

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.

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Happy Linux hacking,

Daniele Raffo

Version history

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Sources and suggested readings

- Evi Nemeth et al., *UNIX and Linux System Administration Handbook*, O'Reilly
- Rebecca Thomas et al., *Advanced Programmer's Guide to Unix System V*, McGraw-Hill
- Mendel Cooper, *Advanced Bash-Scripting Guide*, <http://tldp.org/LDP/abs/html>
- Adam Haeder et al., *LPI Linux Certification in a Nutshell*, O'Reilly
- Heinrich W. Klöpping et al., *The LPIC-2 Exam Prep*, <http://lpic2.unix.nl>
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- Asghar Ghori, *RHCSA & RHCE RHEL 7: Training and Exam Preparation Guide*, Lightning Source Inc.
- Colin Barschel, *Unix Toolbox*, <http://cb.vu/unixtoolbox.xhtml>
- Ellen Siever et al., *Linux in a Nutshell*, O'Reilly, <http://archive.oreilly.com/linux/cmd>
- Bruce Barnett, *The Grymoire*, <http://www.grymoire.com/Unix>
- Brendan Gregg, *Linux performance*, <http://www.brendangregg.com/linuxperf.html>
- RHEL manuals, https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux
- A-Z index of Bash command line, <http://ss64.com/bash>
- GNU software manuals, <http://www.gnu.org/manual>
- Shell command line snippets, <http://www.commandlinefu.com>
- Bash command line snippets, <http://www.bashoneliners.com>
- RAM management in Linux, <http://www.linuxatemyram.com>
- Regular expressions tester, <http://www.regextester.com>
- Bash pitfalls, <http://mywiki.woledge.org/BashPitfalls>
- Linux man pages, <https://www.kernel.org/doc/man-pages>

Index

LVM.....	1	Vi commands.....	53	TCP Wrapper.....	105
LVM commands.....	2	Vi options.....	54	Routing.....	106
System boot.....	3	SQL.....	55	iptables.....	107
SysV startup sequence.....	4	SQL SELECTs.....	56	iptables rules.....	108
Login.....	5	SQL JOINs.....	57	firewalld.....	109
Runlevels.....	6	MySQL.....	58	firewalld rules.....	110
SysV vs Systemd.....	7	MySQL syntax.....	59	NAT routing.....	111
/etc/inittab.....	8	MySQL status.....	60	SSH.....	112
Filesystem Hierarchy Standard.....	9	MySQL recipes.....	61	SSH operations.....	113
Partitions.....	10	MySQL operations.....	62	SSH configuration.....	114
mount.....	11	X Window.....	63	OpenSSL.....	115
Filesystem types.....	12	X Window tools.....	64	CA.pl.....	116
Swap.....	13	X11 keysim codes.....	65	GnuPG.....	117
/etc/fstab.....	14	/etc/passwd.....	66	OpenVPN.....	118
Filesystem operations.....	15	User management.....	67	Key bindings - terminal.....	119
Filesystem maintenance.....	16	UID and GID.....	68	Key bindings - X.....	120
XFS, ReiserFS, CD-ROM fs.....	17	su and sudo.....	69	udev.....	121
AutoFS.....	18	Terminals.....	70	Kernel.....	122
RAID.....	19	Messaging.....	71	Kernel management.....	123
Bootloader.....	20	cron.....	72	Kernel compile and patching.....	124
GRUB 2 configuration.....	21	at.....	73	Kernel modules.....	125
GRUB 2 usage.....	22	Utilities.....	74	/proc filesystem.....	126
GRUB Legacy.....	23	Localization.....	75	System recovery.....	127
Low-level package managers.....	24	System time.....	76	DNS.....	128
High-level package managers.....	25	Syslog.....	77	DNS configuration.....	129
Package management tools.....	26	E-mail.....	78	DNS zone file.....	130
Backup.....	27	SMTP.....	79	Apache.....	131
Archive formats.....	28	Sendmail.....	80	Apache configuration.....	132
Command line basics.....	29	Exim.....	81	Apache virtual hosts.....	133
Directories.....	30	Postfix.....	82	Apache directory protection.....	134
Text filters.....	31	Postfix configuration.....	83	Apache SSL/TLS.....	135
Advanced text filters.....	32	Procmail.....	84	Tomcat.....	136
Regular expressions.....	33	Courier POP configuration.....	85	Samba server.....	137
File management.....	34	Courier IMAP configuration.....	86	Samba client.....	138
I/O streams.....	35	Dovecot.....	87	Samba global configuration.....	139
read and echo.....	36	Dovecot mailbox configuration.....	88	Samba share configuration.....	140
Processes.....	37	Dovecot POP and IMAP configuration.....	89	Samba share access and macros.....	141
Signals.....	38	Dovecot authentication.....	90	NFS.....	142
Resource monitoring.....	39	FTP.....	91	/etc/exports.....	143
vmstat and free.....	40	vsftpd.....	92	DHCP.....	144
File permissions.....	41	CUPS.....	93	PAM.....	145
File attributes.....	42	IP addressing.....	94	LDAP.....	146
ACLs.....	43	Subnetting.....	95	OpenLDAP.....	147
Links.....	44	Network services.....	96	SELinux.....	148
Find system files.....	45	Network configuration commands.....	97	KVM.....	149
Shell options.....	46	Wireless networking.....	98	Git.....	150
Shell variables.....	47	Network tools.....	99	HTML 4.01 - components.....	151
Bash scripting.....	48	Network monitoring.....	100	HTML 4.01 - text.....	152
Bash advanced scripting.....	49	tcpdump.....	101	HTML 4.01 - images.....	153
Tests.....	50	netcat.....	102	HTML 4.01 - tables and lists.....	154
Flow control.....	51	Network configuration.....	103	7-bit ASCII table.....	155
Text processors.....	52	Network configuration (Red Hat).....	104		

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 extend the Logical Volume taking all free space
- or `lvresize -l+100%FREE /dev/myvg0/mylv` Extend the filesystem
6. `resize2fs /dev/myvg0/mylv`

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/myvg0/snapshot0` Delete the snapshot

PV commands		VG commands		LV commands	
<code>pvs</code>	Report information about Physical Volumes	<code>vgs</code>	Report information about Volume Groups	<code>lvs</code>	Report information about Logical Volumes
<code>pvscan</code>	Scan all disks for Physical Volumes	<code>vgscan</code>	Scan all disks for Volume Groups	<code>lvscan</code>	Scan all disks for Logical Volumes
<code>pvdisplay</code>	Display Physical Volume attributes	<code>vgdisplay</code>	Display Volume Group attributes	<code>lvdisplay</code>	Display Logical Volume attributes
<code>pvck</code>	Check Physical Volume metadata	<code>vgck</code>	Check Volume Group metadata		
<code>pvcreate</code>	Initialize a disk or partition for use with LVM	<code>vgcreate</code>	Create a Volume Group using Physical Volumes	<code>lvcreate</code>	Create a Logical Volume in a Volume Group
<code>pvchange</code>	Change Physical Volume attributes	<code>vgchange</code>	Change Volume Group attributes	<code>lvchange</code>	Change Logical Volume attributes
<code>pvremove</code>	Remove a Physical Volume	<code>vgremove</code>	Remove a Volume Group	<code>lvremove</code>	Remove a Logical Volume
		<code>vgextend</code>	Add a Physical Volume to a Volume Group	<code>lvextend</code>	Increase the size of a Logical Volume
		<code>vgreduce</code>	Remove a Physical Volume from a Volume Group	<code>lvreduce</code>	Shrink the size a Logical Volume
<code>pvresize</code>	Resize a disk or partition in use with LVM			<code>lvresize</code>	Modify the size of a Logical Volume
		<code>vgmerge</code>	Merge two Volume Groups		
		<code>vgsplit</code>	Split two Volume Groups		
		<code>vgimport</code>	Import a Volume Group into a system		
		<code>vgexport</code>	Export a Volume Group from a system		
<code>pvmove</code>	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					
<code>lvmdiskscan</code>	Scan the system for disks and partitions usable by LVM				
<code>dmsetup command</code>	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)	<p>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.</p> <p>The chain loader also mounts <code>initrd</code>, 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 <code>/linuxrc</code> with PID 1. (From Linux 2.6.13 onward, the system instead loads into memory <code>initramfs</code>, a cpio-compressed image, and unpacks it into an instance of <code>tmpfs</code> in RAM. The kernel then executes <code>/init</code> from within the image.)</p>
Linux kernel	<p>Kernel decompression into memory.</p> <p>Kernel execution.</p> <p>Detection of devices.</p> <p>The real root filesystem is mounted on <code>/</code> in place of the initial ramdisk.</p>
init	<p>Execution of <code>init</code>, the first process (PID 1).</p> <p>The system tries to execute in the following order:</p> <pre>/sbin/init /etc/init /bin/init /bin/sh</pre> <p>If none of these succeeds, the kernel panics.</p>
Startup	The system loads startup scripts and runlevel scripts.
Login	<p>If in text mode, <code>init</code> calls the <code>getty</code> process, which runs the <code>login</code> command that asks the user for login and password.</p> <p>If in graphical mode, the X Display Manager starts the X Server.</p>

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 <code>/sbin/init</code> executes all instructions on <code>/etc/inittab</code> . This script at first switches to the default runlevel...	<code>id:2:initdefault:</code>	<code>id:5:initdefault:</code>
... then it runs the following script (same for all runlevels) which configures peripheral hardware, applies kernel parameters, sets hostname, and provides disks initialization...	<code>/etc/init.d/rcS</code>	<code>/etc/rc.d/rc.sysinit</code> or <code>/etc/rc.sysinit</code>
... and then, for runlevel <i>N</i> , it calls the script <code>/etc/init.d/rc N</code> (i.e. with the runlevel number as parameter) which launches all services and daemons specified in the following startup directories:	<code>/etc/rcN.d/</code>	<code>/etc/rc.d/rcN.d/</code>
The startup directories contain symlinks to the init scripts in <code>/etc/init.d/</code> which are executed in numerical order. Links starting with K are called with argument <code>stop</code> , links starting with S are called with argument <code>start</code> .		
<pre>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</pre>		
The last script to be run is <code>S99local -> ../init.d/rc.local</code> ; therefore, an easy way to run a specific program upon boot is to call it from this script file.		
<code>/etc/init.d/boot.local</code>		runs only at boot time, not when switching runlevel.
<code>/etc/init.d/before.local</code> (SUSE)		runs only at boot time, before the scripts in the startup directories.
<code>/etc/init.d/after.local</code> (SUSE)		runs only at boot time, after the scripts in the startup directories.
To add or remove services at boot sequence:	<code>update-rc.d service defaults</code> <code>update-rc.d -f service remove</code>	<code>chkconfig --add service</code> <code>chkconfig --del service</code>
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 <code>xinetd</code> super server.		

