from `/etc/localtime` to the correct timezone file in `/usr/share/zoneinfo/`

`date`	Show current date and time
`date -d "9999 days ago"`	Show a different date
`date -d "1970/01/01 + 14662"`	Convert number of days since 1 January 1970 (e.g. 14662) in a canonical date
`date +"%F %H:%M:%S"`	Show date in the format specified
`date -s "20130305 23:30:00"`	Set the date
`date 030523302013`	Set the date in the format MMDDhhmmYYYY
`ntpd`	NTP daemon, keeps the clock in sync with Internet time servers
`ntpd -q`	Synchronize the time once and quit
`ntpd -g`	Force NTP to start even if clock is off by more than the panic threshold (1000 secs)
`ntpd -n -g -q`	Start NTP as a non-daemon, force set the clock, and quit
`ntpq -p [server]`	Query the time server for a list of peers
`ntpdate [server]`	Synchronizes the clock with the specified time server
`ntpdate -b [server]`	Brutally set the clock, without waiting for a slow adjusting
`ntpdate -q [server]`	Query the time server without setting the clock

`hwclock --show`
`hwclock -r`
	Show the hardware clock

`hwclock --hctosys`
`hwclock -s`
	Set the system time from the hardware clock

`hwclock --systohc`
`hwclock -w`
	Set the hardware clock from system time

`hwclock --utc`	Indicate that the hardware clock is kept in Coordinated Universal Time
`hwclock --localtime`	Indicate that the hardware clock is kept in local time

Logging

Syslog logging facility:		
	syslogd	Daemon logging events from user processes
	klogd	Daemon logging events from kernel processes

/etc/syslog.conf

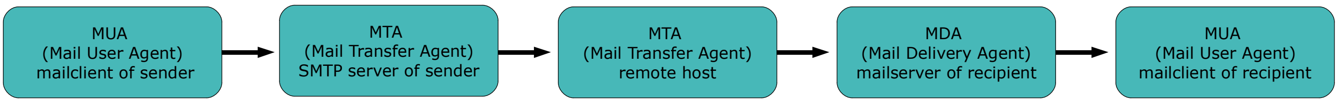
```
# facility.level                  action
*.info;mail.none;authpriv.none   /var/log/messages
authpriv.*                       /var/log/secure
mail.*                           /var/log/maillog
*.alert                          root
*.emerg                          *
local5.*                         @10.7.7.7
local7.*                         /var/log/boot.log
```

Facility Creator of the message	**Level** Severity of the message	**Action** Destination of the message	
auth or security†	emerg or panic† (highest)	filename	message is written into a logfile
authpriv	alert	@hostname	message is sent to a logger server (via UDP port 514)
cron	crit	user1,user2,user3	message is sent to users' consoles
daemon	err or error†	*	message is sent to all logged-in users' consoles
kern	warning or warn†		
lpr	notice		
mail	info		
mark (for syslog internal use)	debug (lowest)		
news			
syslog	none (facility disabled)		
user			
uucp			
local0 ... local7 (custom)			

† deprecated

`logger -p auth.info "Message"`	Send a message to syslogd with the specified facility and priority
`man 3 syslog`	Syslog manpage listing facilities and levels
`logrotate`	Rotate logs (by gzipping, renaming, and eventually deleting old logfiles) according to `/etc/logrotate.conf`
`tail -f /var/log/messages`	Print the last lines of a file, moving forward as the file grows (useful to read logs in real-time)
`zgrep [grep options] [file]`	Grep search in a gzipped file
`zcat /var/log/messages.1.gz`	Print a gzipped file on stdout

`/var/log/messages`
`/var/log/syslog`
`/var/log/kern.log`
	System and kernel logs



MUA (Mail User Agent) mailclient of sender → MTA (Mail Transfer Agent) SMTP server of sender → MTA (Mail Transfer Agent) remote host → MDA (Mail Delivery Agent) mailserver of recipient → MUA (Mail User Agent) mailclient of recipient

