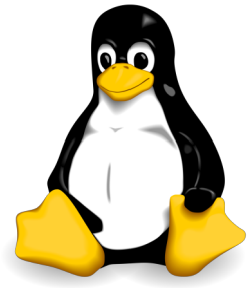

Linux
Quick Reference Guide

5th edition September 2017

Foreword

This guide stems from the notes I have been taking while working as a Linux sysadmin and while preparing the certification exams LPIC-1 (Linux Professional Institute Certification level 1), LPIC-2, and RHCSA (Red Hat Certified System Administrator). This document was originally named *Linux & LPIC Quick Reference Guide*, then I changed its title to be more certification-agnostic.
This guide contains a good amount of topics for these certification exams, with some subjects handled in more details than others, plus other information about standards and useful tools for Linux system administration. I started writing this document in 2013 and it is my aim to update and integrate it periodically.

Happy Linux hacking,

Daniele Raffo

Version history

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Sources and suggested readings

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- RAM management in Linux, http://www.linuxatemyram.com
- Regular expressions tester, http://www.regextester.com
- Bash pitfalls, http://mywiki.wooledge.org/BashPitfalls
- Linux man pages, https://www.kernel.org/doc/man-pages

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Logical Volume Management (LVM) introduces an abstraction between physical and logical storage that permits a more versatile use of filesystems. LVM uses the Linux device mapper feature (`/dev/mapper`).

Disks, partitions, and RAID devices are made of **Physical Volumes**, which are grouped into a **Volume Group**.
A Volume Group is divided into small fixed-size chunks called Physical Extents, which are mapped 1-to-1 to Logical Extents.
Logical Extents are grouped into **Logical Volumes**, on which filesystems are created.

How to create a Logical Volume

1.	Add a new physical or virtual disk to the machine	
2.	`lsblk`	Check that the new disk is being recognized e.g. as /dev/sda
3.	`fdisk /dev/sda`	Create a new partition (should be of type 0x8E = Linux LVM) on the new disk. This is not necessary but recommended, because other OSes might not recognize LVM and see the whole unpartitioned disk as empty
4.	`pvcreate /dev/sda1`	Initialize the Physical Volume to be used with LVM
5.	`vgcreate -s 8M myvg0 /dev/sda1`	Create a Volume Group and define the size of Physical Extents to 8 Mb (default value is 4 Mb)
or	`vgextend myvg0 /dev/sda1`	or add the Physical Volume to an existing Volume Group
6.	`lvcreate -L 1024M -n mylv myvg0`	Create a Logical Volume
7.	`mkfs -t ext3 /dev/myvg0/mylv`	Create a filesystem on the Logical Volume
8.	`mount /dev/myvg0/mylv /mnt/mystuff`	Mount the Logical Volume which is now ready to be used

How to increase the size of a Logical Volume (only if the underlying filesystem permits it)

1.	Add a new physical or virtual disk to the machine; this will provide the extra disk space	
2.	`fdisk /dev/sdc`	Partition the new disk
3.	`pvcreate /dev/sdc`	Initialize the Physical Volume /dev/sdc
4.	`vgextend myvg0 /dev/sdc`	Add /dev/sdc to an existing Volume Group
5.	`lvextend -L 2048M /dev/myvg0/mylv`	Extend the Logical Volume by 2 Gb
or	`lvresize -L+2048M /dev/myvg0/mylv`	
or	`lvresize -l+100%FREE /dev/myvg/mylv`	or extend the Logical Volume taking all free space
6.	`resize2fs /dev/myvg0/mylv`	Extend the filesystem

How to reduce the size of a Logical Volume (only if the underlying filesystem permits it)

1.	`resize2fs /dev/myvg0/mylv 900M`	Shrink the filesystem
2.	`lvreduce -L 900M /dev/myvg0/mylv`	Shrink the Logical Volume by 900 Mb
or	`lvresize -L-900M /dev/myvg0/mylv`	

How to snapshot and backup a Logical Volume

1.	`lvcreate -s -L 1024M -n snapshot0 /dev/myvg0/mylv`	Create the snapshot just like another Logical Volume
2.	`tar cvzf snapshot0.tar.gz snapshot0`	Backup the snapshot with any backup tool
3.	`lvremove /dev/mvvg0/snapshot0`	Delete the snapshot

PV commands		VG commands		LV commands	
`pvs`	Report information about Physical Volumes	`vgs`	Report information about Volume Groups	`lvs`	Report information about Logical Volumes
`pvscan`	Scan all disks for Physical Volumes	`vgscan`	Scan all disks for Volume Groups	`lvscan`	Scan all disks for Logical Volumes
`pvdisplay`	Display Physical Volume attributes	`vgdisplay`	Display Volume Group attributes	`lvdisplay`	Display Logical Volume attributes
`pvck`	Check Physical Volume metadata	`vgck`	Check Volume Group metadata		
`pvcreate`	Initialize a disk or partition for use with LVM	`vgcreate`	Create a Volume Group using Physical Volumes	`lvcreate`	Create a Logical Volume in a Volume Group
`pvchange`	Change Physical Volume attributes	`vgchange`	Change Volume Group attributes	`lvchange`	Change Logical Volume attributes
`pvremove`	Remove a Physical Volume	`vgremove`	Remove a Volume Group	`lvremove`	Remove a Logical Volume
		`vgextend`	Add a Physical Volume to a Volume Group	`lvextend`	Increase the size of a Logical Volume
		`vgreduce`	Remove a Physical Volume from a Volume Group	`lvreduce`	Shrink the size a Logical Volume
`pvresize`	Resize a disk or partition in use with LVM			`lvresize`	Modify the size of a Logical Volume
		`vgmerge`	Merge two Volume Groups		
		`vgsplit`	Split two Volume Groups		
		`vgimport`	Import a Volume Group into a system		
		`vgexport`	Export a Volume Group from a system		
`pvmove`	Move the Logical Extents on a Physical Volume to wherever there are available Physical Extents (within the Volume Group) and then put the Physical Volume offline				

LVM global commands	
`lvmdiskscan`	Scan the system for disks and partitions usable by LVM
`dmsetup` *`command`*	Perform low-level LVM operations

`/dev/mapper/`*`vgname-lvname`* `/dev/`*`vgname/lvname`*	Mapping of Logical Volumes in the filesystem

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 also mounts `initrd`, an initial ramdisk (typically a compressed ext2 filesystem) to be used as the initial root device during kernel boot; this make possible to load kernel modules that recognize hard drives hardware and that are hence needed to mount the real root filesystem. Afterwards, the system runs `/linuxrc` with PID 1. (From Linux 2.6.13 onward, the system instead loads into memory `initramfs`, a cpio-compressed image, and unpacks it into an instance of tmpfs in RAM. The kernel then executes `/init` from within the image.)
Linux kernel	Kernel decompression into memory. Kernel execution. Detection of devices. The real root filesystem is mounted on `/` in place of the initial ramdisk.

init	Execution of `init`, the first process (PID 1).
	The system tries to execute in the following order:
	`/sbin/init`
	`/etc/init`
	`/bin/init`
	`/bin/sh`
	If none of these succeeds, the kernel panics.

Startup	The system loads startup scripts and runlevel scripts.
Login	If in text mode, `init` calls the `getty` process, which runs the `login` command that asks the user for login and password. If in graphical mode, the X Display Manager starts the X Server.

Newer systems use UEFI (Unified Extensible Firmware Interface) instead of BIOS. UEFI does not use the MBR boot code; it has knowledge of partition table and filesystems, and stores its application files required for launch in a EFI System Partition, mostly formatted as FAT32.
After the POST, the system loads the UEFI firmware which initializes the hardware required for booting, then reads its Boot Manager data to determine which UEFI application to launch. The launched UEFI application may then launch another application, e.g. the kernel and `initramfs` in case of a boot loader like GRUB.

Startup sequence	Debian	Red Hat
At startup `/sbin/init` executes all instructions on `/etc/inittab`. This script at first switches to the default runlevel...	`id:2:initdefault:`	`id:5:initdefault:`
... then it runs the following script (same for all runlevels) which configures peripheral hardware, applies kernel parameters, sets hostname, and provides disks initialization...	`/etc/init.d/rcS`	`/etc/rc.d/rc.sysinit` or `/etc/rc.sysinit`
... and then, for runlevel *N*, it calls the script `/etc/init.d/rc N` (i.e. with the runlevel number as parameter) which launches all services and daemons specified in the following startup directories:	`/etc/rcN.d/`	`/etc/rc.d/rcN.d/`

The startup directories contain symlinks to the init 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
```

The last script to be run is `S99local -> ../init.d/rc.local` ; therefore, an easy way to run a specific program upon boot is to call it from this script file.

`/etc/init.d/boot.local`		runs only at boot time, not when switching runlevel.
`/etc/init.d/before.local`	(SUSE)	runs only at boot time, before the scripts in the startup directories.
`/etc/init.d/after.local`	(SUSE)	runs only at boot time, after the scripts in the startup directories.

To add or remove services at boot sequence:	`update-rc.d` *service* `defaults` `update-rc.d -f` *service* `remove`	`chkconfig --add` *service* `chkconfig --del` *service*

When adding or removing a service at boot, startup directories will be updated by creating or deleting symlinks for the default runlevels: K symlinks for runlevels 0 1 6, and S symlinks for runlevels 2 3 4 5.
Service will be run via the `xinetd` super server.

Service operation parameters supported by the init scripts		
`start`	Start the service	Mandatory
`stop`	Stop the service	
`restart`	Restart the service (stop, then start)	
`status`	Display daemon PID and execution status	
`force-reload`	Reload configuration if service supports it, otherwise restart	
`condrestart` `try-restart`	Restart the service only if already running	Optional
`reload`	Reload the service configuration	

Linux Standard Base (LSB)

The Linux Standard Base defines a format to specify default values on an init script `/etc/init.d/foo` :

```
### BEGIN INIT INFO
# Provides: foo
# Required-Start: bar
# Defalt-Start: 2 3 4 5
# Default-Stop: 0 1 6
# Description: Service Foo init script
### END INIT INFO
```

Default runlevels and S/K symlinks values can also be specified as such:

```
# chkconfig: 2345 85 15
# description: Foo service
```

`/etc/init/start-ttys.conf` (Red Hat)

Start the specified number of terminals at bootup via `getty`, which manages physical or virtual terminals (TTYs)

`/etc/sysconfig/init` (Red Hat)

Control appearance and functioning of the system during bootup

`/etc/machine-id` (Red Hat)

Randomly-generated machine ID

```
rm /etc/machine-id && \
systemd-machine-id-setup
```
(Red Hat)

Initialize the machine ID

`/etc/securetty`

List of TTYs from which the root user is allowed to login

`/etc/issue`

Message that will be printed before the login prompt.
Can contain the following escape codes:

`\b`	Baudrate of line	`\o`	Domain name
`\d`	Date	`\r`	OS release number
`\s`	System name and OS	`\t`	Time
`\l`	Terminal device line	`\u`	Number of users logged in
`\m`	Architecture identifier of machine	`\U`	"*n* users" logged in
`\n`	Nodename aka hostname	`\v`	OS version and build date

`/etc/issue.net`

Message that will be printed before the login prompt on a remote session

`/etc/motd`

Message that will be printed after a successful login, before execution of the login shell

```
cat /etc/debian_version   (Debian)
cat /etc/fedora-release   (Fedora)
cat /etc/redhat-release   (Red Hat)
cat /etc/lsb-release
lsb_release -a
```

Show the version of this Linux distribution

`/etc/os-release`

Definitions of values for the name, version, and other information about this Linux distribution

	Runlevel (SysV)	Target (Systemd)	Debian	Red Hat
	0		Shutdown	
	1		Single user / maintenance mode	
default runlevels	**2**		Multi-user mode (default)	Multi-user mode without network
	3	`multi-user.target`	Multi-user mode	Multi-user mode with network
	4		Multi-user mode	Unused, for custom use
	5	`graphical.target`	Multi-user mode	Multi-user mode with network and X (default)
	6		Reboot	
	S		Single user / maintenance mode (usually accessed through runlevel 1)	

Systemd's `runlevel`*n*`.target` emulates a SysV's runlevel *n*.

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

`init` *runlevel*
`telinit` *runlevel*
Change to *runlevel*

`systemctl get-default`
Get the default target

`systemctl set-default` *target*
Set the default *target*

`systemctl isolate` *target*
Change to *target*

`systemctl emergency`
Change to maintenance single-user mode with only `/root` filesystem mounted

`systemctl rescue`
Change to maintenance single-user mode with only local filesystems mounted

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

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

`shutdown`
Shut down the system in a secure way: all logged-in users are notified via a message to their terminal, and login is disabled.
This command can be run only by the root user, and by the users (if any) listed in `/etc/shutdown.allow`

`shutdown -h 16:00` *message*
Schedule a shutdown for 4 PM and send a warning message to all logged-in users

`shutdown -a`
Non-root users that are listed in `/etc/shutdown.allow` can use this command to shut down the system

`shutdown -f`
Skip fsck on reboot

`shutdown -F`
Force fsck on reboot

`shutdown -c`
Cancel a shutdown that has been already initiated

System V	Systemd	Action

`/etc/init.d/`*`service operation`*
 	
`service` *`service operation`* (Red Hat)
 	
`rcservice operation` (SUSE)
	`systemctl` *`operation service`*	Perform one of these operations on the specified service:
		`start`
		`stop`
		`restart`
		`status`
		`force-reload`
		`condrestart`
		`try-restart`
		`reload`

`update-rc.d` *`service`* `defaults` (Debian) `chkconfig --add` *`service`* (Red Hat)		Add a service at boot
`update-rc.d -f` *`service`* `remove` (Debian) `chkconfig --del` *`service`* (Red Hat)		Remove a service at boot
`update-rc.d -f` *`service`* `\` `start 30 2 3 4 5 . stop 70 0 1 6 .`		Add a service on the default runlevels; create S30 symlinks for starting the service and K70 symlinks for stopping it
`chkconfig --levels 245` *`service`* `on`		Add the service on runlevels 2 4 5
`chkconfig` *`service`* `on`	`systemctl enable` *`service`*	Add the service on default runlevels
`chkconfig` *`service`* `off`	`systemctl disable` *`service`*	Remove the service on default runlevels
`chkconfig` *`service`*	`systemctl is-enabled` *`service`*	Check if the service is enabled on the current runlevel
`chkconfig` *`service`* `reset`		Reset the on/off state of the service for all runlevels to whatever the LSB specifies in the init script
`chkconfig` *`service`* `resetpriorities`		Reset the start/stop priorities of the service for all runlevels to whatever the LSB specifies in the init script
`chkconfig --list` *`service`*		Display current configuration of service (its status and the runlevels in which it is active)
`chkconfig` `chkconfig --list`	`systemctl list-unit-files \` `--type=service`	List all active services and their current configuration
`ls /etc/rc`*`n`*`.d` (Debian)		List services started on runlevel *n*
	`systemctl`	List loaded and active units
	`systemctl --all`	List all units, including inactive ones
	`systemctl -t target`	List targets

/etc/inittab

```
# The default runlevel.
id:2:initdefault:

# Boot-time system configuration/initialization script.
# This is run first except when booting in emergency (-b) mode.
si::sysinit:/etc/init.d/rcS

# What to do in single-user mode.
~~:S:wait:/sbin/sulogin

# /etc/init.d executes the S and K scripts upon change of runlevel.
l0:0:wait:/etc/init.d/rc 0
l1:1:wait:/etc/init.d/rc 1
l2:2:wait:/etc/init.d/rc 2
l3:3:wait:/etc/init.d/rc 3
l4:4:wait:/etc/init.d/rc 4
l5:5:wait:/etc/init.d/rc 5
l6:6:wait:/etc/init.d/rc 6
# Normally not reached, but fall through in case of emergency.
z6:6:respawn:/sbin/sulogin

# /sbin/getty invocations for the runlevels.
# Id field must be the same as the last characters of the device (after "tty").
1:2345:respawn:/sbin/getty 38400 tty1
2:23:respawn:/sbin/getty 38400 tty2
```

`/etc/inittab` describes which processes are started at bootup and during normal operation; it is read and executed by `init` at bootup.
All its entries have the form ***id*:*runlevels*:*action*:*process***

id	1-4 characters, uniquely identifies an entry. For gettys and other login processes it should be equal to the suffix of the corresponding tty	
runlevels	Runlevels for which the specified action must be performed. If empty, action is performed on all runlevels	
action	`respawn`	Process will be restarted when it terminates
	`wait`	Process is started at the specified runlevel and `init` will wait for its termination (i.e. execution of further lines of `/etc/inittab` stops until the process exits)
	`once`	Process is executed once at the specified runlevel
	`boot`	Process is executed at system boot. Runlevels field is ignored
	`bootwait`	Process is executed at system boot and `init` will wait for its termination. Runlevels field is ignored
	`off`	Does nothing
	`ondemand`	Process is executed when an on-demand runlevel (A, B, C) is called
	`initdefault`	Specifies the default runlevel to boot on. Process field is ignored
	`sysinit`	Process is executed at system boot, before any `boot` or `bootwait` entries. Runlevels field is ignored
	`powerfail`	Process is executed when power goes down and an UPS kicks in. `init` will not wait for its termination
	`powerwait`	Process is executed when power goes down and an UPS kicks in. `init` will wait for its termination
	`powerfailnow`	Process is executed when power is down and the UPS battery is almost empty
	`powerokwait`	Process is executed when power has been restored from UPS
	`ctrlaltdel`	Process is executed when `init` receives a SIGINT via CTRL ALT DEL
	`kbdrequest`	Process is executed when a special key combination is pressed on console
process	Process to execute. If prepended by a `+`, `utmp` and `wtmp` accounting will not be done	

Filesystem Hierarchy Standard (FHS)	
/bin	Essential command binaries
/boot	Bootloader files (e.g. OS loader, kernel image, initrd)
/dev	Virtual filesystem containing device nodes to devices and partitions
/etc	System configuration files and scripts
/home	Home directories for users
/lib	Libraries for the binaries in /bin and /sbin, kernel modules
/lost+found	Storage directory for recovered files in this partition
/media	Mount points for removable media
/mnt	Mount points for temporary filesystems
/net	Access to directory tree on different external NFS servers
/opt	Optional, large add-on application software packages
/proc	Virtual filesystem providing kernel and processes information
/root	Home directory for the root user
/sbin	Essential system binaries, system administration commands
/srv	Data for services provided by the system
/sys	Virtual filesystem providing information about hotplug hardware devices
/tmp	Temporary files (deleted at reboot)
/usr	User utilities and applications
/usr/bin	Non-essential command binaries (for all users)
/usr/include	C header files
/usr/lib	Libraries for the binaries in /usr/bin and /usr/sbin
/usr/local	Software installed locally
/usr/local/bin	Local software binaries
/usr/local/games	Local game binaries
/usr/local/include	Local C header files
/usr/local/lib	Local libraries for the binaries in /usr/local/bin and /usr/local/sbin
/usr/local/man	Local man pages
/usr/local/sbin	Local system binaries
/usr/local/share	Local architecture-independent hierarchy
/usr/local/src	Local source code
/usr/sbin	Non-essential system binaries (daemons and services)
/usr/share	Architecture-independent files (e.g. icons, fonts, documentation)
/usr/share/doc	Package-specific documentation not included in man pages
/usr/share/man	Man pages
/usr/share/info	Documentation in Info format
/usr/src	Source code for the actual OS
/var	Variable files (e.g. logs, caches, mail spools)
/var/log	Logfiles
/var/opt	Variable files for the application software installed in /opt
/var/spool	Queued items to be processed (e.g. mail messages, cron jobs, print jobs)
/var/tmp	Temporary files that need to be stored for a longer time (preserved between reboots)

Information about filesystem hierarchy can also be obtained via the manpage `man hier`

`/dev/hda` IDE hard drive
`/dev/sda` SCSI, PATA, or SATA hard drive
`/dev/vda` Virtual disk for KVM-based virtual machines

`/dev/hda, /dev/hdb, /dev/hdc ...` first, second, third ... hard drive
`/dev/sda1, /dev/sda2, /dev/sda3 ...` first, second, third ... partition of the first hard drive

The superblock contains information relative to the filesystem e.g. 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. On recent systems, the MBR has been replaced by the GUID Partition Table (GPT).
Most modern filesystems use journaling; in a journaling filesystem, the journal logs changes before committing them to the filesystem, which ensures faster recovery and less corruption in case of a crash.

Partitioning limits for Linux using MBR:
Max 4 primary partitions per hard disk, or 3 primary partitions + 1 extended partition — Partition numbers: 1-4
Max 11 logical partitions (inside the extended partition) per hard disk — Partition numbers: 5-15
Max disk size is 2 Tb

GPT makes no difference between primary, extended, or logical partitions; moreover, it has practically no limits concerning number and size of partitions.

`fdisk /dev/sda` — Disk partitioning interactive tool

`fdisk -l /dev/sda` — List the partition table of `/dev/sda`

`parted` — Disk partitioning interactive tool

`sfdisk /dev/sda` — Disk partitioning non-interactive tool

`cfdisk` — Disk partitioning tool with text-based UI

`gparted`
`gnome-disks` — Disk partitioning tool with GUI

`partprobe` — After fdisk operations, this command can be run to notify the OS of partition table changes. Otherwise, these changes will take place only after reboot

`mkfs -t fstype device` — Create a filesystem of the specified type on a partition (i.e. format the partition).
mkfs is a wrapper utility for the actual filesystem-specific maker commands:

`mkfs.ext2`	aka `mke2fs`
`mkfs.ext3`	aka `mke3fs`
`mkfs.ext4`	
`mkfs.msdos`	aka `mkdosfs`
`mkfs.ntfs`	aka `mkntfs`
`mkfs.reiserfs`	aka `mkreiserfs`
`mkfs.jfs`	
`mkfs.xfs`	

`mkfs -t ext2 /dev/sda`
`mkfs.ext2 /dev/sda`
`mke2fs /dev/sda` — Create an ext2 filesystem on `/dev/sda`

`mke2fs -j /dev/sda`
`mkfs.ext3 /dev/sda`
`mke3fs /dev/sda` — Create an ext3 filesystem (ext2 with journaling) on `/dev/sda`

`mkfs -t msdos /dev/sda`
`mkfs.msdos /dev/sda`
`mkdosfs /dev/sda` — Create a MS-DOS filesystem on `/dev/sda`

`mount`
`cat /proc/mounts`
`cat /etc/mtab`
Display the currently mounted filesystems.
The commands `mount` and `umount` maintain in `/etc/mtab` a database of currently mounted filesystems, but `/proc/mounts` is authoritative

`mount -a`
Mount all devices listed in `/etc/fstab` (except those indicated as `noauto`)

`mount -t ext3 /dev/sda /foobar`
Mount a Linux-formatted disk. The mount point (directory) must exist

`mount -t msdos /dev/fd0 /mnt`
Mount a MS-DOS filesystem floppy disk to mount point `/mnt`

`mount /dev/fd0`
Mount a floppy disk. `/etc/fstab` must contain an entry for `/dev/fd0`

`mount -o remount,rw /`
Remount the root directory as read-write (supposing it was mounted read-only). Useful to change flags (in this case, read-only to read-write) for a mounted filesystem that cannot be unmounted at the moment

`mount -o nolock 10.7.7.7:/export/ /mnt/nfs`
Mount a NFS share without running NFS daemons. Useful during system recovery

`mount -t iso9660 -o ro,loop=/dev/loop0 cd.img /mnt/cdrom`
Mount a CD-ROM ISO9660 image file like a CD-ROM (via the loop device)

`umount /dev/fd0`
`umount /mnt`
Unmount a floppy disk that was mounted on `/mnt` (device must not be busy)

`umount -l /dev/fd0`
Unmount the floppy disk as soon as it is not in use anymore

The UUID (Universal Unique Identifier) of a partition is a 128-bit hash number that is associated to the partition when it is initialized.

`blkid -U 652b786e-b87f-49d2-af23-8087ced0c667`
Print the name of the specified partition, given its UUID

`blkid -L /boot`
Print the UUID of the specified partition, given its label

`findfs UUID=652b786e-b87f-49d2-af23-8087ced0c667`
Print the name of the specified partition, given its UUID

`findfs LABEL=/boot`
Print the name of the specified partition, given its label

`e2label /dev/sda1`
Print the label of the specified partition, given its name

Partition types		
0x00 Empty	0x4e QNX4.x 2nd part	0xa8 Darwin UFS
0x01 FAT12	0x4f QNX4.x 3rd part	0xa9 NetBSD
0x02 XENIX root	0x50 OnTrack DM	0xab Darwin boot
0x03 XENIX usr	0x51 OnTrack DM6 Aux1	0xaf HFS / HFS+
0x04 FAT16 <32M	0x52 CP/M	0xb7 BSDI fs
0x05 Extended	0x53 OnTrack DM6 Aux3	0xb8 BSDI swap
0x06 FAT16	0x54 OnTrackDM6	0xbb Boot Wizard hidden
0x07 HPFS/NTFS/exFAT	0x55 EZ-Drive	0xbe Solaris boot
0x08 AIX	0x56 Golden Bow	0xbf Solaris
0x09 AIX bootable	0x5c Priam Edisk	0xc1 DRDOS/sec (FAT-12)
0x0a OS/2 Boot Manager	0x61 SpeedStor	0xc4 DRDOS/sec (FAT-16 < 32M)
0x0b W95 FAT32	0x63 GNU HURD or SysV	0xc6 DRDOS/sec (FAT-16)
0x0c W95 FAT32 (LBA)	0x64 Novell Netware 286	0xc7 Syrinx
0x0e W95 FAT16 (LBA)	0x65 Novell Netware 386	0xda Non-FS data
0x0f W95 extended (LBA)	0x70 DiskSecure Multi-Boot	0xdb CP/M / CTOS / ...
0x10 OPUS	0x75 PC/IX	0xde Dell Utility
0x11 Hidden FAT12	0x80 Old Minix	0xdf BootIt
0x12 Compaq diagnostics	0x81 Minix / old Linux	0xe1 DOS access
0x14 Hidden FAT16 <32M	0x82 Linux swap / Solaris	0xe3 DOS R/O
0x16 Hidden FAT16	0x83 Linux	0xe4 SpeedStor
0x17 Hidden HPFS/NTFS	0x84 OS/2 hidden C: drive	0xeb BeOS fs
0x18 AST SmartSleep	0x85 Linux extended	0xee GPT
0x1b Hidden W95 FAT32	0x86 NTFS volume set	0xef EFI (FAT-12/16/32)
0x1c Hidden W95 FAT32 (LBA)	0x87 NTFS volume set	0xf0 Linux/PA-RISC boot
0x1e Hidden W95 FAT16 (LBA)	0x88 Linux plaintext	0xf1 SpeedStor
0x24 NEC DOS	0x8e Linux LVM	0xf4 SpeedStor
0x27 Hidden NTFS WinRE	0x93 Amoeba	0xf2 DOS secondary
0x39 Plan 9	0x94 Amoeba BBT	0xfb VMware VMFS
0x3c PartitionMagic recovery	0x9f BSD/OS	0xfc VMware VMKCORE
0x40 Venix 80286	0xa0 IBM Thinkpad hibernation	0xfd Linux raid autodetect
0x41 PPC PReP Boot	0xa5 FreeBSD	0xfe LANstep
0x42 SFS	0xa6 OpenBSD	0xff BBT
0x4d QNX4.x	0xa7 NeXTSTEP	

Above is the list of partition IDs and their names, as obtained by the command `sfdisk -T`

Most used Linux-supported filesystems	
ext2	Linux default filesystem, offering the best performances
ext3	ext2 with journaling
ext4	Linux journaling filesystem, upgrade from ext3
Reiserfs	Journaling filesystem
XFS	Journaling filesystem, developed by SGI
JFS	Journaling filesystem, developed by IBM
Btrfs	B-tree filesystem, developed by Oracle
msdos	DOS filesystem, supporting only 8-char filenames
umsdos	Extended DOS filesystem used by Linux, compatible with DOS
fat32	MS-Windows FAT filesystem
vfat	Extended DOS filesystem, with support for long filenames
ntfs	Replacement for fat32 and vfat filesystems
minix	Native filesystem of the MINIX OS
iso9660	CD-ROM filesystem
cramfs	Compressed RAM disk
nfs	Network filesystem, used to access files on remote machines
SMB	Server Message Block, used to mount Windows network shares
proc	Pseudo filesystem, used as an interface to kernel data structures
swap	Pseudo filesystem, Linux swap area

In Linux, the swap space is a virtual memory area (a file or a partition) used as RAM extension. Usually a partition is preferred because of better performances concerning fragmentation and disk speed. Although listed as filesystem type 0x82, the swap partition is not a filesystem but a raw addressable memory with no structure; therefore it is not shown in the output of `mount` or `df` commands.
The `fdisk` tool can be used to create a swap partition.

`dd if=/dev/zero of=/swapfile \ bs=1024 count=512000`	Create a 512-Mb swap file
`mkswap /swapfile`	Initialize a (already created) swap file or partition
`swapon /swapfile`	Enable a swap file or partition, thus telling the kernel that it can use it now
`swapoff /swapfile`	Disable a swap file or partition

`swapon -s`
`cat /proc/swaps`
`cat /proc/meminfo`
`free`
`top`
	Show the sizes of total and used swap areas

How to extend a swap partition using LVM

1.	`lvs`	Determine the name of the swap Logical Volume
2.	`swapoff /dev/volgroup0/swap_lv`	Turn off the swap volume
3.	`lvresize -L+1G /dev/volgroup0/swap_lv`	Extend the swap volume with an additional 1 Gb of space
4.	`mkswap /dev/volgroup0/swap_lv`	Format the swap volume
5.	`swapon /dev/volgroup0/swap_lv`	Turn on the swap volume

/etc/fstab Filesystems information

```
# <filesystem>      <mount point>      <type>    <options>                          <dump> <pass>

/dev/sda2           /                  ext2      defaults                             0 1
/dev/sdb1           /home              ext2      defaults                             1 2
/dev/cdrom          /media/cdrom       auto      ro,noauto,user,exec                  0 0
/dev/fd0            /media/floppy      auto      rw,noauto,user,sync                  0 0
proc                /proc              proc      defaults                             0 0
/dev/hda1           swap               swap      pri=42                               0 0
nfsserver:/dirs     /mnt               nfs       intr                                 0 0
//smbserver/jdoe    /shares/jdoe       cifs      auto,credentials=/etc/smbcreds       0 0
LABEL=/boot         /boot              ext2      defaults                             0 0
UUID=652b786e-b87f-49d2-af23-8087ced0c667  /test  ext4  errors=remount-ro,noatime    0 0
```

filesystem	Device or partition. The filesystem can be identified either by its name, label, or UUID	
mount point	Directory on which the partition must be mounted	
type	Filesystem type, or `auto` if detected automatically	
options	`defaults`	Use the default options: `rw, suid, dev, exec, auto, nouser, async`
	`ro`	Mount read-only
	`rw`	Mount read-write (default)
	`suid`	Permit SUID and SGID bit operations (default)
	`nosuid`	Do not permit SUID and SGID bit operations
	`dev`	Interpret block special devices on the filesystem (default)
	`nodev`	Do not interpret block special devices on the filesystem
	`auto`	Mount automatically at bootup, or when command `mount -a` is given (default)
	`noauto`	Mount only if explicitly demanded
	`user`	Partition can be mounted by any user
	`nouser`	Partition can be mounted only by the root user (default)
	`exec`	Binaries contained on the partition can be executed
	`noexec`	Binaries contained on the partition cannot be executed
	`sync`	Write files immediately to the partition
	`async`	Buffer write ops and commit them later, or when device is unmounted (default)
	Other specific options apply to specific partition types (e.g. NFS or Samba)	
dump	Options for the `dump` backup utility. `0` = do not backup	
pass	Order in which the filesystem must be checked by `fsck`. `0` = do not check	

`df`	Report filesystem disk space usage
`df -h`	Report filesystem disk space usage in human-readable output
`df` *directory*	Shows on which device the specified *directory* is mounted
`du` *directory*	Report disk usage as size of each file inside *directory*
`du -s` *directory*	Report the sum of all files contained inside *directory*
`du -sh` *directory*	Report the sum of all files contained inside *directory* in human-readable output
`ncdu`	Disk usage analyzer with ncurses UI
`lsblk`	List information about all available block devices
`lsscsi`	List information about all SCSI devices
`blockdev --getbsz /dev/sda1`	Get the block size of the specified partition
`sync`	Flush the buffer and commit all pending writes. To improve performance of Linux filesystems, many write operations are buffered in RAM and written at once; writes are done in any case before unmount, reboot, or shutdown
`chroot /mnt/sysimage`	Start a shell with `/mnt/sysimage` as filesystem root. Useful during system recovery when the machine has been booted from a removable media (which hence is defined as the filesystem root)
`mknod /dev/sda`	Create a directory allocating the proper inode. Useful during system recovery when experiencing filesystem problems
`hdparm`	Get/set drive parameters for SATA/IDE devices
`hdparm -g /dev/hda`	Display drive geometry (cylinders, heads, sectors) of /dev/hda
`hdparm -i /dev/hda`	Display identification information for /dev/hda
`hdparm -tT /dev/hda`	Perform disk read benchmarks on the /dev/hda drive
`hdparm -p 12 /dev/hda`	Reprogram IDE interface chipset of /dev/hda to mode 4. Use with caution!
`sdparm`	Access drive parameters for SCSI devices

`fsck` *device*

Check and repair a Linux filesystem. Warning: filesystem must be unmounted!
Corrupted files will be placed into the `/lost+found` of the partition.
The exit code returned is the sum of the following conditions:

0	No errors	8	Operational error
1	File system errors corrected	16	Usage or syntax error
2	System should be rebooted	32	Fsck canceled by user
4	File system errors left uncorrected	128	Shared library error

Fsck is a wrapper utility for the actual filesystem-specific checker commands:
`fsck.ext2` aka `e2fsck`
`fsck.ext3` aka `e2fsck`
`fsck.ext4` aka `e2fsck`
`fsck.msdos`
`fsck.vfat`
`fsck.cramfs`

`fsck`
`fsck -As`

Check and repair serially all filesystems listed in `/etc/fstab`

`fsck -f /dev/sda1`

Force a filesystem check on `/dev/sda1` even if it thinks is not necessary

`fsck -y /dev/sda1`

During filesystem repair, do not ask questions and assume that the answer is always yes

`fsck.ext2 -c /dev/sda1`
`e2fsck -c /dev/sda1`

Check an ext2 filesystem, running the `badblocks` command to mark all bad blocks and add them to the bad block inode so they will not be allocated to files or directories

`touch /forcefsck`

Force a filesystem check after next reboot (Red Hat)

`tune2fs` *options device*

Adjust tunable filesystem parameters on ext2/ext3/ext4 filesystems

`tune2fs -l /dev/sda1`

List the contents of the filesystem superblock

`tune2fs -j /dev/sda1`

Add a journal to this ext2 filesystem, making it an ext3

`tune2fs -C 7 /dev/sda1`

Set the mount count of the filesystem to 7

`tune2fs -c 20 /dev/sda1`

Set the filesystem to be checked by fsck after 20 mounts

`tune2fs -i 15d /dev/sda1`

Set the filesystem to be checked by fsck each 15 days

Both mount-count-dependent and time-dependent checking are enabled by default for all hard drives on Linux, to avoid the risk of filesystem corruption going unnoticed.

`dumpe2fs` *options device*

Dump ext2/ext3/ext4 filesystem information

`dumpe2fs -h /dev/sda1`

Display filesystem's superblock information (e.g. number of mounts, last checks, UUID)

`dumpe2fs /dev/sda1 | grep -i superblock`

Display locations of superblock (primary and backup) of filesystem

`dumpe2fs -b /dev/sda1`

Display blocks that are marked as bad in the filesystem

`resize2fs` *options device size*

Resize an ext2/ext3/ext4 filesystem

`debugfs` *device*

Interactive ext2/ext3/ext4 filesystem debugger

`debugfs -w /dev/sda1`

Debug `/dev/sda1` in read-write mode
(by default, debugfs accesses the device in read-only mode)

Many hard drives feature the Self-Monitoring, Analysis and Reporting Technology (SMART) whose purpose is to monitor the reliability of the drive, predict drive failures, and carry out different types of drive self-tests.
The `smartd` daemon attempts to poll this information from all drives every 30 minutes, logging all data to syslog.

`smartctl -a /dev/sda`

Print SMART information for drive `/dev/sda`

`smartctl -s off /dev/sda`

Disable SMART monitoring and log collection for drive `/dev/sda`

`smartctl -t long /dev/sda`

Begin an extended SMART self-test on drive `/dev/sda`

`xfs_growfs` *options mountpoint*
Expand an XFS filesystem (there must be at least one spare new disk partition available)