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

Linux Standard Base (LSB)
The Linux Standard Base defines a format to specify default values on an init script <code>/etc/init.d/foo</code> :
<pre>### BEGIN INIT INFO # Provides: foo # Required-Start: bar # Default-Start: 2 3 4 5 # Default-Stop: 0 1 6 # Description: Service Foo init script ### END INIT INFO</pre>
Default runlevels and S/K symlinks values can also be specified as such:
<pre># chkconfig: 2345 85 15 # description: Foo service</pre>

<code>/etc/init/start-ttys.conf</code> (Red Hat)	Start the specified number of terminals at bootup via <code>getty</code> , which manages physical or virtual terminals (TTYs)												
<code>/etc/sysconfig/init</code> (Red Hat)	Control appearance and functioning of the system during bootup												
<code>/etc/machine-id</code> (Red Hat)	Randomly-generated machine ID												
<code>rm /etc/machine-id && \</code> <code>systemd-machine-id-setup</code> (Red Hat)	Initialize the machine ID												
<code>/etc/securetty</code>	List of TTYs from which the root user is allowed to login												
<code>/etc/issue</code>	Message that will be printed before the login prompt. Can contain the following escape codes:												
	<table border="0"> <tr> <td><code>\b</code> Baudrate of line</td> <td><code>\o</code> Domain name</td> </tr> <tr> <td><code>\d</code> Date</td> <td><code>\r</code> OS release number</td> </tr> <tr> <td><code>\s</code> System name and OS</td> <td><code>\t</code> Time</td> </tr> <tr> <td><code>\l</code> Terminal device line</td> <td><code>\u</code> Number of users logged in</td> </tr> <tr> <td><code>\m</code> Architecture identifier of machine</td> <td><code>\U</code> "<i>n</i> users" logged in</td> </tr> <tr> <td><code>\n</code> Nodename aka hostname</td> <td><code>\v</code> OS version and build date</td> </tr> </table>	<code>\b</code> Baudrate of line	<code>\o</code> Domain name	<code>\d</code> Date	<code>\r</code> OS release number	<code>\s</code> System name and OS	<code>\t</code> Time	<code>\l</code> Terminal device line	<code>\u</code> Number of users logged in	<code>\m</code> Architecture identifier of machine	<code>\U</code> " <i>n</i> users" logged in	<code>\n</code> Nodename aka hostname	<code>\v</code> OS version and build date
<code>\b</code> Baudrate of line	<code>\o</code> Domain name												
<code>\d</code> Date	<code>\r</code> OS release number												
<code>\s</code> System name and OS	<code>\t</code> Time												
<code>\l</code> Terminal device line	<code>\u</code> Number of users logged in												
<code>\m</code> Architecture identifier of machine	<code>\U</code> " <i>n</i> users" logged in												
<code>\n</code> Nodename aka hostname	<code>\v</code> OS version and build date												
<code>/etc/issue.net</code>	Message that will be printed before the login prompt on a remote session												
<code>/etc/motd</code>	Message that will be printed after a successful login, before execution of the login shell												
<code>cat /etc/debian_version</code> (Debian)	Show the version of this Linux distribution												
<code>cat /etc/fedora-release</code> (Fedora)													
<code>cat /etc/redhat-release</code> (Red Hat)													
<code>cat /etc/lsb-release</code>													
<code>lsb_release -a</code>													
<code>/etc/os-release</code>	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	<code>multi-user.target</code>	Multi-user mode	Multi-user mode with network
	4		Multi-user mode	Unused, for custom use
	5	<code>graphical.target</code>	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 `runleveln.target` emulates a SysV's runlevel *n*.

<code>runlevel</code>	Display the previous and the current runlevel
<code>who -r</code>	
<code>init runlevel</code>	Change to <i>runlevel</i>
<code>telinit runlevel</code>	
<code>systemctl get-default</code>	Get the default target
<code>systemctl set-default target</code>	Set the default <i>target</i>
<code>systemctl isolate target</code>	Change to <i>target</i>
<code>systemctl emergency</code>	Change to maintenance single-user mode with only <code>/root</code> filesystem mounted
<code>systemctl rescue</code>	Change to maintenance single-user mode with only local filesystems mounted
<code>init 0</code>	Halt the system
<code>telinit 0</code>	
<code>shutdown -h now</code>	
<code>halt</code>	
<code>poweroff</code>	
<code>init 6</code>	Reboot the system
<code>telinit 6</code>	
<code>shutdown -r now</code>	
<code>reboot</code>	
<code>shutdown</code>	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 <code>/etc/shutdown.allow</code>
<code>shutdown -h 16:00 message</code>	Schedule a shutdown for 4 PM and send a warning message to all logged-in users
<code>shutdown -a</code>	Non-root users that are listed in <code>/etc/shutdown.allow</code> can use this command to shut down the system
<code>shutdown -f</code>	Skip fsck on reboot
<code>shutdown -F</code>	Force fsck on reboot
<code>shutdown -c</code>	Cancel a shutdown that has been already initiated

System V	Systemd	Action
<pre>/etc/init.d/service operation</pre> <pre>service service operation (Red Hat)</pre> <pre>rcservice operation (SUSE)</pre>	<pre>systemctl operation service</pre>	Perform one of these operations on the specified service: start stop restart status force-reload condrestart try-restart reload
<pre>update-rc.d service defaults (Debian)</pre> <pre>chkconfig --add service (Red Hat)</pre>		Add a service at boot
<pre>update-rc.d -f service remove (Debian)</pre> <pre>chkconfig --del service (Red Hat)</pre>		Remove a service at boot
<pre>update-rc.d -f service \</pre> <pre>start 30 2 3 4 5 . stop 70 0 1 6 .</pre>		Add a service on the default runlevels; create S30 symlinks for starting the service and K70 symlinks for stopping it
<pre>chkconfig --levels 245 service on</pre>		Add the service on runlevels 2 4 5
<pre>chkconfig service on</pre>	<pre>systemctl enable service</pre>	Add the service on default runlevels
<pre>chkconfig service off</pre>	<pre>systemctl disable service</pre>	Remove the service on default runlevels
<pre>chkconfig service</pre>	<pre>systemctl is-enabled service</pre>	Check if the service is enabled on the current runlevel
<pre>chkconfig service reset</pre>		Reset the on/off state of the service for all runlevels to whatever the LSB specifies in the init script
<pre>chkconfig service resetpriorities</pre>		Reset the start/stop priorities of the service for all runlevels to whatever the LSB specifies in the init script
<pre>chkconfig --list service</pre>		Display current configuration of service (its status and the runlevels in which it is active)
<pre>chkconfig</pre> <pre>chkconfig --list</pre>	<pre>systemctl list-unit-files \</pre> <pre>--type=service</pre>	List all active services and their current configuration
<pre>ls /etc/rcn.d (Debian)</pre>		List services started on runlevel <i>n</i>
	<pre>systemctl</pre>	List loaded and active units
	<pre>systemctl --all</pre>	List all units, including inactive ones
	<pre>systemctl -t target</pre>	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.
10:0:wait:/etc/init.d/rc 0
11:1:wait:/etc/init.d/rc 1
12:2:wait:/etc/init.d/rc 2
13:3:wait:/etc/init.d/rc 3
14:4:wait:/etc/init.d/rc 4
15:5:wait:/etc/init.d/rc 5
16:6: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 wait once boot bootwait off ondemand initdefault sysinit powerfail powerwait powerfailnow powerokwait ctrlaltdel kbdtrequest	Process will be restarted when it terminates Process is started at the specified runlevel and <code>init</code> will wait for its termination (i.e. execution of further lines of <code>/etc/inittab</code> stops until the process exits) Process is executed once at the specified runlevel Process is executed at system boot. Runlevels field is ignored Process is executed at system boot and <code>init</code> will wait for its termination. Runlevels field is ignored Does nothing Process is executed when an on-demand runlevel (A, B, C) is called Specifies the default runlevel to boot on. Process field is ignored Process is executed at system boot, before any <code>boot</code> or <code>bootwait</code> entries. Runlevels field is ignored Process is executed when power goes down and an UPS kicks in. <code>init</code> will not wait for its termination Process is executed when power goes down and an UPS kicks in. <code>init</code> will wait for its termination Process is executed when power is down and the UPS battery is almost empty Process is executed when power has been restored from UPS Process is executed when <code>init</code> receives a SIGINT via CTRL ALT DEL Process is executed when a special key combination is pressed on console
process	Process to execute. If prepended by a <code>+</code> , <code>utmp</code> and <code>wtmp</code> 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