Examples of MTAs: Sendmail, Exim, Postfix, qmail

`mail -s "Subject" -c "jdoe@abc.org" < body`	Send a mail message
`~/.forward`	Specifies one or more mail addresses to forward the user's mail to
`/etc/aliases` `/etc/mail/aliases`	Aliases database for users on the local machine; each line is on the form `alias: user`

`newaliases`
`sendmail -bi`
	Update the aliases database (must be run after any change)

`/var/spool/mail/user`	Inbox for `user` on the local machine
`/var/log/mail.log` (Debian) `/var/log/maillog` (Red Hat)	Mail logs

Exim (MTA)

`mailq`
`exim4 -bp`
	Examine the mail queue

`exim4 -M [message id]`	Attempt delivery of message
`exim4 -Mrm [message id]`	Remove a message from the mail queue
`exim4 -Mvh [message id]`	See the headers of a message in the mail queue
`exim4 -Mvb [message id]`	See the body of a message in the mail queue
`exim4 -Mvc [message id]`	See a message in the mail queue
`exim4 -qf [domain]`	Force a queue run
`exim4 -Rff [domain]`	Attempt delivery of all queued messages for a domain
`exim4 -bV`	Show version and other info
`exinext`	Give the times of the next queue runs
`exigrep`	Search through Exim logfiles
`exicyclog`	Rotate Exim logfiles

`cupsd`	CUPS (Common Unix Printing System) daemon. Administration of printers is done via web interface on http://localhost:631
`/etc/init.d/cupsys start`	Start the CUPS service
`/etc/cups/cupsd.conf`	CUPS configuration file
`/etc/cups/printers.conf`	Database of available local CUPS printers
`/etc/printcap`	Database of printer capabilities, for old printing applications
`/var/spool/cups/`	Printer spooler for data awaiting to be printed
`/var/log/cups/error_log`	CUPS error log
`/var/log/cups/page_log`	Information about printed pages
`gnome-cups-manager`	Run the CUPS Manager graphical application
`cupsenable printer0`	Enable a CUPS printer
`cupsdisable printer0`	Disable a CUPS printer
`cupsaccept printer0`	Accept a job sent on a printer queue
`cupsreject -r "Rejected" printer0`	Reject a job sent on a printer queue, with an informational message
`cupstestppd LEXC510.ppd`	Test the conformance of a PPD file to the format specification
`cupsaddsmb printer0`	Export a printer to SAMBA (for use with Windows clients)
`cups-config --cflags`	Show the necessary compiler options
`cups-config --datadir`	Show the default CUPS data directory
`cups-config --ldflags`	Show the necessary linker options
`cups-config --libs`	Show the necessary libraries to link to
`cups-config --serverbin`	Show the default CUPS binaries directory that stores filters and backends
`cups-config --serverroot`	Show the default CUPS configuration file directory
`lpstat`	Show CUPS status information
`lpadmin`	Administer CUPS printers
`lpadmin -p printer0 -P LEXC750.ppd`	Specify a PPD (Adobe PostScript Printer Description) file to associate to a printer
`lp -d printer0 file`	Print a file on the specified printer
`lpq`	View the default print queue
`lpq -P printer0`	View a specific print queue
`lpq jdoe`	View the print queue of a specific user
`lprm -P printer0 5`	Delete a specific job from a printer queue
`lprm -P printer0 jdoe`	Delete all jobs from a specific user from a printer queue
`lprm -P printer0 -`	Delete all jobs from a printer queue
`lpc`	Manage print queues
`a2ps file.txt`	Convert a text file to PostScript
`ps2pdf file.ps`	Convert a file from PostScript to PDF
`mpage file.ps`	Print a PostScript document on multiple pages per sheet on a PostScript printer
`gv file.ps`	View a PostScript document (the gv software is derived from GhostView)

Network addressing

IPv4	
193.22.33.44	32-bit divised in 4 octects (dotted-quad) 4 billion addresses

IPv6	

`2130:0000:0000:0000:0007:0040:15bc:235f`
`2130:0:0:0:7:40:15bc:235f`
`2130::7:40:15bc:235f`
	128-bit
	divised in 8 16-bit sections
	