```
xfs_info /dev/sda1
xfs_growfs -n /dev/sda1
```
Print XFS filesystem geometry

`xfs_check` *options device*
Check XFS filesystem consistency

`xfs_repair` *options device*
Repair a damaged or corrupt XFS filesystem

`xfsdump -v silent -f /dev/tape /`
Dump the root of a XFS filesystem to tape, with lowest level of verbosity. Incremental and resumed dumps are stored in the inventory database `/var/lib/xfsdump/inventory`

`xfsrestore -f /dev/tape /`
Restore a XFS filesystem from tape

`xfsdump -J - / | xfsrestore -J - /new`
Copy the contents of a XFS filesystem to another directory (without updating the inventory database)

`reiserfstune` *options device*
Adjust tunable filesystem parameters on ReiserFS filesystem

`debugreiserfs` *device*
Interactive ReiserFS filesystem debugger

`mkisofs -r -o cdrom.img data/`
Create a CD-ROM image from the contents of the target directory. Enable Rock Ridge extension and set all content on CD to be public readable (instead of inheriting the permissions from the original files)

CD-ROM filesystems		
Filesystem	**Commands**	
ISO9660	`mkisofs`	Create a ISO9660 filesystem
UDF (Universal Disk Format)	`mkudffs`	Create a UDF filesystem
	`udffsck`	Check a UDF filesystem
	`wrudf`	Maintain a UDF filesystem
	`cdrwtool`	Manage CD-RW drives (disk format, read/write speed, ...)
HFS (Hierarchical File System)		
CD-ROM filesystem extensions		
Rock Ridge	Contains the original file information (e.g. permissions, filename) for MS Windows 8.3 filenames	
MS Joliet	Used to create more MS Windows friendly CD-ROMs	
El Torito	Used to create bootable CD-ROMs	

AutoFS is a client-side service that permits automounting of filesystems, even for nonprivileged users.
AutoFS is composed of the `autofs` kernel module that monitors specific directories for attempts to access them; in this case, the kernel module signals the `automount` userspace daemon which mounts the directory when it needs to be accessed and unmounts it when is no longer accessed.
Mounts managed by AutoFS should not be mounted/unmounted manually or via `/etc/fstab`, to avoid inconsistencies.

AutoFS configuration files	
`/etc/sysconfig/autofs`	AutoFS configuration file

`/etc/auto.master`	Master map file for AutoFS. Each line is an indirect map, and each map file stores the configuration for the automounting of the subdir.
	
	`# mount point  map  options`
	`/net  -hosts`
	`/-  /etc/auto.direct`
	`/misc  /etc/auto.misc`
	`/home  /etc/auto.home  --timeout=60`
	
	The `-hosts` map tells AutoFS to mount/unmount automatically any export from the NFS server *nfsserver* when the directory `/net/nfsserver/` is accessed.

AutoFS map files	

`/etc/auto.direct`	Direct map file for automounting of a NFS share.
	
	`# dir  filesystem`
	`/mydir  nfsserver1.foo.org:/myshare`

`/etc/auto.misc`	Indirect map file for automounting of directory `/misc` .
	
	`# subdir  options  filesystem`
	`public  -ro,soft,intr  ftp.example.org:/pub`
	`cd  -fstype=iso9660,ro,nosuid,nodev  :/dev/cdrom`

`/etc/auto.home`	Indirect map file for automounting of directory `/home` on a NFS share.
	The `*` wildcard matches any subdir the system attempts to access, and the `&` variable takes the value of the match.
	
	`# subdir  options  filesystem`
	`*  -rw,soft,intr  nfsserver2.bar.org:/home/&`

RAID levels		
Level	**Description**	**Storage capacity**
RAID 0	Striping (data is written across all member disks). High I/O but no redundancy	Sum of the capacity of member disks
RAID 1	Mirroring (data is mirrored on all disks). High redundancy but high cost	Capacity of the smaller member disk
RAID 4	Parity on a single disk. I/O bottleneck unless coupled to write-back caching	Sum of the capacity of member disks, minus one
RAID 5	Parity distributed across all disks. Can sustain one disk crash	Sum of the capacity of member disks, minus one
RAID 6	Double parity distributed across all disks. Can sustain two disk crashes	Sum of the capacity of member disks, minus two
RAID 10 (1+0)	Striping + mirroring. High redundancy but high cost	Capacity of the smaller member disk
Linear RAID	Data written sequentially across all disks. No redundancy	Sum of the capacity of member disks

```
mdadm -C /dev/md0 -l 5 \
-n 3 /dev/sdb1 /dev/sdc1 /dev/sdd1 \
-x 1 /dev/sde1
```

Create a RAID 5 array from three partitions and a spare.
Partitions type must be set to 0xFD.
Once the RAID device has been created, it must be formatted e.g. via `mke2fs -j /dev/md0`

```
mdadm --manage /dev/md0 -f /dev/sdd1
```

Mark a drive as faulty, before removing it

```
mdadm --manage /dev/md0 -r /dev/sdd1
```

Remove a drive from the RAID array.
The faulty drive can now be physically removed

```
mdadm --manage /dev/md0 -a /dev/sdd1
```

Add a drive to the RAID array.
To be run after the faulty drive has been physically replaced

```
mdadm --misc -Q /dev/sdd1
```

Display information about a device

```
mdadm --misc -D /dev/md0
```

Display detailed information about the RAID array

```
mdadm --misc -o /dev/md0
```

Mark the RAID array as readonly

```
mdadm --misc -w /dev/md0
```

Mark the RAID array as read & write

```
/etc/mdadm.conf
```

Configuration file for the `mdadm` command.

```
DEVICE /dev/sdb1 /dev/sdc1 /dev/sdd1 /dev/sde1
ARRAY /dev/md0 level=raid5 num-devices=3
  UUID=0098af43:812203fa:e665b421:002f5e42
  devices=/dev/sdb1,/dev/sdc1,/dev/sdd1,/dev/sde1
```

```
cat /proc/mdstat
```

Display information about RAID arrays and devices

<table>
<tr><th colspan="3">Non-GRUB bootloaders</th></tr>
<tr><td colspan="2">LILO
(Linux Loader)</td><td>Obsolete. Small bootloader that can be placed in the MBR or the boot sector of a partition.
The configuration file is <code>/etc/lilo.conf</code> (run <code>/sbin/lilo</code> afterwards to validate changes).</td></tr>
<tr><td rowspan="3">SYSLINUX</td><td>SYSLINUX</td><td>Able to boot from FAT and NTFS filesystems e.g. floppy disks and USB drives.
Used for boot floppy disks, rescue floppy disks, and Live USBs.</td></tr>
<tr><td>ISOLINUX</td><td>Able to boot from CD-ROM ISO 9660 filesystems.
Used for Live CDs and bootable install CDs.

The CD must contain the following files:

<code>isolinux/isolinux.bin</code> ISOLINUX image, from the SYSLINUX distro
<code>boot/isolinux/isolinux.cfg</code> ISOLINUX configuration
<code>images/</code> Floppy images to boot
<code>kernel/memdisk</code>

The CD can be burnt with the command:
<code>mkisofs -o output.iso -b isolinux/isolinux.bin -c isolinux/boot.cat \
-no-emul-boot -boot-load-size 4 -boot-info-table CDrootdir</code></td></tr>
<tr><td>PXELINUX</td><td>Able to boot from PXE (Pre-boot eXecution Environment). PXE uses DHCP or BOOTP to enable basic networking, then uses TFTP to download a bootstrap program that loads and configures the kernel.
Used for Linux installations from a central server or network boot of diskless workstations.

The boot TFTP server must contain the following files:

<code>/tftpboot/pxelinux.0</code> PXELINUX image, from the SYSLINUX distro
<code>/tftpboot/pxelinux.cfg/</code> Directory containing a configuration file for each machine.
A machine with Ethernet MAC address 88:99:AA:BB:CC:DD and IP address 192.0.2.91 (C000025B in hexadecimal) will search for its configuration filename in this order:
<code>01-88-99-aa-bb-cc-dd
C000025B
C000025
C00002
C0000
C000
C00
C0
C
default</code></td></tr>
<tr><td colspan="2">EXTLINUX</td><td>General-purpose bootloader like LILO or GRUB. Now merged with SYSLINUX.</td></tr>
</table>

- For good resource on installing linux (ubuntu) on uefi or legacy bios see:https://help.ubuntu.com/community/UEFI#Iden

GRUB (Grand Unified Bootloader) is the standard boot manager on modern Linux distros. The latest version is GRUB 2; the older version is GRUB Legacy.
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 then accesses the GRUB configuration and commands available on the filesystem, usually on `/boot/grub` .

`/boot/grub/grub.cfg` or `/boot/grub2/grub.cfg` GRUB 2 configuration file

```
# 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
}
```

The GRUB 2 configuration file must not be edited manually. Instead, edit the files in `/etc/grub.d/` (these are scripts that will be run in order) and the file `/etc/default/grub` (the configuration file for menu display settings), then run `update-grub` (Debian) or `grub2-mkconfig` (Red Hat) which will recreate this configuration file.

Common kernel parameters:

`root=`	Specify the location of the filesystem root. This is a required parameter
`ro`	Mount read-only on boot
`quiet`	Disable non-critical kernel messages during boot
`debug`	Enable kernel debugging
`splash`	Show splash image
`single`	Boot in single-user mode (runlevel 1)
`emergency`	Emergency mode: after the kernel is booted, run `sulogin` (single-user login) which asks for the root password for system maintenance, then run a Bash. Does not load `init` or any daemon or configuration setting.
`init=/bin/bash`	Run a Bash shell (may also be any other executable) instead of `init`

The GRUB menu, presented at startup, permits to choose the OS or kernel to boot:

ENTER	Boot the currently selected GRUB entry
C	Get a GRUB command line
E	Edit the selected GRUB entry (e.g. to edit kernel parameters in order to boot in single-user emergency mode, or to change IRQ or I/O port of a device driver compiled in the kernel)
B	Boot the currently selected GRUB entry (this is usually done after finishing modifying it)
P	Bring up the GRUB password prompt (necessary if a GRUB password has been set)

`grub-install /dev/sda`	Install GRUB on first SATA drive
`grub`	Access the GRUB shell
`grub2-set-default 1`	Set GRUB to automatically boot the second entry in the GRUB menu
`grub2-editenv list`	Display the current GRUB menu entry that is automatically booted

`/boot/grub/device.map` This file can be created to map Linux device filenames to BIOS drives:

```
(fd0)   /dev/fd0
(hd0)   /dev/hda
```

GRUB Legacy shell commands			
`blocklist` *file*	Print the block list notation of a file	`kernel` *file*	Load a kernel
`boot`	Boot the loaded OS	`lock`	Lock a GRUB menu entry
`cat` *file*	Show the contents of a file	`makeactive`	Set active partition on root disk to GRUB's root device
`chainloader` *file*	Chainload another bootloader	`map` *drive1 drive2*	Map a drive to another drive
`cmp` *file1 file2*	Compare two files	`md5crypt`	Encrypt a password in MD5 format
`configfile` *file*	Load a configuration file	`module` *file*	Load a kernel module
`debug`	Toggle debugging mode	`modulenounzip` *file*	Load a kernel module without decompressing it
`displayapm`	Display APM BIOS information	`pause` *message*	Print a message and wait for a key press
`displaymem`	Display memory configuration	`quit`	Quit the GRUB shell
`embed` *stage device*	Embed Stage 1.5 in the device	`reboot`	Reboot the system
`find` *file*	Find a file	`read` *address*	Read a 32-bit value from memory and print it
`fstest`	Toggle filesystem test mode	`root` *device*	Set the current root device
`geometry` *drive*	Print information on a drive geometry	`rootnoverify` *device*	Set the current root device without mounting it
`halt`	Shut down the system	`savedefault`	Save current menu entry as the default entry
`help` *command*	Show help for a command, or the available commands	`setup` *device*	Install GRUB automatically on the device
`impsprobe`	Probe the Intel Multiprocessor Specification	`testload` *file*	Test the filesystem code on a file
`initrd` *file*	Load an initial ramdisk image file	`testvbe` *mode*	Test a VESA BIOS EXTENSION mode
`install` *options*	Install GRUB (deprecated, use `setup` instead)	`uppermem` *kbytes*	Set the upper memory size (only for old machines)
`ioprobe` *drive*	Probe I/O ports used for a drive	`vbeprobe` *mode*	Probe a VESA BIOS EXTENSION mode

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

```
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

# Section 2: Firmware/BIOS update from floppy disk
title    Firmware update
kernel /memdisk    # boot a floppy disk image
initrd /floppy-img-7.7.7
```

Low-level package managers	Debian	Red Hat

Install a package file	`dpkg -i package.deb`	`rpm -i package.rpm`
		`rpm -i ftp://host/package.rpm`
		`rpm -i http://host/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 installed packages and their installation date, from newest to oldest		`rpm -qa --last`
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`
Verify an installed package		`rpm -V package`
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 package managers	Debian	Red Hat
Install a package	`apt-get install` *package*	`yum install` *package*
Install a package file		`yum install` *package.rpm* `yum localinstall` *package.rpm*
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`	
Replace a package with another		`yum swap` *packageout packagein*
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 on available packages	`apt-get update`	
List all installed and available packages		`yum list`
List installed and available packages that match the search term		`yum list` *searchterm*
List installed packages		`yum list installed`
List packages available for install		`yum list available`
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*
Show the installation history		`yum history` `yum history list`
Show the installation history about a package		`yum history package` *package* `yum history list package` *package*
Update information about package contents	`apt-file update`	
List the content of an uninstalled package	`apt-file list` *package*	
Show which package provides a specific file	`apt-file search` *file*	`yum whatprovides` *file*
Add a CD-ROM to the sources list	`apt-cdrom add`	
Download package and all its dependencies		`yumdownloader --resolve` *package*
Show URLs that would be downloaded		`yumdownloader --urls` *package*
Try to complete unfinished or aborted package installations		`yum-complete-transaction`
Print list of available repositories	`cat /etc/apt/sources.list`	`yum repolist` `cat /etc/yum.repos.d/*.repo`
Package format	compressed with `ar`	compressed with `cpio`

High-level package managers are able to install remote packages and automatically solve dependencies.

GUI package managers	Debian	Red Hat
Manage packages and dependencies using a graphical or text-based UI	`aptitude`	`pirut`
	`dselect`	
	`synaptic`	

Package management tools	Debian	Red Hat
Convert a RPM package to DEB and install it. Might break the package system!	`alien -i package.rpm`	
Convert a RPM package to cpio archive		`rpm2cpio package.rpm`
Add a key to the list of keys used to authenticate packages	`apt-key add keyfile`	
Register a system to the RHSM (Red Hat Subscription Management) portal		`subscription-manager register`
Attach a RHSM subscription to a registered system		`subscription-manager attach`

`/etc/yum.repos.d/fedora.repo` Configuration file for a specific "Fedora" repository	
`[fedora]`	Repository ID
`name=Fedora $releasever - $basearch`	Repository name

`baseurl=http://download.fedoraproject.org/pub/fedora/linux/\`
`releases/$releasever/Everything/$basearch/os/`
`http://foo.org/fedora/$releasever/$basearch/`
`http://bar.org/fedora/$releasever/$basearch/`
	List of URLs to the repository's repodata directory. Can be any of these types:
	`file:///` local file
	`file://` NFS
	`http://` HTTP
	`https://` HTTPS
	`ftp://` FTP

`enabled=1`	Whether this repository is enabled
`gpgcheck=1`	Whether to perform a GPG signature check on the packages downloaded from this repository
`failovermethod=priority`	Makes yum try the baseurls in the order they're listed. By default, if more than one baseurl is specified, yum chooses one randomly
`metalink=https://mirrors.fedoraproject.org/metalink?repo=\` `fedora-$releasever&arch=$basearch`	URL to a metalink file that specifies the list of mirrors to use. Can be used with or in alternative to a baseurl
`gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-fedora-\` `$releasever-$basearch`	ASCII-armored GPG public key file of the repository

A detailed list of repository configuration options can be read on the manpage `man yum.conf`

```
dd if=/dev/sda of=/dev/sdb
cat /dev/sda > /dev/sdb
```
Copy the content of one hard disk over another, byte by byte

```
dd if=/dev/sda1 of=sda1.img
```
Generate the image file of a partition

```
dd if=/dev/cdrom of=cdrom.iso bs=2048
```
Create an ISO file from a CD-ROM, using a block size transfer of 2 Kb

```
dd if=install.iso of=/dev/sdc bs=512k
```
Write an installation ISO file to a device (e.g. a USB thumb drive)

```
rsync -rzv /home  /tmp/bak
rsync -rzv /home/ /tmp/bak/home
```
Synchronize the content of the home directory with the temporary backup directory. Use recursion, compression, and verbosity.
For all transfers subsequent to the first, rsync only copies the blocks that have changed, making it a very efficient backup solution in terms of speed and bandwidth

```
rsync -avz /home root@10.0.0.7:/backup/
```
Synchronize the content of the home directory with the backup directory on the remote server, using SSH. Use archive mode (operates recursively and preserves owner, group, permissions, timestamps, and symlinks)

Tape libraries		
Devices	`/dev/st0`	First SCSI tape device
	`/dev/nst0`	First SCSI tape device (no-rewind device file)
Utility for magnetic tapes	`mt -f /dev/nst0 asf 3`	Position the tape at the start of 3rd file
Utility for tape libraries	`mtx -f /dev/sg1 status`	Display status of tape library
	`mtx -f /dev/sg1 load 3`	Load tape from slot 3 to drive 0
	`mtx -f /dev/sg1 unload`	Unload tape from drive 0 to original slot
	`mtx -f /dev/sg1 transfer 3 4`	Transfer tape from slot 3 to slot 4
	`mtx -f /dev/sg1 inventory`	Force robot to rescan all slots and drives
	`mtx -f /dev/sg1 inquiry`	Inquiry about SCSI media device (Medium Changer = tape library)

cpio	`ls | cpio -o > archive.cpio` `ls | cpio -oF archive.cpio`	Create a cpio archive of all files in the current directory
	`find /home/ | cpio -o > archive.cpio`	Create a cpio archive of all users' home directories
	`cpio -id < archive.cpio`	Extract all files, recreating the directory structure
	`cpio -i -t < archive.cpio`	List the contents of a cpio archive file
gzip	`gzip file`	Compress a file with gzip
	`gunzip file.gz`	Decompress a gzip-compressed file
	`gunzip -tv file.gz`	Test the integrity of a gzip-compressed file
	`zcat file.gz`	Read a gzip-compressed text file
	`zgrep pattern file.gz`	`grep` for a gzip-compressed text file
	`zless file.gz`	`less` for a gzip-compressed text file
	`zmore file.gz`	`more` for a gzip-compressed text file
bzip2	`bzip2 file`	Compress a file with bzip2
	`bunzip2 file.bz2`	Decompress a bzip2-compressed file
	`bzcat file.bz2`	Read a bzip2-compressed text file
7-Zip	`7z a -t7z archive.7z dir/`	Create a 7-Zip archive (has the highest compression ratio)
xz	`xz file`	Compress a file with xz
	`unxz file.xz` `xz -d file.xz`	Decompress a xz-compressed file
	`xzcat file.xz`	Read a xz-compressed file
LZMA	`lzma file` `xz --format=lzma file`	Compress a file with LZMA
	`unlzma file.lzma` `xz --format=lzma -d file.lzma`	Decompress a LZMA-compressed file
	`lzcat file.lzma` `xz --format=lzma --d --stdout file.lzma`	Read a LZMA-compressed file
rar	`rar a archive.rar dir/`	Create a RAR archive
	`unrar x archive.rar`	Extract a RAR archive
tar	`tar cvf archive.tar dir/`	Create a tarred archive (bundles multiple files in a single one)
	`tar cvzf archive.tar.gz dir/`	Create a tarred gzip-compressed archive
	`tar xvzf archive.tar.gz`	Extract a tarred gzip-compressed archive
	`tar cvjf archive.tar.bz2 dir/`	Create a tarred bzip2-compressed archive
	`tar xvjf archive.tar.bz2`	Extract a tarred bzip2-compressed archive
	`tar cvJf archive.tar.xz dir/`	Create a tarred xz-compressed archive
	`tar xvJf archive.tar.xz`	Extract a tarred xz-compressed archive
	`tar tvf archive.tar`	List the contents of a tarred archive
star	`star -c -f=archive.star dir/`	Create a star archive
	`star -x -f=archive.star`	Extract a star archive

`man` *command*	Show the man page for a command
`man 7` *command*	Show section 7 of the command man page
`man man`	Show information about man pages' sections: 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
`whatis` *command*	Show the man page's short description for a command
`apropos` *keyword*	Show the commands whose man page's short description matches the keyword. Inverse of the `whatis` command
`apropos -r` *regex* `man -k` *regex*	Show the commands whose man page's short description matches the regex
`man -K` *regex*	Show the commands whose man page's full text matches the regex
`info` *command*	Show the Info documentation for a command
`history`	Show the history of command lines executed up to this moment. Commands prepended by a space will be executed but will not show up in the history. After the user logs out from Bash, history is saved into `~/.bash_history`
`!`*n*	Execute command number *n* in the command line history
`history -c`	Clear the command line history
`history -d` *n*	Delete command number *n* from the command line history
`alias ls='ls -lap'`	Set up an alias for the `ls` command
`alias`	Show defined aliases
`unalias ls`	Remove the alias for the `ls` command
`\ls` `/bin/ls`	Run the non-aliased version of the `ls` command

Unless otherwise specified, shell commands and operations in this guide refer to Bash which is the default shell in many Linux distributions.

Almost all Linux commands accept the option `-v` (verbose), and some commands also accept the options `-vv` or `-vvv` (increasing levels of verbosity).

All Bash built-in commands, and many other commands, accept the flag `--` which denotes the end of options and the start of positional parameters:

`grep -- -i` *file*	Search for the string "-i" in *file*
`rm -- -rf`	Delete a file called "-rf"

`cd` *directory*	Change to the specified directory
`cd -`	Change to the previously used directory
`pwd`	Print the current working directory
`pushd` *directory*	Add a directory to the top of the directory stack and make it the current working directory
`popd`	Remove the top directory from the directory stack and change to the new top directory
`dirname` *file*	Output the directory path the file is in, stripping any non-directory suffix from the filename

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

`cat` *file*	Print a text file
`cat` *file1 file2* `>` *file3*	Concatenate text files

`cat >` *file* `<<EOF`
line 1
line 2
line 3
`EOF`
	Create a Here Document, storing the lines entered in input to a file

`cat` *file1* `>` *file2* `>` *file2* `<` *file1* `cat`	Copy *file1* to *file2*. Note that these can also be binary files of any kind, because `cat` is able to operate on binary streams as well
`tac` *file*	Print or concatenate text files in reverse, from last line to first line
`head` *file* `head -n 10` *file*	Print the first 10 lines of a text file
`tail` *file* `tail -n 10` *file*	Print the last 10 lines of a text file
`tail -f` *file*	Output appended data as the text file grows; useful to read logs in realtime
`column` *file*	Format a text file into columns
`pr` *file*	Format a text file for a printer
`fmt -w 75` *file*	Format a text file so that each line has a max width of 75 characters
`fold -w40` *file*	Wrap each line of a text file to 40 characters
`nl` *file*	Prepend line numbers to a text file
`wc` *file*	Print the number of lines, words, and bytes of a text file
`join` *file1 file2*	Join lines of two text files on a common field
`paste` *file1 file2*	Merge lines of text files
`split -l 1` *file*	Split a text file into 1-line files (named `xaa`, `xab`, `xac`, and so on)
`uniq` *file*	Print the unique lines of a text file, omitting consecutive identical lines
`sort` *file*	Sort alphabetically the lines of a text file
`shuf` *file*	Shuffle randomly the lines of a text file
`expand` *file*	Convert tabs into spaces
`unexpand` *file*	Convert spaces into tabs
`od` *file*	Dump a file into octal (or other formats)
`diff` *file1 file2*	Compare two text files line by line and print the differences
`cmp` *file1 file2*	Compare two files and print the differences

`cut -d: -f3 file`	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
`cut -c3-50 file`	Print character 3 to 50 of each line of a file
`sed 's/foo/bar/' file`	Stream Editor: Replace the first occurrence on a line of foo with bar in *file*, and print on stdout the result
`sed -i 's/foo/bar/' file`	Replace foo with bar, overwriting the results in *file*
`sed 's/foo/bar/g' file`	Replace all occurrences of foo with bar
`sed '0,/foo/s//bar/' file`	Replace only the first line match
`sed -n '7,13p' file`	Print line 7 to 13 of a text file
`sed "s/foo/$var/" file`	Replace foo with the value of variable $var. The double quotes allow for variable expansion
`tr a-z A-Z <file` `tr [:lower:] [:upper:] <file`	Translate characters: Convert all lowercase into uppercase in a text file
`tr -d 0-9 <file` `tr -d [:digit:] <file`	Delete all digits from a text file
`awk`	Interpreter for the AWK programming language, designed for text processing and data extraction
`grep foo file`	Print the lines of a file containing foo
`grep -v foo file`	Print the lines of a file not containing foo
`grep -e foo -e bar file` `grep -E 'foo|bar' file`	Print the lines of a file containing foo or bar
`grep -v -e foo -e bar file`	Print the lines of a file containing neither foo nor bar
`grep -E regex file` `egrep regex file`	Print the lines of a file matching the given Extended Regex

`^`	Beginning of a line
`$`	End of a line
`\< \>`	Word boundaries (beginning of line, end of line, space, or punctuation mark)
`.`	Any character, except newline
`[abc]`	Any of the characters specified
`[a-z]`	Any of the characters in the specified range
`[^abc]`	Any character except those specified
`*`	Zero or more times the preceding regex
`+`	One or more times the preceding regex
`?`	Zero or one time the preceding regex
`{5}`	Exactly 5 times the preceding regex
`{5,}`	5 times or more the preceding regex
`{5,10}`	Between 5 and 10 times the preceding regex
`|`	The regex either before or after the vertical bar
`( )`	Grouping, to be used for back-references. `\1` expands to the 1st match, `\2` to the 2nd, and so on until `\9`

The symbols above are used in POSIX EREs (Extended Regular Expressions).
For POSIX BREs (Basic Regular Expressions), some symbols will need escaping.

`cp file file2`	Copy a file
`cp file dir/`	Copy a file to a directory
`cp -ar /root/mydir/. /opt/`	Copy a directory recursively
`mv file file2`	Rename a file
`mv file dir/`	Move a file to a directory
`rm file`	Delete a file

Common options:
- `-i` Prompt before overwriting/deleting files (interactive)
- `-f` Don't ask before overwriting/deleting files (force)

`pv file > file2`	Copy a file, monitoring the progress of data through a pipe
`mkdir dir`	Create a directory
`mkdir -m 755 dir`	Create a directory with mode 755
`mkdir -p /tmp/mydir1/mydir2`	Create a directory, creating also the parent directories if they don't exist
`rmdir dir`	Delete a directory (which must be empty)
`touch file`	Change access/modification timestamp on a file, creating it if it doesn't exist
`mktemp`	Create a temporary file or directory, using as filename template `tmp.XXXXXXXXXX`
`ls`	List the contents of the current directory
`ls -d */`	List only directories contained on the current directory
`tree`	List directories and their contents in hierarchical format
`stat file`	Display file or filesystem status
`stat -c %A file`	Display file permissions
`stat -c %s file`	Display file size, in bytes
`shred /dev/hda`	Securely wipe the contents of a device
`shred -u file`	Securely delete a file
`lsof`	List all open files
`lsof -u jdoe`	List all files currently open by user jdoe
`lsof -i`	List open files and their sockets (equivalent to `netstat -ap`)
`lsof -i :80`	List connections of local processes on port 80
`lsof -i@10.0.0.3`	List connections of local processes to remote host 10.0.0.3
`lsof -i@10.0.0.3:80`	List connections of local processes to remote host 10.0.0.3 on port 80
`lsof -c mysqld`	List all files opened by the MySQL daemon
`lsof /var/lib/mysql/mysqld.pid`	List all processes using a specific file

File-naming wildcards (globbing)

`*`	Matches zero or more characters
`?`	Matches one character
`[kxw]`	Matches k, x, or w
`[!kxw]`	Matches any character except k, x, or w
`[a-z]`	Matches any character between a and z

Brace expansion

`cp foo.{txt,bak}`	Copy file foo.txt to foo.bak
`touch foo_{a,b,c}` `touch foo_{a..c}`	Create files foo_a, foo_b, foo_c

In Linux, everything is (displayed as) a file. File descriptors are automatically associated to any process launched.

File descriptors				
#	**Name**	**Type**	**Default device**	**Device file**
0	Standard input (stdin)	Input text stream	Keyboard	`/dev/stdin`
1	Standard output (stdout)	Output text stream	Terminal	`/dev/stdout`
2	Standard error (stderr)	Output text stream	Terminal	`/dev/stderr`

`cat /etc/passwd | wc -l`
Pipe the stdout of command `cat` to the stdin of command `wc` (hence printing the number of accounts in the system). Note that piped commands run concurrently

`ls > file`
`ls 1> file`
Redirect the stdout of command `ls` to a file (hence writing on a file the content of the current directory). File is overwritten if it already exists, unless the Bash noclobber option is set (via `set -o noclobber`)

`ls >| file`
Redirect the stdout of command `ls` to a file, even if noclobber is set

`ls >> file`
`ls 1>> file`
Append the stdout of command `ls` to a file

`ls 2> file`
Redirect the stderr of command `ls` to a file (hence writing any error encountered by the command to a file)

`ls 2>> file`
Append the stderr of command `ls` to a file

`ls 2> /dev/null`
Silence any error coming from command `ls`

`mail user@foo.com < file`
Redirect a file to the stdin of command `mail` (hence sending via e-mail a file to the specified email address)

`echo "$(sort file)" > file`
`echo "`sort file`" > file`
`sort file | sponge file`
Sort the contents of a file and write the output in the file itself.
`sort file > file` would not produce the desired result, because the stdout destination is created (deleting the content of the existing file) before the sort command is run

`ls 2>&1`
Redirect stderr of command `ls` to stdout

`ls > file 2>&1`
Redirect both stdout and stderr of command `ls` to a file

`ls &> file`
`ls >& file`
Redirect both stdout and stderr of command `ls` to a file.
This usage is not POSIX standard and therefore is not recommended

`> file`
Create an empty file. If the file exists, its content will be deleted

`ls | tee file`
`tee` reads from stdin and writes both to stdout and a file (hence writing content of current directory to screen and to a file at the same time)

`ls | tee -a file`
`tee` reads from stdin and appends both to stdout and a file

`ls foo* | xargs cat`
`xargs` calls the `cat` command multiple times for each argument found on stdin (hence printing the content of every file whose filename starts by foo)

```
while read -r line
do
   echo "Hello $line"
done < file
```
Process a text file line by line, reading from *file*.
If *file* is `/dev/stdin`, reads from standard input instead

```
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 "message"
printf "message"
```
Print *message* onscreen without a trailing line feed

```
echo -e '\a'
```
Produce an alert sound (BEL sequence)

```
pv -qL10 <<< "Hello world"
```
Print onscreen one character at a time

Any application, program, or script that runs on the system is a process. Signals are used for inter-process communication.
Each process has a unique PID (Process ID) and a PPID (Parent Process ID); when a process spawns a child, the process PID is assigned to the child's PPID.
The `/sbin/init` process, run at bootup, has PID 1. It is the ancestor of all processes and becomes the parent of any orphaned process. It is also unkillable; should it die, the kernel will panic.
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 process remains a zombie.

`ps -ef` (UNIX options) `ps aux` (BSD options)	List all processes
`pstree` *PID*	Display all processes in hierarchical format. The process tree is rooted at *PID*, or at `init` if *PID* is omitted
`pidof` *process*	Show PID of *process*
`top`	Monitor processes in realtime
`htop`	Monitor processes in realtime (ncurses UI)
`ipcs`	Show IPC facilities information (shared memory, message queues, and semaphores)

`kill -9 1138`	Send a signal 9 (SIGKILL) to process 1138, hence 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
`pkill -9 -u root sshd`	Kill processes whose name is sshd and are owned by root

Note: `pgrep` and `pkill` accept the same options

`xkill`	Interactive program to kill a process by its X GUI resource

`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 terminating (receiving a SIGHUP) when its parent Bash dies

To each process is associated a niceness value: the higher the niceness, the lower 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

`strace` *command*	Trace the execution of a command, intercepting and printing the system calls called by a process and the signals received by a process

`( command )& pid=$!; sleep n; kill -9 $pid`	Run a command and kill it after *n* seconds
`:(){ :|:& };:`	Fork bomb. Don't try this at home!

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

`man 7 signal` Display the man page about signals

`kill -l` List all available signal names

`kill -l` *n* Print the name of signal number *n*

`trap` *action condition* Trap a signal

`vmstat`	Print a report about virtual memory statistics: processes, memory, paging, block I/O, traps, disks, and CPU activity
`iostat`	Print a report about CPU utilization, device utilization, and network filesystem. The first report shows statistics since the system boot; subsequent reports will show statistics since the previous report
`mpstat`	Print a report about processor activities

`vmstat 2 5`
`iostat 2 5`
`mpstat 2 5`
	Print the relevant report every 2 seconds, for 5 times

`iotop`	Display I/O usage by processes in the system
`atop`	Advanced system monitor that displays the load on CPU, RAM, disk, and network
`free`	Show the amount of free and used memory in the system
`uptime`	Show how long the system has been up, how many users are connected, and the system load averages for the past 1, 5, and 15 minutes
`time` *command*	Execute *command* and, at its completion, write to stderr timing statistics about the run i.e. elapsed real time, user CPU time, system CPU time
`sar`	Show reports about system activity. Reports are generated from data collected via the cron job `sysstat` and stored in `/var/log/sa/sn`, where *n* is the day of the month
`sar -n DEV`	Show reports about network activity (received and transmitted packets per second)
`sar -f /var/log/sa/s19 \` `-s 06:00:00 -e 06:30:00`	Show reports for system activity from 6 to 6:30 AM on the 19th of the month
`powertop`	Power consumption and power management diagnosis tool
`sysbench`	Multithreaded benchmark tool able to monitor different OS parameters: file I/O, scheduler, memory allocation, thread implementation, databases
`inxi`	Debugging tool to rapidly and easily gather system information and configuration

Linux monitoring tools	
collectd	System statistics collector
Nagios	System monitor and alert
MRTG	Network load monitor
Cacti	Network monitor
Munin	System and network monitor and alert
Zabbix	System and network monitor and alert
Centreon	System and network monitor and alert

Output of command `vmstat`