`cgdisk` Disk partitioning tool with text-based UI

`gparted` Disk partitioning tool with GUI

`gnome-disks`

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

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

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

<pre>mount cat /proc/mounts cat /etc/mtab</pre>	<p>Display the currently mounted filesystems. The commands <code>mount</code> and <code>umount</code> maintain in <code>/etc/mtab</code> a database of currently mounted filesystems, but <code>/proc/mounts</code> is authoritative</p>
<pre>mount -a</pre>	<p>Mount all devices listed in <code>/etc/fstab</code> (except those indicated as <code>noauto</code>)</p>
<pre>mount -t ext3 /dev/sda /foobar</pre>	<p>Mount a Linux-formatted disk. The mount point (directory) must exist</p>
<pre>mount -t msdos /dev/fd0 /mnt</pre>	<p>Mount a MS-DOS filesystem floppy disk to mount point <code>/mnt</code></p>
<pre>mount /dev/fd0</pre>	<p>Mount a floppy disk. <code>/etc/fstab</code> must contain an entry for <code>/dev/fd0</code></p>
<pre>mount -o remount,rw /</pre>	<p>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</p>
<pre>mount -o nolock 10.7.7.7:/export/ /mnt/nfs</pre>	<p>Mount a NFS share without running NFS daemons. Useful during system recovery</p>
<pre>mount -t iso9660 -o ro,loop=/dev/loop0 cd.img /mnt/cdrom</pre>	<p>Mount a CD-ROM ISO9660 image file like a CD-ROM (via the loop device)</p>
<pre>umount /dev/fd0 umount /mnt</pre>	<p>Unmount a floppy disk that was mounted on <code>/mnt</code> (device must not be busy)</p>
<pre>umount -l /dev/fd0</pre>	<p>Unmount the floppy disk as soon as it is not in use anymore</p>
<p>The UUID (Universal Unique Identifier) of a partition is a 128-bit hash number that is associated to the partition when it is initialized.</p>	
<pre>blkid -U 652b786e-b87f-49d2-af23-8087ced0c667</pre>	<p>Print the name of the specified partition, given its UUID</p>
<pre>blkid -L /boot</pre>	<p>Print the UUID of the specified partition, given its label</p>
<pre>findfs UUID=652b786e-b87f-49d2-af23-8087ced0c667</pre>	<p>Print the name of the specified partition, given its UUID</p>
<pre>findfs LABEL=/boot</pre>	<p>Print the name of the specified partition, given its label</p>
<pre>e2label /dev/sda1</pre>	<p>Print the label of the specified partition, given its name</p>

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 \    Create a 512-Mb swap file
bs=1024 count=512000
```

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

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 <code>auto</code> if detected automatically	
options	defaults	Use the default options: <code>rw, suid, dev, exec, auto, nouser, async</code>
	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 <code>mount -a</code> 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 <code>dump</code> backup utility. <code>0</code> = do not backup	
pass	Order in which the filesystem must be checked by <code>fsck</code> . <code>0</code> = do not check	

<code>df</code>	Report filesystem disk space usage
<code>df -h</code>	Report filesystem disk space usage in human-readable output
<code>df <i>directory</i></code>	Shows on which device the specified <i>directory</i> is mounted
<code>du <i>directory</i></code>	Report disk usage as size of each file inside <i>directory</i>
<code>du -s <i>directory</i></code>	Report the sum of all files contained inside <i>directory</i>
<code>du -sh <i>directory</i></code>	Report the sum of all files contained inside <i>directory</i> in human-readable output
<code>ncdu</code>	Disk usage analyzer with ncurses UI
<code>lsblk</code>	List information about all available block devices
<code>lsscsi</code>	List information about all SCSI devices
<code>blockdev --getbsz /dev/sda1</code>	Get the block size of the specified partition
<code>sync</code>	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
<code>chroot /mnt/sysimage</code>	Start a shell with <code>/mnt/sysimage</code> 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)
<code>mknod /dev/sda</code>	Create a directory allocating the proper inode. Useful during system recovery when experiencing filesystem problems
<code>hdparm</code>	Get/set drive parameters for SATA/IDE devices
<code>hdparm -g /dev/hda</code>	Display drive geometry (cylinders, heads, sectors) of <code>/dev/hda</code>
<code>hdparm -i /dev/hda</code>	Display identification information for <code>/dev/hda</code>
<code>hdparm -tT /dev/hda</code>	Perform disk read benchmarks on the <code>/dev/hda</code> drive
<code>hdparm -p 12 /dev/hda</code>	Reprogram IDE interface chipset of <code>/dev/hda</code> to mode 4. Use with caution!
<code>sdparm</code>	Access drive parameters for SCSI devices

<code>fsck device</code>	Check and repair a Linux filesystem. Warning: filesystem must be unmounted! Corrupted files will be placed into the <code>/lost+found</code> of the partition. The exit code returned is the sum of the following conditions:																
	<table border="0"> <tr> <td>0</td> <td>No errors</td> <td>8</td> <td>Operational error</td> </tr> <tr> <td>1</td> <td>File system errors corrected</td> <td>16</td> <td>Usage or syntax error</td> </tr> <tr> <td>2</td> <td>System should be rebooted</td> <td>32</td> <td>Fsck canceled by user</td> </tr> <tr> <td>4</td> <td>File system errors left uncorrected</td> <td>128</td> <td>Shared library error</td> </tr> </table>	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
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:																
	<code>fsck.ext2</code> aka <code>e2fsck</code>																
	<code>fsck.ext3</code> aka <code>e2fsck</code>																
	<code>fsck.ext4</code> aka <code>e2fsck</code>																
	<code>fsck.msdos</code>																
	<code>fsck.vfat</code>																
	<code>fsck.cramfs</code>																
<code>fsck</code>	Check and repair serially all filesystems listed in <code>/etc/fstab</code>																
<code>fsck -As</code>																	
<code>fsck -f /dev/sda1</code>	Force a filesystem check on <code>/dev/sda1</code> even if it thinks is not necessary																
<code>fsck -y /dev/sda1</code>	During filesystem repair, do not ask questions and assume that the answer is always yes																
<code>fsck.ext2 -c /dev/sda1</code>	Check an ext2 filesystem, running the <code>badblocks</code> command to mark all bad blocks and add them to the bad block inode so they will not be allocated to files or directories																
<code>e2fsck -c /dev/sda1</code>																	
<code>touch /forcefsck</code>	Force a filesystem check after next reboot (Red Hat)																
<code>tune2fs options device</code>	Adjust tunable filesystem parameters on ext2/ext3/ext4 filesystems																
<code>tune2fs -l /dev/sda1</code>	List the contents of the filesystem superblock																
<code>tune2fs -j /dev/sda1</code>	Add a journal to this ext2 filesystem, making it an ext3																
<code>tune2fs -C 7 /dev/sda1</code>	Set the mount count of the filesystem to 7																
<code>tune2fs -c 20 /dev/sda1</code>	Set the filesystem to be checked by fsck after 20 mounts																
<code>tune2fs -i 15d /dev/sda1</code>	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.																	
<code>dumpe2fs options device</code>	Dump ext2/ext3/ext4 filesystem information																
<code>dumpe2fs -h /dev/sda1</code>	Display filesystem's superblock information (e.g. number of mounts, last checks, UUID)																
<code>dumpe2fs /dev/sda1 grep -i superblock</code>	Display locations of superblock (primary and backup) of filesystem																
<code>dumpe2fs -b /dev/sda1</code>	Display blocks that are marked as bad in the filesystem																
<code>resize2fs options device size</code>	Resize an ext2/ext3/ext4 filesystem																
<code>debugfs device</code>	Interactive ext2/ext3/ext4 filesystem debugger																
<code>debugfs -w /dev/sda1</code>	Debug <code>/dev/sda1</code> 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 <code>smartd</code> daemon attempts to poll this information from all drives every 30 minutes, logging all data to syslog.																	
<code>smartctl -a /dev/sda</code>	Print SMART information for drive <code>/dev/sda</code>																
<code>smartctl -s off /dev/sda</code>	Disable SMART monitoring and log collection for drive <code>/dev/sda</code>																
<code>smartctl -t long /dev/sda</code>	Begin an extended SMART self-test on drive <code>/dev/sda</code>																

<code>xfs_growfs options mountpoint</code>	Expand an XFS filesystem (there must be at least one spare new disk partition available)
<code>xfs_info /dev/sda1</code> <code>xfs_growfs -n /dev/sda1</code>	Print XFS filesystem geometry
<code>xfs_check options device</code> <code>xfs_repair options device</code>	Check XFS filesystem consistency Repair a damaged or corrupt XFS filesystem
<code>xfsdump -v silent -f /dev/tape /</code>	Dump the root of a XFS filesystem to tape, with lowest level of verbosity. Incremental and resumed dumps are stored in the inventory database <code>/var/lib/xfsdump/inventory</code>
<code>xfsrestore -f /dev/tape /</code> <code>xfsdump -J - / | xfsrestore -J - /new</code>	Restore a XFS filesystem from tape Copy the contents of a XFS filesystem to another directory (without updating the inventory database)
<code>reiserfstune options device</code> <code>debugreiserfs device</code>	Adjust tunable filesystem parameters on ReiserFS filesystem Interactive ReiserFS filesystem debugger
<code>mkisofs -r -o cdrom.img data/</code>	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	<code>mkisofs</code> Create a ISO9660 filesystem
UDF (Universal Disk Format)	<code>mkudffs</code> Create a UDF filesystem
	<code>udffsck</code> Check a UDF filesystem
	<code>wrudf</code> Maintain a UDF filesystem
	<code>cdrwtool</code> 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	
<code>/etc/sysconfig/autofs</code>	AutoFS configuration file
<code>/etc/auto.master</code>	<p>Master map file for AutoFS. Each line is an indirect map, and each map file stores the configuration for the automounting of the subdir.</p> <pre># mount point map options /net -hosts /- /etc/auto.direct /misc /etc/auto.misc /home /etc/auto.home --timeout=60</pre> <p>The <code>-hosts</code> map tells AutoFS to mount/unmount automatically any export from the NFS server <code>nfsserver</code> when the directory <code>/net/nfsserver/</code> is accessed.</p>

AutoFS map files	
<code>/etc/auto.direct</code>	<p>Direct map file for automounting of a NFS share.</p> <pre># dir filesystem /mydir nfsserver1.foo.org:/myshare</pre>
<code>/etc/auto.misc</code>	<p>Indirect map file for automounting of directory <code>/misc</code>.</p> <pre># subdir options filesystem public -ro,soft,intr ftp.example.org:/pub cd -fstype=iso9660,ro,nosuid,nodev :/dev/cdrom</pre>
<code>/etc/auto.home</code>	<p>Indirect map file for automounting of directory <code>/home</code> on a NFS share. The <code>*</code> wildcard matches any subdir the system attempts to access, and the <code>&</code> variable takes the value of the match.</p> <pre># subdir options filesystem * -rw,soft,intr nfsserver2.bar.org:/home/&</pre>

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

Mark a drive as faulty, before removing it
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  
mdadm --misc -D /dev/md0  
mdadm --misc -o /dev/md0  
mdadm --misc -w /dev/md0
```