	3 × 10^{38} addresses

IPv4 classful addressing

		Address range	Prefix	Number of addresses	Reference
Classful	Class A (Unicast)	0.0.0.0 – 127.255.255.255 first octet: 0XXX XXXX	/8	128 networks × 16,777,216 addresses	RFC 791
	Class B (Unicast)	128.0.0.0 – 191.255.255.255 first octet: 10XX XXXX	/16	16,384 networks × 65,536 addresses	RFC 791
	Class C (Unicast)	192.0.0.0 – 223.255.255.255 first octet: 110X XXXX	/24	2,097,152 networks × 256 addresses	RFC 791
	Class D (Multicast)	224.0.0.0 – 239.255.255.255 first octet: 1110 XXXX	/4	268,435,456	RFC 3171
	Class E (Experimental)	240.0.0.0 – 255.255.255.255 first octet: 1111 XXXX	/4	268,435,456	RFC 1166
Private	Private Class A	10.0.0.0 – 10.255.255.255	10/8	16,777,216	RFC 1918
	Private Class B	172.16.0.0 – 172.31.255.255	172.16/12	1,048,576	RFC 1918
	Private Class C	192.168.0.0 – 192.168.255.255	192.168/16	65,536	RFC 1918
Reserved	Source	0.0.0.0 – 0.255.255.255	0/8	16,777,216	RFC 1700
	Loopback	127.0.0.0 – 127.255.255.255	127/8	16,777,216	RFC 1700
	Autoconf	169.254.0.0 – 169.254.255.255	169.254/16	65,536	RFC 3330
	TEST-NET	192.0.2.0 – 192.0.2.255	192.0.2/24	256	RFC 3330
	6to4 relay anycast	192.88.99.0 – 192.88.99.255	192.88.99/24	256	RFC 3068
	Device benchmarks	198.18.0.0 – 198.19.255.255	198.18.0.0/15	131,072	RFC 2544

VLSM chart - Last octet subnetting

Prefix: /24 Netmask: .0 00000000 1 subnet 254 hosts each 254 total hosts	Prefix: /25 Netmask: .128 10000000 2 subnets 126 hosts each 252 total hosts	Prefix: /26 Netmask: .192 11000000 4 subnets 62 hosts each 248 total hosts	Prefix: /27 Netmask: .224 11100000 8 subnets 30 hosts each 240 total hosts	Prefix: /28 Netmask: .240 11110000 16 subnets 14 hosts each 224 total hosts	Prefix: /29 Netmask: .248 11111000 32 subnets 6 hosts each 192 total hosts	Prefix: /30 Netmask: .252 11111100 64 subnets 2 hosts each 128 total hosts
.0	.0	.0	.0	.0	.0	.0
						.4
					.8	.8
						.12
				.16	.16	.16
						.20
					.24	.24
						.28
			.32	.32	.32	.32
						.36
					.40	.40
						.44
				.48	.48	.48
						.52
					.56	.56
						.60
		.64	.64	.64	.64	.64
						.68
					.72	.72
						.76
				.80	.80	.80
						.84
					.88	.88
						.92
			.96	.96	.96	.96
						.100
					.104	.104
						.108
				.112	.112	.112
						.116
					.120	.120
						.124
	.128	.128	.128	.128	.128	.128
						.132
					.136	.136
						.140
				.144	.144	.144
						.148
					.152	.152
						.156
			.160	.160	.160	.160
						.164
					.168	.168
						.172
				.176	.176	.176
						.180
					.184	.184
						.188
		.192	.192	.192	.192	.192
						.196
					.200	.200
						.204
				.208	.208	.208
						.212
					.216	.216
						.220
			.224	.224	.224	.224
						.228
					.232	.232
						.236
				.240	.240	.240
						.244
					.248	.248
						.252

Each block of a column identifies a subnet, whose range of valid hosts addresses is [network address +1 — broadcast address -1] inclusive.
The network address of the subnet is the number shown inside a block.
The broadcast address of the subnet is the network address of the block underneath -1 or, for the bottom block, .255.