```
procs -----------memory---------- ---swap-- -----io---- --system-- -----cpu-----
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
 0  0      0 296724 267120 3393400    0    0    17    56    0    3  2  2 95  1  0
```

procs	**r**	Number of runnable processes (running or waiting for run time)	
	b	Number of processes in uninterruptible sleep	
memory	**swpd**	Virtual memory used (swap)	in Kb
	free	Free memory (idle)	
	buff	Memory used as buffers	
	cache	Memory used as cache	
swap	**si**	Memory swapped in from disk	in Kb/second
	so	Memory swapped out to disk	
io	**bi**	Blocks received in from a block device	in blocks/second
	bo	Blocks sent out to a block device	
system	**in**	Number of interrupts	per second
	cs	Number of context switches	
cpu	**us**	Time spent running user code (non-kernel)	in percentage of total CPU time
	sy	Time spent running system code (kernel)	
	id	Time spent idle	
	wa	Time spent waiting for I/O	
	st	Time stolen from a virtual machine	

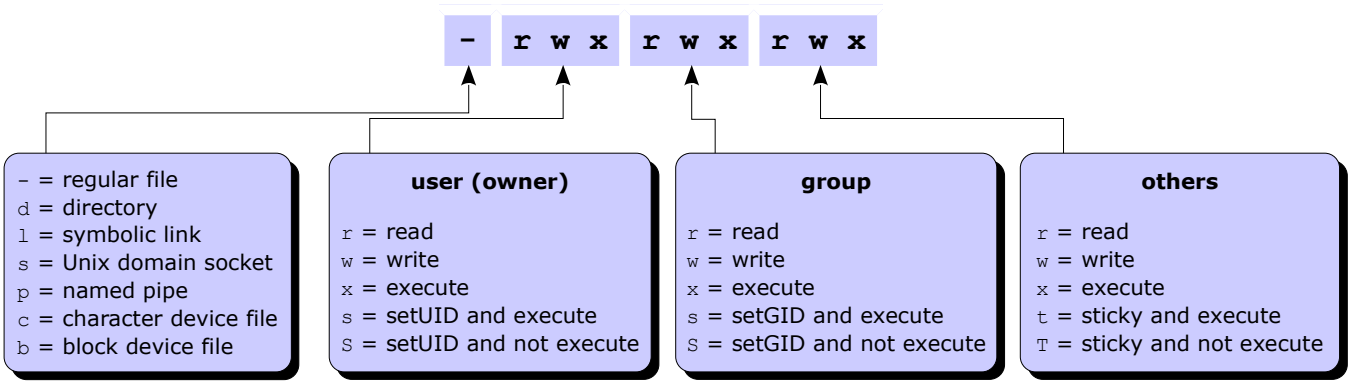
Output of command `free`

```
              total        used        free      shared  buff/cache   available
Mem:       16344088     2273312    11531400      776228     2539376    12935112
Swap:       1048572           0     1048572

              total        used        free      shared     buffers     cached
Mem:        1504544     1491098       13021           0       91112     764542
-/+ buffers/cache:      635212      869498
Swap:       2047686        7667     2040019
```

Mem	**total**	Total configured amount of memory
	used	Used memory
	free	Unused memory
	shared	Memory used by tmpfs, 0 if not available
	buff/cache	Memory used by kernel buffers, page cache, and slabs
	available	Memory available for new applications (without using swap) *
-/+ buffers/cache	**used**	Memory used by kernel buffers
	free	Memory available for new applications (without using swap) *
Swap	**total**	Total configured amount of swap space
	used	Used swap space
	free	Free swap space *

* These are the true values indicating the free system resources available. All values are in Kb, unless options are used.



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 enter the directory, and search files within (by accessing a file's inode)
	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	Files inside the directory can be deleted or moved only by the file's owner

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

`chmod 660 file`
`chmod ug=rw 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.

`chattr +mode file`	Add a file or directory attribute
`chattr -mode file`	Remove a file or directory attribute
`chattr =mode file`	Set a file or directory attribute, removing all other attributes
`lsattr file`	List file or directory attributes

Mode	Effect
a	File can only be open in append mode for writing
A	When file is accessed, its atime record is not modified
c	File is automatically compressed on-the-fly on disk by the kernel
C	File is not subject to copy-on-write updates (only for filesystems which perform copy-on-write)
d	File will not be backed up by the `dump` program
D	When directory is modified, changes are written synchronously on disk (equivalent to `dirsync` mount option)
e	File is using extents for mapping the blocks on disk
E	Compression error on file (attribute used by experimental compression patches)
h	File is storing its blocks in units of filesystem blocksize instead of in units of sectors, and was larger than 2 Tb
i	File is immutable: cannot be modified, linked, or changed permissions
I	Directory is being indexed using hashed trees
j	All file data is written to the ext3 or ext4 journal before being written to the file itself
N	File has data stored inline within the inode itself
s	File will be securely wiped by zeroing when deleted
S	When file is modified, changes are written synchronously on disk (equivalent to `sync` mount option)
t	File will not have EOF partial block fragment merged with other files (only for filesystems supporting tail-merging)
T	Directory is the top of directory hierarchies for the purpose of the Orlov block allocator
u	After file is deleted, it can be undeleted
X	Raw contents of compressed file can be accessed directly (attribute used by experimental compression patches)
Z	Compressed file is dirty (attribute used by experimental compression patches)

Access Control Lists (ACLs) provide a fine-grained set of permissions that can be applied to files and directories.
An **access ACL** is set on an individual file or directory; a **default ACL** is set on a directory, and applies to all files and subdirs created inside it that don't have an access ACL.
The final permissions are the intersection of the ACL with the chmod/umask value.
A partition must have been mounted with the `acl` option in order to support ACLs on files.

`setfacl -m u:`*`user`*`:`*`permissions file`*	Set an access ACL on a file for an user
`setfacl -m g:`*`group`*`:`*`permissions file`*	Set an access ACL on a file for a group
`setfacl -m m:`*`permissions file`*	Set the effective rights mask on a file
`setfacl -m o:`*`permissions file`*	Set the permissions on a file for other users
`setfacl -x u:`*`user file`*	Remove an access ACL from a file for an user
`setfacl -x g:`*`group file`*	Remove an access ACL from a file for a group

The *permissions* are standard Unix permissions specified as any combination of `r w x` .

`setfacl -m d:u:`*`user`*`:`*`permissions dir`* `setfacl -d -m u:`*`user`*`:`*`permissions dir`*	As above, but set a default ACL instead of an access ACL. This applies to all commands above
`getfacl `*`file`*	Display the access (and default, if any) ACL for a file
`getfacl `*`file1`*` | setfacl --set-file=- `*`file2`*	Copy the ACL of *file1* and apply it to *file2*
`getfacl --access `*`dir`*` | setfacl -d -M- `*`dir`*	Copy the access ACL of a directory and set it as default ACL
`chacl `*`options`*	Change an ACL. This is an IRIX-compatibility command
`man acl`	Show the manpage about ACLs

A Linux directory contains a list of structures which are associations between a filename and an inode.
An inode contains all 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.
An inode does not contain the name of the file; this information is stored in the directory where the file is.

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

`df -i` Report filesystem inode usage

	Hard link	Soft or symbolic link
Definition	A link to an already existing inode	A path to a filename; a shortcut
Command to create it	`ln` *`file hardlink`*	`ln -s` *`file symlink`*
Link is still valid if the original file is moved or deleted	Yes (because the link references the inode the original file pointed to)	No (because 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 / -name "foo*"` `find / -name "foo*" -print`	Find all files, starting from the root dir, whose name start with foo
`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 / -size +128M`	Find all files larger than 128 Mb
`find / -ctime +10`	Find all files created more than 10 days ago
`find / -perm -4000 -type f`	Find all files of type file (i.e. not directories) and 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
`find /home/jdoe/path -type f \` `-newermt "May 4 14:50" -delete`	Find and delete all files newer than the specified datetime. Using `-delete` is preferable to using `-exec rm {} \;`
`find . -type f -print -exec cat {} \;`	Print all files in the current directory with a filename header
`locate` *command* `slocate` *command*	Locate *command* by searching the file index `/etc/updatedb.conf`, not by actually walking the filesystem. The search is fast but will only held results relative to the last rebuilding of the file index
`updatedb`	Rebuild the file index
`which` *command*	Locate a binary executable command within the PATH
`which -a` *command*	Locate all matches of a command, not only the first one
`whereis` *command*	Locate the binary, source, and manpage files for a command
`whereis -b` *command*	Locate the binary files for a command
`whereis -s` *command*	Locate the source files for a command
`whereis -m` *command*	Locate the manpage files for a command
`type` *command*	Determine if a command is a program or a built-in (i.e. an internal feature of the shell)
`file` *myfile*	Analyze the content of a file or directory, and display the kind of file (e.g. executable, text file, program text, swap file)

Bash shell event	Files run	

When a login shell is launched	`/etc/profile`
	`/etc/profile.d/*.sh`
	`~/.bash_profile`
	`~/.bash_login`
	`~/.profile`
		The shell executes the system-wide profile files, 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`
	`/etc/bashrc`
	`~/.bashrc`	

`set -o`	Show the status of all Bash options
`set -`*`option`* `set -o `*`long_option`	Enable a Bash option
`set +`*`option`* `set +o `*`long_option`	Disable a Bash option
`set -v` `set -o verbose`	Enable printing of shell input lines as they are read
`set -x` `set -o xtrace`	Enable printing of command traces before execution of each command (debug mode)

To run a script with a Bash option enabled, either:
a. Run the script with `bash -`*`option scriptfile`*`.sh`
b. Specify the shebang line as `#!/bin/bash -`*`option`*
c. Add the command `set -`*`option`* at the beginning of the script

The scope of variables is the current shell only, while **environment variables** are visible within the current shell as well as within all subshells and Bash child processes spawned by the shell.
Environment variables are set in `/etc/environment` in the form *var=value*.

`set`	Display all variables
`env`	Display all environment variables
`export MYVAR`	Export a variable, making it an environment variable

`MYVAR=value`
`((MYVAR=value))`
`let "MYVAR=value"`
	Set a variable

`echo $MYVAR` `echo ${MYVAR}`	Use a variable (in this case, echo it to screen). If other characters follow the variable name, it is necessary to specify the boundaries of the variable name via `{}` to make it unambiguous

`MYVAR=$((2+2))`
`MYVAR=$[2+2]`
`FOO=$((BAR + 42))`
`FOO=`expr $BAR + 42``
	Evaluate a numeric expression and assign the result to another variable

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

`for i in $(ls)`
`do`
`  echo "Item: $i"`
`done`
	Loop and operate through all the output tokens (in this case, the contents of the current directory). Warning: depending on the operation, filenames containing whitespace or glob characters may break the script

`unset MYVAR`	Delete a variable
`set ${MYVAR:=value}` `MYVAR=${MYVAR:-value}`	Set a variable, only if it is not already set (i.e. does not exist) or is null
`echo ${MYVAR:-message}`	If variable exists and is not null, print its value, otherwise print *message*
`echo ${MYVAR:+message}`	If variable exists and is not null, print *message*, otherwise print nothing
`echo ${MYVAR,,}`	Print a string variable in lowercase

Bash built-in variables	
`$0`	Script name
`$n`	*n*th argument passed to the script or function
`$@`	All arguments passed to the script or function (each argument as a separate word)
`$*`	All arguments passed to the script or function (all arguments as a single word)
`$#`	Number of arguments passed to the script or function
`$?`	Exit status of the last executed command
`${PIPESTATUS[n]}`	Exit status of the *n*th command in the executed pipeline
`$$`	PID of the script in which this variable is called
`$SHLVL`	Deepness level of current shell, starting with 1

Bash 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 *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)
(*command1* && *command2*)	Group commands together for evaluation priority
(*command*)	Run *command* in a subshell. This is used to isolate *command*'s effects, as variable assignments and other changes to the shell environment operated by *command* will not remain after *command* completes
exit	Terminate a script
exit *n*	Terminate a script with the specified exit status number *n*. By convention, a 0 exit status is used if the script executed successfully, non-zero otherwise
command || exit 1	(To be used inside a script.) Exit the script if *command* fails

Run a command, then evaluate whether it exited successfully or failed

```
if command
then
   echo "Success"
else
   echo "Fail"
fi
```

Evaluate whether the last executed command exited successfully or failed

```
if [ $? -eq 0 ]
then
   echo "Success"
else
   echo "Fail"
fi
```

Define a function

```
function myfunc { commands }
myfunc() { commands }
```

myfunc *arg1 arg2* ...	Call a function
typeset -f	Show functions defined in the current Bash session

Loop through a list of directories

```
for DIR in `ls`
do
   rmdir $DIR
done
```

`watch` *command*	Execute *command* every 2 seconds
`watch -d -n 1` *command*	Execute *command* every second, highlighting the differences in the output
`timeout 30s` *command*	Execute *command* and kill it after 30 seconds
`time` *command*	Execute *command* and print its execution time: elapsed real time between invocation and termination, user CPU time, and system CPU time
command `|` `ts`	Prepend a timestamp to each line of the output of *command*
`sleep 5`	Pause for 5 seconds
`usleep 5000`	Pause for 5000 microseconds
`expect`	Dialogue with interactive programs according to a script, analyzing what can be expected from the interactive program and replying accordingly
`parallel` *command*	Run a command in parallel. This is used to operate on multiple inputs, similarly to `xargs`
`zenity`	Display GTK+ graphical dialogs for user messages and input

```
test $MYVAR = "value" && command
[ $MYVAR = "value" ] && command
if [ $MYVAR = "value" ]; then command; fi
```

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

Test operators					
Integer operators		**File operators**		**Expression operators**	
-eq	Equal to	-e or -a	Exists	-a	Logical AND
-ne	Not equal to	-d	Is a directory	-o	Logical OR
-lt	Less than	-b	Is a block special file	!	Logical NOT
-le	Less than or equal to	-c	Is a character special file	\(\)	Priority
-gt	Greater than	-f	Is a regular file		
-ge	Greater than or equal to	-r	Is readable		
String operators		-w	Is writable		
-z	Is zero length	-x	Is executable		
-n or nothing	Is non-zero length	-s	Is non-zero length		
= or ==	Is equal to	-u	Is SUID		
!=	Is not equal to	-g	Is SGID		
<	Is alphabetically before	-k	Is sticky		
>	Is alphabetically after	-h	Is a symbolic link		

```
expr $MYVAR = "39 + 3"
MYVAR=$((39 + 3))
```

Evaluate an expression (in this case, assigns the value 42 to the variable)

```
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	+	Plus	*string* : *regex* match *string regex*	String matches regex
!=	Not equal to	-	Minus		
<	Less than	*	Multiplied by	substr *string pos length*	Substring
<=	Less than or equal to	/	Divided by	index *string chars*	Index of any chars in string
>	Greater than	%	Remainder	length *string*	String length
>=	Greater than or equal to				

Tests

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

```
case $VAR in
   pattern1)
      command1
      command1bis
      ;;
   pattern2)
      command2
      ;;
   *)
      command3
      ;;
esac
```

Loops

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

The *command block* executes as long as *test* is true

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

The *command block* executes as long as *test* is false

```
for I in [list]
do [command block]
done
```

The *command block* executes for each I in *list*

```
i=0
while [ $i -le 7 ]
do
   echo $i
   let i++
done
```

```
i=0
until [ $i -gt 7 ]
do
   echo $i
   let i++
done
```

```
for i in 0 1 2 3 4 5 6 7
do
   echo $i
done
```

```
for i in {0..7}
do
   echo $i
done
```

```
start=0
end=7
for i in $(seq $start $end)
do
   echo $i
done
```

```
start=0
end=7
for ((i = start; i <= end; i++))
do
   echo $i
done
```

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

`vi`	Vi, text editor
`vim`	Vi Improved, an advanced text editor
`gvim`	Vim with GUI
`vimdiff` *file1 file2*	Compare two text files
`pico`	Pico, simple text editor
`nano`	Nano, simple text editor (a GNU clone of Pico)
`emacs`	GNU Emacs, a GUI text editor
`gedit`	GUI text editor
`ed`	Line-oriented text editor
`more`	Text pager (obsolete)
`less`	Text pager
`strings` *file*	Show all printable character sequences at least 4-character long that are inside a file
`antiword` *docfile*	Show text and images from a MS Word document
`catdoc` *docfile*	Output plaintext from a MS Word document

`less` pager commands

`h`	Help
`g`	Go to first line in the file
`G`	Go to last line in the file
`F`	Go to the end of the file, and move forward automatically as the file grows
CTRL C	Stop moving forward
`-N`	Show line numbers
`-n`	Don't show line numbers
`=`	Show information about the file
CTRL G	Show current and total line number, byte, and percentage of the file read
`q`	Quit

ESC	Go to Command mode		
i	Insert text before cursor		
I	Insert text after line		
a	Append text after cursor	and go to Insert mode	
A	Append text after line		
v	Go to Visual mode, character-wise		
V	Go to Visual mode, line-wise	then use the arrow keys to select a block of text	
d	Delete selected block	gu	Switch block to lowercase
y	Copy (yank) selected block into buffer	gU	Switch block to uppercase
w	Move to next word	$	Move to end of line
b	Move to beginning of word	1G	Move to line 1 i.e. beginning of file
e	Move to end of word	G	Move to end of file
0	Move to beginning of line	z RETURN	Make current line the top line of the screen
CTRL G	Show current line and column number		
ma	Mark position "a". Marks a-z are local to current file, while marks A-Z are global to a specific file		
'a	Go to mark "a". If using a global mark, it also opens the specific file		
y'a	Copy (yank) from mark "a" to current line, into the buffer		
d'a	Delete from mark "a" to current line		
p	Paste buffer after current line	yy	Copy current line
P	Paste buffer before current line	yyp	Duplicate current line
x	Delete current character	D	Delete from current character to end of line
X	Delete before current character	dd	Delete current line
7dd	Delete 7 lines. Almost any command can be prepended by a number to repeat it a number of times		
u	Undo last command. Vi can undo the last command only, Vim is able to undo several commands		
.	Repeat last text-changing command		
/*string*	Search for *string* forward	n	Search for next match of *string*
?*string*	Search for *string* backwards	N	Search for previous match of *string*
:s/*s1*/*s2*/	Replace the first occurrence of *s1* with *s2* in the current line		
:s/*s1*/*s2*/g	Replace globally every occurrence of *s1* with *s2* in the current line		
:%s/*s1*/*s2*/g	Replace globally every occurrence of *s1* with *s2* in the whole file		
:%s/*s1*/*s2*/gc	Replace globally every occurrence of *s1* with *s2* in the whole file, asking for confirmation		
:5,40s/^/#/	Add a hash character at the beginning of each line, from line 5 to 40		
!!*program*	Replace line with output from *program*		
:r *file*	Read *file* and insert it after current line		
:X	Encrypt current document. Vi will automatically prompt for the password to encrypt and decrypt		
:w *file*	Write to *file*		
:wq :x ZZ	Save changes and quit		
:q	Quit (fails if there are unsaved changes)	:q!	Abandon all changes and quit

Option	Effect
ai	Turn on auto indentation
all	Display all options
ap	Print a line after the commands d c J m :s t u
aw	Automatic write on commands :n ! e# ^^ :rew ^} :tag
bf	Discard control characters from input
dir=*tmpdir*	Set *tmpdir* as directory for temporary files
eb	Precede error messages with a bell
ht=8	Set terminal tab as 8 spaces
ic	Ignore case when searching
lisp	Modify brackets for Lisp compatibility
list	Show tabs and EOL characters
set listchars=tab:>-	Show tab as > for the first char and as – for the following chars
magic	Allow pattern matching with special characters
mesg	Enable UNIX terminal messaging
nu	Show line numbers
opt	Speed up output by eliminating automatic Return
para=LIlPLPPPQPbpP	Set macro to start paragraphs for { } operators
prompt	Prompt : for command input
re	Simulate smart terminal on dumb terminal
remap	Accept macros within macros
report	Show largest size of changes on status line
ro	Make file readonly
scroll=12	Set screen size as 12 lines
sh=/bin/bash	Set shell escape to /bin/bash
showmode	Show current mode on status line
slow	Postpone display updates during inserts
sm	Show matching parentheses when typing
sw=8	Set shift width to 8 characters
tags=/usr/lib/tags	Set path for files checked for tags
term	Print terminal type
terse	Print terse messages
timeout	Eliminate 1-second time limit for macros
tl=3	Set significance of tags beyond 3 characters (0 = all)
ts=8	Set tab stops to 8 for text input
wa	Inhibit normal checks before write commands
warn	Warn "No write since last change"
window=24	Set text window as 24 lines
wm=0	Set automatic wraparound 0 spaces from right margin

:set *option* turn on an *option*
:set no*option* turn off an *option*
Options can also be permanently set by including them in ~/.exrc

vi -R *file* Open *file* in read-only mode

cat *file* | vi - Open *file* in read-only mode (this is done by having Vi read from stdin)

```
SHOW DATABASES;
```
Show all existing databases

```
SHOW TABLES;
```
Show all tables from the selected database

```
USE CompanyDatabase;
```
Choose which database to use

```
SELECT DATABASE();
```
Show which database is currently selected

```
CREATE TABLE customers (
cusid INT NOT NULL AUTO_INCREMENT PRIMARY KEY,
firstname VARCHAR(32), lastname VARCHAR(32), dob DATE,
city VARCHAR(24), zipcode VARCHAR(5));

CREATE TABLE payments (
payid INT NOT NULL AUTO_INCREMENT PRIMARY KEY,
date DATE, fee INT, bill VARCHAR(128), cusid INT,
CONSTRAINT FK1 FOREIGN KEY (cusid) REFERENCES customers(cusid));
```
Create tables

```
CREATE INDEX lastname_index ON customers(lastname);
ALTER TABLE customers ADD INDEX lastname_index (lastname);
```
Create an index for faster searches

```
DESCRIBE customers;
```
Describe the columns of a table

```
SHOW CREATE TABLE customers;
```
Show the code used to create a table

```
DROP TABLE customers;
```
Delete a table

```
DROP DATABASE CompanyDatabase;
```
Delete a database

```
ALTER TABLE customers MODIFY city VARCHAR(32);
```
Modify the type of a column

```
INSERT INTO customers (firstname,lastname,dob)
VALUES ('Arthur','Dent',1959-08-01), ('Trillian','',1971-03-19);
```
Insert a new record in a table

```
DELETE FROM customers WHERE firstname LIKE 'Zaphod';
```
Delete some records in a table

```
UPDATE customers SET city = 'London' WHERE zipcode = '00789';
```
Modify records in a table

```
CREATE VIEW cust_view AS
SELECT * FROM customers WHERE city != 'London';
```
Create a view

```
COMMIT;
```
Commit changes to the database

```
ROLLBACK;
```
Rollback the current transaction, canceling any changes done during it

```
START TRANSACTION;
BEGIN;
```
Disable autocommit for this transaction, until a COMMIT or ROLLBACK is issued

```
SELECT * FROM customers;
```
Select all columns from the customers table

```
SELECT firstname, lastname FROM customers LIMIT 5;
```
Select first and last name of customers, showing 5 records only

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123';
```
Select first and last name of customers whose zip code is 00123

```
SELECT firstname, lastname FROM customers WHERE zipcode IS NOT NULL;
```
Select first and last name of customers with a recorded zip code

```
SELECT * FROM customers ORDER BY lastname, firstname;
```
Select customers in alphabetical order by last name, then first name

```
SELECT * FROM customers ORDER by zipcode DESC;
```
Select customers, sorting them by zip code in reverse order

```
SELECT firstname, lastname,
TIMESTAMPDIFF(YEAR,dob,CURRENT_DATE) as AGE FROM customers;
```
Select first name, last name, and calculated age of customers

```
SELECT DISTINCT city FROM customers;
```
Show all cities but retrieving each unique output record only once

```
SELECT city, COUNT(*) FROM customers GROUP BY city;
```
Show all cities and the number of customers in each city. NULL values are not counted

```
SELECT cusid, SUM(fee) FROM payments GROUP BY cusid;
```
Show all fee payments grouped by customer ID, summed up

```
SELECT cusid, AVG(fee) FROM payments GROUP BY cusid
HAVING AVG(fee)<50;
```
Show the average of fee payments grouped by customer ID, where this average is less than 50

```
SELECT MAX(fee) FROM payments;
```
Show the highest fee in the table

```
SELECT COUNT(*) FROM customers;
```
Show how many rows are in the table

```
SELECT cusid FROM payments t1 WHERE fee =
(SELECT MAX(t2.fee) FROM payments t2 WHERE t1.cusid=t2.cusid);
```
Show the customer ID that pays the highest fee (via a subquery)

```
SELECT @maxfee:=MAX(fee) FROM payments;
SELECT cusid FROM payments t1 WHERE fee = @maxfee;
```
Show the customer ID that pays the highest fee (via a user set variable)

```
SELECT cusid FROM payments WHERE fee >
ALL (SELECT fee FROM payments WHERE cusid = 4242001;
```
Show the customer IDs that pay fees higher than the highest fee paid by customer ID 4242001

```
SELECT * FROM customers WHERE firstname LIKE 'Trill%';
```
Select customers whose first name starts with "Trill"

```
SELECT * FROM customers WHERE firstname LIKE 'F_rd';
```
Select matching customers; the _ matches a single character

```
SELECT * FROM customers WHERE firstname REGEXP '^Art.*r$';
```
Select customers whose first name matches the regex

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123'
UNION
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```
Select customers that satisfy any of the two requirements

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123'
INTERSECT
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```
Select customers that satisfy both of the two requirements

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123'
EXCEPT
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```
Select customers that satisfy the first requirement but not the second

SQL	MySQL	Operation

`SELECT customers.name, payments.bill`
`FROM customers, payments`
`WHERE customers.cusid = payments.cusid;`
 	
`SELECT customers.name, payments.bill`
`FROM customers NATURAL JOIN payments;`
 	
`SELECT customers.name, payments.bill`
`FROM customers JOIN payments`
`USING (cusid);`
 	
`SELECT customers.name, payments.bill`
`FROM customers JOIN payments`
`ON customers.cusid = payments.cusid;`
	`SELECT customers.name, payments.bill`
	`FROM customers`
	`[ JOIN | INNER JOIN | CROSS JOIN ]`
	`payments`
	`ON customers.cusid = payments.cusid;`
	
	`SELECT customers.name, payments.bill`
	`FROM customers`
	`[ JOIN | INNER JOIN | CROSS JOIN ]`
	`payments`
	`USING (cusid);`
		Perform a **join** (aka **inner join**) of two tables to select data that are in a relationship

`SELECT customers.name, payments.bill`
`FROM customers CROSS JOIN payments;`
	`SELECT customers.name, payments.bill`
	`FROM customers JOIN payments;`
	(`ON` clause is missing)
		Perform a **Cartesian product** (aka **cross join**) of two tables

`SELECT customers.name, payments.bill`
`FROM customers LEFT JOIN payments`
`ON customers.cusid = payments.cusid;`
		Perform a **left join** (aka **left outer join**) of two tables, returning records matching the join condition and also records in the left table with unmatched values in the right table

`SELECT customers.name, payments.bill`
`FROM customers RIGHT JOIN payments`
`ON customers.cusid = payments.cusid;`
		Perform a **right join** (aka **right outer join**) of two tables, returning records matching the join condition and also records in the right table with unmatched values in the left table

MySQL is the most used open source RDBMS (Relational Database Management System). It runs on TCP port 3306.

`mysqld_safe`
Start the MySQL server (`mysqld`) with safety features such as restarting the server if errors occur and logging runtime information to the error logfile. Recommended

`mysql_install_db` (deprecated)
`mysqld --initialize`
Initialize the MySQL data directory, create system tables, and set up an administrative account.
To be run after installing the MySQL server

`mysql_secure_installation`
Set password for root, remove anonymous users, disable remote root login, and remove test database.
To be run after installing the MySQL server

`mysql -u root -p`
Login to MySQL as root and prompt for the password

`mysql -u root -p`*`password`*
Login to MySQL as root with the specified *password*

`mysql -u root -p -h` *`host`* `-P` *`port`*
Login to the specified remote MySQL server and port

`mysql -u root -p -eNB'SHOW DATABASES'`
Run a SQL command via MySQL. Flags are:
`e` Run in batch mode
`N` Do not print table header
`B` Do not print table decoration characters `+-|`

`mysqldump -u root -p --all-databases > alldbs.sql`
Backup all databases to a dump file

`mysqldump -u root -p MyDatabase > mydb.sql`
Backup a database to a dump file

`mysqldump -u root -p --databases MyDb1 MyDb2 > dbs.sql`
Backup several databases to a dump file

`mysqldump -u root -p MyDatabase t1 t2 > tables.sql`
Backup some tables of a database to a dump file

`mysql -u root -p < alldbsbak.sql`
Restore all databases from a dump file (which contains a complete dump of a MySQL server)

`mysql -u root -p MyDatabase < mydbbak.sql`
Restore a specific database from a dump file (which contains one database)

`mysql_upgrade -u root -p`
Check all tables in all databases for incompatibilities with the current version of MySQL

`mysqlcheck` *`options`*
Perform table maintenance. Each table is locked while is being processed. Options are:
`--check` Check table for errors (default)
`--analyze` Analyze table
`--optimize` Optimize table
`--repair` Repair table; can fix almost all problems except unique keys that are not unique

`mysqlcheck --check` *`db table`*
Check the specified table of the specified database

`mysqlcheck --check --databases` *`db1 db2`*
Check the specified databases

`mysqlcheck --check --all-databases`
Check all databases

`mysqltuner.pl`
Review the current MySQL installation configuration for performances and stability

`mysqlreport` (obsolete)
Generate a user-friendly report of MySQL status values

`mytop`
Monitor MySQL processes and queries

`innotop`
Monitor MySQL InnoDB transactions

```
SELECT Host, User FROM mysql.user;
```
List all MySQL users

```
CREATE USER 'john'@'localhost' IDENTIFIED BY 'p4ssw0rd';
```
Create a MySQL user and set his password

```
DROP USER 'john'@'localhost';
```
Delete a MySQL user

```
SET PASSWORD FOR 'john'@'localhost' = PASSWORD('p4ssw0rd');
SET PASSWORD FOR 'john'@'localhost' = '*7E684A3DF6273CD1B6DE53';
```
Set a password for a MySQL user. The password can be specified either in plaintext or by its hash value

```
SHOW GRANTS FOR 'john'@'localhost';
```
Show permissions for a user

```
GRANT ALL PRIVILEGES ON MyDatabase.* TO 'john'@'localhost';
```
Grant permissions to a user

```
REVOKE ALL PRIVILEGES ON MyDatabase.* FROM 'john'@'localhost';
```
Revoke permissions from a user; must match the granted permission on the same database or table

```
GRANT SELECT ON *.* TO 'john'@'localhost' IDENTIFIED BY 'p4ssw0rd';
GRANT SELECT ON *.* TO 'john'@'localhost' IDENTIFIED BY PASSWORD
'*7E684A3DF6273CD1B6DE53';
```
Create a MySQL user and set his grants

```
FLUSH PRIVILEGES;
```
Reload and commit the grant tables; to be used after any GRANT command

```
SELECT * INTO OUTFILE '/tmp/mytable.csv'
FIELDS TERMINATED BY ',' OPTIONALLY ENCLOSED BY '"'
LINES TERMINATED BY '\n' FROM MyDatabase.mytable;
```
Export a table to a CSV file

```
USE MyDatabase; SOURCE mydbbak.sql;
```
Restore a database from a dump file

```
USE MyDatabase; LOAD DATA LOCAL INFILE 'foofile' INTO TABLE foo;
```
Populate a table with data from file (one record per line, values separated by tabs)

```
statement;
statement\g
```
Send a SQL statement to the server

```
statement\G
```
Display result in vertical format, showing each record in multiple rows

```
SELECT /*!99999 comment*/ * FROM MyDatabase.mytable;
```
Insert a comment

```
SELECT /*!n statement*/ * FROM MyDatabase.mytable;
```
The commented *statement* is executed only if MySQL is version *n* or higher

```
\c
```
Cancel current input

```
\! command
```
Run a shell command

```
TEE logfile
```
Log all I/O of the current MySQL session to the specified logfile

```
SHOW VARIABLES;
SHOW SESSION VARIABLES;
SHOW LOCAL VARIABLES;
```
Print session variables (affecting the current connection only)

```
SHOW GLOBAL VARIABLES;
```
Print global variables (affecting the global operations on the server)

```
SHOW VARIABLES LIKE '%query%';
```
Print session variables that match the given pattern

```
SHOW VARIABLES LIKE 'hostname';
SELECT @@hostname;
```
Print a session variable with the given name

```
SET sort_buffer_size=10000;
SET @@sort_buffer_size=10000;
SET SESSION sort_buffer_size=10000;
SET LOCAL sort_buffer_size=10000;
SET @@session.sort_buffer_size=10000;
SET @@local.sort_buffer_size=10000;
```
Set a session variable

```
SET GLOBAL sort_buffer_size=10000;
SET @@global.sort_buffer_size=10000;
```
Set a global variable

```
SHOW STATUS;
SHOW SESSION STATUS;
SHOW LOCAL STATUS;
```
Print session status (concerning the current connection only)

```
SHOW GLOBAL STATUS;
```
Print global status (concerning the global operations on the server)

```
SHOW STATUS LIKE '%wsrep%';
```
Print session status values that match the given pattern

```
SHOW WARNINGS;
```
Print warnings, errors and notes resulting from the most recent statement in the current session that generated messages

```
SHOW ERRORS;
```
Print errors resulting from the most recent statement in the current session that generated messages

```
SHOW TABLE STATUS;
```
Print information about all tables of the currently selected database e.g. engine (InnoDB or MyISAM), rows, indexes, data length

```
SHOW ENGINE INNODB STATUS;
```
Print statistics concerning the InnoDB engine

```
SHOW FULL PROCESSLIST;
```
Print the list of threads running on the system

```
SHOW CREATE TABLE table;
SHOW CREATE VIEW view;
```
Print the CREATE statement that created the specified table or view