Display information about a device
Display detailed information about the RAID array
Mark the RAID array as readonly
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

Non-GRUB bootloaders		
LILO (Linux Loader)		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).
SYSLINUX	SYSLINUX	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.
	ISOLINUX	<p>Able to boot from CD-ROM ISO 9660 filesystems. Used for Live CDs and bootable install CDs.</p> <p>The CD must contain the following files:</p> <pre> isolinux/isolinux.bin ISOLINUX image, from the SYSLINUX distro boot/isolinux/isolinux.cfg ISOLINUX configuration images/ Floppy images to boot kernel/memdisk </pre> <p>The CD can be burnt with the command:</p> <pre> mkisofs -o output.iso -b isolinux/isolinux.bin -c isolinux/boot.cat \ -no-emul-boot -boot-load-size 4 -boot-info-table CDrootdir </pre>
	PXELINUX	<p>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.</p> <p>The boot TFTP server must contain the following files:</p> <pre> /tftpboot/pxelinux.0 PXELINUX image, from the SYSLINUX distro /tftpboot/pxelinux.cfg/ </pre> <p>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:</p> <pre> 01-88-99-aa-bb-cc-dd C000025B C000025 C00002 C0000 C000 C00 C0 C default </pre>
	EXTLINUX	General-purpose bootloader like LILO or GRUB. Now merged with SYSLINUX.

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.

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

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

<code>/boot/grub/menu.lst</code> or <code>/boot/grub/grub.conf</code> GRUB Legacy configuration file	
<code>timeout 10</code>	# Boot the default kernel after 10 seconds
<code>default 0</code>	# Default kernel is 0
# Section 0: Linux boot	
<code>title Debian</code>	# Menu item to show on GRUB bootmenu
<code>root (hd0,0)</code>	# root filesystem is /dev/hda1
<code>kernel /boot/vmlinuz-2.6.24-19-generic</code>	<code>root=/dev/hda1 ro quiet splash</code>
<code>initrd /boot/initrd.img-2.6.24-19-generic</code>	
# Section 1: Windows boot	
<code>title Microsoft Windows XP</code>	
<code>root (hd0,1)</code>	# root filesystem is /dev/hda2
<code>savedefault</code>	
<code>makeactive</code>	# set the active flag on this partition
<code>chainloader +1</code>	# read 1 sector from start of partition and run
# Section 2: Firmware/BIOS update from floppy disk	
<code>title Firmware update</code>	
<code>kernel /memdisk</code>	# boot a floppy disk image
<code>initrd /floppy-img-7.7.7</code>	

Low-level package managers	Debian	Red Hat
Install a package file	<code>dpkg -i package.deb</code>	<code>rpm -i package.rpm</code> <code>rpm -i ftp://host/package.rpm</code> <code>rpm -i http://host/package.rpm</code>
Remove a package	<code>dpkg -r package</code>	<code>rpm -e package</code>
Upgrade a package (and remove old versions)		<code>rpm -U package.rpm</code>
Upgrade a package (only if an old version is already installed)		<code>rpm -F package.rpm</code>
List installed packages and their state	<code>dpkg -l</code>	<code>rpm -qa</code>
List installed packages and their installation date, from newest to oldest		<code>rpm -qa --last</code>
List the content of an installed package	<code>dpkg -L package</code>	<code>rpm -ql package</code>
List the content of a package file	<code>dpkg -c package.deb</code>	<code>rpm -qp1 package.rpm</code>
Show the package containing a specific file	<code>dpkg -S file</code>	<code>rpm -qf file</code>
Verify an installed package		<code>rpm -V package</code>
Reconfigure a package	<code>dpkg-reconfigure package</code>	
Install a package source file		<code>rpm -i package.src.rpm</code>
Compile a package source file		<code>rpm -ba package.spec</code>

High-level package managers	Debian	Red Hat
Install a package	<code>apt-get install package</code>	<code>yum install package</code>
Install a package file		<code>yum install package.rpm</code> <code>yum localinstall package.rpm</code>
Remove a package	<code>apt-get remove package</code>	<code>yum remove package</code>
Upgrade an installed package		<code>yum update package</code>
Upgrade all installed packages	<code>apt-get upgrade</code>	<code>yum update</code>
Upgrade all installed packages and handle dependencies with new versions	<code>apt-get dist-upgrade</code>	
Replace a package with another		<code>yum swap packageout packagein</code>
Get the source code for a package	<code>apt-get source package</code>	
Check for broken dependencies and update package cache	<code>apt-get check</code>	
Fix broken dependencies	<code>apt-get install -f</code>	
Update information on available packages	<code>apt-get update</code>	
List all installed and available packages		<code>yum list</code>
List installed and available packages that match the search term		<code>yum list searchterm</code>
List installed packages		<code>yum list installed</code>
List packages available for install		<code>yum list available</code>
Search for a package	<code>apt-cache search package</code>	<code>yum search package</code>
Show package dependencies	<code>apt-cache depends package</code>	<code>yum deplist package</code>
Show package records	<code>apt-cache show package</code>	<code>yum list package</code>
Show information about a package	<code>apt-cache showpkg package</code>	<code>yum info package</code>
Show the installation history		<code>yum history</code> <code>yum history list</code>
Show the installation history about a package		<code>yum history package package</code> <code>yum history list package package</code>
Update information about package contents	<code>apt-file update</code>	
List the content of an uninstalled package	<code>apt-file list package</code>	
Show which package provides a specific file	<code>apt-file search file</code>	<code>yum whatprovides file</code>
Add a CD-ROM to the sources list	<code>apt-cdrom add</code>	
Download package and all its dependencies		<code>yumdownloader --resolve package</code>
Show URLs that would be downloaded		<code>yumdownloader --urls package</code>
Try to complete unfinished or aborted package installations		<code>yum-complete-transaction</code>
Print list of available repositories	<code>cat /etc/apt/sources.list</code>	<code>yum repolist</code> <code>cat /etc/yum.repos.d/*.repo</code>
Package format	compressed with <code>ar</code>	compressed with <code>cpio</code>

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	<code>aptitude</code>	<code>pirut</code>
	<code>dselect</code>	
	<code>synaptic</code>	

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

<code>/etc/yum.repos.d/fedora.repo</code>	Configuration file for a specific "Fedora" repository
<code>[fedora]</code>	Repository ID
<code>name=Fedora \$releasever - \$basearch</code>	Repository name
<code>baseurl=http://download.fedoraproject.org/pub/fedora/linux/\</code> <code>releases/\$releasever/Everything/\$basearch/os/</code> <code>http://foo.org/fedora/\$releasever/\$basearch/</code> <code>http://bar.org/fedora/\$releasever/\$basearch/</code>	List of URLs to the repository's repodata directory. Can be any of these types: <code>file:///</code> local file <code>file://</code> NFS <code>http://</code> HTTP <code>https://</code> HTTPS <code>ftp://</code> FTP
<code>enabled=1</code>	Whether this repository is enabled
<code>gpgcheck=1</code>	Whether to perform a GPG signature check on the packages downloaded from this repository
<code>failovermethod=priority</code>	Makes yum try the baseurls in the order they're listed. By default, if more than one baseurl is specified, yum chooses one randomly
<code>metalink=https://mirrors.fedoraproject.org/metalink?repo=\</code> <code>fedora-\$releasever&arch=\$basearch</code>	URL to a metalink file that specifies the list of mirrors to use. Can be used with or in alternative to a baseurl
<code>gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-fedora-\</code> <code>\$releasever-\$basearch</code>	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 3 rd 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	<pre>ls | cpio -o > archive.cpio ls | cpio -oF archive.cpio find /home/ | cpio -o > archive.cpio cpio -id < archive.cpio cpio -i -t < archive.cpio</pre>	<p>Create a cpio archive of all files in the current directory</p> <p>Create a cpio archive of all users' home directories</p> <p>Extract all files, recreating the directory structure</p> <p>List the contents of a cpio archive file</p>
gzip	<pre>gzip file gunzip file.gz gunzip -tv file.gz zcat file.gz zgrep pattern file.gz zless file.gz zmore file.gz</pre>	<p>Compress a file with gzip</p> <p>Decompress a gzip-compressed file</p> <p>Test the integrity of a gzip-compressed file</p> <p>Read a gzip-compressed text file</p> <p>grep for a gzip-compressed text file</p> <p>less for a gzip-compressed text file</p> <p>more for a gzip-compressed text file</p>
bzip2	<pre>bzip2 file bunzip2 file.bz2 bzcat file.bz2</pre>	<p>Compress a file with bzip2</p> <p>Decompress a bzip2-compressed file</p> <p>Read a bzip2-compressed text file</p>
7-Zip	<pre>7z a -t7z archive.7z dir/</pre>	<p>Create a 7-Zip archive (has the highest compression ratio)</p>
xz	<pre>xz file unxz file.xz xz -d file.xz xzcat file.xz</pre>	<p>Compress a file with xz</p> <p>Decompress a xz-compressed file</p> <p>Read a xz-compressed file</p>
LZMA	<pre>lzma file xz --format=lzma file unlzma file.lzma xz --format=lzma -d file.lzma lzcat file.lzma xz --format=lzma --d --stdout file.lzma</pre>	<p>Compress a file with LZMA</p> <p>Decompress a LZMA-compressed file</p> <p>Read a LZMA-compressed file</p>
rar	<pre>rar a archive.rar dir/ unrar x archive.rar</pre>	<p>Create a RAR archive</p> <p>Extract a RAR archive</p>
tar	<pre>tar cvf archive.tar dir/ tar cvzf archive.tar.gz dir/ tar xvzf archive.tar.gz tar cvjf archive.tar.bz2 dir/ tar xvjf archive.tar.bz2 tar cvJf archive.tar.xz dir/ tar xvJf archive.tar.xz tar tvf archive.tar</pre>	<p>Create a tarred archive (bundles multiple files in a single one)</p> <p>Create a tarred gzip-compressed archive</p> <p>Extract a tarred gzip-compressed archive</p> <p>Create a tarred bzip2-compressed archive</p> <p>Extract a tarred bzip2-compressed archive</p> <p>Create a tarred xz-compressed archive</p> <p>Extract a tarred xz-compressed archive</p> <p>List the contents of a tarred archive</p>
star	<pre>star -c -f=archive.star dir/ star -x -f=archive.star</pre>	<p>Create a star archive</p> <p>Extract a star archive</p>