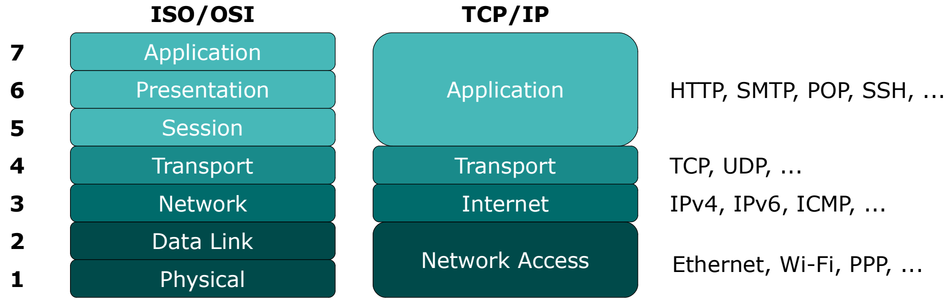
Well-known ports

Port number		Service
20	TCP	FTP (data)
21	TCP	FTP (control)
22	TCP	SSH
23	TCP	Telnet
25	TCP	SMTP
53	TCP/UDP	DNS
67	UDP	BOOTP/DHCP (server)
68	UDP	BOOTP/DHCP (client)
80	TCP	HTTP
110	TCP	POP3
119	TCP	NNTP
139	TCP/UDP	Microsoft NetBIOS
143	TCP	IMAP
161	UDP	SNMP
443	TCP	HTTPS
465	TCP	SMTP over SSL
993	TCP	IMAPS
995	TCP	POP3S

1-1023:	privileged ports	used server-side
1024-65535:	unprivileged ports	used client-side

The well-known ports are listed in `/etc/services`

Protocol stack models



	ISO/OSI	TCP/IP	
7	Application	Application	HTTP, SMTP, POP, SSH, …
6	Presentation		
5	Session		
4	Transport	Transport	TCP, UDP, …
3	Network	Internet	IPv4, IPv6, ICMP, …
2	Data Link	Network Access	Ethernet, Wi-Fi, PPP, …
1	Physical		

Network tools

`dig example.org` (most powerful) `host example.org` `nslookup example.org` (deprecated)	Perform a DNS lookup for the specified domain or hostname
`dig @10.7.7.7 -t MX example.org`	Perform a DNS lookup for the MX record of the domain example.org, querying nameserver 10.7.7.7
`dig -x 192.0.32.8`	Perform a reverse lookup on the IP address 192.0.32.8
`host example.org 10.7.7.7`	Perform a DNS lookup for the domain example.org, querying nameserver 10.7.7.7
`whois example.org`	Query the WHOIS service for a Internet resource, usually a domain name
`ping 192.0.32.8`	Test reachability and measure the round-trip time to a remote host (by sending an ICMP ECHO_REQUEST datagram and expecting an ICMP ECHO_RESPONSE)

`traceroute 192.0.32.8`
`tracepath 192.0.32.8`
	Print the route packets trace to a remote host

`telnet 192.0.32.8 23`	Establish a TELNET connection to host 192.0.32.8 on port 23 (if port is omitted, use default port 23)
`ftp 192.0.32.8`	Establish an interactive FTP connection with a host

`wget --recursive --no-clobber \`
`--page-requisites –html-extension \`
`--convert-links --domains example.org \`
`--no-parent www.example.org/foobar`
	Download a whole website www.example.org/foobar

Network scanning

`netstat`	Display network connections
`netstat –-tcp`	Display active TCP connections
`netstat -a`	Display all listening and non-listening sockets
`netstat -n`	Display network connections, without resolving hostnames or portnames
`netstat -p`	Display network connections, with PID and name of program to which each socket belongs
`netstat -i`	Display network interfaces
`netstat -s`	Display protocol statistics
`netstat -r`	Display kernel routing tables (equivalent to `route -en`)