```
SELECT VERSION();
```
Print the version of the MySQL server

```
SELECT CURDATE();
SELECT CURRENT_DATE;
```
Print the current date

```
SELECT CURTIME();
SELECT CURRENT_TIME;
```
Print the current time

```
SELECT NOW();
```
Print the current date and time

```
SELECT USER();
```
Print the current user@hostname that is logged in

```
\s
```
Print status information about server and current connection

```
SELECT table_schema "Name",
SUM(data_length+index_length)/1024/1024 "Size in Mb"
FROM information_schema.tables GROUP BY table_schema;
```

Display the sizes of all databases in the system (counting data + indexes)

```
SELECT table_schema "Name",
SUM(data_length+index_length)/1024/1024 "Size in Mb"
FROM information_schema.tables WHERE table_schema='database';
```

Display the size of *database*

```
SELECT table_name "Name",
ROUND(((data_length)/1024/1024),2) "Data size in Mb",
ROUND(((index_length)/1024/1024),2) "Index size in Mb"
FROM information_schema.TABLES WHERE table_schema='database'
ORDER BY table_name;
```

Display data and index size of all tables of *database*

```
SELECT table_name, table_rows
FROM information_schema.tables WHERE table_schema = 'database';
```

Print an estimate of the number of rows of each table of *database*

```
SELECT SUM(data_length+index_length)/1024/1024 "InnoDB in Mb"
FROM information_schema.tables WHERE engine='InnoDB';
```

Display the amount of InnoDB data in all databases

```
SELECT table_name, engine FROM information_schema.tables
WHERE table_schema = 'database';
```

Print name and engine of all tables in *database*

```
SELECT CONCAT('KILL ',id,';')
FROM information_schema.processlist WHERE user='user'
INTO OUTFILE '/tmp/killuser'; SOURCE /tmp/killuser;
```

Kill all connections belonging to *user*

```
SELECT COUNT(1) SlaveThreadCount
FROM information_schema.processlist WHERE user='system user';
```

Distinguish between master and slave server; returns 0 on a master, >0 on a slave

```
SELECT ROUND(SUM(LENGTH(field)<40)*100/COUNT(*),2)
FROM table;
```

Display the percentage of rows on which the VARCHAR *field* is shorter than 40 chars

```
SHOW FULL TABLES IN database WHERE TABLE_TYPE LIKE 'VIEW';
```

Display the list of views in *database*

```
SELECT 'table1' AS `set`, t1.* FROM table1 t1
WHERE
ROW(t1.col1, t1.col2, t1.col3) NOT IN (SELECT * FROM table2)
UNION ALL
SELECT 'table2' AS `set`, t2.* FROM table2 t2
WHERE
ROW(t2.col1, t2.col2, t1.col3) NOT IN (SELECT * FROM table1)
```

Display the differences between the contents of two tables (assuming they're composed of 3 columns each)

```
dbs="$(mysql -uroot -ppassword -Bse'SHOW DATABASES;')"
for db in $dbs
do
        [operation on $db]
done
```

Perform an operation on each database name

How to resync a master-slave replication

1. On the master, on terminal 1:
```
mysql -uroot -p
RESET MASTER;
FLUSH TABLES WITH READ LOCK;
SHOW MASTER STATUS;
```
Note the values of MASTER_LOG_FILE and MASTER_LOG_POS; these values will need to be copied on the slave
2. On the master, on terminal 2:
```
mysqldump -uroot -p --all-databases > /root/dump.sql
```
3. On the master, on terminal 1:
```
UNLOCK TABLES;
```
4. Transfer the dump file from the master to the slave
5. On the slave:
```
mysql -uroot -p
STOP SLAVE;
SOURCE /root/dump.sql;
RESET SLAVE;
CHANGE MASTER TO MASTER_LOG_FILE='mysql-bin.nnnnnn', MASTER_LOG_POS=mm;
START SLAVE;
SHOW SLAVE STATUS;
```

How to recover the MySQL root password

1. Stop the MySQL server
2. Restart the MySQL server skipping the grant tables:
```
mysqld_safe --skip-grant-tables --skip-networking &
```
3. Connect to the MySQL server passwordlessly:
```
mysql -uroot
```
4. Reload the grant tables:
```
FLUSH PRIVILEGES;
```
5. Change the root password:
```
SET PASSWORD FOR 'root'@'localhost' = PASSWORD('s3cr3t');
```
6. Stop the MySQL server and restart it normally

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 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`
`/etc/init.d/gdm start`
`/etc/init.d/kdm start`
	Start the X Display Manager

`xorgconfig` (Debian) `Xorg -configure` (Red Hat)	Configure X (text mode)
`xorgcfg` (Debian) `system-config-display` (Red Hat)	Configure X (graphical mode)
`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` `xhost - 10.3.3.3`	Add or remove 10.3.3.3 to the list of hosts allowed to make X connections to the local machine
`switchdesk gde`	Switch to the GDE Display Manager at runtime
`gnome-shell --version`	Show which version of GNOME is running
`/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`	Instruct `init` to launch XDM at runlevel 5: `x:5:respawn:/usr/X11R6/bin/xdm -nodaemon`

`/etc/sysconfig/desktop`	Define GNOME as the default Display Environment and Display Manager:
	`desktop="gde"`
	`displaymanager="gdm"`

`xdotool`	X automation tool
`xdotool getwindowfocus`	Get the ID of the currently focused window (usually the terminal where this command is typed)
`xdotool selectwindow`	Pop up an X cursor and get the ID of the window selected by it
`xdotool key --window 12345678 Return`	Simulate a Return keystroke inside window ID 12345678
`xprop`	X property displayer
`xrandr` `xrandr -q`	Show screen(s) size and resolution
`xrandr --output eDP1 --right-of VGA1`	Extend the screen on an additional VGA physical screen situated to the left
`xsel`	Manipulate the X selection (primary, secondary, and clipboard)
`xsel -b < file`	Put the contents of a file in the X clipboard
`xsel -b -a < file`	Append the contents of a file to the X clipboard
`xsel -b -o`	Output onscreen the contents of the X clipboard
`mkfontdir`	Catalog the newly installed fonts in the new directory
`xset fp+ /usr/local/fonts`	Dynamically add new 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

Main

BackSpace	ff08
Tab	ff09
Linefeed	ff0a
Clear	ff0b
Return	ff0d
Pause	ff13
Scroll_Lock	ff14
Sys_Req	ff15
Escape	ff1b
Delete	ffff

Cursor control

Home	ff50
Left	ff51
Up	ff52
Right	ff53
Down	ff54
Prior	ff55
Page_Up	ff55
Next	ff56
Page_Down	ff56
End	ff57
Begin	ff58

Misc functions

Select	ff60
Print	ff61
Execute	ff62
Insert	ff63
Undo	ff65
Redo	ff66
Menu	ff67
Find	ff68
Cancel	ff69
Help	ff6a
Break	ff6b
Mode_switch	ff7e
script_switch	ff7e
Num_Lock	ff7f

Modifiers

Shift_L	ffe1
Shift_R	ffe2
Control_L	ffe3
Control_R	ffe4
Caps_Lock	ffe5
Shift_Lock	ffe6
Meta_L	ffe7
Meta_R	ffe8
Alt_L	ffe9
Alt_R	ffea
Super_L	ffeb
Super_R	ffec
Hyper_L	ffed
Hyper_R	ffee

Latin 1

space	0020
exclam	0021
quotedbl	0022
numbersign	0023
dollar	0024
percent	0025
ampersand	0026
apostrophe	0027
quoteright	0027
parenleft	0028
parenright	0029
asterisk	002a
plus	002b
comma	002c
minus	002d
period	002e
slash	002f
0 - 9	0030 - 0039
colon	003a
semicolon	003b
less	003c
equal	003d
greater	003e
question	003f
at	0040
A - Z	0041 - 005a
bracketleft	005b
backslash	005c
bracketright	005d
asciicircum	005e
underscore	005f
grave	0060
quoteleft	0060
a - z	0061 - 007a
braceleft	007b
bar	007c
braceright	007d
asciitilde	007e
nobreakspace	00a0
exclamdown	00a1
cent	00a2
sterling	00a3
currency	00a4
yen	00a5
brokenbar	00a6
section	00a7
diaeresis	00a8
copyright	00a9
ordfeminine	00aa
guillemotleft	00ab
notsign	00ac
hyphen	00ad
registered	00ae
macron	00af
degree	00b0
plusminus	00b1
twosuperior	00b2
threesuperior	00b3
acute	00b4
mu	00b5
paragraph	00b6
periodcentered	00b7
cedilla	00b8
onesuperior	00b9
masculine	00ba
guillemotright	00bb
onequarter	00bc
onehalf	00bd
threequarters	00be
questiondown	00bf
Agrave	00c0
Aacute	00c1
Acircumflex	00c2
Atilde	00c3
Adiaeresis	00c4
Aring	00c5
AE	00c6
Ccedilla	00c7
Egrave	00c8
Eacute	00c9
Ecircumflex	00ca
Ediaeresis	00cb
Igrave	00cc
Iacute	00cd
Icircumflex	00ce
Idiaeresis	00cf
ETH	00d0
Eth	00d0
Ntilde	00d1
Ograve	00d2
Oacute	00d3
Ocircumflex	00d4
Otilde	00d5
Odiaeresis	00d6
multiply	00d7
Oslash	00d8
Ooblique	00d8
Ugrave	00d9
Uacute	00da
Ucircumflex	00db
Udiaeresis	00dc
Yacute	00dd
THORN	00de
Thorn	00de
ssharp	00df
agrave	00e0
aacute	00e1
acircumflex	00e2
atilde	00e3
adiaeresis	00e4
aring	00e5
ae	00e6
ccedilla	00e7
egrave	00e8
eacute	00e9
ecircumflex	00ea
ediaeresis	00eb
igrave	00ec
iacute	00ed
icircumflex	00ee
idiaeresis	00ef
eth	00f0
ntilde	00f1
ograve	00f2
oacute	00f3
ocircumflex	00f4
otilde	00f5
odiaeresis	00f6
division	00f7
oslash	00f8
ooblique	00f8
ugrave	00f9
uacute	00fa
ucircumflex	00fb
udiaeresis	00fc
yacute	00fd
thorn	00fe
ydiaeresis	00ff

Latin 2

Aogonek	01a1
breve	01a2
Lstroke	01a3
Lcaron	01a5
Sacute	01a6
Scaron	01a9
Scedilla	01aa
Tcaron	01ab
Zacute	01ac
Zcaron	01ae
Zabovedot	01af
aogonek	01b1
ogonek	01b2
lstroke	01b3
lcaron	01b5
sacute	01b6
caron	01b7
scaron	01b9
scedilla	01ba
tcaron	01bb
zacute	01bc
doubleacute	01bd
zcaron	01be
zabovedot	01bf
Racute	01c0
Abreve	01c3
Lacute	01c5
Cacute	01c6
Ccaron	01c8
Eogonek	01ca
Ecaron	01cc
Dcaron	01cf
Dstroke	01d0
Nacute	01d1
Ncaron	01d2
Odoubleacute	01d5
Rcaron	01d8
Uring	01d9
Udoubleacute	01db
Tcedilla	01de
racute	01e0
abreve	01e3
lacute	01e5
cacute	01e6
ccaron	01e8
eogonek	01ea
ecaron	01ec
dcaron	01ef
dstroke	01f0
nacute	01f1
ncaron	01f2
odoubleacute	01f5
rcaron	01f8
uring	01f9
udoubleacute	01fb
tcedilla	01fe
abovedot	01ff

This is an excerpt of `keysymdef.h` which defines keysym codes (i.e. characters or functions associated with each key in X11) as `XK_`*`key`* and the *key* hex value. These keys can be used as argument for the `xdotool key` command.

/etc/passwd User 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	Hashed password (obsolete), or `x` if password is in `/etc/shadow`
3	UID – User ID
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 (if set to `/bin/false`, user will be unable to log in)

/etc/shadow User passwords

```
root:$6$qk8JmJHf$X9GfOZ/i9LZP4Kldu6.D3cx2pXA:15537:0:99999:7:::
bin:*:15637:0:99999:7:::
jdoe:!$6$YOiH1otQ$KxeeUKHExK8e3jCUdw9Rxy3Wu53:15580:0:99999:7::15766:
1    2 a b         c                          3     4 5     6 7 8     9
```

1	Login name
2	Hashed password (`*` if account is disabled, `!` or `!!` if no password is set, prefixed by `!` if the account is locked). Composed of the following subfields separated by `$`: **a** Hashing algorithm: `1` = MD5, `2a` = Blowfish, `5` = SHA256, `6` = SHA512 (recommended) **b** Random salt, up to 16 chars long. This is to thwart password cracking attempts based on rainbow tables **c** String obtained by hashing the user's plaintext password concatenated to the stored salt
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

```
root::root:root
jdoe:!::
staff:0cfz7IpLhW19i::root,jdoe
1     2             3 4
```

1	Group name
2	Encrypted password, or `!` if no password set (default)
3	Group administrators
4	Group members

`/etc/shadow` and `/etc/gshadow` are mode 000 and therefore readable only by the root user.

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

`usermod -c "Jonas Doe" jdoe`	Modify the GECOS field of a user account
`usermod -L jdoe`	Lock a user account
`usermod -U jdoe`	Unlock a user account

Many options for `usermod` are the same as `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`	Change the password of a user
`passwd -l jdoe`	Lock a user account
`passwd -S jdoe`	Show information about a user account: username, account status (L=locked, P=password, NP=no password), date of last password change, min age, max age, warning period, inactivity period in days

`chage -E 2013-02-14 jdoe`	Change the password expiration date; account will be locked at that date
`chage -d 13111 jdoe`	Change the date (in number of days since 1 January 1970) of last password change
`chage -d 0 jdoe`	Force the user to change password at his next login
`chage -M 30 jdoe`	Change the max number of days during which a password is valid
`chage -m 7 jdoe`	Change the min number of days between password changes
`chage -W 15 jdoe`	Change the number of days before password expiration that the user will be warned
`chage -I 3 jdoe`	Change the number of days after password expiration before the account is locked
`chage -l jdoe`	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`	Set or change the password of a group
`gpasswd -a jdoe staff`	Add a user to a group
`gpasswd -d jdoe staff`	Delete a user from a group
`gpasswd -A jdoe staff`	Add a user to the list of administrators of the group

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

`system-config-users`	(Red Hat)	GUI for user and group management

UID 0 is assigned to the superuser.
UIDs from 0 to 99 should* be reserved for static allocation by the system and not be created by applications.
UIDs from 100 to 499 should* be reserved for dynamic allocation by the superuser and post-install scripts.
UIDs for user accounts start from 500 (Red Hat) or 1000 (SUSE, Debian).

* as recommended by the Linux Standard Base core specifications

A process has an effective, saved, and real UID and GID:

Effective UID	Used for most access checks, and as the owner for files created by the process. An unprivileged process can change its effective UID only to either its saved UID or its real UID.
Saved UID	Used when a process running with elevated privileges needs to temporarily lower its privileges. The process changes its effective UID (usually root) to an unprivileged one, and its privileged effective UID is copied to the saved UID. Later, the process can resume its elevated privileges by resetting its effective UID back to the saved UID.
Real UID	Used to identify the real owner of the process and affect the permissions for sending signals. An unprivileged process can signal another process only if the sender's real or effective UID matches the receiver's real or saved UID. Child processes inherit the credentials from the parent, so they can signal each other.

`/etc/nologin`	If this file exists, `login` and `sshd` deny login to the system. Useful to prevent users to log in when doing system maintenance
`/etc/login.defs`	Definition of default values (UID and GID ranges, mail directory, account validity, password encryption method, and so on) for user account creation
`whoami`	Print your username (as effective UID)
`id`	Print your real and effective UID and GID, and the groups you are a member of
`id -u`	Print your effective UID
`id` *`user`*	Print UID, GID, and groups information about a user
`who`	Print the list of users logged into the system
`w`	Print the list of users logged into the system, and what they are doing
`last`	Print the list of users that logged in and out. Searches through the file `/var/log/wtmp`
`lastb`	Print the list of bad login attempts. Searches through the file `/var/log/btmp`
`fail2ban`	Scan authentication logs and temporarily ban IP addresses (via firewall rules) that have too many failed password logins
`/var/log/auth.log`	Logfile containing user logins and authentication mechanisms
`/var/log/pwdfail`	Logfile containing failed authentication attempts

`runuser -u jdoe` *command*	Run a command as user jdoe. Can be launched only by the superuser

`su jdoe`	Run a shell as user jdoe
`su` `su root`	Run a shell as root
`su -c "fdisk -l"`	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 -ujdoe` *command*	Run a command as user jdoe
`sudo` *command* `sudo -uroot` *command*	Run a command as root
`sudo -l`	List the allowed commands for the current user
`sudo !!`	Run again the last command, but this time as root
`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 will cause security problems if the editor spawns a shell
`visudo`	Edit `/etc/sudoers`, the configuration file that specifies access rights to sudo

Sudo commands are logged via syslog on `/var/log/auth.log` (Debian) or `/var/log/secure` (Red Hat).

`sudo su -` `sudo -i`	Login on an interactive shell as the superuser

`gksu -u root -l` `gksudo -u root` *guicommand*	GUI front-ends to `su` and `sudo` used to run an X Window command as root. Will pop up a requester prompting the user for root's password

`chvt` *n* CTRL ALT F*n*	Make `/dev/tty`*n* the foreground terminal
`vlock` `away`	Lock the virtual console (terminal)
`tty` `echo $(tty)`	Print your terminal device (e.g. `/dev/tty1`, `/dev/pts/1`)
`stty`	Change or display terminal line settings
`stty -ixon`	Disable XON/XOFF flow control
`screen`	Screen manager that multiplexes a single virtual VT100/ANSI terminal between multiple processes or shells. When the connection to a terminal is lost (e.g. because the terminal is closed manually or because of timeout during a remote SSH session), the processes running in it are terminated. The `screen` command starts an interactive shell screen session, to which you will be able to reattach later
`screen -S` *sessionname*	Start a screen session with the specified session name
`screen` *command*	Start the specified command in a screen session; session will end when the command exits
`screen -list`	Show the list of detached screen sessions
`screen -r` *pid.tty.host* `screen -r` *sessionowner/pid.tty.host*	Resume a detached screen session
`screen -R`	Resume the last detached screen session
`screen -d -R` *sessionname*	Detach a remote screen session and reattach your current terminal to it
CTRL A	Send a command to the window manager: `0` ... `9` Switch between screen sessions `c` Create a new screen session `?` Show help

How to detach an already-running job that was not started in a `screen` session

1.	CTRL Z	Suspend the job
2.	`bg`	Send the job to background
3.	`jobs`	Show the number of the backgrounded job; let's assume it's *n*
4.	`disown -h %`*n*	Detach job *n* from its parent shell

or

1.	`screen`	Start a screen session
2.	`reptyr` *pid*	Attach the job with process ID *pid* to the current terminal (screen session)

Now the terminal can be closed without killing the job.

`write jdoe`	Write interactively a message to the terminal of user jdoe (must be logged in)
`wall`	Write interactively a message to the terminal of all logged in users
`echo "Hello" | write jdoe`	Write a message to the terminal of user jdoe (must be logged in)
`echo "Hello" | wall`	Write a message to the terminal of all logged in users
`talk jdoe`	Open an interactive chat session with user jdoe (must be logged in)

`mesg y` `chmod g+w $(tty)`	Allow the other users to message you via `write`, `wall`, and `talk`
`mesg n` `chmod g-w $(tty)`	Disallow the other users to message you via `write`, `wall`, and `talk`
`mesg`	Display your current message permission status

`mesg` works by enabling/disabling the group write permission of your terminal device, which is owned by system group `tty`. The root user is always able to message users.

`cron` is used for repeated scheduled execution of commands.

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.

It is not necessary to restart `crond` after the modification of a crontab file, as the changes will be reloaded automatically.

`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 (command available only to the superuser)
`/etc/crontab`	System-wide crontab file; this is the list of commands to execute periodically
`/etc/cron.d/`	Directory containing commands to execute periodically, one command per file (which must have the same syntax as `/etc/crontab`)

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

`/var/spool/cron/`*`user`*	Crontab of *user*

/etc/crontab

```
# m   h   dom mon dow   user   command
  25  6    *   *   1    root   foo.sh
*/5 16    *   *   *    root   /opt/myscript.sh
0,30 7   25   12   *    jdoe   /home/jdoe/bar.sh
   3 17    *   *  1-5   root   baz.sh
```

every Monday at 6:25 AM
from 4:00 to 4:55 PM every 5 minutes everyday
at 7:00 and 7:30 AM on 25th December
at 5:03 PM everyday, from Monday to Friday

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)
user	User as whom the command will be executed
command	Command that will be executed at the specified times

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

/etc/anacrontab

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

If the job has not been run in the last 7 days, wait 10 minutes and then execute the command

period	period, in days, during which the command was not executed
delay	delay to wait, in minutes, before execution of the command
job-identifier	job identifier in anacron messages; should be unique for each anacron job
command	command that will be executed

Anacron jobs are run by `crond`, and permit the execution of periodic jobs on a machine that is not always powered on, such as a laptop.
Only the superuser can schedule anacron jobs, which have a granularity of one day (vs one minute for cron jobs).
The file `/var/spool/anacron/`*`job_identifier`* contains the date of the last execution of the specified anacron job.

`at` is used for scheduled execution of commands that must run only 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

`bc`	Calculator
`cal`	Calendar
`units`	Converter of quantities between different units
`banner` `figlet`	Print a message in large letters
`sensors`	Print sensor chips information (e.g. temperature)
`beep`	Produce a beep from the machine's speakers
`speaker-test`	Speaker test tone generator for the ALSA (Advanced Linux Sound Architecture) framework
`on_ac_power`	Return an exit code of 0 (true) if the machine is currently connected to AC power, 1 if it is powered by battery (e.g. a laptop)
`ipcalc`	IP addresses calculator
`pwgen`	Password generator
`aspell`	Spell checker
`cloc`	Count lines of source code and comments on a project' files
`gnome-terminal`	GNOME shell terminal (GUI application)

Locale environment variables	
LANG LANGUAGE	Language, stored in /etc/default/locale . When scripting, it is recommended to 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
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
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	

`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 filein > fileout`	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.

`date`	Show current date and time
`date -d "9999 days ago"` `date -d "1970/01/01 + 4242"`	Calculate a date and show it
`date +"%F %H:%M:%S"`	Show current date in the format specified
`date +"%s"`	Show current date in Unix time format (seconds elapsed since 00:00:00 1/1/1970)
`date -s "20130305 23:30:00"`	Set the date
`date 030523302013`	Set the date, in the format *MMDDhhmmYYYY*

`timedatectl`	Show current date and time
`timedatectl set-time 2013-03-05` `timedatectl set-time 23:30`	Set the date
`timedatectl list-timezones`	List all possible timezones

`zdump GMT`	Show current date and time in the GMT timezone

`tzselect`
`tzconfig`
`dpkg-reconfigure tzdata` (Debian)
`timedatectl set-timezone` *timezone* (Red Hat)
	Set the timezone

`/etc/timezone` (Debian)	Timezone
`/etc/localtime` (Red Hat)	Timezone, a symlink to the appropriate timezone file in `/usr/share/zoneinfo/`

`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` *timeserver*	Print the list of peers for the time server

`ntpdate` *timeserver*	Synchronizes the clock with the specified time server
`ntpdate -b` *timeserver*	Brutally set the clock, without waiting for a slow adjusting
`ntpdate -q` *timeserver*	Query the time server without setting the clock

The `ntpdate` command is deprecated and will be phased out in future Linux releases.

`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

Syslog logging facility:

`syslogd`		Daemon logging events from user processes
`rsyslogd`	(Ubuntu 14)	
`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
```

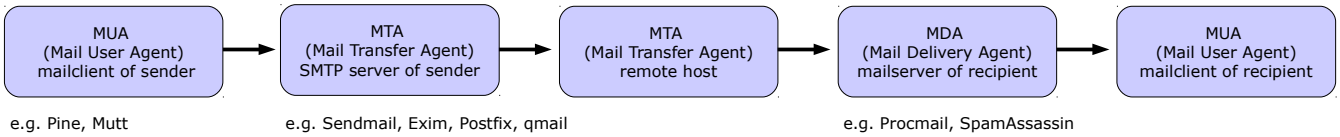
Facility Creator of the message	**Level** Severity of the message	**Action** Destination of the message
`auth` or `security`†	`emerg` or `panic`† (highest)	`filename` message is written into a logfile
`authpriv`	`alert`	`@hostname` message is sent to a logger server (via UDP port 514)
`cron`	`crit`	`user1,user2,user3` 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`	Show the 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` `less +F /var/log/messages`	Print the end of the message log file, moving forward as the file grows (i.e. read logs in real-time)

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

In Systemd there is no `/var/log/messages` ; instead, the command `journalctl` must be used to view the kernel logs.



`~/.forward`	Mail address(es) to which forward the user's mail, or mail commands
`/etc/aliases` `/etc/mail/aliases`	Aliases database for users on the local machine. Each line has syntax *`alias`*`: `*`user`
`/var/spool/mail/`*`user`*	Inbox for *`user`* on the local machine
`/var/log/mail.log` (Debian) `/var/log/maillog` (Red Hat)	Mail logs
`mail` `mailx`	Commands to send mail

`mailx -s "`*`Subject`*`" \`
`-S smtp="mailserver.foobar.com:25" \`
`jdoe@example.org <` *`messagefile`*
	Send a mail message to jdoe@example.org, using an external SMTP server

`uuencode` *`binaryfile`* `| mail jdoe@example.org`	Send a binary file to jdoe@example.org (not recommended because many mailclients will display the received attachment inline)
`mutt -a` *`binaryfile`* `-- jdoe@example.org < /dev/null`	Send a binary file to jdoe@example.org using the Mutt MUA

Mailbox formats		
mbox	Each mail folder is a single file, storing multiple email messages. Advantages: universally supported, fast search inside a mail folder. Disadvantages: issues with file locking, possible mailbox corruption.	`$HOME/Mail/myfolder`
Maildir	Each mail folder is a directory, and contains the subdirectories `/cur`, `/new`, and `/tmp`. Each email message is stored in its own file with an unique filename ID. The process that delivers an email message writes it to a file in the `tmp/` directory, and then moves it to `new/`. The moving is commonly done by hard linking the file to `new/` and then unlinking the file from `tmp/`, which guarantees that a MUA will not see a partially written message as it never looks in `tmp/`. When the MUA finds mail messages in `new/` it moves them to `cur/`. Advantages: fast location/retrieval/deletion of a specific mail message, no file locking needed, can be used with NFS. Disadvantages: some filesystems may not efficiently handle a large number of small files, searching text inside all mail messages is slow	`$HOME/Mail/myfolder/`

SMTP commands

```
220 smtp.example.com ESMTP Postfix
HELO abc.example.org
250 Hello abc.example.org, glad to meet you
MAIL FROM: alice@example.org
250 Ok
RCPT TO bob@foobar.com
250 Ok
RCPT TO eve@quux.org
250 Ok
DATA
354 End data with <CR><LF>.<CR><LF>
From: Alice <alice@example.org>
To: Bob <bob@foobar.com>
Cc: Eve <eve@quux.org>
Date: Wed, 13 August 2014 18:02:43 -0500
Subject: Test message

This is a test message.
.
250 OK id=1OjReS-0005kT-Jj
QUIT
221 Bye
```

`HELO abc.example.org`	Initiate the conversation and identify client host to server
`EHLO abc.example.org`	Like HELO, but tell server to use Extended SMTP
`MAIL FROM: alice@example.org`	Specify mail sender
`RCPT TO: bob@foobar.com`	Specify mail recipient
`DATA`	Specify data to send. Ended with a dot on a single line
`QUIT` `RSET`	Disconnect
`HELP`	List all available commands
`NOOP`	Empty command
`VRFY jdoe@example.org`	Verify the existence of an e-mail address (this command should not be implemented, for security reasons)
`EXPN mailinglist`	Check mailing list membership

SMTP response codes

first digit	**1**	Command accepted, but not processed until client sends confirmation
	2	Command successfully completed
	3	Command accepted, but not processed until client sends more information
	4	Command failed due to temporary errors
	5	Command failed due to permanent errors
second digit	**0**	Syntax error or command not implemented
	1	Informative response in reply to a request for information
	2	Connection response in reply to a data transmission
	5	Status response in reply to a mail transfer operation
third digit		Specifies further the response

211	System status or help reply
214	Help message
220	The server is ready
221	The server is ending the conversation
250	The requested action was completed
251	The specified user is not local, but the server will forward the mail message
354	Reply to the DATA command. After getting this, start sending the message body
421	The mail server will be shut down, try again later
450	The mailbox that you are trying to reach is busy, try again later
451	The requested action was not done. Some error occurred in the mail server
452	The requested action was not done. The mail server ran out of system storage
500	The last command contained a syntax error or the command line was too long
501	The parameters or arguments in the last command contained a syntax error
502	The last command is not implemented in the mail server
503	The last command was sent out of sequence
504	One of the parameters of the last command is not implemented by the server
550	The mailbox that you are trying to reach can't be found or you don't have access rights
551	The specified user is not local; part of message text will contain a forwarding address
552	The mailbox that you are trying to reach has run out of space, try again later
553	The mail address that you specified was not syntactically correct
554	The mail transaction has failed for unknown causes

Sendmail is a MTA distributed as a monolithic binary file.
Previous versions used to run SUID `root`, which caused many security problems; recent versions run SGID `smmsp`, the group that has write access on the mail queue.
Sendmail uses `smrsh`, a restricted shell, to run some external programs.

`/etc/mail/submit.cf`	Sendmail local mail transfer configuration file
`/etc/mail/sendmail.cf`	Sendmail MTA configuration file

The `.cf` configuration files must not be edited by hand and are generated from editable `.mc` text files via the `m4` command, e.g. `m4 /etc/mail/submit.mc > /etc/mail/submit.cf`

`/etc/mail/access.db`	Access control file to allow or deny access to systems or users
`/etc/mail/local-host-names.db`	List of domains that must be considered as local accounts
`/etc/mail/virtusertable.db`	Map for local accounts, used to distribute incoming email
`/etc/mail/mailertable.db`	Routing table, used to dispatch emails from remote systems
`/etc/mail/domaintable.db`	Domain table, used for transitions from an old domain to a new one
`/etc/mail/genericstable.db`	Map for local accounts, used to specify a different sender for outgoing mail
`/etc/mail/genericsdomain.db`	Local FQDN

The `.db` database files must not be edited by hand and are generated from editable text files via the `makemap` command, e.g. `makemap hash /etc/mail/access.db < /etc/mail/access`

`/var/spool/mqueue/`	Temporary mailqueue files (where *nnn* is the Message ID):	
	`df`*nnn*	Mail body
	`qf`*nnn*	Message envelope with headers and routing information
	`Qf`*nnn*	Message envelope if abandoned
	`hf`*nnn*	Message envelope if held / quarantined by a milter (i.e. mail filter)
	`tf`*nnn*	Temporary file
	`lf`*nnn*	Lock file
	`nf`*nnn*	Backup file
	`xf`*nnn*	Transcript of delivery attempts

`newaliases` `sendmail -bi`	Update the aliases database; must be run after any change to `/etc/aliases`
`mailq` `sendmail -bp`	Examine the mail queue
`sendmail -bt`	Run Sendmail in test mode
`sendmail -q`	Force a queue run

`hoststat`	Print statistics about remote hosts usage
`purgestat`	Clear statistics about remote host usage
`mailstats`	Print statistics about the mailserver
`praliases`	Display email aliases

Exim is a free MTA, distributed under open source GPL license.

`/etc/exim.conf`	Exim4 configuration file
`/usr/local/etc/exim/configure` (FreeBSD)	

`exim4 -bp`	Examine the mail queue
`exim4 -M` *`messageID`*	Attempt delivery of message
`exim4 -Mrm` *`messageID`*	Remove a message from the mail queue
`exim4 -Mvh` *`messageID`*	See the headers of a message in the mail queue
`exim4 -Mvb` *`messageID`*	See the body of a message in the mail queue
`exim4 -Mvc` *`messageID`*	See a message in the mail queue
`exim4 -qf` *`domain`*	Force a queue run of all queued messages for a *domain*
`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 run
`exigrep`	Search through Exim logfiles
`exicyclog`	Rotate Exim logfiles

Postfix is a fast, secure, easy to configure, open source MTA intended as a replacement for Sendmail. It is implemented as a set of small helper daemons, most of which run in a chroot jail with low privileges. The main ones are:

`master`	Postfix master daemon, always running; starts the other daemons when necessary
`nqmgr`	Queue manager for incoming and outgoing mail, always running
`smtpd`	SMTP daemon for incoming mail
`smtp`	SMTP daemon for outgoing mail
`bounce`	Manager of bounce messages
`cleanup`	Daemon that verifies the syntax of outgoing messages before they are handed to the queue manager
`local`	Daemon that handles local mail delivery
`virtual`	Daemon that handles mail delivery to virtual users

`/var/spool/postfix/incoming`	Incoming queue. All new mail entering the Postfix queue is written here by the cleanup daemon. Under normal conditions this queue is nearly empty
`/var/spool/postfix/active`	Active queue. Contains messages ready to be sent. The queue manager places messages here from the incoming queue as soon as they are available
`/var/spool/postfix/deferred`	Deferred queue. A message is placed here when all its deliverable recipients are delivered, and for some recipients delivery failed for a transient reason. The queue manager scans this queue periodically and puts some messages into the active queue for a retry
`/var/spool/postfix/bounce`	Message delivery status report about why mail is bounced (non-delivered mail)
`/var/spool/postfix/defer`	Message delivery status report about why mail is delayed (non-delivered mail)
`/var/spool/postfix/trace`	Message delivery status report (delivered mail)

`postfix reload`	Reload configuration
`postconf -e 'mydomain = example.org'`	Edit a setting in the Postfix configuration
`postconf -l`	List supported mailbox lock methods
`postconf -m`	List supported database types
`postconf -v`	Increase logfile verbosity
`postmap` *`dbtype:textfile`*	Manage Postfix lookup tables, creating a hashed map file of database type *dbtype* from *textfile*
`postmap hash:/etc/postfix/transport`	Regenerate the transport database
`postalias`	Convert `/etc/aliases` into the aliases database file `/etc/aliases.db`
`postsuper`	Operate on the mail queue
`postqueue`	Unprivileged mail queue manager

/etc/postfix/main.cf	Postfix main configuration file
`mydomain = example.org`	This system's domain
`myorigin = $mydomain`	Domain from which all sent mail will appear to originate
`myhostname = foobar.$mydomain`	This system's hostname
`inet_interfaces = all`	Network interface addresses that this system receives mail on. Value can also be `localhost`, `all`, or `loopback-only`
`proxy_interfaces = 1.2.3.4`	Network interface addresses that this system receives mail on by means of a proxy or NAT unit
`mynetworks = 10.3.3.0/24 !10.3.3.66`	Networks the SMTP clients are allowed to connect from

`mydestination = $myhostname, localhost,`
`  $mydomain, example.com,`
`  hash:/etc/postfix/otherdomains`
	Domains for which Postfix will accept received mail.
	Value can also be a lookup database file e.g. a hashed map

`relayhost = 10.6.6.6`	Relay host to which Postfix should send all mail for delivery, instead of consulting DNS MX records
`relay_domains = $mydestination`	Sources and destinations for which mail will be relayed. Can be empty if Postfix is not intended to be a mail relay

`virtual_alias_domains = virtualex.org`
`virtual_alias_maps = /etc/postfix/virtual`
 	
or
 	
`virtual_alias_domains = hash:/etc/postfix/virtual`
	Set up Postfix to handle mail for virtual domains too.
	The `/etc/postfix/virtual` file is a hashed map, each line of the file containing the virtual domain email address and the destination real domain email address:
	`jdoe@virtualex.org  john.doe@example.org`
	`ksmith@virtualex.org  kim.smith`
	`@virtualex.org  root`
	The last line is a catch-all specifying that all other email messages to the virtual domain are delivered to the root user on the real domain

`mailbox_command = /usr/bin/procmail`	Use Procmail as MDA
A line beginning with whitespace or tab is a continuation of the previous line. A line beginning with a `#` is a comment. The `#` is not a comment delimiter if it is not placed at the beginning of a line.	