<code>man <i>command</i></code>	Show the man page for a command
<code>man 7 <i>command</i></code>	Show section 7 of the command man page
<code>man man</code>	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
<code>whatis <i>command</i></code>	Show the man page's short description for a command
<code>apropos <i>keyword</i></code>	Show the commands whose man page's short description matches the keyword. Inverse of the <code>whatis</code> command
<code>apropos -r <i>regex</i></code> <code>man -k <i>regex</i></code>	Show the commands whose man page's short description matches the regex
<code>man -K <i>regex</i></code>	Show the commands whose man page's full text matches the regex
<code>info <i>command</i></code>	Show the Info documentation for a command
<code>history</code>	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 <code>~/.bash_history</code>
<code>!<i>n</i></code>	Execute command number <i>n</i> in the command line history
<code>history -c</code>	Clear the command line history
<code>history -d <i>n</i></code>	Delete command number <i>n</i> from the command line history
<code>alias ls='ls -lap'</code>	Set up an alias for the <code>ls</code> command
<code>alias</code>	Show defined aliases
<code>unalias ls</code>	Remove the alias for the <code>ls</code> command
<code>\ls</code> <code>/bin/ls</code>	Run the non-aliased version of the <code>ls</code> 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:

<code>grep -- -i <i>file</i></code>	Search for the string "-i" in <i>file</i>
<code>rm -- -rf</code>	Delete a file called "-rf"

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

Bash directory shortcuts	
<code>.</code>	Current directory
<code>..</code>	Parent directory
<code>~</code>	Home directory of current user
<code>~jdoe</code>	Home directory of user jdoe
<code>~-</code>	Previously used directory

<code>cat file</code>	Print a text file
<code>cat file1 file2 > file3</code>	Concatenate text files
<code>cat > file <<EOF</code> <code>line 1</code> <code>line 2</code> <code>line 3</code> <code>EOF</code>	Create a Here Document, storing the lines entered in input to a file
<code>cat file1 > file2</code> <code>> file2 < file1 cat</code>	Copy <i>file1</i> to <i>file2</i> . Note that these can also be binary files of any kind, because <code>cat</code> is able to operate on binary streams as well
<code>tac file</code>	Print or concatenate text files in reverse, from last line to first line
<code>head file</code> <code>head -n 10 file</code>	Print the first 10 lines of a text file
<code>tail file</code> <code>tail -n 10 file</code>	Print the last 10 lines of a text file
<code>tail -f file</code>	Output appended data as the text file grows; useful to read logs in realtime
<code>column file</code>	Format a text file into columns
<code>pr file</code>	Format a text file for a printer
<code>fmt -w 75 file</code>	Format a text file so that each line has a max width of 75 characters
<code>fold -w40 file</code>	Wrap each line of a text file to 40 characters
<code>nl file</code>	Prepend line numbers to a text file
<code>wc file</code>	Print the number of lines, words, and bytes of a text file
<code>join file1 file2</code>	Join lines of two text files on a common field
<code>paste file1 file2</code>	Merge lines of text files
<code>split -l 1 file</code>	Split a text file into 1-line files (named <code>xaa</code> , <code>xab</code> , <code>xac</code> , and so on)
<code>uniq file</code>	Print the unique lines of a text file, omitting consecutive identical lines
<code>sort file</code>	Sort alphabetically the lines of a text file
<code>shuf file</code>	Shuffle randomly the lines of a text file
<code>expand file</code>	Convert tabs into spaces
<code>unexpand file</code>	Convert spaces into tabs
<code>od file</code>	Dump a file into octal (or other formats)
<code>diff file1 file2</code>	Compare two text files line by line and print the differences
<code>cmp file1 file2</code>	Compare two files and print the differences

<code>cut -d: -f3 file</code>	Cut the lines of a file, considering : as the delimiter and printing only the 3 rd field
<code>cut -d: -f1 /etc/passwd</code>	Print the list of user accounts in the system
<code>cut -c3-50 file</code>	Print character 3 to 50 of each line of a file
<code>sed 's/foo/bar/' file</code>	Stream Editor: Replace the first occurrence on a line of foo with bar in <i>file</i> , and print on stdout the result
<code>sed -i 's/foo/bar/' file</code>	Replace foo with bar, overwriting the results in <i>file</i>
<code>sed 's/foo/bar/g' file</code>	Replace all occurrences of foo with bar
<code>sed '0,/foo/s//bar/' file</code>	Replace only the first line match
<code>sed -n '7,13p' file</code>	Print line 7 to 13 of a text file
<code>sed "s/foo/\$var/" file</code>	Replace foo with the value of variable \$var. The double quotes allow for variable expansion
<code>tr a-z A-Z <file</code>	Translate characters: Convert all lowercase into uppercase in a text file
<code>tr [:lower:] [:upper:] <file</code>	
<code>tr -d 0-9 <file</code>	Delete all digits from a text file
<code>tr -d [:digit:] <file</code>	
<code>awk</code>	Interpreter for the AWK programming language, designed for text processing and data extraction
<code>grep foo file</code>	Print the lines of a file containing foo
<code>grep -v foo file</code>	Print the lines of a file not containing foo
<code>grep -e foo -e bar file</code>	Print the lines of a file containing foo or bar
<code>grep -E 'foo|bar' file</code>	
<code>grep -v -e foo -e bar file</code>	Print the lines of a file containing neither foo nor bar
<code>grep -E regex file</code>	Print the lines of a file matching the given Extended Regex
<code>egrep regex file</code>	

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

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

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

File-naming wildcards (globbing)

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

Brace expansion

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

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

<code>cat /etc/passwd | wc -l</code>	Pipe the stdout of command <code>cat</code> to the stdin of command <code>wc</code> (hence printing the number of accounts in the system). Note that piped commands run concurrently
<code>ls > file</code> <code>ls 1> file</code>	Redirect the stdout of command <code>ls</code> to a file (hence writing on a file the content of the current directory). File is overwritten if it already exists, unless the Bash <code>noclobber</code> option is set (via <code>set -o noclobber</code>)
<code>ls >| file</code>	Redirect the stdout of command <code>ls</code> to a file, even if <code>noclobber</code> is set
<code>ls >> file</code> <code>ls 1>> file</code>	Append the stdout of command <code>ls</code> to a file
<code>ls 2> file</code>	Redirect the stderr of command <code>ls</code> to a file (hence writing any error encountered by the command to a file)
<code>ls 2>> file</code>	Append the stderr of command <code>ls</code> to a file
<code>ls 2> /dev/null</code>	Silence any error coming from command <code>ls</code>
<code>mail user@foo.com < file</code>	Redirect a file to the stdin of command <code>mail</code> (hence sending via e-mail a file to the specified email address)
<code>echo "\$(sort file)" > file</code> <code>echo "`sort file`" > file</code> <code>sort file | sponge file</code>	Sort the contents of a file and write the output in the file itself. <code>sort file > file</code> 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
<code>ls 2>&1</code>	Redirect stderr of command <code>ls</code> to stdout
<code>ls > file 2>&1</code>	Redirect both stdout and stderr of command <code>ls</code> to a file
<code>ls &> file</code> <code>ls >& file</code>	Redirect both stdout and stderr of command <code>ls</code> to a file. This usage is not POSIX standard and therefore is not recommended
<code>> file</code>	Create an empty file. If the file exists, its content will be deleted
<code>ls | tee file</code>	<code>tee</code> 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)
<code>ls | tee -a file</code>	<code>tee</code> reads from stdin and appends both to stdout and a file
<code>ls foo* | xargs cat</code>	<code>xargs</code> calls the <code>cat</code> command multiple times for each argument found on stdin (hence printing the content of every file whose filename starts by <code>foo</code>)

```
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 -n 8 MYVAR
read -t 60 MYVAR
read -s MYVAR
```

Read a variable from standard input
Read only max 8 chars from standard input
Read a variable from standard input, timing out after one minute
Read a variable from standard input without echoing to terminal (silent mode)

```
echo $MYVAR
echo -n "message"
printf "message"
```

Print a variable on screen
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.