`nmap 192.0.32.8`
`nmap -sS 192.0.32.8`
	Scan for open ports (TCP SYN scan by default) on remote host

`nmap -sP 192.0.32.8`	Do a ping sweep on remote host
`nmap -sU 192.0.32.8`	Scan UDP ports on remote hosts
`nmap -p 1-65535 192.0.32.8`	Scan all ports (1-65535) on remote host, not only the common ports
`nmap -sV 192.0.32.8`	Do a service and version scan on open ports
`nmap -O 192.0.32.8`	Find which operating system is running on remote host (OS fingerprinting)
`tcpdump ip host 10.3.3.3 tcp port 25`	Sniff network packets on TCP port 25 from and to the specified host
`tcpdump ether host '45:67:89:ab:cd:ef'`	Sniff traffic from and to the network interface with that MAC address
`lsof`	List all open files
`lsof -u jdoe`	List all files currently open by a user
`lsof -i`	List open files and their sockets (equivalent to `netstat -anp`)
`lsof -i@10.2.2.2`	List connections of local processes to remote host 10.2.2.2
`iptraf`	IP LAN monitor (ncurses GUI)

Net config files

`/etc/hosts`	`127.0.0.1   localhost   localhost.localdomain`
	`10.2.3.4    myhost`
		Mappings between IP addresses and hostnames, for simple name resolution

`/etc/nsswitch.conf`	`passwd:  files nisplus nis`
	`shadow:  files nisplus nis`
	`group:   files nisplus nis`
	`hosts:   files dns nisplus nis`
		Controls the sources used by various system library lookup functions

`/etc/host.conf`	`order hosts,bind`
	`multi on`
		Controls the sources for name resolution for systems before glibc2.
		Superseded by `/etc/nsswitch.conf`

`/etc/resolv.conf`	`nameserver  192.168.3.3`
	`nameserver  192.168.4.4`
		DNS servers to use

`/etc/networks`	`loopback  127.0.0.0`
	`mylan     10.2.3.0`
		Mappings between network addresses and names

`/etc/hostname`		Hostname of the local machine
`/etc/network/interfaces`		List and config of all network interfaces

`/etc/sysconfig/network-scripts/ifcfg-eth0`	`DEVICE=eth0`
	`BOOTPROTO=none`
	`ONBOOT=yes`
	`NETMASK=255.255.255.0`
	`IPADDR=10.2.3.4`
	`USERCTL=no`
		Configuration file for network interface eth0 (RedHat)

`/etc/services`		List of service TCP/UDP port numbers
`/etc/protocols`		List of available protocols
`/etc/inetd.conf`		Configuration file for inetd, the super-server Internet daemon
`/etc/dhcpd.conf`		Configuration file for the DHCP server

Net config commands

`ifconfig -a`	Display all configured network interfaces
`ifconfig eth0`	Display configuration of eth0

`ifconfig eth0 up`
`ifup eth0`
	Activate eth0

`ifconfig eth0 down`
`ifdown eth0`
	Shut down eth0

`ifconfig eth0 10.2.3.4 netmask 255.255.255.0 broadcast 10.2.3.255`	Configure IP address of eth0
`ifconfig eth0 hw ether 45:67:89:ab:cd:ef`	Configure MAC address of eth0
`dhclient` `pump`	Request an IP address via DHCP
`iwlist wlan0 scanning`	Scan for wireless networks

`route`
`route -en`
`route -F`
	Display IP routing table

Gateway:

`[host]`	gateway name
`*`	no gateway
`-`	rejected route

Flags:

`U`	route is up
`G`	use gateway
`H`	target is host
`!`	rejected route
`D`	dynamically installed by daemon
`M`	modified from routing daemon
`R`	reinstate route for dynamic routing