/etc/postfix/master.cf **Postfix master daemon configuration file**

```
# service type private unpriv chroot wakeup maxproc command + args
smtp      inet n       -      -      -      -       smtpd
pickup    fifo n       -      -      60     1       pickup
cleanup   unix n       -      -      -      0       cleanup
qmgr      fifo n       -      -      300    1       qmgr
rewrite   unix -       -      -      -      -       trivial-rewrite
bounce    unix -       -      -      -      0       bounce
defer     unix -       -      -      -      0       bounce
flush     unix n       -      -      1000?  0       flush
smtp      unix -       -      -      -      -       smtp
showq     unix n       -      -      -      -       showq
error     unix -       -      -      -      -       error
local     unix -       n      n      -      -       local
virtual   unix -       n      n      -      -       virtual
lmtp      unix -       -      n      -      -       lmtp
```

service	Name of the service
type	Transport mechanism used by the service
private	Whether the service is accessible only by Postfix daemons and not by the whole system. Default is yes
unprivileged	Whether the service is unprivileged i.e. not running as root. Default is yes
chroot	Whether the service is chrooted. Default is yes
wakeup	How often the service needs to be woken up by the master daemon. Default is never
maxproc	Max number of simultaneous processes providing the service. Default is 50
command	Command used to start the service
The – indicates that an option is set to its default value.	

Procmail is a regex-based MDA whose main purpose is to preprocess and sort incoming email messages.
It is able to work both with the standard mbox format and the Maildir format.

To have all email processed by Procmail, the `~/.forward` file may be edited to contain:
`"|exec /usr/local/bin/procmail || exit 75"`

`/etc/procmailrc`	System-wide recipes
`~/.procmailrc`	User's recipes
`procmail -h`	List all Procmail flags for recipes
`formail`	Utility for email filtering and editing
`lockfile`	Utility for mailbox file locking
`mailstat`	Utility for generation of reports from Procmail logs

`/etc/procmailrc` and `~/.procmailrc` Procmail recipes	

`PATH=$HOME/bin:/usr/bin:/bin:/usr/sbin:/sbin`
`MAILDIR=$HOME/Mail`
`DEFAULT=$MAILDIR/Inbox`
`LOGFILE=$HOME/.procmaillog`
	Common parameters, non specific to Procmail

`:0h:` or `:0:`
`* ^From: .*(alice|bob)@foobar\.org`
`$DEFAULT`
	Flag: match headers (default) and use file locking (highly recommended when writing to a file or a mailbox in mbox format)
	Condition: match the header specifying the sender address
	Destination: default mailfolder

`:0:`
`* ^From: .*owner@listserv\.com`
`* ^Subject:.*Linux`
`$MAILDIR/Geekstuff1`
	Conditions: match sender address and subject headers
	Destination: specified mailfolder, in mbox format

`:0`
`* ^From: .*owner@listserv\.com`
`* ^Subject:.*Linux`
`$MAILDIR/Geekstuff2/`
	Flag: file locking not necessary because using Maildir format
	Conditions: match sender address and subject headers
	Destination: specified mailfolder, in Maildir format

`# Blacklisted by SpamAssassin`
`:0`
`* ^X-Spam-Status: Yes`
`/dev/null`
	Flag: file locking not necessary because blackholing to `/dev/null`
	Condition: match SpamAssassin's specific header
	Destination: delete the message

`:0B:`
`* hacking`
`$MAILDIR/Geekstuff`
	Flag: match body of message instead of headers

`:0HB:`
`* hacking`
`$MAILDIR/Geekstuff`
	Flag: match either headers or body of message

`:0:`
`* > 256000`
`| /root/myprogram`
	Condition: match messages larger than 256 Kb
	Destination: pipe message through the specified program

`:0fw`
`* ^From: .*@foobar\.org`
`| /root/myprogram`
	Flags: use the pipe as a filter (modifying the message), and tell Procmail to wait that the filter finished processing the message

`:0c`
`* ^Subject:.*administration`
`! secretary@domain.com`
 	
`:0:`
`$MAILDIR/Forwarded`
	Flag: copy the message and proceed with next recipe
	Destination: forward to specified email address, and (as ordered by the next recipe) save in the specified mailfolder

The Courier MTA provides modules for ESMTP, IMAP, POP3, webmail, and mailing list services in a single framework.

To use it, you must first launch the `courier-authlib` service, then launch the desired mail service e.g. `courier-imap` for the IMAP service.

`/usr/lib/courier-imap/etc/` or `/etc/courier/`	`imapd`	Courier IMAP daemon configuration
	`imapd-ssl`	Courier IMAPS daemon configuration
	`pop3d`	Courier POP3 daemon configuration
	`pop3d-ssl`	Courier POP3S daemon configuration
`/usr/lib/courier-imap/share/`		Directory for public and private keys

`mkimapdcert` — Generate a certificate for the IMAPS service

`mkpop3dcert` — Generate a certificate for the POP3 service

`makealiases` — Create system aliases in `/usr/lib/courier/etc/aliases.dat` , which is made by processing a `/usr/lib/courier/etc/aliases/system` text file:

```
root          : postmaster
mailer-daemon : postmaster
MAILER-DAEMON : postmaster
uucp          : postmaster
postmaster    : admin
```

`/usr/lib/courier-imap/etc/pop3d` **Courier POP configuration file**	
`ADDRESS=0`	Address to listen on. `0` means all addresses
`PORT=127.0.0.1.900,192.168.0.1.900`	Port number connections are accepted on. Accept connections on port 900 on IP addresses 127.0.0.1 and 192.168.0.1
`POP3AUTH="LOGIN CRAM-MD5 CRAM-SHA1"`	POP authentication advertising SASL (Simple Authentication and Security Layer) capability, with CRAM-MD5 and CRAM-SHA1
`POP3AUTH_TLS="LOGIN PLAIN"`	Also advertise SASL PLAIN if SSL is enabled
`MAXDAEMONS=40`	Maximum number of POP3 servers started
`MAXPERIP=4`	Maximum number of connections to accept from the same IP address
`PIDFILE=/var/run/courier/pop3d.pid`	PID file
`TCPDOPTS="-nodnslookup -noidentlookup"`	Miscellaneous `couriertcpd` options that shouldn't be changed
`LOGGEROPTS="-name=pop3d"`	`courierlogger` options
`POP3_PROXY=0`	Enable or disable proxying
`PROXY_HOSTNAME=myproxy`	Override value from `gethostname()` when checking if a proxy connection is required
`DEFDOMAIN="@example.com"`	Optional default domain. If the username does not contain the first character of `DEFDOMAIN`, then it is appended to the username. If `DEFDOMAIN` and `DOMAINSEP` are both set, then `DEFDOMAIN` is appended only if the username does not contain any character from `DOMAINSEP`
`POP3DSTART=YES`	Flag intended to be read by the system startup script
`MAILDIRPATH=Maildir`	Name of the maildir directory

/usr/lib/courier-imap/etc/imapd Courier IMAP configuration file	
ADDRESS=0	Address to listen on. 0 means all addresses
PORT=127.0.0.1.900,192.168.0.1.900	Port number connections are accepted on. Accept connections on port 900 on IP addresses 127.0.0.1 and 192.168.0.1
AUTHSERVICE143=imap	Authenticate using a different service parameter depending on the connection's port. This only works with authentication modules that use the service parameter, such as PAM
MAXDAEMONS=40	Maximum number of IMAP servers started
MAXPERIP=20	Maximum number of connections to accept from the same IP address
PIDFILE=/var/run/courier/imapd.pid	File where couriertcpd will save its process ID
TCPDOPTS="-nodnslookup -noidentlookup"	Miscellaneous couriertcpd options that shouldn't be changed
LOGGEROPTS="-name=imapd"	courierlogger options
DEFDOMAIN="@example.com"	Optional default domain. If the username does not contain the first character of DEFDOMAIN, then it is appended to the username. If DEFDOMAIN and DOMAINSEP are both set, then DEFDOMAIN is appended only if the username does not contain any character from DOMAINSEP
IMAP_CAPABILITY="IMAP4rev1 UIDPLUS \ CHILDREN NAMESPACE THREAD=ORDEREDSUBJECT \ THREAD=REFERENCES SORT QUOTA IDLE"	Specifies what most of the response should be to the CAPABILITY command
IMAP_KEYWORDS=1	Enable or disable custom IMAP keywords. Possible values are: 0 disable keywords 1 enable keywords 2 enable keywords with a slower algorithm
IMAP_ACL=1	Enable or disable IMAP ACL extension
SMAP_CAPABILITY=SMAP1	Enable the experimental Simple Mail Access Protocol extensions
IMAP_PROXY=0	Enable or disable proxying
IMAP_PROXY_FOREIGN=0	Proxying to non-Courier servers. Re-sends the CAPABILITY command after logging in to remote server. May not work with all IMAP clients
IMAP_IDLE_TIMEOUT=60	How often, in seconds, the server should poll for changes to the folder while in IDLE mode
IMAP_CHECK_ALL_FOLDERS=0	Enable or disable server check for mail in every folder
IMAP_UMASK=022	Set the umask of the server process. This value is passed to the umask command. This feature is mostly useful for shared folders, where the file permissions of the messages may be important
IMAP_ULIMITD=131072	Set the upper limit of the size of the data segment of the server process, in Kb. This value is passed to the ulimit -d command. This feature is used as an additional safety check that should stop any potential DoS attacks that exploit any kind of a memory leak to exhaust all the available memory on the server
IMAP_USELOCKS=1	Enable or disable dot-locking to support concurrent multiple access to the same folder. Strongly recommended when using shared folders
IMAP_SHAREDINDEXFILE=\ /etc/courier/shared/index	Index of all accessible folders. Normally, this setting should not be changed
IMAP_TRASHFOLDERNAME=Trash	Name of the trash folder
IMAP_EMPTYTRASH=Trash:7,Sent:30	Purge folders i.e. delete all messages from the specified folders after the specified number of days
IMAP_MOVE_EXPUNGE_TO_TRASH=0	Enable or disable moving expunged messages to the trash folder (instead of straight deleting them)
HEADERFROM=X-IMAP-Sender	Make the return address, $SENDER, being saved in the X-IMAP-Sender mail header. This header gets added to the sent message (but not in the copy of the message saved in the folder)
MAILDIRPATH=Maildir	Name of the mail directory

Dovecot is an open source, security-hardened, fast and efficient IMAP and POP3 server.
By default it uses PAM authentication. The script `mkcert.sh` can be used to create self-signed SSL certificates.

/etc/dovecot.conf Dovecot configuration file	
`base_dir = /var/run/dovecot/`	Base directory where to store runtime data
`protocols = imaps pop3s`	Protocols to serve. If Dovecot should use dovecot-auth, this can be set to `none`
`listen = *, [::]`	Network interfaces to accept connections on. Here, listen to all IPv4 and IPv6 interfaces
`disable_plaintext_auth = yes`	Disable LOGIN command and all other plaintext authentications unless SSL/TLS is used (LOGINDISABLED capability)
`shutdown_clients = yes`	Kill all IMAP and POP3 processes when Dovecot master process shuts down. If set to no, Dovecot can be upgraded without forcing existing client connections to close
`log_path = /dev/stderr`	Log file to use for error messages, instead of sending them to syslog. Here, log to stderr
`info_log_path = /dev/stderr`	Log file to use for informational and debug messages. Default value is the same as log_path
`syslog_facility = mail`	Syslog facility to use if logging to syslog
`login_dir = /var/run/dovecot/login`	Directory where the authentication process places authentication UNIX sockets, to which the login process needs to be able to connect
`login_chroot = yes`	Chroot login process to the `login_dir`
`login_user = dovecot`	User to use for the login process. This user is used to control access for authentication process, and not to access mail messages
`login_process_size = 64`	Maximum login process size, in Mb
`login_process_per_connection = yes`	If yes, each login is processed in its own process (more secure); if no, each login process processes multiple connections (faster)
`login_processes_count = 3`	Number of login processes to keep for listening for new connections
`login_max_processes_count = 128`	Maximum number of login processes to create
`login_max_connections = 256`	Maximum number of connections allowed per each login process. This setting is used only if `login_process_per_connection = no`; once the limit is reached, the process notifies master so that it can create a new login process
`login_greeting = Dovecot ready.`	Greeting message for clients
`login_trusted_networks = \` `10.7.7.0/24 10.8.8.0/24`	Trusted network ranges (usually IMAP proxy servers). Connections from these IP addresses are allowed to override their IP addresses and ports, for logging and authentication checks. `disable_plaintext_auth` is also ignored for these networks
`mbox_read_locks = fcntl` `mbox_write_locks = dotlock fcntl`	Locking methods to use for locking mailboxes in mbox format. Possible values are: `dotlock` Create *`mailbox`*`.lock` file; oldest and NSF-safe method `dotlock_try` Same as `dotlock`, but skip if failing `fcntl` Recommended; works with NFS too if `lockd` is used `flock` May not exist in all systems; doesn't work with NFS `lockf` May not exist in all systems; doesn't work with NFS
`maildir_stat_dirs = no`	Option for mailboxes in Maildir format. If no (default), the LIST command returns all entries in the mail directory beginning with a dot. If yes, returns only entries which are directories
`dbox_rotate_size = 2048` `dbox_rotate_min_size = 16`	Maximum and minimum file size, in Kb, of a mailbox in dbox format until it is rotated
`!include /etc/dovecot/conf.d/*.conf`	Include configuration file
`!include_try /etc/dovecot/extra.conf`	Include optional configuration file, do not give error if file not found

/etc/dovecot.conf Dovecot configuration file	

`mail_location = \`
`mbox:~/mail:INBOX=/var/spool/mail/%u`
or
`mail_location = maildir:~/Maildir`
	Mailbox location, in mbox or Maildir format. Variables:
	`%u` username
	`%n` user part in *user@domain*, same as `%u` if there is no domain
	`%d` domain part in *user@domain*, empty if there is no domain
	`%h` home directory

`namespace shared {`	Definition of a shared namespace, for accessing other users' mailboxes that have been shared. Private namespaces are for users' personal emails. Public namespaces are for shared mailboxes managed by root user
`separator = /`	Hierarchy separator to use. Should be the same for all namespaces; it depends on the underlying mail storage format
`prefix = shared/%%u/`	Prefix required to access this namespace; must be different for each. Here, mailboxes are visible under shared/*user@domain*/ ; the variables `%%n`, `%%d` and `%%u` are expanded to the destination user
`location = maildir:%%h/Maildir:\` `INDEX=~/Maildir/shared/%%u`	Mailbox location for other users' mailboxes; it is in the same format as `mail_location` which is also the default for it. `%`*`variable`* and `~/` expand to the logged in user's data; `%%`*`variable`* expands to the destination user's data
`inbox = no`	There can be only one INBOX, and this setting defines which namespace has it
`hidden = no`	Define whether the namespace is hidden i.e. not advertised to clients via NAMESPACE extension
`subscriptions = no`	Namespace handles its own subscriptions; if set to no, the parent namespace handles them and Dovecot uses the default namespace for saving subscriptions. If `prefix` is empty, this should be set to yes
`list = children`	Show the mailboxes under this namespace with LIST command, making the namespace visible for clients that do not support the NAMESPACE extension. Here, lists child mailboxes but hide the namespace prefix; list the namespace only if there are visible shared mailboxes
`}`	
`mail_uid = 666` `mail_gid = 666`	UID and GID used to access mail messages
`mail_privileged_group = mail`	Group to enable temporarily for privileged operations; currently this is used only with INBOX when its initial creation or a dotlocking fails
`mail_access_groups = tmpmail`	Supplementary groups to grant access to for mail processes; typically these are used to set up access to shared mailboxes
`lock_method = fcntl`	Locking method for index files. Can be `fcntl`, `flock`, or `dotlock`
`first_valid_uid = 500` `last_valid_uid = 0`	Valid UID range for users; default is 500 and above. This makes sure that users cannot login as daemons or other system users. Denying root login is hardcoded to Dovecot and cannot be bypassed
`first_valid_gid = 1` `last_valid_gid = 0`	Valid GID range for users; default is non-root/wheel. Users having non-valid primary GID are not allowed to login
`max_mail_processes = 512`	Maximum number of running mail processes. When this limit is reached, new users are not allowed to login
`mail_process_size = 256`	Maximum mail process size, in Mb
`valid_chroot_dirs =`	List of directories under which chrooting is allowed for mail processes
`mail_chroot =`	Default chroot directory for mail processes. Usually not needed as Dovecot does not allow users to access files outside their mail directory
`mailbox_idle_check_interval = 30`	When IDLE command is running, mailbox is checked once in a while to see if there are any new mails or other changes. This setting defines the minimum time to wait between these checks, in seconds

/etc/dovecot.conf Dovecot configuration file	
`protocol pop3 {`	Block with options for the POP3 protocol
`listen = *:110`	Network interfaces to accept POP3 connections on
`login_executable = /usr/libexec/dovecot/pop3-login`	Location of the POP3 login executable
`mail_executable = /usr/libexec/dovecot/pop3`	Location of the POP3 mail executable
`pop3_no_flag_updates = no`	If set to no, do not try to set mail messages non-recent or seen with POP3 sessions, to reduce disk I/O. With Maildir format do not move files from `new/` to `cur/`, with mbox format do not write `Status-` headers
`pop3_lock_session = no`	Whether to keep the mailbox locked for the whole POP3 session
`pop3_uidl_format = %08Xu%08Xv`	POP3 UIDL (Unique Mail Identifier) format to use
`}`	
`protocol imap {`	Block with options for the IMAP protocol
`listen = *:143` `ssl_listen = *:993`	Network interfaces to accept IMAP and IMAPS connections on
`login_executable = /usr/libexec/dovecot/imap-login`	Location of the IMAP login executable
`mail_executable = /usr/libexec/dovecot/imap`	Location of the IMAP mail executable
`mail_max_userip_connections = 10`	Maximum number of IMAP connections allowed for a user from each IP address
`imap_idle_notify_interval = 120`	How many seconds to wait between "OK Still here" notifications when client is IDLE
`}`	
`ssl = yes`	SSL/TLS support. Possible values are `yes`, `no`, `required`
`ssl_cert_file = /etc/ssl/certs/dovecot-cert.pem`	Location of the SSL certificate
`ssl_key_file = /etc/ssl/private/dovecot-key.pem`	Location of private key
`ssl_key_password = b1gs3cr3t`	Password of private key, if it is password-protected. Since `/etc/dovecot.conf` is usually world-readable, it is better to place this setting into a root-owned 0600 file instead and include it via the setting `!include_try /etc/dovecot/dovecot-passwd.conf` . Alternatively, Dovecot can be started with `dovecot -p b1gs3cr3t`
`ssl_ca_file = /etc/dovecot/cafile.pem`	List of trusted SSL certificate authorities; the file contains the CA certificates followed by the CRLs
`ssl_verify_client_cert = yes`	Request client to send a certificate
`ssl_cipher_list = ALL:!LOW:!SSLv2`	List of SSL ciphers to use
`verbose_ssl = yes`	Show protocol level SSL errors

/etc/dovecot.conf Dovecot configuration file	
`auth_executable = /usr/libexec/dovecot/dovecot-auth`	Location of the authentication executable
`auth_process_size = 256`	Max authentication process size, in Mb
`auth_username_chars = abcde ... VWXYZ01234567890.-_@`	List of allowed characters in the username. If the username entered by user contains a character not listed in here, the login automatically fails. This is to prevent an user exploiting any potential quote escaping vulnerabilities with SQL/LDAP databases
`auth_realms =`	List of realms for SASL authentication mechanisms that need them. If empty, multiple realms are not supported
`auth_default_realm = example.org`	Default realm/domain to use if none was specified
`auth_anonymous_username = anonymous`	Username to assign to users logging in with ANONYMOUS SASL mechanism
`auth_verbose = no`	Whether to log unsuccessful authentication attempts and the reasons why they failed
`auth_debug = no`	Whether to enable more verbose logging (e.g. SQL queries) for debugging purposes
`auth_failure_delay = 2`	Delay before replying to failed authentications, in seconds
`auth default {`	
`mechanisms = plain login cram-md5`	Accepted authentication mechanisms

`passdb passwd-file {`
`args = /etc/dovecot.deny`
`deny = yes`
`}`
	Deny login to the users listed in `/etc/dovecot.deny` (file contains one user per line)

`passdb pam {`
`args = cache_key=%u%r dovecot`
`}`
	PAM authentication block.
	Enable authentication matching (username and remote IP address) for PAM.

`passdb passwd {`
`blocking = yes`
`args =`
`}`
	System users e.g. NSS or `/etc/passwd`

`passdb shadow {`
`blocking = yes`
`args =`
`}`
	Shadow passwords for system users e.g. NSS or `/etc/passwd`

`passdb bsdauth {`
`cache_key = %u`
`args =`
`}`
	PAM-like authentication for OpenBSD

`passdb sql {`
`args = /etc/dovecot/dovecot-sql.conf`
`}`
	SQL database

`passdb ldap {`
`args = /etc/dovecot/dovecot-ldap.conf`
`}`
	LDAP database

`socket listen {`
`master {`
`path = /var/run/dovecot/auth-master`
`mode = 0600`
`user =`
`group =`
`}`
`client {`
`path = /var/run/dovecot/auth-client`
`mode = 0660`
`}`
`}`
	Export the authentication interface to other programs.
	Master socket provides access to userdb information; it is typically used to give Dovecot's local delivery agent access to userdb so it can find mailbox locations. The default user/group is the one who started `dovecot-auth` (i.e. root).
	The client socket is generally safe to export to everyone. Typical use is to export it to the SMTP server so it can do SMTP AUTH lookups using it

`}`	

Active mode (default)
1. Client connects to FTP server on port 21 (control channel) and sends second unprivileged port number
2. Server acknowledges
3. Server connects from port 20 (data channel) to client's second unprivileged port number
4. Client acknowledges

Passive mode (more protocol-compliant, because it is the client that initiates the connection)
1. Client connects to FTP server on port 21 and requests passive mode via the PASV command
2. Server acknowledges and sends unprivileged port number via the PORT command
3. Client connects to server's unprivileged port number
4. Server acknowledges

FTP servers		
Very Secure FTP	A hardened and high-performance FTP implementation. The `vsftpd` daemon operates with multiple processes that run as a non-privileged user in a chrooted jail.	
Pure-FTP	A free, easy-to-use FTP server.	
	`pure-ftpd`	Pure-FTP daemon
	`pure-ftpwho`	Show clients connected to the Pure-FTP server
	`pure-mrtginfo`	Show connections to the Pure-FTP server as a MRTG graph
	`pure-statsdecode`	Show Pure-FTP log data
	`pure-pw`	Manage Pure-FTP virtual accounts
	`pure-pwconvert`	Convert the system user database to a Pure-FTP virtual accounts database
	`pure-quotacheck`	Manage Pure-FTP quota database
	`pure-uploadscript`	Run a command on the Pure-FTP server to process an uploaded file
FTP clients		
ftp	Standard FTP client.	
lftp	A sophisticated FTP client with support for HTTP and BitTorrent.	
	`lftp ftpserver.domain.org`	Connect to a FTP server and tries an anonymous login

/etc/vsftpd/vsftpd.conf	Very Secure FTP server configuration file
listen=NO	Run vsftpd in standalone mode (i.e. not via inetd)?
local_enable=YES	Allow local system users (i.e. in /etc/passwd) to log in?
chroot_local_user=YES	Chroot local users in their home directory?
write_enable=YES	Allow FTP commands that write on the filesystem (i.e. STOR, DELE, RNFR, RNTO, MKD, RMD, APPE and SITE)?
anonymous_enable=YES	Allow anonymous logins? If yes, anonymous and ftp are accepted as logins
anon_root=/var/ftp/pub	After anonymous login, go to directory /var/ftp/pub
anon_upload_enable=YES	Allow anonymous uploads?
chown_uploads=YES	Change ownership of anonymously uploaded files?
chown_username=ftp	Change ownership of anonymously uploaded files to user ftp
anon_world_readable_only=NO	Allow anonymous users to only download files which are world readable?
ssl_enable=YES	Enable SSL?
force_local_data_ssl=NO	Encrypt local data?
force_local_logins_ssl=YES	Force encrypted authentication?
allow_anon_ssl=YES	Allow anonymous users to use SSL?
ssl_tlsv1=YES ssl_tlsv2=NO ssl_tlsv3=NO	Versions of SSL/TLS to allow
rsa_cert_file=/etc/pki/tls/certs/vsftpd.pem	Location of certificate file
rsa_private_key_file=/etc/pki/tls/certs/vsftpd.pem	Location of private key file

`cupsd`	CUPS (Common Unix Printing System) daemon. Administration of printers is done via web interface on http://localhost:631
`/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
`/etc/init.d/cupsys start`	Start the CUPS service
`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)

IPv4 classful addressing (assigned by IANA)					
		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	10.0.0.0/8	16,777,216	RFC 1918
	Private Class B	172.16.0.0 – 172.31.255.255	172.16.0.0/12	1,048,576	RFC 1918
	Private Class C	192.168.0.0 – 192.168.255.255	192.168.0.0/16	65,536	RFC 1918
Reserved	Source	0.0.0.0 – 0.255.255.255	0.0.0.0/8	16,777,216	RFC 1700
	Loopback	127.0.0.0 – 127.255.255.255	127.0.0.0/8	16,777,216	RFC 1700
	Autoconf	169.254.0.0 – 169.254.255.255	169.254.0.0/16	65,536	RFC 3330
	TEST-NET	192.0.2.0 – 192.0.2.255	192.0.2.0/24	256	RFC 3330
	6to4 relay anycast	192.88.99.0 – 192.88.99.255	192.88.99.0/24	256	RFC 3068
	Device benchmarks	198.18.0.0 – 198.19.255.255	198.18.0.0/15	131,072	RFC 2544

IPv4 address: 32-bit long, represented divided in four octets (dotted-quad).

e.g. 193.22.33.44

4×10^9 total addresses

IPv6 addressing	
Unicast	64-bit network prefix (>= 48-bit routing prefix + <= 16-bit subnet id) + 64-bit interface identifier A 48-bit MAC address is transformed into a 64-bit EUI-64 by inserting ff:fe in the middle. A EUI-64 is then transformed into a IPv6 interface identifier by inverting the 7th most significant bit.
Link-local	fe80:0000:0000:0000 + 64-bit interface identifier
Multicast	ff + 4-bit flag + 4-bit scope field + 112-bit group ID

IPv6 address: 128-bit long, represented divided in eight 16-bit groups (4 hex digits).

e.g. 2130:0000:0000:0000:0007:0040:15bc:235f which can also be written as 2130::7:40:15bc:235f
Leading zeros in each group can be deleted. A single chunk of one or more adjacent 0000 groups can be deleted.

3×10^{38} total addresses

VLSM chart - Last octet subnetting (CIDR notation)						
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.

Most common 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
123	UDP	NTP
139	TCP/UDP	Microsoft NetBIOS
143	TCP	IMAP
161	UDP	SNMP
443	TCP	HTTPS (HTTP over SSL/TLS)
465	TCP	SMTP over SSL
993	TCP	IMAPS (IMAP over SSL)
995	TCP	POP3S (POP3 over SSL)

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

`/etc/services` lists all well-known ports.
Many network services are run by the `xinetd` super server.

ISO/OSI and TCP/IP protocol stack models

Layer	ISO/OSI	TCP/IP	Standards (e.g.)	Data transmission unit
7	Application	Application	HTTP, SMTP, POP	Message
6	Presentation			
5	Session			
4	Transport	Transport	TCP, UDP	Segment (TCP), Datagram (UDP)
3	Network	Internet	IPv4, IPv6, ICMP	Packet
2	Data Link	Network Access	Ethernet, Wi-Fi, PPP	Frame
1	Physical			Bit

```
ip a
ip addr
ip addr show
ifconfig -a
```
Display configuration of all network interfaces

```
ip link show eth0
ifconfig eth0
```
Display configuration of eth0

```
ip addr add dev eth0 10.1.1.1/8
ifconfig eth0 10.1.1.1 netmask 255.0.0.0 broadcast 10.255.255.255
```
Configure IP address of eth0

```
ifconfig eth0 hw ether 45:67:89:ab:cd:ef
```
Configure MAC address of eth0

```
ip link set eth0 up
ifconfig eth0 up
ifup eth0
```
Activate eth0

```
ip link set eth0 down
ifconfig eth0 down
ifdown eth0
```
Shut down eth0

```
dhclient eth0
pump
dhcpcd eth0  (SUSE)
```
Request an IP address via DHCP

```
ip neigh
arp -a
```
Show the ARP cache table

```
ip neigh show 10.1.0.6
arp 10.1.0.6
```
Show the ARP cache entry for a host

```
ip neigh add 10.1.0.7 lladdr 01:23:45:67:89:ab dev eth0
arp -s 10.1.0.7 01:23:45:67:89:ab
```
Add a new ARP entry for a host

```
ip neigh del 10.1.0.7 dev eth0
arp -d 10.1.0.7
```
Delete a ARP entry

```
ip neigh flush all
```
Delete the ARP table for all interfaces

```
hostname
```
Get the hostname

```
hostname -f
```
Get the FQDN (Fully Qualified Domain Name)

```
hostname mylinuxbox
hostnamectl set-hostname --static "mylinuxbox"  (RHEL 7)
```
Set the hostname

```
hostnamectl  (RHEL 7)
```
Get the hostname, OS, and other information

```
/etc/init.d/networking restart  (Debian)
/etc/init.d/network restart     (Red Hat)
```
Restart network services

```
brctl command bridge
```
Manage the Ethernet bridge configuration in the Linux kernel

```
ethtool option device
```
Query or control network driver and hardware settings

```
ethtool eth0
```
View hardware settings of eth0

`iwlist wlan0 scan`	List all wireless devices in range, with their quality of signal and other information
`iwlist wlan0 freq`	Display transmission frequency settings
`iwlist wlan0 rate`	Display transmission speed settings
`iwlist wlan0 txpower`	Display transmission power settings
`iwlist wlan0 key`	Display encryption settings
`iwgetid wlan0 option`	Print NWID, ESSID, AP/Cell address or other information about the wireless network that is currently in use
`iwconfig wlan0`	Display configuration of wireless interface wlan0
`iwconfig wlan0 option`	Configure wireless interface wlan0
`iw dev wlan0 station dump`	On a wireless card configured in AP Mode, display information (e.g. MAC address, tx/rx, bitrate, signal strength) about the clients
`rfkill list`	List installed wireless devices
`rfkill unblock n`	Enable wireless device number *n*
`hcidump -i device`	Display raw HCI (Host Controller Interface) data exchanged with a Bluetooth *device*

`dig example.org`	Perform a DNS lookup for the specified domain or hostname. Returns information in BIND zone file syntax; uses an internal resolver and hence does not honor `/etc/resolv.conf`
`host example.org`	Perform a DNS lookup for the specified domain or hostname. Does honor `/etc/resolv.conf`
`nslookup example.org` (deprecated)	Perform a DNS lookup for the specified domain or hostname
`dig @10.7.7.7 -t MX example.org` `host -t example.org 10.7.7.7`	Perform a DNS lookup for the MX record of the domain example.org, querying nameserver 10.7.7.7
`dig example.org any` `host -a example.org`	Get all DNS records for a domain
`dig -x 203.0.113.1` `host 203.0.113.1`	Perform a reverse DNS lookup for the IP address 203.0.113.1
`whois example.org`	Query the WHOIS service for an Internet resource, usually a domain name
`ping 10.0.0.2`	Test if a remote host can be reached and measure the round-trip time to it (by sending an ICMP ECHO_REQUEST datagram and expecting an ICMP ECHO_RESPONSE)
`fping -a 10.0.0.2 10.0.0.7 10.0.0.8`	Ping multiple hosts in parallel and report which ones are alive
`bing 10.0.0.10 10.0.0.11`	Calculate point-to-point throughput between two remote hosts
`traceroute 10.0.0.3`	Print the route, hop by hop, packets trace to a remote host (by sending a sequence of ICMP ECHO_REQUEST datagrams with increasing TTL values, starting with TTL=1)
`tracepath 10.0.0.3`	Simpler `traceroute`
`mtr 10.0.0.3`	`traceroute` and `ping` combined
`telnet 10.0.0.4 23`	Establish a telnet connection to the specified host and port (if port is omitted, use default port 23)
`ftp 10.0.0.5`	Establish an interactive FTP connection with host 10.0.0.5

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

`curl -XPUT 10.0.0.6 -d'`*`data`*`'`	Send a HTTP PUT command with *data* to 10.0.0.6
`curl -o file.html www.example.org/file.html`	Download a file via HTTP

`netstat`	Display network connections
`netstat --tcp` `netstat -t`	Display active TCP connections
`netstat -l`	Display only listening sockets
`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 -e`)
`netstat -c`	Display network connections continuously
`ss`	Display socket statistics (similar to `netstat`)
`ss -t -a`	Display all TCP sockets
`nmap 10.0.0.1` `nmap -sS 10.0.0.1`	Scan for open ports (TCP SYN scan) on remote host 10.0.0.1
`nmap -sP 10.0.0.1`	Do a ping sweep (ICMP ECHO probes) on remote host
`nmap -sU 10.0.0.1`	Scan UDP ports on remote host
`nmap -sV 10.0.0.1`	Do a service and version scan on open ports
`nmap -p 1-65535 10.0.0.1`	Scan all ports (1-65535) on remote host, not only the common ports
`nmap -O 10.0.0.1`	Find which operating system is running on remote host (OS fingerprinting)
`ngrep`	Filter data payload of network packets matching a specified regex
`nload`	Display a graph of the current network usage
`iptraf` `iptraf-ng`	IP LAN monitor (ncurses UI)
`netserver`	Run a network performance benchmark server
`netperf`	Do network performance benchmarks by connecting to a netserver
`iperf -s`	Run a network throughput benchmark server
`iperf -c` *`server`*	Perform network throughput tests in client mode, by connecting to an iperf server

```
tcpdump -ni eth0
```
Sniff all network traffic on interface eth0, suppressing DNS resolution

```
tcpdump ip host 10.0.0.2 tcp port 25
```
Sniff network packets on TCP port 25 from and to 10.0.0.2

```
tcpdump ether host '45:67:89:ab:cd:ef'
```
Sniff traffic from and to the network interface having MAC address 45:67:89:ab:cd:ef

```
tcpdump 'src host 10.0.0.2 and \
(tcp port 80 or tcp port 443)'
```
Sniff HTTP and HTTPS traffic having as source host 10.0.0.2

```
tcpdump -ni eth0 not port 22
```
Sniff all traffic on eth0 except that belonging to the SSH connection

```
tcpdump -vvnn -i eth0 arp
```
Sniff ARP traffic on eth0, on maximum verbosity level, without converting host IP addresses and port numbers to names

```
tcpdump ip host 10.0.0.2 and \
not 10.0.0.9
```
Sniff IP traffic between 10.0.0.2 and any other host except 10.0.0.9

```
dhcpdump -i eth0
```
Sniff all DHCP packets on interface eth0

`nc`
`ncat` (Red Hat)
`netcat` (SUSE)

Netcat, "the Swiss Army knife of networking", a very flexible generic TCP/IP client/server

```
nc -z 10.0.0.7 22
ncat 10.0.0.7 22
```

Scan for a listening SSH daemon on remote host 10.0.0.7

```
nc -l -p 25
```

Listen for connections on port 25 (i.e. mimic a SMTP server). Send any input received on stdin to the connected client and dump on stdout any data received from the client

```
nc 10.0.0.7 389 < file
```

Push the content of *file* to port 389 on remote host 10.0.0.7

```
echo "GET / HTTP/1.0\r\n\r\n" | nc 10.0.0.7 80
```

Connect to web server 10.0.0.7 and issue a HTTP GET

```
while true; \
do nc -l -p 80 -q 1 < page.html; done

while true; \
do echo "<html><body><h1>WWW</h1></body></html>" \
| ncat -l -p 80; done
```

Start a minimal web server, serving the specified HTML page to any connected client

```
nc -v -n -z -w1 -r 10.0.0.7 1-1023
```

Run a TCP port scan against remote host 10.0.0.7.
Probe randomly all privileged ports with a 1-second timeout, without resolving service names, and with verbose output

```
echo "" | nc -v -n -w1 10.0.0.7 1-1023
```

Retrieve the greeting banner of any network service that might be running on remote host 10.0.0.7

`/etc/hosts`

Mappings between IP addresses and hostnames, for name resolution

```
127.0.0.1  localhost.localdomain  localhost
10.2.3.4   myhost.domain.org      myhost
```

`/etc/nsswitch.conf`

Sources that must be used by various system library lookup functions

```
passwd:  files nisplus nis
shadow:  files nisplus nis
group:   files nisplus nis
hosts:   files dns nisplus nis
```

`/etc/host.conf`

Sources for name resolution, for systems before glibc2.
Obsolete, superseded by `/etc/nsswitch.conf`

```
order hosts,bind
multi on
```

`/etc/resolv.conf`

Domain names that must be appended to bare hostnames, and DNS servers that will be used for name resolution

```
search domain1.org domain2.org
nameserver  192.168.3.3
nameserver  192.168.4.4
```

`/etc/networks`

Mappings between network addresses and names

```
loopback  127.0.0.0
mylan     10.2.3.0
```

`/etc/network/interfaces` (Debian)

List and configuration of all network interfaces

```
allow-hotplug eth0
iface eth0 inet static
   address 10.2.3.4
   netmask 255.255.255.0
   gateway 10.2.3.254
   dns-domain example.com
   dns-nameservers 8.8.8.8 4.4.4.4
```

`/etc/hostname` (Debian)

Hostname of the local machine

`/sys/class/net`

List of all network interfaces in the system

`/etc/services`

List of service TCP/UDP port numbers

`/etc/protocols`

List of available protocols

`/etc/ethers`

ARP mappings (i.e. MAC to IP addresses)

/etc/sysconfig/network

Network configuration file

```
ADDRESS=10.2.3.4
NETMASK=255.255.255.0
GATEWAY=10.2.3.254
HOSTNAME=mylinuxbox.example.org
NETWORKING=yes
```

/etc/sysconfig/network-scripts/ifcfg-eth0

Configuration file for network interface eth0.
This file is read by the `ifup` and `ifdown` scripts

```
DEVICE=eth0
TYPE=Ethernet
HWADDR=AA:BB:CC:DD:EE:FF
BOOTPROTO=none
ONBOOT=yes
NM_CONTROLLED=no
IPADDR=10.2.3.4
NETMASK=255.255.255.0
GATEWAY=10.2.3.254
DNS1=8.8.8.8
DNS2=4.4.4.4
USERCTL=no
```

/etc/sysconfig/network-scripts/ifcfg-eth0:0
/etc/sysconfig/network-scripts/ifcfg-eth0:1
/etc/sysconfig/network-scripts/ifcfg-eth0:2

Configuration files for different interface aliases.
This makes possible to bind multiple IP addresses to a single NIC

/etc/sysconfig/network-scripts/route-eth0

Static route configuration for eth0

```
default 10.2.3.4 dev eth0
10.7.8.0/24 via 10.2.3.254 dev eth0
10.7.9.0/24 via 10.2.3.254 dev eth0
```

`/etc/hosts.allow`
`/etc/hosts.deny`

Host access control files used by the TCP Wrapper system.