<code>ps -ef</code> (UNIX options)	List all processes	
<code>ps aux</code> (BSD options)		
<code>pstree PID</code>	Display all processes in hierarchical format. The process tree is rooted at <code>PID</code> , or at <code>init</code> if <code>PID</code> is omitted	
<code>pidof process</code>	Show PID of <code>process</code>	
<code>top</code>	Monitor processes in realtime	
<code>htop</code>	Monitor processes in realtime (ncurses UI)	
<code>ipcs</code>	Show IPC facilities information (shared memory, message queues, and semaphores)	
<code>kill -9 1138</code>	Send a signal 9 (SIGKILL) to process 1138, hence killing it	
<code>killall -9 sshd</code>	Kill processes whose name is <code>sshd</code>	
<code>pgrep -u root sshd</code>	Show processes whose name is <code>sshd</code> and are owned by <code>root</code>	Note: <code>pgrep</code> and <code>pkill</code> accept the same options
<code>pkill -9 -u root sshd</code>	Kill processes whose name is <code>sshd</code> and are owned by <code>root</code>	
<code>xkill</code>	Interactive program to kill a process by its X GUI resource	
<code>jobs</code>	List all jobs (i.e. processes whose parent is a Bash shell)	
<code>CTRL Z</code>	Suspend a job, putting it in the stopped state (send a <code>SIGTSTP</code>)	
<code>bg %1</code>	Put job #1 in the background (send a <code>SIGCONT</code>)	
<code>fg %1</code>	Resume job #1 in the foreground and make it the current job (send a <code>SIGCONT</code>)	
<code>kill %1</code>	Kill job #1	
When a Bash shell is terminated cleanly via <code>exit</code> , its jobs will become child of the Bash's parent and will continue running. When a Bash is killed instead, it issues a <code>SIGHUP</code> to his children which will terminate.		
<code>nohup myscript.sh</code>	Prevent a process from terminating (receiving a <code>SIGHUP</code>) 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.		
<code>nice -n -5 command</code>	Start a command with a niceness of -5. If niceness is omitted, a default value of 10 is used	
<code>renice -5 command</code>	Change the niceness of a running command to -5	
<code>strace command</code>	Trace the execution of a command, intercepting and printing the system calls called by a process and the signals received by a process	
<code>(command) & pid=\$!; sleep n; kill -9 \$pid</code>	Run a command and kill it after <code>n</code> seconds	
<code>:(){ :|:& };:</code>	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

<code>vmstat</code>	Print a report about virtual memory statistics: processes, memory, paging, block I/O, traps, disks, and CPU activity
<code>iostat</code>	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
<code>mpstat</code>	Print a report about processor activities
<code>vmstat 2 5</code> <code>iostat 2 5</code> <code>mpstat 2 5</code>	Print the relevant report every 2 seconds, for 5 times
<code>iotop</code>	Display I/O usage by processes in the system
<code>atop</code>	Advanced system monitor that displays the load on CPU, RAM, disk, and network
<code>free</code>	Show the amount of free and used memory in the system
<code>uptime</code>	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
<code>time command</code>	Execute <i>command</i> and, at its completion, write to stderr timing statistics about the run i.e. elapsed real time, user CPU time, system CPU time
<code>sar</code>	Show reports about system activity. Reports are generated from data collected via the cron job <code>sysstat</code> and stored in <code>/var/log/sa/sn</code> , where <i>n</i> is the day of the month
<code>sar -n DEV</code>	Show reports about network activity (received and transmitted packets per second)
<code>sar -f /var/log/sa/s19 \</code> <code>-s 06:00:00 -e 06:30:00</code>	Show reports for system activity from 6 to 6:30 AM on the 19 th of the month
<code>powertop</code>	Power consumption and power management diagnosis tool
<code>sysbench</code>	Multithreaded benchmark tool able to monitor different OS parameters: file I/O, scheduler, memory allocation, thread implementation, databases
<code>inxi</code>	Debugging tool to rapidly and easily gather system information and configuration

Linux monitoring tools

<code>collectd</code>	System statistics collector
<code>Nagios</code>	System monitor and alert
<code>MRTG</code>	Network load monitor
<code>Cacti</code>	Network monitor
<code>Munin</code>	System and network monitor and alert
<code>Zabbix</code>	System and network monitor and alert
<code>Centreon</code>	System and network monitor and alert

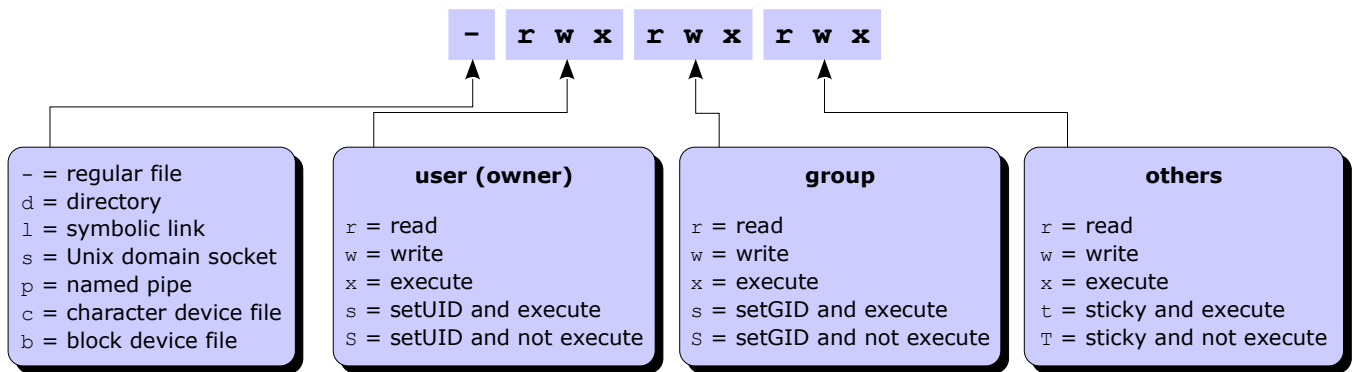
Output of command <code>vmstat</code>																
procs		memory				swap		io		system			cpu			
r	b	swpd	free	buff	cache	si	so	bi	bo	in	cs	us	sy	id	wa	st
0	0	0	296724	267120	3393400	0	0	17	56	0	3	2	2	95	1	0

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)
	free	Free memory (idle)
	buff	Memory used as buffers in Kb
	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)
	sy	Time spent running system code (kernel)
	id	Time spent idle in percentage of total CPU time
	wa	Time spent waiting for I/O
	st	Time stolen from a virtual machine

Output of command <code>free</code>						
	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           Set read, write, and execute permission to user; set execute permission to group
chmod u=rwx,g=x file

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

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 <code>dump</code> program
D	When directory is modified, changes are written synchronously on disk (equivalent to <code>dirsync</code> 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 <code>sync</code> 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.

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

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

<code>setfacl -m d:u:user:permissions dir</code>	As above, but set a default ACL instead of an access ACL.
<code>setfacl -d -m u:user:permissions dir</code>	This applies to all commands above

<code>getfacl file</code>	Display the access (and default, if any) ACL for a file
<code>getfacl file1 | setfacl --set-file=- file2</code>	Copy the ACL of <i>file1</i> and apply it to <i>file2</i>
<code>getfacl --access dir | setfacl -d -M- dir</code>	Copy the access ACL of a directory and set it as default ACL
<code>chacl options</code>	Change an ACL. This is an IRIX-compatibility command
<code>man acl</code>	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 -li` Show a listing of the directory with the files' inode numbers

`df -li` 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	<code>ln file hardlink</code>	<code>ln -s file symlink</code>
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	<code>rwXrwxrwx</code>
Link attributes	- (regular file)	<code>l</code> (symbolic link)
Inode number	The same as the original file	A new inode number

<code>find / -name "foo*"</code>	Find all files, starting from the root dir, whose name start with foo
<code>find / -name "foo*" -print</code>	
<code>find / -name "foo*" -exec chmod 700 {} \;</code>	Find all files whose name start with foo and apply permission 700 to all of them
<code>find / -name "foo*" -ok chmod 700 {} \;</code>	Find all files whose name start with foo and apply permission 700 to all of them, asking for confirmation before each file
<code>find / -size +128M</code>	Find all files larger than 128 Mb
<code>find / -ctime +10</code>	Find all files created more than 10 days ago
<code>find / -perm -4000 -type f</code>	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)
<code>find / -perm -2000 -type f</code>	Find all files with SGID set
<code>find /home/jdoe/path -type f \</code> <code>-newermt "May 4 14:50" -delete</code>	Find and delete all files newer than the specified datetime. Using <code>-delete</code> is preferable to using <code>-exec rm {} \;</code>
<code>find . -type f -print -exec cat {} \;</code>	Print all files in the current directory with a filename header
<code>locate command</code>	Locate <i>command</i> by searching the file index <code>/etc/updatedb.conf</code> , not by actually walking the filesystem. The search is fast but will only held results relative to the last rebuilding of the file index
<code>slocate command</code>	
<code>updatedb</code>	Rebuild the file index
<code>which command</code>	Locate a binary executable command within the PATH
<code>which -a command</code>	Locate all matches of a command, not only the first one
<code>whereis command</code>	Locate the binary, source, and manpage files for a command
<code>whereis -b command</code>	Locate the binary files for a command
<code>whereis -s command</code>	Locate the source files for a command
<code>whereis -m command</code>	Locate the manpage files for a command
<code>type command</code>	Determine if a command is a program or a built-in (i.e. an internal feature of the shell)
<code>file myfile</code>	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          Enable a Bash option
set -o long_option
set +option          Disable a Bash option
set +o long_option