`route -C`	Display kernel routing cache
`route add default gw 10.2.3.1 eth0`	Add a default route via eth0
`route add -host 10.7.0.9 gw 10.7.0.1`	Add a route for a host
`route add -net 10.7.0.0 netmask 255.255.0.0 gw 10.7.0.1`	Add a route for a network
`route del -host 10.7.0.66 gw 10.7.0.1`	Delete a route for a host
`arp`	Show the ARP cache table
`arp 10.7.0.9`	Show the ARP cache for a host
`arp -s 10.7.0.9 01:23:45:67:89:ab`	Add a new ARP entry for a host
`arp -d 10.7.0.9`	Delete a ARP entry
`hostname`	Get or set the hostname (stored in `/etc/hostname`)
`/etc/init.d/networking` `/etc/init.d/network`	Initialize network services

Secure Shell (SSH)

SSH configuration files

`/etc/ssh/sshd_config`	SSH server daemon configuration file
`/etc/ssh/ssh_config`	SSH client configuration file

SSH key generation

`ssh-keygen -t rsa -b 2048`	Generate interactively a 2048-bit RSA key pair, prompting for a passphrase. Private key is stored in `~/.ssh/id_rsa` Public key is stored in `~/.ssh/id_rsa.pub`
`ssh-keygen -p -t rsa`	Change passphrase of the private key
`ssh-keygen -q -t rsa -f /etc/ssh/host_key -N '' -C ''`	Generate a RSA host key with no passphrase and no comment
`ssh-keygen -l -f /etc/ssh/host_key`	View fingerprint of a public key

SSH Port Forwarding

`ssh -L 2525:mail.example.com:25 user@login.example.com`	Forwarding: redirect traffic from local port 2525 to port 25 of remote host mail.example.com
`ssh -R 80:local:8080 user@login.example.com`	Reverse forwarding: redirect connections to port 80 of login.example.com towards port 8080 of local machine

How to enable Public Key Authentication:

1. Set `PubkeyAuthentication yes` in `/etc/ssh/sshd_config` of remote server
2. Copy your public key `~/.ssh/id_rsa.pub` in `~/.ssh/authorized_keys2` on the remote server

How to enable Host-based Authentication amongst a group of hosts:

1. Set `HostbasedAuthentication yes` in `/etc/ssh/sshd_config` on all hosts
2. Create `/etc/ssh/shosts.equiv` on all hosts, and enter there all hostnames
3. Connect via SSH manually on each host so that all hosts' public keys are stored into `~/.ssh/known_hosts`, and copy this file to `/etc/ssh/ssh_known_hosts` on all hosts

How to enable SSH Agent:

1. Type ``eval `ssh-agent` `` (this will show the PID of ssh-agent)
2. Type `ssh-add` and enter the passphrase of the private key to escrow

GNU Privacy Guard (GPG)	
`gpg --gen-key`	Generate a key pair
`gpg --import alice.asc`	Import Alice's public key into your keyring
`gpg --list-keys`	List the keys contained into your keyring
`gpg --list-secret-keys`	List your private keys contained into your keyring
`gpg --list-public-keys`	List the public keys contained into your keyring
`gpg --export -o keyring_backup.gpg`	Export your whole keyring to a file
`gpg --export-secret-key -a "You" -o private.key`	Export your private key (username You) to a file
`gpg --export-public-key -a "Alice" -o alice.pub`	Export Alice's public key to a file
`gpg --edit-key "Alice"`	Sign Alice's public key
`gpg -e -u "You" -r "Alice" file.txt`	Encrypt a file (to Alice i.e. with Alice's public key), signing it with your private key
`gpg -d file.txt.gpg`	Decrypt a file (with your own public key)

`openssl x509 -text -in certif.crt -noout`	Read a certificate
`openssl req -text -in request.csr -noout`	Read a Certificate Signing Request
`openssl req -new -key private.key -out request.csr`	Generate a Certificate Signing Request for the public key of a key pair

`openssl req -new -nodes -keyout newprivate.key \`
`-out request.csr -newkey rsa:2048`
	Create a 2048-bit RSA key pair and generates a Certificate Signing Request for it