Each file contains zero or more *`daemon`*`:`*`client`* lines. The first matching line is considered.

Access is granted when a *`daemon`*`:`*`client`* pair matches an entry in `/etc/hosts.allow`. Otherwise, access is denied when a *`daemon`*`:`*`client`* pair matches an entry in `/etc/hosts.deny`. Otherwise, access is granted.

`/etc/hosts.allow` and `/etc/hosts.deny` lines syntax	
`ALL: ALL`	All services to all hosts
`ALL: .example.edu`	All services to all hosts of the example.edu domain
`ALL: .example.edu EXCEPT host1.example.edu`	All services to all hosts of example.edu, except host1
`in.fingerd: .example.com`	Finger service to all hosts of example.com
`in.tftpd: LOCAL`	TFTP to hosts of the local domain only
`sshd: 10.0.0.3 10.0.0.4 10.1.1.0/24`	SSH to the hosts and network specified
`sshd: 10.0.1.0/24`	SSH to 10.0.1.0/24
`sshd: 10.0.1.`	SSH to 10.0.1.0/24
`sshd: 10.0.1.0/255.255.255.0`	SSH to 10.0.1.0/24
`in.tftpd: ALL: spawn (/safe_dir/safe_finger \ -l @%h | /bin/mail -s %d-%h root) &`	Send a finger probe to hosts attempting TFTP and notify root user via email
`portmap: ALL: (echo Illegal RPC request \ from %h | /bin/mail root) &`	When a client attempts a RPC request via the portmapper (NFS access), echo a message to the terminal and notify root user via email

Output of command `route -en`

```
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.3.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
0.0.0.0         192.168.3.1     0.0.0.0         UG    0      0        0 eth0
```

Destination	*network or host*	destination network or host
	0.0.0.0	default route
Gateway	*host*	gateway
	0.0.0.0 *	no gateway needed, network is directly connected
	-	rejected route
Genmask	*network mask*	network mask to apply for the destination network
	255.255.255.255	destination host
	0.0.0.0	default 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

```
ip route
route -en
route -F
netstat -rn
```
Display IP routing table

```
ip route show cache
route -C
```
Display kernel routing cache

```
ip route add default via 10.1.1.254
route add default gw 10.1.1.254
```
Add a default gateway

```
ip route add 10.2.0.1 dev eth0
ip route add 10.2.0.1 via 10.2.0.254
route add -host 10.2.0.1 gw 10.2.0.254
```
Add a route for a host

```
ip route add 10.2.0.0/16 via 10.2.0.254
route add -net 10.2.0.0 netmask 255.255.0.0 gw 10.2.0.254
```
Add a route for a network

```
ip route delete 10.2.0.1 dev eth0
route del -host 10.2.0.1 gw 10.2.0.254
```
Delete a route for a host

```
ip route flush all
```
Delete the routing table for all interfaces

The Netfilter framework provides firewalling capabilities in Linux. It is implemented by the user-space application programs `iptables` for IPv4 (which replaced `ipchains`, which itself replaced `ipfwadm`) and `ip6tables` for IPv6.
Iptables is implemented in the kernel and therefore does not have a daemon process or a service.
The ability to track connection state is provided by the `ip_conntrack` kernel module.

From RHEL 7 onward, iptables has been replaced by the `firewalld` daemon. To use it anyway, it is necessary to install the package `iptables-services` which provides a systemd interface for iptables, and disable firewalld.
In Ubuntu, iptables is managed by the `ufw` service (Uncomplicated Firewall).

`/etc/sysconfig/iptables`	Default file containing the firewall rules
`iptables-restore < file`	Load into iptables the firewall rules specified in the *file*
`iptables-save > file`	Save into iptables the firewall rules specified in the *file*

iptables rules file	

`*filter`
`:INPUT ACCEPT [0:0]`
`:FORWARD ACCEPT [0:0]`
`:OUTPUT ACCEPT [0:0]`
`COMMIT`
	Delete all rules and open the firewall to all connections

Iptables uses **tables** containing sets of **chains**, which contain sets of **rules**. Each rule has a **target** (e.g. ACCEPT).
The "filter" table contains chains INPUT, FORWARD, OUTPUT (built-in chains); this is the default table to which all iptables commands are applied, unless another table is specified via the `-t` option.
The "nat" table contains chains PREROUTING, OUTPUT, POSTROUTING.
The "mangle" table contains chains PREROUTING, OUTPUT.
When a packet enters the system, it is handed to the INPUT chain. If the destination is local, it is processed; if the destination is not local and IP forwarding is enabled, the packet is handed to the FORWARD chain, otherwise it is dropped.
An outgoing packet generated by the system will go through the OUTPUT chain.
If NAT is in use, an incoming packet will pass at first through the PREROUTING chain, and an outgoing packet will pass last through the POSTROUTING chain.

`iptables -A INPUT -s 10.0.0.6 -j ACCEPT`	Add a rule to accept all packets from 10.0.0.6
`iptables -A INPUT -s 10.0.0.7 -j REJECT`	Add a rule to reject all packets from 10.0.0.7 and send back a ICMP response to the sender
`iptables -A INPUT -s 10.0.0.8 -j DROP`	Add a rule to silently drop all packets from 10.0.0.8
`iptables -A INPUT -s 10.0.0.9 -j LOG`	Add a rule to log via syslog all packets from 10.0.0.9
`iptables -D INPUT -s 10.0.0.9 -j LOG`	Delete a specific rule
`iptables -D INPUT 42`	Delete rule 42 of the INPUT chain
`iptables -F INPUT`	Flush all rules of the INPUT chain
`iptables -F`	Flush all rules, hence disabling the firewall
`iptables -t mangle -F`	Flush all rules of the "mangle" table
`iptables -t mangle -X`	Delete all user-defined (not built-in) rules in the "mangle" table
`iptables -L INPUT`	List the rules of the INPUT chain
`iptables -L -n`	List all rules, without translating numeric values (IP addresses to FQDNs and port numbers to services)
`iptables -N mychain`	Define a new chain
`iptables -P INPUT DROP`	Define the chain policy target, which takes effect when no rule matches and the end of the rules list is reached
`iptables -A OUTPUT -d 10.7.7.0/24 -j DROP`	Add a rule to drop all packets with destination 10.7.7.0/24
`iptables -A FORWARD -i eth0 -o eth1 -j LOG`	Add a rule to log all packets entering the system via eth0 and exiting via eth1
`iptables -A INPUT -p 17 -j DROP` `iptables -A INPUT -p udp -j DROP`	Add a rule to drop all incoming UDP traffic (protocol numbers are defined in `/etc/protocols`)
`iptables -A INPUT --sport 1024:65535 --dport 53 \` `-j ACCEPT`	Add a rule to accept all packets coming from any unprivileged port and with destination port 53
`iptables -A INPUT -p icmp --icmp-type echo-request \` `-m limit --limit 1/s -i eth0 -j ACCEPT`	Add a rule to accept incoming pings through eth0 at a maximum rate of 1 ping/second
`iptables -A INPUT -m state --state ESTABLISHED \` `-j ACCEPT`	Load the module for stateful packet filtering, and add a rule to accept all packets that are part of a communication already tracked by the state module
`iptables -A INPUT -m state --state NEW -j ACCEPT`	Add a rule to accept all packets that are not part of a communication already tracked by the state module
`iptables -A INPUT -m state --state RELATED -j ACCEPT`	Add a rule to accept all packets that are related (e.g. ICMP responses to TCP or UDP traffic) to a communication already tracked by the state module
`iptables -A INPUT -m state --state INVALID -j ACCEPT`	Add a rule to accept all packets that do not match any of the states above

In firewalld, a network interface (aka **interface**) or a subnet address (aka **source**) can be assigned to a specific **zone**.
To determine to which zone a packet belongs, first the zone of the source is analyzed, then the zone of the interface; if no source or interface matches, the packet is associated to the default zone (which is "public", unless set otherwise).
If the zone is not specified in a command, the command is applied to the default zone.
By default, commands are temporary; adding the `--permanent` option to a command sets it as permanent, or shows permanent settings only.
Temporary commands are effective immediately but are canceled at reboot, firewall reload, or firewall restart.
Permanent commands are effective only after reboot, firewall reload, or firewall restart.

Firewalld zones (as obtained by `firewall-cmd --get-zones`)	
block	Rejects incoming connections with an ICMP HOST_PROHIBITED; allows only established connections
dmz	Used to expose services to the public; allows only specific incoming connections
drop	Drops all incoming packets; allows only outgoing connections
external	Used for routing and masquerading; allows only specific connections
home	Allows only specific incoming connections
internal	Used to define internal networks and allow only private network traffic
public	Allows only specific incoming connections
trusted	Accepts all traffic
work	Used to define internal networks and allow only private network traffic

```
systemctl status firewalld
firewall-cmd --state
```
Check the status of the firewall

```
firewall-config
```
Firewall management GUI

```
firewall-cmd --reload
```
Reload firewall configuration; this applies all permanent changes and cancels all temporary changes. Current connections are not terminated

```
firewall-cmd --complete-reload
```
Reload firewall configuration, stopping all current connections

```
firewall-cmd --runtime-to-permanent
```
Transform all temporary changes to permanent

```
firewall-cmd --list-all-zones
```
List all zones and their full settings

```
firewall-cmd --get-default-zone
```
Show the default zone

```
firewall-cmd --set-default-zone=home
```
Set "home" as the default zone

```
firewall-cmd --get-active-zones
```
Show the active zones i.e. zones bound to either an interface or a source

```
firewall-cmd --get-zones
```
Show all available zones

```
firewall-cmd --get-zone-of-interface=eth0
```
Show the zone assigned to eth0

```
firewall-cmd --new-zone=test
```
Create a new zone called "test"

```
firewall-cmd --zone=home --change-interface=eth0
```
Assign temporarily eth0 to the "home" zone

```
firewall-cmd --zone=home --change-interface=eth0 --permanent
```
Assign permanently eth0 to the "home" zone

```
firewall-cmd --zone=home --list-all
```
List temporary settings of the "home" zone

```
firewall-cmd --zone=home --list-all --permanent
```
List permanent settings of the "home" zone

```
firewall-cmd --zone=home --add-source=10.1.1.0/24
```
Assign 10.1.1.0/24 to the "home" zone

```
firewall-cmd --zone=home --list-sources
```
List sources bound to the "home" zone

```
firewall-cmd --zone=trusted --add-service=ssh
firewall-cmd --zone=trusted --add-port=22/tcp
```
Add the SSH service to the "trusted" zone

```
firewall-cmd --zone=trusted --add-service={ssh,http,https}
```
Add the SSH, HTTP, and HTTPS services to the "trusted" zone

```
firewall-cmd --zone=trusted --list-services
```
Show temporary and permanent services bound to the "trusted" zone

```
firewall-cmd --zone=trusted --list-ports
```
Show temporary and permanent ports open on the "trusted" zone

```
firewall-cmd --get-icmptypes
```
Show all known types of ICMP messages

```
firewall-cmd --add-icmp-block=echo-reply
```
Block a specific ICMP message type

```
firewall-cmd --query-icmp-block=echo-reply
```
Tell if a specific ICMP message type is blocked

```
firewall-cmd --list-icmp-block
```
Show the list of blocked ICMP message types

```
/usr/lib/firewalld/services/service.xml
```
Predefined configuration of *service*

```
/etc/firewalld/services/service.xml
```
User-defined configuration of *service*

```
firewall-cmd --direct --add-rule ipv4 filter INPUT 0 \
-p tcp --dport 22 -j ACCEPT
```
Set up a direct rule (in iptables format) to accept SSH connections

```
firewall-offline-cmd rule
```
Set up a direct rule when firewalld is not running

```
firewall-cmd --direct --get-all-rules
```
Show all direct rules

```
/etc/firewalld/direct.xml
```
User-defined direct rules

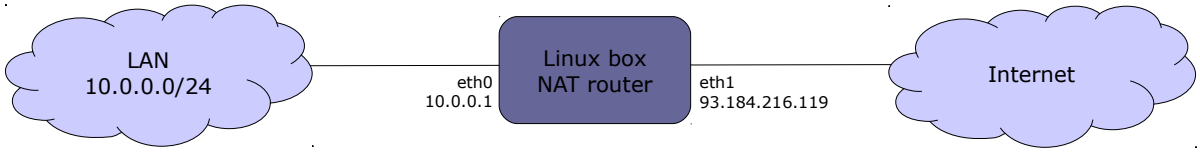
```
firewall-cmd --permanent --add-rich-rule='rule'
```
Set up a rich rule

```
firewall-cmd --list-rich-rules
```
List all rich rules

```
man firewalld.richlanguage
```
Show the manpage about rich rules

```
firewall-cmd --zone=external --add-masquerade
```
Set up masquerading on the "external" zone for machines of the "internal" zone; packets originating from the "internal" zone will get the firewall's IP address as source address

```
firewall-cmd --zone=external --add-forward-port=\
port=22:proto=tcp:toport=2222
```
Set up port forwarding from port 22 to 2222 for the "external" zone



SNAT (Source Network Address Translation)

```
iptables -t nat -A POSTROUTING -s 10.0.0.0/24 -o eth1 \
-j SNAT --to-source 93.184.216.119
```

Map all traffic leaving the LAN to the external IP address 93.184.216.119

```
iptables -t nat -A POSTROUTING -s 10.0.0.0/24 -o eth1 \
-j SNAT --to-source 93.184.216.119:93.184.216.127
```

Map all traffic leaving the LAN to a pool of external IP addresses 93.184.216.119-127

```
iptables -t nat -A POSTROUTING -o eth1 -j MASQUERADE
```

Map all traffic leaving the LAN to the address dynamically assigned to eth1 via DHCP

DNAT (Destination Network Address Translation)

```
iptables -t nat -A PREROUTING -i eth1 -d 93.184.216.119 \
-j DNAT --to-destination 10.0.0.13
```

Allow the internal host 10.0.0.13 to be publicly reachable via the external address 93.184.216.119

PAT (Port Address Translation)

```
iptables -t nat -A PREROUTING -i eth1 -d 93.184.216.119 \
-p tcp --dport 80 -j DNAT --to-destination 10.0.0.13:8080
```

Make publicly accessible a webserver that is located in the LAN, by mapping port 8080 of the internal host 10.0.0.13 to port 80 of the external address 93.184.216.119

```
iptables -t nat -A PREROUTING -i eth0 -d ! 10.0.0.0/24 \
-p tcp --dport 80 -j REDIRECT --to-ports 3128
```

Redirect all outbound HTTP traffic originating from the LAN to a proxy running on port 3128 on the Linux box

```
sysctl -w net.ipv4.ip_forward=1
echo 1 > /proc/sys/net/ipv4/ip_forward
```

Enable IP forwarding; necessary to set up a Linux machine as a router. (This command causes other network options to be changed as well.)

```
ssh root@remotehost
```
Connect to a remote host via SSH (Secure Shell) and login as the root user

```
ssh -v root@remotehost
ssh -vv root@remotehost
ssh -vvv root@remotehost
```
Connect via SSH, specifying increasing levels of verbosity

```
ssh -p 2222 root@remotehost
```
SSH as root using port 2222 instead of standard port 22

```
ssh root@remotehost /root/mycommand
```
Execute a command on a remote host

```
sftp root@remotehost
```
FTP-like tool for secure file transfer

```
scp myfile root@remotehost:/tmp/myfile2
scp root@remotehost:/tmp/myfile2 myfile
scp jdoe@host1:/tmp/myfile root@host2:/root/myfile2
```
Non-interactive secure file copy.
Can transfer files from local to remote, from remote to local, or between two remote hosts

```
sshpass -p p455w0rd ssh root@remotehost
```
Connect to a remote host using the specified password

```
pssh -i -H "host1 host2 host3" /root/mycommand
```
Execute a command in parallel on a group of remote hosts

```
ssh-keygen -t rsa -b 2048
```
Generate interactively a 2048-bit RSA key pair; will prompt for a passphrase

```
ssh-keygen -t dsa
```
Generate a DSA key pair

```
ssh-keygen -p -t rsa
```
Change passphrase of the private key

```
ssh-keygen -q -t rsa -f /etc/ssh/id_rsa -N '' -C ''
```
Generate a RSA key with no passphrase (for non-interactive use) and no comment

```
ssh-keygen -lf /etc/ssh/id_rsa.pub
```
View key length and fingerprint of a public key

```
ssh-agent
```
Start the SSH Agent daemon that caches decrypted private keys in memory; also echoes to the terminal the environment variables that must be set. The cached keys are automatically used by SSH tools `ssh`, `sftp`, and `scp`

```
eval `ssh-agent`
```
Show the PID of ssh-agent and set appropriate environment variables

```
ssh-add
```
Add the default private keys to the ssh-agent cache

```
ssh-add ~/.ssh/id_rsa
```
Add a specific private key to the ssh-agent cache

```
ssh-copy-id root@remotehost
```
Use locally available keys to authorize, via public key authentication, login of root on a remote host.
Copies root's local public key `~/.ssh/id_rsa.pub` to `~/.ssh/authorized_keys` on the remote host

SSH port forwarding (aka SSH tunneling)

`ssh -L 2525:mail.foo.com:25 user@mail.foo.com`

Establish a SSH encrypted tunnel from localhost to remote host mail.foo.com, redirecting traffic from local port 2525 to port 25 of remote host mail.foo.com.
Useful if the local firewall blocks outgoing port 25. In this case, port 2525 is used to go out; the application must be configured to connect to localhost on port 2525 (instead of mail.foo.com on port 25)

`ssh -L 2525:mail.foo.com:25 user@login.foo.com`

Establish a SSH encrypted tunnel from localhost to remote host login.foo.com.
Remote host login.foo.com will then forward, unencrypted, all data received over the tunnel on port 2525 to remote host mail.foo.com on port 25

SSH reverse forwarding (aka SSH reverse tunneling)

`ssh -R 2222:localhost:22 user@login.foo.com`

Establish a SSH encrypted reverse tunnel from remote host login.foo.com back to localhost, redirecting traffic sent to port 2222 of remote host login.foo.com back towards local port 22.
Useful if the local firewall blocks incoming connections so remote hosts cannot connect back to local machine. In this case, port 2222 of login.foo.com is opened for listening and connecting back to localhost on port 22; remote host login.foo.com is then able to connect to the local machine on port 2222 (redirected to local port 22)

SSH as a SOCKS proxy

`ssh -D 33333 user@login.foo.com`

The application supporting SOCKS must be configured to connect to localhost on port 33333. Data is tunneled from localhost to login.foo.com, then unencrypted to destination

X11 Forwarding

`ssh -X user@login.foo.com`

Enable the local display to execute locally a X application stored on a remote host login.foo.com

How to enable public key authentication

1. On remote host, set `PubkeyAuthentication yes` in `/etc/ssh/sshd_config`
2. On local machine, do `ssh-copy-id you@remotehost` (or copy your public key to the remote host by hand)

How to enable host-based authentication amongst a group of trusted hosts

1. On all hosts, set `HostbasedAuthentication yes` in `/etc/ssh/sshd_config`
2. On all hosts, create `/etc/ssh/shosts.equiv` and enter in this file all trusted hostnames
3. Connect via SSH manually from your machine on each host so that all hosts' public keys go into `~/.ssh/known_hosts`
4. Copy `~/.ssh/known_hosts` from your machine to `/etc/ssh/ssh_known_hosts` on all hosts

How to enable SSH Agent

1. Type `eval `ssh-agent``
2. Type `ssh-add` to add the private key to cache, and enter the key's passphrase

How to enable X11 Forwarding

1. On remote host 10.2.2.2, set `X11Forwarding yes` in `/etc/ssh/sshd_config`, and make sure that `xauth` is installed
2. On local host 10.1.1.1, type `ssh -X 10.2.2.2`, then run on remote host the graphical application e.g. `xclock &`

It is also possible to enable X11 Forwarding via telnet (but this is insecure and obsolete, and therefore not recommended):
1. On remote host 10.2.2.2, type `export DISPLAY=10.1.1.1:0.0`
2. On local host 10.1.1.1, type `xhost +`
3. On local host 10.1.1.1, type `telnet 10.2.2.2`, then run on remote host the graphical application e.g. `xclock &`

/etc/ssh/sshd_config	SSH server daemon configuration file
/etc/ssh/ssh_config	SSH client global configuration file
/etc/ssh/ssh_host_key	Host's private key (should be mode 0600)
/etc/ssh/ssh_host_key.pub	Host's public key
/etc/ssh/shosts.equiv	Names of trusted hosts for host-based authentication
/etc/ssh/ssh_known_hosts	Database of host public keys that were previously accepted as legitimate
~/.ssh/	User's SSH directory (must be mode 0700)
~/.ssh/config	SSH client user configuration file
~/.ssh/id_rsa ~/.ssh/id_dsa	User's RSA or DSA private key, as generated by ssh-keygen
~/.ssh/id_rsa.pub ~/.ssh/id_dsa.pub	User's RSA or DSA public key, as generated by ssh-keygen
~/.ssh/known_hosts	Host public keys that were previously accepted as legitimate by the user
~/.ssh/authorized_keys ~/.ssh/authorized_keys2 (obsolete)	Trusted public keys; the corresponding private keys allow the user to authenticate on this host

/etc/ssh/sshd_config SSH server configuration file	
PermitRootLogin yes	Control superuser login via SSH. Possible values are: yes — Superuser can login no — Superuser cannot login without-password — Superuser cannot login with password forced-commands-only — Superuser can only run commands in SSH command line
AllowUsers jdoe ksmith DenyUsers jhacker	List of users that can/cannot login via SSH, or * for everybody
AllowGroups geeks DenyGroups *	List of groups whose members can/cannot login via SSH, or * for all groups
PasswordAuthentication yes	Permit authentication via login and password
PubKeyAuthentication yes	Permit authentication via public key
HostbasedAuthentication yes	Permit authentication based on trusted hosts
Protocol 1,2	Specify protocols supported by SSH. Value can be 1 or 2 or both
X11Forwarding yes	Allow X11 Forwarding

/etc/ssh/ssh_config and ~/.ssh/config SSH client configuration file	
Host *	List of hosts to which the following directives will apply, or * for all hosts
StrictHostKeyChecking yes	Ask before adding new host keys to the ~/.ssh/known_hosts file, and refuse to connect if the key for a known host has changed. This prevents MITM attacks
GSSAPIAuthentication yes	Support authentication using GSSAPI
ForwardX11Trusted yes	Allow remote X11 clients to fully access the original X11 display
IdentityFile ~/.ssh/id_rsa	User identity file for authentication. Default values are: ~/.ssh/identity for protocol version 1 ~/.ssh/id_rsa and ~/.ssh/id_dsa for protocol version 2

`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 (in PEM format) for the public key of a key pair
`openssl req -new -nodes -keyout private.key \ -out request.csr -newkey rsa:2048`	Create a 2048-bit RSA key pair and generate a Certificate Signing Request for it
`openssl req -x509 -newkey rsa:2048 -nodes \ -keyout private.key -out certif.crt -days validity`	Generate a self-signed root certificate (and create a new CA private key)
`openssl ca -config ca.conf -in request.csr \ -out certif.crt -days validity -verbose`	Generate a self-signed certificate
`openssl ca -config ca.conf -gencrl -revoke certif.crt \ -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
`cat cert.crt cert.key > cert.pem`	Create a PEM certificate from CRT and 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 (no output means that 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 pkey -text -in private.key -noout`	Examine a private key
`openssl pkey -in old.key -out new.key -cipher`	Change the passphrase of a private key
`openssl pkey -in old.key -out new.key`	Remove the passphrase from a private key
1. `openssl s_client -connect www.website.com:443 > tmpfile` 2. CTRL C 3. `openssl x509 -in tmpfile -text`	Retrieve and inspect a SSL certificate from a website
`openssl list-message-digest-commands`	List all available hash functions
`openssl list-cipher-commands`	List all available ciphers

`CA.pl -newca`	Create a Certification Authority hierarchy
`CA.pl -newreq`	Generate a Certificate Signing Request
`CA.pl -signreq`	Sign a Certificate Signing Request
`CA.pl -pkcs12 "`*`Certificate name`*`"`	Generate a PKCS#12 certificate from a Certificate Signing Request
`CA.pl -newcert`	Generate a self-signed certificate
`CA.pl -newreq-nodes`	Generate a Certificate Signing Request, with unencrypted private key (this is necessary for use in servers, because the private key is accessed in non-interactive mode i.e. without passphrase typing)
`CA.pl -verify`	Verify a certificate against the Certification Authority certificate for "demoCA"

`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`	Sign a file (with your private key) and encrypt it to Alice (i.e. with Alice's public key)
`gpg -d file.txt.gpg`	Decrypt a file (with your own public key)

`md5sum`
`sha1sum`
`sha224sum`
`sha256sum`
`sha384sum`
`sha512sum`
	Print a digest of a file generated by the relevant hashing algorithm

`openvpn --genkey --secret keyfile`

Generate a shared secret keyfile for OpenVPN authentication.
The keyfile must be copied on both server and client

`openvpn server.conf`

Start the VPN on the server side. The encrypted VPN tunnel uses UDP port 1194

`openvpn client.conf`

Start the VPN on the client side

`/etc/openvpn/server.conf`

Server-side configuration file:

```
dev tun
ifconfig server_IP client_IP
keepalive 10 60
ping-timer-rem
persist-tun
persist-key
secret keyfile
```

`/etc/openvpn/client.conf`

Client-side configuration file:

```
remote server_public_IP
dev tun
ifconfig client_IP server_IP
keepalive 10 60
ping-timer-rem
persist-tun
persist-key
secret keyfile
```

Key	Alternate key	Function
CTRL F	→	Move cursor forward one char
CTRL B	←	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 screen buffer
SHIFT PAGE DOWN		Scroll down the screen buffer
CTRL L		Clear screen (same as `clear`)
CTRL P	↑	Previous command in history
CTRL N	↓	Next command in history
CTRL R		Reverse history search
TAB		Autocomplete commands, filenames, and directory names
ALT /		Autocomplete filenames and directory names only
CTRL ALT E		Expand the Bash alias currently entered on the command line
CTRL J	RETURN	Line feed
CTRL M		Carriage return
CTRL S		Pause transfer to terminal Forward history search (if XON/XOFF flow control is disabled)
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 (if it's a shell, same as `logout`)
CTRL ALT DEL		Send a SIGINT to reboot the machine (same as `shutdown -r now`); specified in `/etc/inittab` and `/etc/init/control-alt-delete`
CTRL ALT F1 ... F6		Switch between text consoles (same as `chvt n`)

Key	Alternate key	Function
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		Switch between X Window tasks
CTRL ALT →	CTRL ALT ↓	Switch to next workspace
CTRL ALT ←	CTRL ALT ↑	Switch to previous workspace
CTRL ALT BACKSPACE		Reboot the X Window server
ALT TAB		Switch between windows in the current workspace in GNOME
SUPER		Show activities overview in GNOME
SUPER L		Lock screen in GNOME
SUPER M		Show tray messages in GNOME
ALT F2		Run command in GNOME

The Hardware Abstraction Layer (HAL) manages device files and provides plug-and-play facilities. The HAL daemon `hald` maintains a persistent database of devices.
udev is the device manager for the Linux kernel. It dynamically generates the device nodes in `/dev/` for devices present on the system; it also provides persistent naming for storage devices in `/dev/disk` .
When a device is added, removed, or changes state, the kernel sends an uevent received by the `udevd` daemon which will pass the uevent through a set of rules stored in `/etc/udev/rules.d/*.rules` and `/lib/udev/rules.d/*.rules` .

`udevadm monitor` `udevmonitor`	Show all kernel uevents and udev messages
`udevadm info --attribute-walk --name=/dev/sda`	Print all attributes of device `/dev/sda` in udev rules key format
`cat /sys/block/sda/size`	Print the size attribute of disk `sda` in 512-byte blocks. This information is retrieved from sysfs
`udevadm test /dev/sdb`	Simulate a udev event run for the device and print debug output
`gnome-device-manager`	Browser for the HAL device manager

`/etc/udev/rules.d/*.rules` and `/lib/udev/rules.d/*.rules` udev rules

`KERNEL=="hda", NAME="mydisk"`	Match a device which was named by the kernel as `hda`; name the device node as mydisk. The device node will be therefore `/dev/mydisk`
`KERNEL=="hdb", DRIVER=="ide-disk", SYMLINK+="mydisk myhd"`	Match a device with kernel name and driver as specified; name the device node with the default name and create two symbolic links `/dev/mydisk` and `/dev/myhd` pointing to `/dev/hdb`
`KERNEL=="fd[0-9]*", NAME="floppy/%n", SYMLINK+="%k"`	Match all floppy disk drives (i.e. `fd`*n*); place device node in `/dev/floppy/`*n* and create a symlink `/dev/fd`*n* to it
`SUBSYSTEM=="block", ATTR{size}=="41943040", SYMLINK+="mydisk"`	Match a block device with a size attribute of 41943040; create a symlink `/dev/mydisk`
`KERNEL=="fd[0-9]*", OWNER="jdoe"`	Match all floppy disk drives; give ownership of the device file to user jdoe
`KERNEL=="sda", PROGRAM="/bin/mydevicenamer %k", SYMLINK+="%c"`	Match a device named by the kernel as `sda`; to name the device, use the defined program which takes on stdin the kernel name and output on stdout e.g. *name1 name2*. Create symlinks `/dev/`*name1* and `/dev/`*name2* pointing to `/dev/sda`
`KERNEL=="sda", ACTION=="add", RUN+="/bin/myprogram"`	Match a device named by the kernel as `sda`; run the defined program when the device is connected
`KERNEL=="sda", ACTION=="remove", RUN+="/bin/myprogram"`	Match a device named by the kernel as `sda`; run the defined program when the device is disconnected

`%n` = kernel number (e.g. = `3` for `fd3`)
`%k` = kernel name (e.g. = `fd3` for `fd3`)
`%c` = device name as output from program

A kernel version number has the form *major.minor.patchlevel*.
Kernel images are usually gzip-compressed and can be of two types: zImage (max 520 Kb) and bzImage (no size limit).
Kernel modules can be loaded dynamically into the kernel to provide additional functionalities on demand, instead of being included when the kernel is compiled; this reduces memory footprint.
`kerneld` (daemon) and `kmod` (kernel thread) facilitate the dynamic loading of kernel modules.