set -v                Enable printing of shell input lines as they are read
set -o verbose

set -x                Enable printing of command traces before execution of each command (debug mode)
set -o xtrace

```

To run a script with a Bash option enabled, either:

- Run the script with `bash -option scriptfile.sh`
- Specify the shebang line as `#!/bin/bash -option`
- 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`.

<code>set</code>	Display all variables
<code>env</code>	Display all environment variables
<code>export MYVAR</code>	Export a variable, making it an environment variable
<code>MYVAR=value</code> <code>((MYVAR=value))</code> <code>let "MYVAR=value"</code>	Set a variable
<code>echo \$MYVAR</code> <code>echo \${MYVAR}</code>	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 <code>{}</code> to make it unambiguous
<code>MYVAR=\$((2+2))</code> <code>MYVAR=\$((2+2))</code> <code>FOO=\$((BAR + 42))</code> <code>FOO=`expr \$BAR + 42`</code>	Evaluate a numeric expression and assign the result to another variable
<code>MYVAR=`date`</code> <code>MYVAR=\$(date)</code>	Assign to a variable the output resulting from a command
<code>for i in \$(ls)</code> <code>do</code> <code> echo "Item: \$i"</code> <code>done</code>	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
<code>unset MYVAR</code>	Delete a variable
<code>set \${MYVAR:=value}</code> <code>MYVAR=\${MYVAR:-value}</code>	Set a variable, only if it is not already set (i.e. does not exist) or is null
<code>echo \${MYVAR:-message}</code>	If variable exists and is not null, print its value, otherwise print <i>message</i>
<code>echo \${MYVAR:+message}</code>	If variable exists and is not null, print <i>message</i> , otherwise print nothing
<code>echo \${MYVAR,,}</code>	Print a string variable in lowercase

Bash built-in variables

<code>\$0</code>	Script name
<code>\$n</code>	<i>n</i> th argument passed to the script or function
<code>\$@</code>	All arguments passed to the script or function (each argument as a separate word)
<code>\$*</code>	All arguments passed to the script or function (all arguments as a single word)
<code>\$#</code>	Number of arguments passed to the script or function
<code>\$?</code>	Exit status of the last executed command
<code>\${PIPESTATUS[n]}</code>	Exit status of the <i>n</i> th command in the executed pipeline
<code>\$\$</code>	PID of the script in which this variable is called
<code>\$SHLVL</code>	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	
<code>source myscript.sh</code> <code>. myscript.sh</code>	Script execution takes place in the same shell. Variables defined and exported in the script are seen by the shell when the script exits
<code>bash myscript.sh</code> <code>./myscript.sh</code> (file must be executable)	Script execution spawns a new shell

<code>command &</code>	Execute <i>command</i> in the background
<code>command1; command2</code>	Execute <i>command 1</i> and then <i>command 2</i>
<code>command1 && command2</code>	Execute <i>command 2</i> only if <i>command 1</i> executed successfully (exit status = 0)
<code>command1 || command2</code>	Execute <i>command 2</i> only if <i>command 1</i> did not execute successfully (exit status > 0)
<code>(command1 && command2)</code>	Group commands together for evaluation priority
<code>(command)</code>	Run <i>command</i> in a subshell. This is used to isolate <i>command</i> 's effects, as variable assignments and other changes to the shell environment operated by <i>command</i> will not remain after <i>command</i> completes
<code>exit</code>	Terminate a script
<code>exit n</code>	Terminate a script with the specified exit status number <i>n</i> . By convention, a 0 exit status is used if the script executed successfully, non-zero otherwise
<code>command || exit 1</code>	(To be used inside a script.) Exit the script if <i>command</i> fails
<code>if command</code> <code>then</code> <code>echo "Success"</code> <code>else</code> <code>echo "Fail"</code> <code>fi</code>	Run a command, then evaluate whether it exited successfully or failed
<code>if [\$? -eq 0]</code> <code>then</code> <code>echo "Success"</code> <code>else</code> <code>echo "Fail"</code> <code>fi</code>	Evaluate whether the last executed command exited successfully or failed
<code>function myfunc { commands }</code> <code>myfunc() { commands }</code>	Define a function
<code>myfunc arg1 arg2 ...</code>	Call a function
<code>typeset -f</code>	Show functions defined in the current Bash session
<code>for DIR in `ls`</code> <code>do</code> <code>rmdir \$DIR</code> <code>done</code>	Loop through a list of directories

<code>watch command</code>	Execute <i>command</i> every 2 seconds
<code>watch -d -n 1 command</code>	Execute <i>command</i> every second, highlighting the differences in the output
<code>timeout 30s command</code>	Execute <i>command</i> and kill it after 30 seconds
<code>time command</code>	Execute <i>command</i> and print its execution time: elapsed real time between invocation and termination, user CPU time, and system CPU time
<code>command | ts</code>	Prepend a timestamp to each line of the output of <i>command</i>
<code>sleep 5</code>	Pause for 5 seconds
<code>usleep 5000</code>	Pause for 5000 microseconds
<code>expect</code>	Dialogue with interactive programs according to a script, analyzing what can be expected from the interactive program and replying accordingly
<code>parallel command</code>	Run a command in parallel. This is used to operate on multiple inputs, similarly to <code>xargs</code>
<code>zenity</code>	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			
-eq	Equal to	-e or -a	Exists	Expression operators	
-ne	Not equal to	-d	Is a directory	-a	Logical AND
-lt	Less than	-b	Is a block special file	-o	Logical OR
-le	Less than or equal to	-c	Is a character special file	!	Logical NOT
-gt	Greater than	-f	Is a regular file	\ (\)	Priority
-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	<i>string</i> : <i>regex</i>	String matches regex
!=	Not equal to	- Minus	match <i>string</i> <i>regex</i>	
<	Less than	* Multiplied by	substr <i>string</i> <i>pos</i> <i>length</i>	Substring
<=	Less than or equal to	/ Divided by	index <i>string</i> <i>chars</i>	Index of any chars in string
>	Greater than	% Remainder	length <i>string</i>	String length
>=	Greater than or equal to			

Tests	
<pre>if [test 1] then [command block 1] elif [test 2] then [command block 2] else [command block 3] fi</pre>	<pre>case \$VAR in pattern1) command1 command1bis ;; pattern2) command2 ;; *) command3 ;; esac</pre>

Loops		
<pre>while [test] do [command block] done</pre> <p>The <i>command block</i> executes as long as <i>test</i> is true</p>	<pre>until [test] do [command block] done</pre> <p>The <i>command block</i> executes as long as <i>test</i> is false</p>	<pre>for I in [list] do [command block] done</pre> <p>The <i>command block</i> executes for each I in <i>list</i></p>
<pre>i=0 while [\$i -le 7] do echo \$i let i++ done</pre>	<pre>i=0 until [\$i -gt 7] do echo \$i let i++ done</pre>	<pre>for i in 0 1 2 3 4 5 6 7 do echo \$i done</pre> <hr/> <pre>for i in {0..7} do echo \$i done</pre> <hr/> <pre>start=0 end=7 for i in \$(seq \$start \$end) do echo \$i done</pre> <hr/> <pre>start=0 end=7 for ((i = start; i <= end; i++)) do echo \$i done</pre>
<pre>break</pre>	Exit a loop	
<pre>continue</pre>	Jump to the next iteration	

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

less pager commands	
<code>h</code>	Help
<code>g</code>	Go to first line in the file
<code>G</code>	Go to last line in the file
<code>F</code>	Go to the end of the file, and move forward automatically as the file grows
<code>CTRL C</code>	Stop moving forward
<code>-N</code>	Show line numbers
<code>-n</code>	Don't show line numbers
<code>=</code>	Show information about the file
<code>CTRL G</code>	Show current and total line number, byte, and percentage of the file read
<code>q</code>	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		then use the arrow keys to select a block of text
V	Go to Visual mode, line-wise		
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
O	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 <i>string</i> forward	n	Search for next match of <i>string</i>
?string	Search for <i>string</i> backwards	N	Search for previous match of <i>string</i>
:s/s1/s2/	Replace the first occurrence of <i>s1</i> with <i>s2</i> in the current line		
:s/s1/s2/g	Replace globally every occurrence of <i>s1</i> with <i>s2</i> in the current line		
:%s/s1/s2/g	Replace globally every occurrence of <i>s1</i> with <i>s2</i> in the whole file		
:%s/s1/s2/gc	Replace globally every occurrence of <i>s1</i> with <i>s2</i> 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 <i>program</i>		
:r file	Read <i>file</i> 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 <i>file</i>		
:wq	Save changes and quit		
:x			
ZZ			
: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 <code>d c J m :s t u</code>
aw	Automatic write on commands <code>:n ! e# ^^ :rew ^} :tag</code>
bf	Discard control characters from input
dir= <i>tmpdir</i>	Set <i>tmpdir</i> 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=LlPLPPPQbPpP	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
t1=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 nooption` 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 TABLES;
USE CompanyDatabase;
SELECT DATABASE();
```

Show all existing databases
 Show all tables from the selected database
 Choose which database to use
 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);

DESCRIBE customers;

SHOW CREATE TABLE customers;

DROP TABLE customers;

DROP DATABASE CompanyDatabase;

ALTER TABLE customers MODIFY city VARCHAR(32);
```

Create an index for faster searches

```
INSERT INTO customers (firstname,lastname,dob)
VALUES ('Arthur','Dent',1959-08-01), ('Trillian','',1971-03-19);

DELETE FROM customers WHERE firstname LIKE 'Zaphod';

UPDATE customers SET city = 'London' WHERE zipcode = '00789';
```

Describe the columns of a table
 Show the code used to create a table
 Delete a table
 Delete a database
 Modify the type of a column

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

Insert a new record in a table
 Delete some records in a table
 Modify records in a table

```
COMMIT;
ROLLBACK;
```

Create a view

```
START TRANSACTION;
BEGIN;
```

Commit changes to the database
 Rollback the current transaction, canceling any changes done during it
 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 customers that satisfy any of the two requirements

```
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123'
INTERSECT
```

Select customers that satisfy both of the two requirements

```
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```

```
SELECT firstname, lastname FROM customers WHERE zipcode = '00123'
EXCEPT
```

Select customers that satisfy the first requirement but not the second

```
SELECT firstname, lastname FROM customers WHERE cusid > 4242001;
```

SQL	MySQL	Operation
<pre>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;</pre>	<pre>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);</pre>	Perform a join (aka inner join) of two tables to select data that are in a relationship
<pre>SELECT customers.name, payments.bill FROM customers CROSS JOIN payments;</pre>	<pre>SELECT customers.name, payments.bill FROM customers JOIN payments; (ON clause is missing)</pre>	Perform a Cartesian product (aka cross join) of two tables
<pre>SELECT customers.name, payments.bill FROM customers LEFT JOIN payments ON customers.cusid = payments.cusid;</pre>		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
<pre>SELECT customers.name, payments.bill FROM customers RIGHT JOIN payments ON customers.cusid = payments.cusid;</pre>		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.