`openssl ca -config ca.conf -in request.csr \`
`-out certif.cer -days validity -verbose`
	Sign a certificate

`openssl ca -config ca.conf -gencrl -revoke certif.cer \`
`-crl_reason why`
	Revoke a certificate

`openssl ca -config ca.conf -gencrl -out crlist.crl`	Generate a Certificate Revocation List containing all revoked certificates so far

`openssl x509 -in certif.pem -outform DER \`
`-out certif.der`
	Convert a certificate from PEM to DER

`openssl pkcs12 -export -in certif.pem \`
`-inkey private.key -out certif.pfx -name friendlyname`
	Convert a certificate from PEM to PKCS#12 including the private key

`openssl dgst -hashfunction -out file.hash file`	Generate the digest of a file
`openssl dgst -hashfunction file | cmp -b file.hash`	Verify the digest of a file (if there is no output, then digest verification is successful)

`openssl dgst -hashfunction -sign private.key \`
`-out file.sig file`
	Generate the signature of a file

`openssl dgst -hashfunction -verify public.key \`
`-signature file.sig file`
	Verify the signature of a file

`openssl enc -e -cipher -in file -out file.enc -salt`	Encrypt a file
`openssl enc -d -cipher -in file.enc -out file`	Decrypt a file

`openssl genpkey -algorithm RSA -cipher 3des \`
`-pkeyopt rsa_keygen_bits:2048 -out key.pem`
	Generate a 2048-bit RSA key pair protected by TripleDES passphrase

`openssl genrsa -des3 -out key.pem 2048`	Generate a 2048-bit RSA key pair protected by TripleDES passphrase (older versions of OpenSSL)
`openssl pkey -text -in private.key -noout`	Examine a private key
`openssl rsa -text -in private.key -noout`	Examine a private key (older versions of OpenSSL)
`openssl pkey -in old.key -out new.key -cipher`	Change a private key's passphrase
`openssl rsa -in old.key -out new.key -cipher`	Change a private key's passphrase (older versions of OpenSSL)

`openssl s_client -connect www.website.com:443 > tmpfile`
CTRL C
`openssl x509 -in tmpfile -text`
	Retrieve and inspect a certificate from a website

`openssl list-message-digest-commands`	List all available hash functions
`openssl list-cipher-commands`	List all available ciphers

Key bindings

Key	Alternate key	Function
CTRL F	RIGHT ARROW	Move cursor forward one char
CTRL B	LEFT ARROW	Move cursor backward one char
CTRL A	HOME	Move cursor to beginning of line
CTRL E	END	Move cursor to end of line
CTRL H	BACKSPACE	Delete char to the left of cursor
CTRL W		Delete word to the left of cursor
CTRL U		Delete all chars to the left of cursor
CTRL K		Delete all chars to the right of cursor
CTRL T		Swap current char with previous char
ESC T		Swap current word with previous word
SHIFT PAGE UP		Scroll up the buffer
SHIFT PAGE DOWN		Scroll down the buffer
CTRL L		Clear screen (same as `clear`)
CTRL P	UP ARROW	Previous command in history
CTRL N	DOWN ARROW	Next command in history
CTRL R		Reverse history search
TAB		Autocomplete file and directory names
CTRL J	RETURN	Line feed
CTRL M		Carriage return
CTRL S		Pause trasfer to terminal
CTRL Q		Resume transfer to terminal
CTRL Z		Send a SIGTSTP to put the current job in background
CTRL C		Send a SIGINT to stop the current process
CTRL D		Send a EOF to current process (same as `logout` on shell prompt)
CTRL ALT DEL		Reboot the machine (same as `shutdown -r now`)
CTRL ALT F1 … F6		Switch between text consoles
CTRL ALT F7 … F11		Switch between X Window consoles
CTRL ALT +		Increase X Window screen resolution
CTRL ALT -		Decrease X Window screen resolution
CTRL TAB		Change between X Window tasks
CTRL ALT BACKSPACE		Reboot the X Window server