`/lib/modules/X.Y.Z/*.ko`	Kernel modules for kernel version *X.Y.Z*
`/lib/modules/X.Y.Z/modules.dep`	Modules dependencies. This file needs to be recreated (via the command `depmod -a`) after a reboot or a change in module dependencies
`/etc/modules.conf` `/etc/conf.modules` (deprecated)	Modules configuration file
`/usr/src/linux/`	Contains the kernel source code to be compiled
`/usr/src/linux/.config`	Kernel configuration file

`freeramdisk`	Free the memory used for the `initrd` image. This command must be run directly after unmounting `/initrd`
`mkinitrd initrd_image kernel_version`	Create a `initrd` image file (Red Hat)
`mkinitramfs`	Create a `initrd` image file according to the configuration file `/etc/initramfs-tools/initramfs.conf` (Debian)
`dracut`	Create initial ramdisk images for preloading modules
`dbus-monitor`	Monitor messages going through a D-Bus message bus
`dbus-monitor --session`	Monitor session messages (default)
`dbus-monitor --system`	Monitor system messages

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

1. `LD_LIBRARY_PATH` Environment variable specifying the list of dirs where libraries should be searched for first
2. `/etc/ld.so.cache` Cache file
3. `/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

`lspci`	List PCI devices
`lspci -d 8086:`	List all Intel hardware present. PCI IDs are stored in: `/usr/share/misc/pci.ids` (Debian) `/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` (Debian) `/usr/share/hwdata/usb.ids` (Red Hat)
`lsdev`	List information about the system's hardware
`lshw`	List system hardware
`lscpu`	List information about the CPU architecture
`uname -s`	Print the kernel name
`uname -n`	Print the network node hostname
`uname -r`	Print the kernel release number *X.Y.Z*
`uname -v`	Print the kernel version number
`uname -m`	Print the machine hardware name
`uname -p`	Print the processor type
`uname -i`	Print the hardware platform
`uname -o`	Print the operating system
`uname -a`	Print all the above information, in that order
`dmesg`	Print the messages of the kernel ring buffer
`dmesg -n 1`	Set the logging level to 1 (= only panic messages)
`journalctl`	Query the systemd journal
`journalctl -n`	Query the systemd journal, showing only the 10 most recent lines
`journalctl --since "1 hour ago"`	Query the systemd journal for events happened in the last hour
`journalctl -x`	Query the systemd journal, adding explanations from the message catalog
`journalctl -f`	Query the systemd journal in real time, scrolling as new entries are added
`journalctl -u sshd.service`	Query the systemd journal for a specific unit
`evtest`	Monitor and query input device events in `/dev/input/event`*n*

Kernel compile		
Download	Download kernel source code `linux-X.Y.Z.tar.bz2` from `http://www.kernel.org` to the base of the kernel source tree `/usr/src/linux`	
Clean	`make clean`	Delete most generated files
	`make mrproper`	Delete all generated files and kernel configuration
	`make distclean`	Delete temporary files, patch leftover files, and similar
Configure	`make config`	Terminal-based (options must be set in sequence)
	`make menuconfig`	ncurses UI
	`make xconfig` `make gconfig`	GUI
	`make oldconfig`	Create a new config file, based on the options in the old config file and in the source code
	Components (e.g. device drivers) can be either: - not compiled - compiled into the kernel binary, for support of devices always used on the system or necessary for the system to boot - compiled as a kernel module, for optional devices The configuration command creates a `/usr/src/linux/.config` config file containing instructions for the compile	
Build	`make bzImage`	Compile the kernel
	`make modules`	Compile the kernel modules
	`make all`	Compile kernel and kernel modules
	`make -j2 all` will speed up compilation by allocating 2 simultaneous compile jobs	
Modules install	`make modules_install`	Install the previously built modules present in `/lib/modules/X.Y.Z`
Kernel install	`make install`	Install the kernel automatically
	To install the kernel by hand: Copy the new compiled kernel and other files into the boot partition `cp /usr/src/linux/arch/boot/bzImage /boot/vmlinuz-X.Y.Z` (kernel) `cp /usr/src/linux/arch/boot/System.map-X.Y.Z /boot` `cp /usr/src/linux/arch/boot/config-X.Y.Z /boot` (config options used for this compile) Create an entry in GRUB to boot on the new kernel	
Package	Optionally, the kernel can be packaged for install on other machines	
	`make rpm-pkg`	Build source and binary RPM packages
	`make binrpm-pkg`	Build binary RPM package
	`make deb-pkg`	Builds binary DEB package

Kernel patching		
Download	Download and decompress the patch to `/usr/src`	
Patch	`patch -p1 < file.patch`	Apply the patch
	`patch -Rp1 < file.patch`	To remove a patch, you can either apply the patch again or use this command (reverse patch)
Build	Build the patched kernel as explained previously	
Install	Install the patched kernel as explained previously	

Kernel modules allow the kernel to access functions (symbols) for kernel services e.g. hardware drivers, network stack, or filesystem abstraction.

`lsmod`	List the modules that are currently loaded into the kernel
`insmod` *module*	Insert a module into the kernel. If the module requires another module or if it does not detect compatible hardware, insertion will fail
`rmmod` *module*	Remove a module from the kernel. If the module is in use by another module, it is necessary to remove the latter first
`modinfo` *module*	Display the list of parameters accepted by the module
`depmod -a`	Probe all modules in the kernel modules directory and generate the file that lists their dependencies

It is recommended to use `modprobe` instead of `insmod`/`rmmod`, because it automatically handles prerequisites when inserting modules, is more specific about errors, and accepts just the module name instead of requiring the full pathname.

`modprobe` *module option=value*	Insert a module into the running kernel, with the specified parameters. Prerequisite modules will be inserted automatically
`modprobe -a`	Insert all modules
`modprobe -t` *directory*	Attempt to load all modules contained in the directory until a module succeeds. This action probes the hardware by successive module-insertion attempts for a single type of hardware, e.g. a network adapter
`modprobe -r` *module*	Remove a module
`modprobe -c` *module*	Display module configuration
`modprobe -l`	List loaded modules

Configuration of device drivers	
Device drivers support the kernel with instructions on how to use that device.	
Device driver compiled into the kernel	Configure the device driver by passing a kernel parameter in the GRUB menu: `kernel /vmlinuz ro root=/dev/vg0/root vga=0x33c`
Device driver provided as a kernel module	Edit module configuration in `/etc/modprobe.conf` or `/etc/modprobe.d/` (Red Hat): `alias eth0 3c59x` Specify that eth0 uses the `3c59x.ko` driver module `options 3c509 irq=10,11` Assign IRQ 10 and 11 to 3c509 devices

File	Information stored (viewable via `cat`)	Equivalent command
`/proc/bus`	Buses (e.g. PCI, USB, PC Card)	
`/proc/cpuinfo`	CPUs information	
`/proc/devices`	Drivers currently loaded	
`/proc/dma`	DMA channels in use	
`/proc/filesystems`	Filesystems supported by the system	
`/proc/interrupts`	Current IRQs (Interrupt Requests)	`procinfo`
`/proc/ioports`	I/O addresses in use	
`/proc/loadavg`	System load averages	`uptime`
`/proc/mdstat`	Information about RAID arrays and devices	
`/proc/meminfo`	Total and free memory	`free`
`/proc/modules`	Kernel modules currently loaded	`lsmod`
`/proc/mounts`	Mounted partitions	`mount`
`/proc/`*n*`/`	Information about process with PID *n*	`ps` *n*
`/proc/`*n*`/cmdline`	Command by which the process was launched	
`/proc/`*n*`/cwd`	Symlink to process' working directory	
`/proc/`*n*`/environ`	Values of environment variables of process	
`/proc/`*n*`/exe`	Symlink to process' executable	
`/proc/`*n*`/fd`	Files currently opened by the process	`lsof -p` *n*
`/proc/`*n*`/root`	Symlink to process' filesystem root	
`/proc/`*n*`/status`	Status of process	
`/proc/net/dev`	Network interface statistics	
`/proc/partitions`	Drive partition information	
`/proc/swaps`	Size of total and used swap areas	`swapon -s`
`/proc/sys/`	sysfs: exposes tunable kernel parameters	
`/proc/sys/kernel/`	Kernel information and parameters	
`/proc/sys/net/`	Network information and parameters	
`/proc/uptime`	Time elapsed since boot	`uptime`
`/proc/version`	Linux version	`uname -a`

`/proc` is a pseudo filesystem that gives access to process data held in the kernel.

`/proc/sys` is the only writable branch of `/proc` and can be used to tune kernel parameters on-the-fly.
All changes are lost after system shutdown.

```
sysctl fs.file-max
cat /proc/sys/fs/file-max
```
Get the maximum allowed number of open files

```
sysctl -w "fs.file-max=100000"
echo "100000" > /proc/sys/fs/file-max
```
Set the maximum allowed number of open files to 100000

```
sysctl -a
```
List all available kernel tuning options

```
sysctl -p
```
Apply all tuning settings listed in `/etc/sysctl.conf` .
This command is usually run at boot by the system initialization script, permitting to make permanent changes to kernel parameters

If the kernel has been booted in emergency mode and `init` has not been run, some initial configuration is necessary e.g.

```
mount /proc
mount -o remount,rw /
mount -a
```

If mounting the filesystems fails:

```
mknod /dev/sda
mknod /dev/sda1
fdisk -l /dev/sda
fsck -y /dev/sda1
mount -t ext3 /dev/sda1 /mnt/sysimage
chroot /mnt/sysimage
```

To install a package using an alternative root directory (useful if the system has been booted from a removable media):

```
rpm -U --root /mnt/sysimage package.rpm
```

To install GRUB on the specified directory (which must contain `/boot/grub/`):

```
grub-install --root-directory=/mnt/sysimage /dev/sda
```

An alternative metod is to `chroot /mnt/sysimage` before installing GRUB via `grub-install /dev/sda` .

Run `sync` and unmount all filesystems before exiting the shell, to ensure that all changes have been written on disk.

How to reset the root password (RHEL 7)

1. Power up the system and, on the GRUB 2 boot screen, press E to edit the current entry.
2. Edit the line with `linux16`, removing the `rhgb` and `quiet` parameters and adding `rd.break` at the end.
3. Press CTRL X ; the system will boot on the initramfs `switch_root` prompt.
4. Remount the filesystem as writable: `mount -o remount,rw /sysroot`
5. Change the filesystem root: `chroot /sysroot`
6. Modify the root password: `passwd root`
7. Force SELinux to relabel context on next boot: `touch /.autorelabel`
8. Remount the filesystem as readonly: `mount -o remount,ro /sysroot`
9. Exit the chroot environment: `exit`
10. Resume system boot: `exit`

DNS implementations	
BIND	Berkeley Internet Name Domain system, is the standard DNS server for UNIX
dnsmasq	Lightweight DNS, DHCP and TFTP server for a small network
djbdns	Security-hardened DNS server that also includes DNS debugging tools
PowerDNS	Alternative open-source DNS server

`named` BIND Name Daemon

`ndc` Name Daemon Controller for BIND 8

`rndc` Remote Name Daemon Controller for BIND 9, uses a shared key to communicate securely with `named`

`dnswalk example.org.` DNS debugger

`rndc reconfig` Reload BIND configuration and new zones

`rndc reload example.org` Reload the zone example.org

`rndc freeze example.org` Suspend updates for the zone example.org

`rndc thaw example.org` Resume updates for the zone example.org

`rndc tsig-list` List all currently active TSIG keys

DNSSEC was designed to secure the DNS tree and hence prevent cache poisoning.
The TSIG (Transaction SIGnature) standard, that authenticates communications between two trusted systems, is used to sign zone transfers and DDNS (Dynamic DNS) updates.

`dnssec-keygen -a dsa -b 1024 \ -n HOST dns1.example.org`

Generate a TSIG key with DNSSEC algorithm *nnn* and key fingerprint *fffff*.
This will create two key files
`Kdns1.example.org.+nnn+fffff.key`
`Kdns1.example.org.+nnn+fffff.private`
which contain a key number that has to be inserted both in `/etc/named.conf` and `/etc/rndc.conf`

`rndc-confgen -a`

Generate a `/etc/rndc.key` key file:

```
key "rndc-key" {
   algorithm hmac-md5;
   secret "vyZqL3tPHsqnA57e4LT0Ek==";
};
options {
   default-key "rndc-key";
   default-server 127.0.0.1;
   default-port 953;
};
```

This file is automatically read both by `named` and `rndc`

`dnssec-signzone example.org` Sign the zone example.org

`named -u named -g named` Run BIND as user/group named (both must be created if needed) instead of root

`named -t /var/cache/bind` Run BIND in a chroot jail `/var/cache/bind`
(actually is the `chroot` command that starts the `named` server)

/etc/named.conf DNS server configuration file

```
controls {
   inet 127.0.0.1 allow {localhost;} keys {rndckey;};
};
key "rndc-key" {                                  // TSIG key
   algorithm dsa;
   secret "HYZur46fftdUQ43BJKI093t4t78lkp";
};

acl "mynetwork" {10.7.0.0/24;};                   // Alias definition
                                                  // Built-in ACLs: any, none, localhost, localnets

options {
   directory "/var/named";                        // Working directory
   version "0.0";                                 // Hide version number by replacing it with 0.0
   listen-on port 53 {10.7.0.1; 127.0.0.1;};      // Port and own IP addresses to listen on
   blackhole {172.17.17.0/24;};                   // IPs whose packets are to be ignored
   allow-query {mynetwork;};                      // IPs allowed to do iterative queries
   allow-query-on {any;};                         // Local IPs that can accept iterative queries
   allow-query-cache {any;};                      // IPs that can get an answer from cache
   allow-recursion {mynetwork;};      // IPs to accept recursive queries from (typically
                                      // own network's IPs).  The DNS server does the full
                                      // resolution process on behalf of these client IPs,
                                      // and returns a referral for the other IPs
   allow-recursion-on {mynetwork;};   // Local IPs that can accept recursive queries
   allow-transfer {10.7.0.254;};      // Zone transfer is restricted to these IPs (slaves);
                                      // on slave servers, this option should be disabled
   allow-update {any;};               // IPs to accept DDNS updates from
   recursive-clients 1000;            // Max number of simultaneous recursive lookups
   dnssec-enable yes;                 // Enable DNSSEC
   dialup no;                         // Not a dialup connection: external zone maintenance
                                      // (e.g. sending heartbeat packets, external zone transfers)
                                      // is then permitted
   forward first;                                 // Site-wide cache: bypass the normal resolution
   forwarders {10.7.0.252; 10.7.0.253;};          // method by querying first these central DNS
                                                  // servers if they are available
};

// Define the root name servers
zone "." {
   type hint;
   file "root.cache";
}

// Configure system to act as a master server for the example.org domain
zone "example.org" IN {
   type master;
   file "master/example.org.zone";     // Zone file for the example.org domain
};
zone "240.123.224.in-addr.arpa" IN {   // Configure reverse lookup zone (for 224.123.240.0/24)
   type master;
   file "slave/example.org.revzone";
};

// Configure system to act as a slave server for the example2.org domain
zone "example2.org" IN {
   type slave;
   file "slave/example2.org.zone";     // Slave: do not edit this zone file!
   masters {10.7.0.254;};
};
zone "0.7.10.in-addr.arpa" IN {        // Configure reverse lookup zone (for 10.7.0.0/24)
   type slave;
   file "slave/10.7.0.revzone";
   masters {10.7.0.254;};
};
```

/var/named/master/example.org.zone **DNS zone file for the example.org zone**

```
$TTL 86400      ; TTL (1 day)
$ORIGIN example.org.
example.org IN SOA dns1.example.org. help.example.org. (   ; Master DNS server is dns1.example.org
   2014052300   ; serial                                    ; For problems contact help@example.org
   28800        ; refresh (8 hours)
   7200         ; retry (2 hours)
   604800       ; expire (1 week)
   600 )        ; negative TTL (10 mins)

        IN NS     dns1.example.org.
        IN NS     dns2.example.org.
        IN MX     10 mail1.example.org.
        IN MX     20 mail2.example.org.

dns1    IN A      224.123.240.3
dns2    IN A      224.123.240.4
mail1   IN A      224.123.240.73
mail2   IN A      224.123.240.77
foo     IN A      224.123.240.12
bar     IN A      224.123.240.13
www     IN A      224.123.240.19
baz     IN CNAME  bar

subdomain   IN NS   ns1.subdomain.example.org.   ; Glue records
            IN NS   ns2.subdomain.example.org.
ns1.subdomain.example.org.   IN A   224.123.240.201
ns2.subdomain.example.org.   IN A   224.123.240.202
```

/var/named/master/example.org.revzone **DNS reverse zone file for the example.org zone**

```
$TTL 86400      ; TTL (1 day)
example.org IN SOA dns1.example.org. help.example.org. (
   2014052300   ; serial
   28800        ; refresh (8 hours)
   7200         ; retry (2 hours)
   604800       ; expire (1 week)
   600 )        ; negative TTL (10 mins)

12.240.123.224.in-addr.arpa   IN PTR   foo
13.240.123.224.in-addr.arpa   IN PTR   bar
19.240.123.224.in-addr.arpa   IN PTR   www
```

Resource Records		
	$TTL	How long to cache a positive response
	$ORIGIN	Suffix appended to all names not ending with a dot. Useful when defining multiple subdomains inside the same zone
SOA	Start Of Authority for the example.org zone	
	serial	Serial number. Must be increased after each edit of the zone file
	refresh	How frequently a slave server refreshes its copy of zone data from the master
	retry	How frequently a slave server retries connecting to the master
	expire	How long a slave server relies on its copy of zone data. After this time period expires, the slave server is not authoritative anymore for the zone unless it can contact a master
	negative TTL	How long to cache a non-existent answer
A	Address: maps names to IP addresses. Used for DNS lookups.	
PTR	Pointer: maps IP addresses to names. Used for reverse DNS lookups. Each A record must have a matching PTR record	
CNAME	Canonical Name: specifies an alias for a host with an A record (even in a different zone). Discouraged as it causes multiple lookups; it is better to use multiple A records instead	
NS	Name Service: specifies the authoritative name servers for the zone	
MX	Mailserver: specifies address and priority of the servers able to handle mail for the zone	
Glue Records are not really part of the zone; they delegate authority for other zones, usually subdomains		

`apachectl`	(Red Hat)	Manage the Apache webserver
`httpd`	(Red Hat)	
`apache2ctl`	(Debian)	

`apachectl start`	Start the Apache webserver daemon
`apachectl status`	Display a brief status report
`apachectl fullstatus`	Display a detailed status report
`apachectl graceful`	Gracefully restart Apache; currently open connections are not aborted
`apachectl graceful-stop`	Gracefully stop Apache; currently open connections are not aborted
`apachectl configtest` `apachectl -t`	Test the configuration file, reporting any syntax error
`apachectl -M`	List all loaded and shared modules

`/var/www/html`	Default document root directory
`$HOME/public_html`	Default document root directory for users' websites

Web content must be readable by the user/group the Apache process runs as. For security reasons, it should be owned and writable by the superuser or the webmaster user/group, not the Apache user/group.

`/etc/httpd/conf/httpd.conf`	(Red Hat)	Apache configuration file
`/etc/apache2/httpd.conf`	(Debian and SUSE)	

The Apache webserver contains a number of MPMs (Multi-Processing Modules) which can operate following two methods:

prefork MPM	A number of child processes is spawned in advance, with each child serving one connection. Highly reliable due to Linux memory protection that isolates each child process
worker MPM	Multiple child processes spawn multiple threads, with each thread serving one connection. More scalable but prone to deadlocks if third-party non-threadsafe modules are loaded

HTTPS

A secure web server (one which uses HTTP over SSL i.e. HTTPS) hands over its public key to the client when the latter connects to it via port 443. The server's public key is signed by a CA (Certification Authority), whose validity is ensured by the root certificates stored into the client's browser.

The `openssl` command and its user-friendly `CA.pl` script are the tools of the OpenSSL crypto library that can be used to accomplish all public key crypto operations e.g. generate key pairs, Certificate Signing Requests, self-signed certificates.

Virtual hosting with HTTPS requires assigning an unique IP address for each virtual host; this because the SSL handshake (during which the server sends its certificate to the client's browser) takes place before the client sends the `Host:` header (which tells to which virtual host the client wants to talk).
A workaround for this is SNI (Server Name Indication) that makes the browser send the hostname in the first message of the SSL handshake. Another workaround is to have all multiple name-based virtual hosts use the same SSL certificate with a wildcard domain e.g. *.example.org.

`/etc/ssl/openssl.cnf`		Configuration file for OpenSSL
`/etc/httpd/conf.d/ssl.conf`	(Red Hat)	Configuration file for the mod_ssl module

httpd.conf Apache configuration	
Server configuration directives	
`ServerName www.mysite.org:80`	Name and port (if omitted, uses default HTTP port 80) of server
`ServerRoot /etc/httpd`	Root directory for config and log files
`ServerAdmin webmaster@mysite.org`	Contact address that the server includes in any HTTP error messages to the client. Can be an email address or an URL
`StartServers 5`	Number of servers to start initially
`MinSpareServers 5` `MaxSpareServers 10`	Minimum and maximum number of idle child server processes
`MaxClients 256` (before v2.3.13) `MaxRequestWorkers 256` (v2.3.13 and later)	Max number of simultaneous requests that will be served; clients above this limit will get a HTTP error 503 - Service Unavailable. Prefork MPM: max number of child processes launched to serve requests. Worker MPM: max total number of threads available to serve requests
`ServerLimit 256`	Prefork MPM: max configured value for `MaxRequestWorkers`. Worker MPM: in conjunction with `ThreadLimit`, max configured value for `MaxRequestWorkers`
`ThreadsPerChild 25`	Worker MPM: number of threads created by each child process
`ThreadLimit 64`	Worker MPM: max configured value for `ThreadsPerChild`
`LoadModule mime_module modules/mod_mime.so`	Load the module `mime_module` by linking in the object file or library `modules/mod_mime.so`
`Listen 10.17.1.1:80` `Listen 10.17.1.5:8080`	Make the server accept connections on the specified IP addresses (optional) and ports
`User nobody` `Group nobody`	User and group the Apache process runs as. For security reasons, this should not be `root`
Main configuration directives	
`DocumentRoot /var/www/html`	Directory in filesystem that maps to the root of the website
`Alias /image /mydir/pub/image`	Map the URL `http://www.mysite.org/image/` to the directory `/mydir/pub/image` in the filesystem. This allows Apache to serve content placed outside of the document root
`TypesConfig conf/mime.types`	Media types file. The path is relative to `ServerRoot`
`AddType image/jpeg jpeg jpg jpe`	Map the specified filename extensions onto the specified content type. These entries adds to or override the entries from the media types file `conf/mime.types`
`Redirect permanent /foo /bar`	Redirect to a URL on the same host. Status can be: `permanent` return a HTTP status 301 - Moved Permanently `temp` return a HTTP status 302 - Found (i.e. the resource was temporarily moved) `seeother` return a HTTP status 303 - See Other `gone` return a HTTP status 410 - Gone If status is omitted, default status `temp` is used
`Redirect /foo http://www.example.com/foo`	Redirect to a URL on a different host
`AccessFileName .htaccess`	Name of the distributed configuration file, which contains directives that apply to the document directory it is in and to all its subtrees

`<Directory "/var/www/html/foobar">`
`  AllowOverride AuthConfig Limit`
`</Directory>`
	Specify which global directives a `.htaccess` file can override:
	`AuthConfig` Authorization directives for directory protection
	`FileInfo` Document type and metadata
	`Indexes` Directory indexing
	`Limit` Host access control
	`Options` Specific directory features
	`All` All directives
	`None` No directive

`httpd.conf` **Apache configuration**	
Virtual hosts directives	
`NameVirtualHost *`	Specify which IP address will serve virtual hosting. The argument can be an IP address, an *address:port* pair, or `*` for all IP addresses of the server. The argument will be repeated in the relevant `<VirtualHost>` directive

`<VirtualHost *:80>`
`  ServerName www.mysite.org`
`  ServerAlias mysite.org *.mysite.org`
`  DocumentRoot /var/www/vhosts/mysite`
`</VirtualHost>`
	The first listed virtual host is also the default virtual host.
	It inherits those main settings that does not override.
	This virtual host answers to `http://www.mysite.org` , and also redirects there all HTTP requests on the domain mysite.org

`<VirtualHost *:80>`
`  ServerAdmin webmaster@www.mysite2.org`
`  ServerName www.mysite2.org`
`  DocumentRoot /var/www/vhosts/mysite2`
`  ErrorLog /var/www/logs/mysite2`
`</VirtualHost>`
	Name-based virtual host `http://www.mysite2.org` .
	Multiple name-based virtual hosts can share the same IP address; DNS must be configured accordingly to map each name to the correct IP address. Cannot be used with HTTPS

`<VirtualHost *:8080>`
`  ServerName www.mysite3.org`
`  DocumentRoot /var/www/vhosts/mysite3`
`</VirtualHost>`
	Port-based virtual host answering to connections on port 8080.
	In this case the config file must contain a `Listen 8080` directive

`<VirtualHost 10.17.1.5:80>`
`  ServerName www.mysite4.org`
`  DocumentRoot /var/www/vhosts/mysite4`
`</VirtualHost>`
	IP-based virtual host answering to `http://10.17.1.5`

Logging directives	
`LogFormat "%h %l %u %t \"%r\" %>s %b"`	Specify the format of a log
`LogFormat "%h %l %u %t \"%r\" %>s %b" common`	Specify a nickname (here, "common") for a log format. This one is the CLF (Common Log Format) defined as such: `%h` IP address of the client host `%l` Identity of client as determined by `identd` `%u` User ID of client making the request `%t` Timestamp the server completed the request `%r` Request as done by the user `%s` Status code sent by the server to the client `%b` Size of the object returned, in bytes
`CustomLog /var/log/httpd/access_log common`	Set up a log filename, with the format or (as in this case) the nickname specified
`TransferLog /var/log/httpd/access_log`	Set up a log filename, with format determined by the most recent `LogFormat` directive which did not define a nickname
`TransferLog "|rotatelogs access_log 86400"`	Organize log rotation every 24 hours
`HostnameLookups Off`	Disable DNS hostname lookup to save network traffic. Hostnames can be resolved later by processing the log file: `logresolve <access_log >accessdns_log`

httpd.conf Apache configuration	
Limited scope directives	

`<Directory "/var/www/html/foobar">`
`  [list of directives]`
`</Directory>`
	Limit the scope of the specified directives to the directory `/var/www/html/foobar` and its subdirectories

`<Location /foobar>`
`  [list of directives]`
`</Location>`
	Limit the scope of the specified directive to the URL `http://www.mysite.org/foobar/` and its subdirectories

Directory protection directives	
`<Directory "/var/www/html/protected">`	
`AuthName "Protected zone"`	Name of the realm. The client will be shown the realm name and prompted to enter a user and password
`AuthType Basic`	Type of user authentication: `Basic`, `Digest`, `Form`, or `None`
`AuthUserFile "/var/www/.htpasswd"`	User database file. Each line has the format *user*`:`*encryptedpassword* To add a user to the database file: `htpasswd /var/www/.htpasswd` *user* (will prompt for password)
`AuthGroupFile "/var/www/.htgroup"`	Group database file. Each line specifies a group followed by the usernames of all its members: *group*`: user1 user2 user3`
`Require valid-user`	Control who can access the protected resource. `valid-user` any user in the user database file `user` *user* only the specified user `group` *group* only the members of the specified group
`Allow from 10.13.13.0/24`	Control which host can access the protected resource
`Satisfy Any`	Set the access policy concerning user and host control. `All` both `Require` and `Allow` criteria must be satisfied `Any` any of `Require` or `Allow` criteria must be satisfied
`Order Allow,Deny`	Control the evaluation order of `Allow` and `Deny` directives. `Allow,Deny` First, all `Allow` directives are evaluated; at least one must match, or the request is rejected. Next, all `Deny` directives are evaluated; if any matches, the request is rejected. Last, any requests which do not match an `Allow` or a `Deny` directive are denied `Deny,Allow` First, all `Deny` directives are evaluated; if any match, the request is denied unless it also matches an `Allow` directive. Any requests which do not match any `Allow` or `Deny` directives are permitted
`</Directory>`	

httpd.conf Apache configuration	
SSL/TLS directives (mod_ssl module)	
`SSLCertificateFile \` `/etc/httpd/conf/ssl.crt/server.crt`	SSL server certificate
`SSLCertificateKeyFile \` `/etc/httpd/conf/ssl.key/server.key`	SSL server private key (for security reasons, this file must be mode 600 and owned by root)
`SSLCACertificatePath \` `/usr/local/apache2/conf/ssl.crt/`	Directory containing the certificates of CAs. Files in this directory are PEM-encoded and accessed via symlinks to hash filenames
`SSLCACertificateFile \` `/usr/local/apache2/conf/ssl.crt/ca-bundle.crt`	Certificates of CAs. Certificates are PEM-encoded and concatenated in a single bundle file in order of preference
`SSLCertificateChainFile \` `/usr/local/apache2/conf/ssl.crt/ca.crt`	Certificate chain of the CAs. Certificates are PEM-encoded and concatenated from the issuing CA certificate of the server certificate to the root CA certificate. Optional
`SSLEngine on`	Enable the SSL/TLS Protocol Engine

`SSLProtocol +SSLv3 +TLSv1.2`	SSL protocol flavors that the client can use to connect to server. Possible values are:
	`SSLv2` (deprecated)
	`SSLv3`
	`TLSv1`
	`TLSv1.1`
	`TLSv1.2`
	`All` (all the above protocols)

`SSLCipherSuite \` `ALL:!aDH:RC4+RSA:+HIGH:+MEDIUM:+LOW:+SSLv2:+EXP`	Cipher suite available for the SSL handshake (key exchange algorithms, authentication algorithms, cipher/encryption algorithms, MAC digest algorithms)

`ServerTokens Full`	Server response header field to send back to client. Possible values are:
	`Prod` send `Server: Apache`
	`Major` send `Server: Apache/2`
	`Minor` send `Server: Apache/2.4`
	`Minimal` send `Server: Apache/2.4.2`
	`OS` send `Server: Apache/2.4.2 (Unix)`
	`Full` send `Server: Apache/2.4.2 (Unix) PHP/4.2.2 MyMod/1.2`
	If not specified, sends full header

`ServerSignature Off`	Trailing footer line on server-generated documents. Possible values are:
	`Off` no footer line (default)
	`On` server version number and `ServerName`
	`EMail` as above, plus a mailto link to `ServerAdmin`

`SSLVerifyClient none`	Certificate verification level for client authentication. Possible values are: `none` no client certificate is required `require` the client needs to present a valid certificate `optional` the client may present a valid certificate (this option is unused as it doesn't work on all browsers) `optional_no_ca` the client may present a valid certificate but it doesn't need to be successfully verifiable (this option is pretty much useless and is used only for SSL testing)
`TraceEnable on`	Enable TRACE requests

Tomcat is an open source Java Servlet Container implementing several Java EE specifications, and was originally part of the Jakarta Project. It is composed of:
- Catalina, the core component and servlet container implementation;
- Coyote, an HTTP connector component, providing a pure Java webserver environment to run Java code;
- Jasper, a JSP (Java Server Pages) engine, which parses JSP files and compiles them into Java servlets.

`/usr/share/tomcat7`	`$CATALINA_HOME`. This is the root of the Tomcat installation. Tomcat may also be configured for multiple instances by defining the variable `$CATALINA_BASE` for each instance. If a single instance of Tomcat is running, `$CATALINA_BASE` is the same as `$CATALINA_HOME`
`$CATALINA_BASE/conf/server.xml`	Tomcat main configuration file
`$CATALINA_BASE/conf/web.xml`	Options and values applied to all web applications running on a specific Tomcat instance. These can be overridden by the application-specific servlet configuration defined in `$CATALINA_BASE/webapps/`*`appname`*`/WEB-INF/web.xml`
`$CATALINA_BASE/conf/context.xml`	Context applied to all web applications running on a specific Tomcat instance
`$CATALINA_BASE/conf/tomcat-users.xml`	Users, passwords, and roles applied to a specific Tomcat instance
`$CATALINA_BASE/conf/catalina.policy`	Tomcat's core security policy for the Catalina class
`$CATALINA_BASE/conf/catalina.properties`	Java properties file for the Catalina class
`$CATALINA_BASE/conf/logging.properties`	Java properties file for Catalina's built-in logging functions

Samba is a free-software, cross-platform implementation of SMB/CIFS.
SMB (Server Message Block) is Microsoft's proprietary protocol for file and printer sharing, while CIFS (Common Internet File System) is the public version of SMB.
WINS (Windows Internet Name Service) is a name service used to translate NetBIOS names to IP addresses.

Commonly used ports in Samba		
TCP/UDP 137	netbios-ns	NetBIOS name service requests and responses
TCP/UDP 138	netbios-dgm	NetBIOS datagram services e.g. server announcements
TCP/UDP 139	netbios-ssn	NetBIOS session service e.g. file and printer sharing
TCP 445	microsoft-ds	Active Directory - registration and translation of NetBIOS names, network browsing
TCP 389		LDAP
TCP 901		SWAT service

The full list of used ports can be found via the command `grep -i netbios /etc/services`

`smbd` Server Message Block daemon. Provides SMB file and printer sharing, browser services, user authentication, and resource lock. An extra copy of this daemon runs for each client connected to the server

`nmbd` NetBIOS Name Service daemon. Handles NetBIOS name lookups, WINS requests, list browsing and elections. An extra copy of this daemon runs if Samba functions as a WINS server.
Another extra copy of this daemon runs if DNS is used to translate NetBIOS names

`/etc/smb/`
`/etc/samba/` (RHEL 7 onwards) — Samba directory

`/etc/samba/lmhosts` — Samba NetBIOS hosts file

`/etc/samba/netlogon` — User logon directory

`smbd -V`
`smbclient -V` — Show the version of the Samba server

`testparm` — Check the Samba configuration file and report any error

`smbpasswd jdoe` — Change the Samba password of user jdoe

`smbpasswd -a ksmith` — Create a new Samba user ksmith and set his password

`nmblookup` *`smbserver`* — Look up the NetBIOS name of a server and map it to an IP address

`nmblookup -U` *`winsserver`* `-R` *`WORKGROUP`*`#1B` — Query recursively a WINS server for the Domain Master Browser for the specified workgroup

`nmblookup -U` *`winsserver`* `-R` *`WORKGROUP`*`#1D` — Query recursively a WINS server for the Domain Controller for the specified workgroup

`net` — Tool for administration of Samba and remote CIFS servers

`net rpc shutdown -r -S` *`smbserver`* `-U root%`*`password`* — Reboot a CIFS server

`net rpc service list -S` *`smbserver`* — List available services on a CIFS server

`net status sessions` — Show active Samba sessions

`net status shares` — Show Samba shares

`net rpc info` — Show information about the domain

`net groupmap list` — Show group mappings between Samba and Windows

```
smbmount
mount.cifs
```
Mount a Samba share on a Linux filesystem, using the CIFS filesystem interface

```
smbmount //smbserver/share1 /mnt/shares/sh1 \
-o auto,credentials=/etc/smbcreds
```
Mount a Samba share checking access upon a credentials file `/etc/smbcreds` (which should be readable only by root):

```
username = jdoe
password = jd03s3cr3t
```

```
smbmount //smbserver/share1 /mnt/shares/sh1 \
-o username=jdoe
```
Mount a Samba share as user jdoe

```
smbstatus
```
Display current information about shares, clients connections, and locked files

```
smbclient //smbserver/share1
```
Access a Samba share on a server (with a FTP-like interface)

```
smbclient -L //smbserver -W WORKGROUP -U user
```
List the Samba resources available on a server, belonging to the specified workgroup and accessible to the specified user

```
cat msg.txt | smbclient -M client -U user
```
Show a message popup on the client machine (using the WinPopup protocol)

Samba mount options	
`credentials=`*file*	Mount the share as the user defined in the credentials *file*
`username=`*user*	Mount the share as *user*
`password=`*password*	Specify the mount user's *password*

/etc/samba/smb.conf Samba configuration	
`[global]`	Global server settings: defines parameters applicable for the whole Samba server and sets the defaults that will be used for the parameters not mentioned in other sections
`workgroup = MYWORKGROUP`	Make Samba join the specified workgroup
`server string = Linux Samba Server %L`	Describe server to the clients
`hosts allow = 10.9.9.0/255.255.255.0`	Allow only the specified machines to connect to the server
`security = user`	Set up user-level authentication
`encrypt passwords = yes`	Use encrypted passwords
`smb passwd file = /etc/samba/smbpasswd`	Refer to the specified password file for user authentication. A new user's password will need to be set both in Linux and Samba by using these commands from shell prompt: `passwd` *`newuser`* `smbpasswd` *`newuser`*
`unix password sync = yes`	When the password of a client user (e.g. under Windows) is changed, change the Linux and Samba password too

`username map = /etc/samba/smbusers`	Map each Samba server user name to client user name(s).
	The file `/etc/samba/smbusers` is structured as follows:
	`root = Administrator Admin`
	`jdoe = "John Doe"`
	`kgreen = "Kim Green"`

`netbios name = Mysambabox` `netbios aliases = Mysambabox1`	Set NetBIOS name and alias
`wins support = yes`	Make Samba play the role of a WINS server. Note: There should be only one WINS server on a network
`logon server = yes`	Enable logon support. Logon script parameters will be defined in a `[netlogon]` section
`log file = /var/log/samba/log.%m`	Use a separate logfile for each machine that connects
`max log size = 1000`	Maximum size of each logfile, in Kb
`syslog only = no`	Whether to log only via Syslog
`syslog = 0`	Log everything to the logfiles `/var/log/smb/log.smbd` and `/var/log/smb/log.nmbd`, and log a minimum amount of information to Syslog. This parameter can be set to a higher value to have Syslog log more information
`panic action = \` `/usr/share/samba/panic-action %d`	Mail a backtrace to the sysadmin in case Samba crashes
`[netlogon]` `comment = Netlogon for Windows clients`	Section defining a logon script
`path = /home/netlogon` `logon script = %U.bat`	Specifies a per-user script e.g. `/home/netlogon/jdoe.bat` will be called when user jdoe logs in. It is also possible to specify a per-clientname script `%m.bat`, which will be called when a specific machine logs in.
`browseable = no` `writeable = no`	
`guest ok = no`	Guest access to the service (i.e. access without entering a password) is disabled

`[Canon LaserJet 3]`
`printer name = lp`
`comment = Canon LaserJet 3 main printer`
`path = /var/spool/lpd/samba`
`printable = yes`
`writeable = no`
	Section defining a printer accessible via the network

/etc/samba/smb.conf Samba configuration	
[public]	Section defining a public share accessible on read/write by anyone
comment = Public Storage on %L	Describe the public share to users
path = /home/samba	Path of the public share on the server
browsable = yes	Whether to show the public share when browsing
writeable = yes	Whether to allow all users to write in this directory
[homes]	Section enabling users that have an account and a home directory on the Samba server to access it and modify its contents from a Samba client. The path variable is not set, by default is path=/home/%S
comment = %U's home directory on %L from %m	Describe the share to the user
browseable = no	Whether to show the homes share when browsing
writeable = yes	Whether to allow the user to write in his home directory
[foobar]	Section defining a specific share
path = /foobar	Path of the share on the server
comment = Share Foobar on %L from %m	Describe the share to users
browsable = yes	Whether to show the share when browsing
writeable = yes	Whether to allow the users to write in this share
valid users = jdoe, kgreen, +geeks	Allow access only to users jdoe and kgreen, and local group geeks
invalid users = csmith	Deny access to user csmith
read list = bcameron	Allow read-only access to user bcameron
write list = fcastle	Allow read-write access to user fcastle

Samba share access (defined in the configuration file)	
User-level authentication	
`[global]` `  security = user`	Set up user-level authentication
`  guest account = nobody`	Map the guest account to the system user nobody (default)
`  map to guest = Never`	Specify how incoming requests are mapped to the guest account: `Bad User` redirect from an invalid user to guest account on server `Bad Password` redirect from an invalid password to guest account on server `Never` reject unauthenticated users
Server-level authentication	
`[global]` `  security = server`	Set up server-level authentication
`  password server = srv1 srv2`	Authenticate to server srv1, or to server srv2 if srv1 is unavailable
Domain-level authentication	
`[global]` `  security = ADS`	Set up domain-level authentication as an Active Directory member server
`  realm = KRB_REALM`	Join the specified realm. Kerberos must be installed and an administrator account must be created: `net ads join -U Administrator%`*`password`*
Share-level authentication	
`[global]` `  security = share`	Set up share-level authentication

`[foobar]`
`  path = /foobar`
`  username = quux`
`  only user = yes`
	Define a foobar share accessible to any user which can supply quux's password.
	The user quux must be created on the system:
	`useradd -c "Foobar account" -d /tmp -m -s /sbin/nologin quux`
	and added to the Samba password file:
	`smbpasswd -a quux`

Samba macros			
`%S`	Username		The substitutes below apply only to the configuration options that are used when a connection has been established:
`%U`	Session username (the username that the client requested, not necessarily the same as the one he got)	`%S`	Name of the current service, if any
`%G`	Primary group of session username	`%P`	Root directory of the current service, if any
`%h`	Samba server hostname	`%u`	Username of the current service, if any
`%M`	Client hostname	`%g`	Primary group name of username
`%L`	NetBIOS name of the server	`%H`	Home directory of username
`%m`	NetBIOS name of the client	`%N`	Name of the NIS home directory server as obtained from the NIS `auto.map` entry. Same as `%L` if Samba was not compiled with the `--with-automount` option
`%d`	Process ID of the current server process		
`%a`	Architecture of remote machine		
`%I`	IP address of client machine		
`%i`	Local IP address to which a client connected	`%p`	Path of service's home directory as obtained from the NIS `auto.map` entry. The NIS `auto.map` entry is split up as `%N:%p`
`%T`	Current date and time		
`%D`	Domain or workgroup of the current user		
`%w`	Winbind separator		
`%$(`*`var`*`)`	Value of the environment variable *var*		

A Network File System (NFS) server makes filesystems available to remote clients for mounting.

The portmapper is needed by NFS to map incoming TCP/IP connections to the appropriate NFS RPC calls. Some Linux distributions use rpcbind instead of the portmapper.
For security, the TCP Wrapper should be configured to limit access to the portmapper to NFS clients only:
file `/etc/hosts.deny` should contain `portmap: ALL`
file `/etc/hosts.allow` should contain `portmap: IP_addresses_of_clients`

NFS handles user permissions across systems by considering users with same UID and username as the same user.
Group permission is evaluated similarly, by GID and groupname.

`rpc.nfsd`
`rpc.mountd`
`rpc.lockd`
`rpc.statd`
NFS daemons

`/etc/exports`
List of the filesystems to be exported (via the command `exportfs`)

`/var/lib/nfs/xtab`
List of exported filesystems, maintained by `exportfs`

`/proc/fs/nfs/exports`
Kernel export table (can be examined via the command `cat`)

`exportfs -ra`
Export or reexport all directories.
When exporting, fills the kernel export table `/proc/fs/nfs/exports`.
When reexporting, removes those entries in `/var/lib/nfs/xtab` that are deleted from `/etc/exports` (therefore synchronizing the two files), and removes those entries from `/proc/fs/nfs/exports` that are no longer valid

`exportfs -ua`
Unexport all directories.
Removes from `/proc/fs/nfs/exports` all those entries that are listed in `/var/lib/nfs/xtab`, and clears the latter file

`showmount`
Show the remote client hosts currently having active mounts

`showmount --directories`
Show the directories currently mounted by a remote client host

`showmount --exports`
Show the filesystems currently exported i.e. the active export list

`showmount --all`
Show both remote client hosts and directories

`showmount -e nfsserver`
Show the shares a NFS server has available for mounting

`rpcinfo -p nfsserver`
Probe the portmapper on a NFS server and display the list of all registered RPC services there

`rpcinfo -t nfsserver nfs`
Test a NFS connection by sending a null pseudo request (using TCP)

`rpcinfo -u nfsserver nfs`
Test a NFS connection by sending a null pseudo request (using UDP)

`nfsstat`
Display NFS/RPC client/server statistics.

Options:

	NFS	RPC	both
server	`-sn`	`-sr`	`-s`
client	`-cn`	`-cr`	`-c`
both	`-n`	`-r`	`-nr`

`mount -t nfs nfsserver:/share /usr`
Command to be run on a client to mount locally a remote NFS share.
NFS shares accessed frequently should be added to `/etc/fstab` e.g.
`nfsserver:/share /usr nfs intr 0 0`

/etc/exports

```
/export/          10.3.3.3(rw)
/export/          *(ro,sync)
/home/ftp/pub     client1(rw)  *.example.org(ro)
/home/crew        @FOOBARWORKGROUP(rw)  (ro)
```

filesystem	Filesystem on the NFS server to be exported to clients	
client identity	Client systems allowed to access the exported directory. Can be identified by hostname, IP address, wildcard, subnet, or @NIS workgroup. Multiple client systems can be listed, and each one can have different options	
client options	`ro`	Read-only access (default)
	`rw`	Read and write access. The client may choose to mount read-only anyway
	`sync`	Reply to requests only after the changes made by these requests have been committed to stable storage
	`async`	Reply to requests without waiting that changes are committed to stable storage. Improves performances but might cause loss or corruption of data if server crashes
	`root_squash`	Requests by user `root` on client will be done as user `nobody` on server (default)
	`no_root_squash`	Requests by user `root` on client will be done as same user `root` on server
	`all_squash`	Requests by a non-root user on client will be done as user `nobody` on server
	`no_all_squash`	Requests by a non-root user on client will be attempted as same user on server (default)

NFS mount options	
`rsize=`*`nnn`*	Size for read transfers (from server to client)
`wsize=`*`nnn`*	Size for write transfers (from client to server)
`nfsvers=`*`n`*	Use NFS version *n* for transport
`retry=n`	Keep retrying a mount attempt for *n* minutes before giving up
`timeo=n`	A mount attempt times out after *n* tenths of a second
`intr`	User can interrupt a mount attempt
`nointr`	User cannot interrupt a mount attempt (default)
`hard`	The system will try a mount indefinitely (default)
`soft`	The system will try a mount until an RPC timeout occurs
`bg`	Try a mount in the foreground, all retries occur in the background
`fg`	All mount attempts occur in the foreground (default)
`tcp`	Connect using TCP
`udp`	Connect using UDP

A DHCP (Dynamic Host Configuration Protocol) server listens for requests on UDP port 67 and answers to UDP port 68.
The assignment of an IP address to a host is done through a sequence of DHCP messages initiated by the client host: DHCP Discover, DHCP Offer, DHCP Request, DHCP Acknowledgment.
Because DHCP Discover messages are broadcast and therefore not routed outside a LAN, a DHCP relay agent is necessary for those clients situated outside the DHCP server's LAN. The DHCP relay agent listens to DHCP Discover messages and relays them in unicast to the DHCP server.

`/etc/dhcpd.conf`	Configuration file for the DHCP server
`/etc/sysconfig/dhcrelay` (SUSE)	Configuration file for the DHCP relay agent
`/var/lib/dhcpd/dhcpd.leases`	DHCP current leases

`/etc/dhcpd.conf` DHCP server configuration

```
option domain-name-servers 10.2.2.2;
option smtp-servers 10.3.3.3;
option pop-servers 10.4.4.4;
option time-servers 10.5.5.5;
option nntp-servers 10.6.6.6;
```

Global parameters for DNS, mail, NTP, and news servers specification

```
shared-network geek-net {
```

Definition of a network

```
   default-lease-time 86400;
```

Time, in seconds, that will be assigned to a lease if a client does not ask for a specific expiration time

```
   max-lease-time 172800;
```

Maximum time, in seconds, that can be assigned to a lease if a client asks for a specific expiration time

```
   option routers 10.0.3.252;
   option broadcast-address 10.0.3.255;

   subnet 10.0.3.0 netmask 255.255.255.128 {
      range 10.0.3.1 10.0.3.101;
   }
   subnet 10.0.3.128 netmask 255.255.255.128 {
      range 10.0.3.129 10.0.3.229;
   }
}
```

Definition of different subnets in the network, with specification of different ranges of IP addresses that will be leased to clients depending on the client's subnet

```
group {
```

Definition of a group

```
   option routers 10.0.17.252;
   option broadcast-address 10.0.17.255;
   netmask 255.255.255.0;
   host linuxbox1 {
      hardware ethernet AA:BB:CC:DD:EE:FF;
      fixed-address 10.0.17.42;
      option host-name "linuxbox1";
   }
   host linuxbox2 {
      hardware ethernet 33:44:55:66:77:88;
      fixed-address 10.0.17.66;
      option host-name "linuxbox2";
   }
}
```

Definition of different hosts to whom static IP addresses will be assigned to, depending on their MAC address

PAM (Pluggable Authentication Modules) is an abstraction layer that allows applications to use authentication methods while being implementation-agnostic.

`/etc/pam.d/`*service*	PAM configuration for *service*
`/etc/pam.conf` (obsolete)	PAM configuration for all services
`ldd /usr/sbin/`*service* `| grep libpam`	Check if *service* is enabled to use PAM

/etc/pam.d/*service*

```
auth        requisite   pam_securetty.so
auth        required    pam_nologin.so
auth        required    pam_env.so
auth        required    pam_unix.so nullok
account     required    pam_unix.so
session     required    pam_unix.so
session     optional    pam_lastlog.so
password    required    pam_unix.so nullok obscure min=4 max=8
```

type	`auth`	Authentication module to verify user identity and group membership
	`account`	Authorization module to determine user's right to access a resource (other than his identity)
	`password`	Module to update an user's authentication credentials
	`session`	Module (run at end and beginning of an user session) to set up the user environment
control	`optional`	Module is not critical to the success or failure of *service*
	`sufficient`	If this module successes, and no previous module has failed, module stack processing ends successfully. If this module fails, it is non-fatal and processing of the stack continues
	`required`	If this module fails, processing of the stack continues until the end, and *service* fails
	`requisite`	If this module fails, *service* fails and control returns to the application that invoked *service*
	`include`	Include modules from another PAM service file
module	PAM module and its options, e.g.:	
	`pam_unix.so`	Standard UNIX authentication module via `/etc/passwd` and `/etc/shadow`
	`pam_nis.so`	Module for authentication via NIS
	`pam_ldap.so`	Module for authentication via LDAP
	`pam_fshadow.so`	Module for authentication against an alternative shadow passwords file
	`pam_cracklib.so`	Module for password strength policies (e.g. length, case, max n of retries)
	`pam_limits.so`	Module for system policies and system resource usage limits
	`pam_listfile.so`	Module to deny or allow the service based on an arbitrary text file

LDAP (Lightweight Directory Access Protocol) is a simplified version of the X.500 standard and uses TCP port 389.
LDAP permits to organize hierarchically a database of entries, each one of which is identified by an unique DN (Distinguished Name). Each DN has a set of attributes, each one of which has a value. An attribute may appear multiple times.

Most frequently used LDAP attributes		
Attribute	**Example**	**Meaning**
dn	dn: cn=John Doe,dc=example,dc=org	Distinguished Name (not an attribute; identifies the entry)
cn	cn: John Doe	Common Name
dc	dc=example,dc=org	Domain Component
givenName	givenName: John	Firstname
sn	sn: Doe	Surname
mail	mail: jdoe@example.org	Email address
telephoneNumber	telephoneNumber: +1 505 1234 567	Telephone number
uid	uid: jdoe	User ID
c	c: US	Country code
l	l: San Francisco	Locality
st	st: California	State or province
street	street: 42, Penguin Road	Street
o	o: The Example Foundation	Organization
ou	ou: IT Dept	Organizational Unit
manager	manager: cn=Kim Green,dc=example,dc=org	Manager

```
ldapsearch -H ldap://ldapserver.example.org \
-s base -b "ou=people,dc=example,dc=com" \
"(sn=Doe)" cn sn telephoneNumber
```

Query the specified LDAP server for entries where surname=Doe, and print common name, surname, and telephone number of the resulting entries.
Output is shown in LDIF

```
ldappasswd -x -D "cn=Admin,dc=example,dc=org" \
-W -S "uid=jdoe,ou=IT Dept,dc=example,dc=org"
```

Authenticating as Admin, change the password of user jdoe in the OU called IT Dept, on example.org

```
ldapmodify -b -r -f /tmp/mods.ldif
```

Modify an entry according to the LDIF file `/tmp/mods.ldif`

```
ldapadd -h ldapserver.example.org \
-D "cn=Admin" -W -f /tmp/mods.ldif
```

Authenticating as Admin, add an entry by adding the content of the LDIF file `/tmp/mods.ldif` to the directory.
This command actually invokes `ldapmodify -a`

```
ldapdelete -v "uid=jdoe,dc=example,dc=org" \
-D "cn=Admin,dc=example,dc=org" -W
```

Authenticating as Admin, delete the entry of user jdoe

LDIF (LDAP Data Interchange Format)	
dn: cn=John Doe, dc=example, dc=org changetype: modify replace: mail mail: johndoe@otherexample.com - add: jpegPhoto jpegPhoto:< file://tmp/jdoe.jpg - delete: description -	This LDIF file will change the email address of jdoe, add a picture, and delete the description attribute for the entry

`slapd`	Standalone OpenLDAP daemon
`/var/lib/ldap/`	Files constituting the OpenLDAP database
`/etc/openldap/slapd.conf` `/usr/local/etc/openldap/slapd.conf`	OpenLDAP configuration file
`slapcat -l file.ldif`	Dump the contents of an OpenLDAP database to a LDIF file
`slapadd -l file.ldif`	Import an OpenLDAP database from a LDIF file
`slapindex`	Regenerate OpenLDAP's database indexes

`yum install openldap openldap-clients \` `authconfig sssd nss-pam-ldapd authconfig-gtk`	Install the OpenLDAP client (on RHEL 7)

`authconfig --enableldap --enableldapauth \`
`--ldapserver=ldap://`*`ldapserver`* `\`
`--ldapbasedn="dc=example,dc=org" \`
`--enablesssd --update`
	Set up the LDAP client to connect to a *ldapserver*.
	This will update the configuration files `/etc/sssd/sssd.conf` and `/etc/openldap/ldap.conf`

`getent group` *`groupname`*	Get entries about *groupname* from NSS libraries
`authconfig-gtk` `system-config-authentication`	OpenLDAP configuration GUI

`sssd` (the System Security Services Daemon) must be running to provide access to OpenLDAP as an authentication and identity provider.

Security-Enhanced Linux (SELinux) is a Linux kernel security module that provides a mechanism for supporting access control security policies.
SELinux implements a Mandatory Access Control framework that allows the definition of fine-grained permissions for how **subjects** (i.e. processes) interact with **objects** (i.e. other processes, files, devices, ports, sockets); this improves security with respect to the standard Discretionary Access Control, which defines accesses based on users and groups. The **security context** of a file is stored in its extended attributes.
The decisions SELinux takes about allowing or disallowing access are stored in the AVC (Access Vector Cache).

`setenforce 0`
`echo 0 > /selinux/enforce`
Enter permissive mode

`setenforce 1`
`echo 1 > /selinux/enforce`
Enter enforcing mode

`getenforce`
`cat /selinux/enforce`
`sestatus -v`
Display current mode

`chcon` *`context file`*
Change the security context of *file* to the specified *context*

`chcon --reference=`*`file0 file`*
Change the security context of *file* to the same as the reference file *file0*

`restorecon -f` *`file`*
Restore the security context of *file* to the system default

`ls -Z`
List files and their security context

`ps -eZ`
List processes and their security context

`getsebool` *`boolean`*
Get the value of a SELinux boolean

`setsebool` *`boolean=value`*
Set the value of a SELinux boolean

`tar --selinux` *`[other args]`*
`star -xattr -H=exustar` *`[other args]`*
Create or extract archives that retain the security context of files

`semanage`
Manage SELinux policies

`/etc/selinux/config`
(symlinked in `/etc/sysconfig/selinux`)
SELinux mode can be configured permanently inside this file.

```
# This file controls the state of SELinux on the system.
# SELINUX= can take one of these three values:
# enforcing - SELinux security policy is enforced.
# permissive - SELinux prints warnings instead of enforcing.
# disabled - No SELinux policy is loaded.
SELINUX=enforcing
# SELINUXTYPE= can take one of these two values:
# targeted - Only targeted network daemons are protected.
# strict - Full SELinux protection.
SELINUXTYPE=targeted
```

`/selinux/`
Pseudo filesystem, created by SELinux, containing commands used by the kernel for its operations.

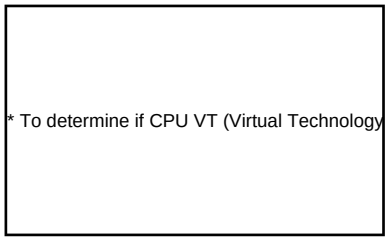
`/var/log/audit/audit.log`
AVC denials are logged on this file if `auditd` is running

`/var/log/messages`
AVC denials are logged on this file if `rsyslogd` is running

`sealert -a` *`logfile`*
Analyze a SELinux logfile and display SELinux policy violations

`grep` *`nnnnn.mmm:pp`* `logfile | audit2why`
Diagnostic a specific AVC event entry from a SELinux logfile:
`type=AVC msg=audit(`*`nnnnn.mmm:pp`*`): avc: denied (...)`

KVM (Kernel-based Virtual Machine) is a virtualization infrastructure for the Linux kernel that allows it to function as an hypervisor.



`/etc/libvirt/qemu/`	Directory containing the XML files that define VMs properties. `libvirtd` must be restarted after modifying a XML file
`/var/lib/libvirt/`	Directory containing files related to the VMs
`virt-manager`	KVM GUI
`virt-install --prompt`	Interactive command-line program to create a VM
`virt-install -n vmname -r 2048 \ --disk path=/var/lib/libvirt/images/vmname.img \ -l /root/vmstuff/inst/ \ -x "ks=/root/vmstuff/kickstart.cfg"`	Create a VM with 2 Gb of RAM, specifying path of virtual disk, location of installation files, and (as extra argument) Kickstart configuration to use
`virt-clone --prompt`	Interactive command-line program to clone a VM. A VM must be shut off or paused before it can be cloned
`virt-clone -o vmname -n vmclonename`	Clone a VM
`virsh`	Interface for VM management
`virsh list --all`	List all VMs present on the system
`virsh start vmname`	Start a VM
`virsh destroy vmname`	Brutally shut down a VM
`virsh shutdown vmname`	Gracefully shut down a VM
`virsh autostart vmname`	Set a VM to be automatically started when the system boots. Done by symlinking the VM to `/etc/libvirt/qemu/autostart/`
`virsh autostart --disable vmname`	Disable the autostart of a VM at system boot
`virsh edit vmname`	Edit the XML file defining a VM's properties
`virt-what`	Detect whether the current machine is a VM

Kickstart

Kickstart is a method to perform automatic installation and configuration of RHEL machines.
This can be done by specifying `inst.ks=hd:/dev/sda:/root/path/ksfile` either as a boot option, or an option to the kernel command in GRUB 2.

`system-config-kickstart`	GUI tool to create a Kickstart file
`ksvalidator ksfile`	Check the validity of a Kickstart file
`/root/anaconda-ks.cfg`	Kickstart file describing the current system. This file was automatically generated during the installation of the current system
`ksverdiff -f RHEL6 -t RHEL7`	Show the differences in the Kickstart syntax between RHEL 6 and RHEL 7

`git init`	Initialize the current directory as a repository

`git clone` *repoaddress*	Clone a remote repository.
	repoaddress can be a URL (SSH, HTTP, HTTPS, FTP, FTPS, Git) or a local path e.g.
	`ssh://user@example.com:8888/path/to/repo.git`
	`git://example.com:9999/path/to/repo.git`
	`/path/to/repo.git`

`git checkout` *branch*	Start working into an already existing *branch*
`git checkout -B` *branch*	Create *branch* and start working into it
`git pull`	Pull the changes from the remote repository branch to the local branch
`git add` *file*	Add *file* to the content staged for the next commit (hence starting to track it)
`git rm` *file*	Remove *file* from the content staged for the next commit
`git status`	See the status (e.g. files changed but not yet staged) of the current branch
`git commit -am "`*Message*`"`	Commit all staged files in the current branch
`git push`	Push the local commits from the current branch to the remote repository
`git push origin` *branch*	Push the local commits from *branch* to the remote repository
`git merge` *branch*	Merge changes made on *branch* to the master branch
`git diff` *checksum1 checksum2*	Compare two commits
`git branch`	Show local branches
`git branch -r`	Show remote branches
`git branch -a`	Show remote and local branches

Tag		Attributes	
<h1>...<h6> Heading		align=left|center|right|justify	Heading alignment †
** Line break**	Line break and carriage return		
<hr> Horizontal line		align=left|center|right	Line alignment †
		noshade	Solid rendering instead of 3D †
		size=*npixels*	Line height
		width=*npixels*|*percent*%	Line width
<p> Paragraph ** Section**		align=left|center|right|justify	Paragraph or section alignment †
** Group**	Group of elements		
<a> Anchor	Hyperlink	charset=*encoding*	Character encoding of target URL
		coords=*left*,*top*,*right*,*bottom*|*cx*,*cy*,*radius*|*x1*,*y1*,...,*xn*,*yn*	Coordinates of region; depends on shape
		href=*url*	Target URL for the link
		hreflang=*language*	Language of document at the target URL
		name=*section*	Name of anchor for document bookmarking
		rel|rev=alternate|stylesheet|start|next|prev|contents|index|glossary|copyright|chapter|section|subsection|appendix|help|bookmark	Relationship between this document and the target URL (rel) or vice versa (rev)
		shape=rectangle|circle|polygon	Shape of region
		target=_blank|_parent|_self|_top	Destination of target URL
		type=*mimetype*	MIME type of target URL
<dl> **Definition list**			
<dt> **Definition term**			
<dd> **Definition description**	Description of a definition term		

† = deprecated

Tag		Attributes	
<i> Italic			
<b> Bold			
<s> **<strike> Strike-through**	Strike-through †		
<u> Underlined	Underlined text †		
<big> Bigger			
<small> Smaller			
<sub> Subscript			
<sup> Superscript			
<tt> Teletype	Monospaced text		
** Emphasized**			
** Strong**			
<del> Deleted **<ins> Inserted**	Deleted/inserted text	cite=*url* datetime=*yyyy-mm-dd*	URL to document explaining deletion/insertion When the text was deleted/inserted
<pre> Preformatted		width=*ncharacters*	Max number of characters per line †
<code> Code	Source code text		
<samp> Sample	Sample code text		
<kbd> Keyboard	Keyboard key		
<var> Variable	Variable name		
<cite> Citation	Citation block		
<blockquote> Quotation **<q> Short quotation**		cite=*url*	URL to document containing the quote
<address> Address	Address block		
<abbr> Abbreviation			
<acronym> Acronym			
<dfn> Definition	Definition term		
<font> Font	Font †	color=rgb(*r*,*g*,*b*)|#*rrggbb*|*color* face=*fontname* size=*[1...7]*|*[-6...+6]*	Text color Text font Text size
<bdo> Bidirectional override		dir=ltr|rtl	Direction of text: left-to-right or right-to-left
<xmp> XMP	Non-formatted text † ; ignores other HTML tags		
other tags	Attributes common to almost all other tags	class=*class*|*style* id=*id* style=*styledef* title=*tooltip* dir=ltr|rtl lang=*language* accesskey=*character* tabindex=*ntab*	Class of the element Unique ID of the element Inline style definition Text of the tooltip to display Direction of text: left-to-right or right-to-left Language of the content Keyboard shortcut for the element N of tab for the element

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Tag	Attributes	
<img> **Image**	align=top|bottom|left|middle|right	Image alignment with respect to surrounding text †
	alt=*alternatetext*	Description of the image for text-only browsers
	border=*npixels*	Border width around the image †
	height=*npixels*|*percent*%	Image height
	hspace=*npixels*	Blank space on the left and right side of image †
	ismap=*url*	URL for server-side image map
	longdesc=*url*	URL containing a long description of the image
	src=*url*	URL of the image
	usemap=*url*	URL for client-side image map
	vspace=*npixels*	Blank space on top and bottom of image †
	width=*npixels*|*percent*%	Image width
<map> **Image map**	id=*id*	Unique ID for the map tag
	name=*name*	Unique name for the map tag
<area> **Area of image map**	alt=*alternatetext*	Description of area for text-only browsers
	coords=*left*,*top*,*right*,*bottom*| *cx*,*cy*,*radius*|*x1*,*y1*,...,*xn*,*yn*	Coordinates of clickable area; depends on shape
	href=*url*	Target URL of area
	nohref=true|false	Excludes or includes the area from image map
	shape=rectangle|circle|polygon	Shape of area
	target=_blank|_parent|_self|_top	Destination of target URL

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Tag	Attributes	
<table> **Table**	align=left|center|right	Table alignment †
	bgcolor=rgb(*r*,*g*,*b*)|#*rrggbb*|*color*	Table background color †
	border=*npixels*	Border width
	cellpadding=*npixels*|*percent*%	Space around the content of each cell
	cellspacing=*npixels*|*percent*%	Space between cells
	frame=void|above|below| lhs|rhs|hsides|vsides|box|border	Visibility of sides of the table border
	rules=none|groups|rows|cols|all	Horizontal or vertical divider lines
	summary=*summary*	Summary of the table for text-only browsers
	width=*npixels*|*percent*%	Table width
<tr> **Table row**	align=left|center|right|justify|char	Horizontal text alignment
	bgcolor=rgb(*r*,*g*,*b*)|#*rrggbb*|*color*	Row background color †
	char=*character*	Character to align text on, if align=char
	charoff=*npixels*|*percent*%	Alignment offset to first character, if align=char
	valign=top|middle|bottom|baseline	Vertical text alignment
<td> **Table cell** **<th>** **Table header**	abbr=*content*	Abbreviated content in a cell
	align=left|center|right|justify|char	Horizontal text alignment
	axis=*category*	Cell name
	bgcolor=rgb(*r*,*g*,*b*)|#*rrggbb*|*color*	Cell background color †
	char=*character*	Character to align text on, if align=char
	charoff=*npixels*|*percent*%	Alignment offset to first character, if align=char
	colspan=*ncolumns*	Number of columns this cell spans on
	headers=*headerid*	Cell header information for text-only browsers
	height=*npixels*	Cell height †
	nowrap	Text in cell stays on a single line †
	rowspan=*nrows*	Number of rows this cell spans on
	scope=col|colgroup|row|rowgroup	Target for cell header information
	valign=top|middle|bottom|baseline	Vertical text alignment
	width=*npixels*|*percent*%	Cell width †
** ** **Ordered list**	compact=compact	List must be more compact †
	start=*firstnumber*	Number to start the list on †
	type=A|a|I|i|1	List numbers type †
** ** **Unordered list**	compact=compact	List must be more compact †
	type=disc|square|circle	List type †
** ** **List item**	type=disc|square|circle|A|a|I|i|1	List item type †
	value=*itemno*	List item value †

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Dec	Hex	Char		Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	
0	0	NUL	Null	32	20	space	64	40	@	96	60	`	
1	1	SOH	Start of heading	33	21	!	65	41	A	97	61	a	
2	2	STX	Start of text	34	22	"	66	42	B	98	62	b	
3	3	ETX	End of text	35	23	#	67	43	C	99	63	c	
4	4	EOT	End of transmission	36	24	$	68	44	D	100	64	d	
5	5	ENQ	Enquiry	37	25	%	69	45	E	101	65	e	
6	6	ACK	Acknowledge	38	26	&	70	46	F	102	66	f	
7	7	BEL	Bell	39	27	'	71	47	G	103	67	g	
8	8	BS	Backspace	40	28	(	72	48	H	104	68	h	
9	9	TAB	Horizontal tab	41	29	)	73	49	I	105	69	i	
10	A	LF	Line feed	42	2A	*	74	4A	J	106	6A	j	
11	B	VT	Vertical tab	43	2B	+	75	4B	K	107	6B	k	
12	C	FF	Form feed	44	2C	,	76	4C	L	108	6C	l	
13	D	CR	Carriage return	45	2D	-	77	4D	M	109	6D	m	
14	E	SO	Shift out	46	2E	.	78	4E	N	110	6E	n	
15	F	SI	Shift in	47	2F	/	79	4F	O	111	6F	o	
16	10	DLE	Data link escape	48	30	0	80	50	P	112	70	p	
17	11	DC1	Device control 1	49	31	1	81	51	Q	113	71	q	
18	12	DC2	Device control 2	50	32	2	82	52	R	114	72	r	
19	13	DC3	Device control 3	51	33	3	83	53	S	115	73	s	
20	14	DC4	Device control 4	52	34	4	84	54	T	116	74	t	
21	15	NAK	Negative ACK	53	35	5	85	55	U	117	75	u	
22	16	SYN	Synchronous idle	54	36	6	86	56	V	118	76	v	
23	17	ETB	End of Tx block	55	37	7	87	57	W	119	77	w	
24	18	CAN	Cancel	56	38	8	88	58	X	120	78	x	
25	19	EM	End of medium	57	39	9	89	59	Y	121	79	y	
26	1A	SUB	Substitute	58	3A	:	90	5A	Z	122	7A	z	
27	1B	ESC	Escape	59	3B	;	91	5B	[	123	7B	{	
28	1C	FS	File separator	60	3C	<	92	5C	\	124	7C	|	
29	1D	GS	Group separator	61	3D	=	93	5D	]	125	7D	}	
30	1E	RS	Record separator	62	3E	>	94	5E	^	126	7E	~	
31	1F	US	Unit separator	63	3F	?	95	5F	_	127	7F	DEL	Delete

Characters 0-31 and 127 are non-printable.