<code>mysqld_safe</code>	Start the MySQL server (<code>mysqld</code>) with safety features such as restarting the server if errors occur and logging runtime information to the error logfile. Recommended
<code>mysql_install_db</code> (deprecated) <code>mysqld --initialize</code>	Initialize the MySQL data directory, create system tables, and set up an administrative account. To be run after installing the MySQL server
<code>mysql_secure_installation</code>	Set password for root, remove anonymous users, disable remote root login, and remove test database. To be run after installing the MySQL server
<code>mysql -u root -p</code>	Login to MySQL as root and prompt for the password
<code>mysql -u root -ppassword</code>	Login to MySQL as root with the specified <i>password</i>
<code>mysql -u root -p -h host -P port</code>	Login to the specified remote MySQL server and port
<code>mysql -u root -p -eNB'SHOW DATABASES'</code>	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 +-|
<code>mysqldump -u root -p --all-databases > alldbs.sql</code>	Backup all databases to a dump file
<code>mysqldump -u root -p MyDatabase > mydb.sql</code>	Backup a database to a dump file
<code>mysqldump -u root -p --databases MyDb1 MyDb2 > dbs.sql</code>	Backup several databases to a dump file
<code>mysqldump -u root -p MyDatabase t1 t2 > tables.sql</code>	Backup some tables of a database to a dump file
<code>mysql -u root -p < alldbsbak.sql</code>	Restore all databases from a dump file (which contains a complete dump of a MySQL server)
<code>mysql -u root -p MyDatabase < mydbbak.sql</code>	Restore a specific database from a dump file (which contains one database)
<code>mysql_upgrade -u root -p</code>	Check all tables in all databases for incompatibilities with the current version of MySQL
<code>mysqlcheck options</code>	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
<code>mysqlcheck --check db table</code>	Check the specified table of the specified database
<code>mysqlcheck --check --databases db1 db2</code>	Check the specified databases
<code>mysqlcheck --check --all-databases</code>	Check all databases
<code>mysqltuner.pl</code>	Review the current MySQL installation configuration for performances and stability
<code>mysqlreport</code> (obsolete)	Generate a user-friendly report of MySQL status values
<code>mytop</code>	Monitor MySQL processes and queries
<code>innotop</code>	Monitor MySQL InnoDB transactions

```

SELECT Host, User FROM mysql.user;

CREATE USER 'john'@'localhost' IDENTIFIED BY 'p4ssw0rd';

DROP USER 'john'@'localhost';

SET PASSWORD FOR 'john'@'localhost' = PASSWORD('p4ssw0rd');
SET PASSWORD FOR 'john'@'localhost' = '*7E684A3DF6273CD1B6DE53';

SHOW GRANTS FOR 'john'@'localhost';

GRANT ALL PRIVILEGES ON MyDatabase.* TO 'john'@'localhost';

REVOKE ALL PRIVILEGES ON MyDatabase.* FROM 'john'@'localhost';

GRANT SELECT ON *.* TO 'john'@'localhost' IDENTIFIED BY 'p4ssw0rd';
GRANT SELECT ON *.* TO 'john'@'localhost' IDENTIFIED BY PASSWORD
 '*7E684A3DF6273CD1B6DE53';

FLUSH PRIVILEGES;

```

```

SELECT * INTO OUTFILE '/tmp/mytable.csv'
FIELDS TERMINATED BY ',' OPTIONALLY ENCLOSED BY '"'
LINES TERMINATED BY '\n' FROM MyDatabase.mytable;

```

```

USE MyDatabase; SOURCE mydbbak.sql;

USE MyDatabase; LOAD DATA LOCAL INFILE 'foofile' INTO TABLE foo;

```

```

statement;
statement\g
statement\G

```

```

SELECT /*!99999 comment*/ * FROM MyDatabase.mytable;
SELECT /*!n statement*/ * FROM MyDatabase.mytable;

```

```
\c
```

```
\! command
```

```
TEE logfile
```

List all MySQL users

Create a MySQL user and set his password

Delete a MySQL user

Set a password for a MySQL user.
The password can be specified either in plaintext or by its hash value

Show permissions for a user

Grant permissions to a user

Revoke permissions from a user; must match the granted permission on the same database or table

Create a MySQL user and set his grants

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

Export a table to a CSV file

Restore a database from a dump file

Populate a table with data from file (one record per line, values separated by tabs)

Send a SQL statement to the server

Display result in vertical format, showing each record in multiple rows

Insert a comment

The commented *statement* is executed only if MySQL is version *n* or higher

Cancel current input

Run a shell command

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 '%srep%';	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 <i>table</i> ; SHOW CREATE VIEW <i>view</i> ;	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	<ul style="list-style-type: none"> <code>/etc/x11/xdm/Xaccess</code> Control inbound requests from remote hosts <code>/etc/x11/xdm/Xresources</code> Configuration settings for X applications and the login screen <code>/etc/x11/xdm/Xservers</code> Association of X displays with local X server software, or with X terminals via XDMCP <code>/etc/x11/xdm/Xsession</code> Script launched by xdm after login <code>/etc/x11/xdm/Xsetup_0</code> Script launched before the graphical login screen <code>/etc/x11/xdm/xdm-config</code> Association of all xdm configuration files 	Defined in <code>/etc/x11/xdm/Xresources</code> by the line: <pre>xlogin*greeting: \ Debian GNU/Linux (CLIENTHOST)</pre>
gdm GNOME Display Manager	<code>/etc/gdm/gdm.conf</code> or <code>/etc/gdm/custom.conf</code>	Configured via <code>gdmsetup</code>
kdm KDE Display Manager	<code>/etc/kde/kdm/kdmrc</code>	Configured via <code>kdm_config</code>

<code>/etc/init.d/xdm start</code>	Start the X Display Manager
<code>/etc/init.d/gdm start</code>	
<code>/etc/init.d/kdm start</code>	
<code>xorgconfig</code> (Debian)	Configure X (text mode)
<code>Xorg -configure</code> (Red Hat)	
<code>xorgcfg</code> (Debian)	Configure X (graphical mode)
<code>system-config-display</code> (Red Hat)	
<code>X -version</code>	Show which version of X is running
<code>xdpyinfo</code>	Display information about the X server
<code>xwininfo</code>	Display information about windows
<code>xhost + 10.3.3.3</code>	Add or remove 10.3.3.3 to the list of hosts allowed to make X connections to the local machine
<code>xhost - 10.3.3.3</code>	
<code>switchdesk gde</code>	Switch to the GDE Display Manager at runtime
<code>gnome-shell --version</code>	Show which version of GNOME is running
<code>/etc/X11/xorg.conf</code>	Configuration file for X
<code>~/.Xresources</code>	Configuration settings for X applications, in the form <i>program*resource: value</i>
<code>\$DISPLAY</code>	Environment variable defining the display name of the X server, in the form <i>hostname:displaynumber.screennumber</i>
<code>/etc/inittab</code>	Instruct <code>init</code> to launch XDM at runlevel 5: <code>x:5:respawn:/usr/X11R6/bin/xdm -nodaemon</code>
<code>/etc/sysconfig/desktop</code>	Define GNOME as the default Display Environment and Display Manager: <code>desktop="gde"</code> <code>displaymanager="gdm"</code>

<code>xdotool</code>	X automation tool
<code>xdotool getwindowfocus</code>	Get the ID of the currently focused window (usually the terminal where this command is typed)
<code>xdotool selectwindow</code>	Pop up an X cursor and get the ID of the window selected by it
<code>xdotool key --window 12345678 Return</code>	Simulate a Return keystroke inside window ID 12345678
<code>xprop</code>	X property displayer
<code>xrandr</code>	Show screen(s) size and resolution
<code>xrandr -q</code>	
<code>xrandr --output eDP1 --right-of VGA1</code>	Extend the screen on an additional VGA physical screen situated to the left
<code>xsel</code>	Manipulate the X selection (primary, secondary, and clipboard)
<code>xsel -b < file</code>	Put the contents of a file in the X clipboard
<code>xsel -b -a < file</code>	Append the contents of a file to the X clipboard
<code>xsel -b -o</code>	Output onscreen the contents of the X clipboard
<code>mkfontdir</code>	Catalog the newly installed fonts in the new directory
<code>xset fp+ /usr/local/fonts</code>	Dynamically add new installed fonts in <code>/usr/local/fonts</code> to the X server
<code>xf86-config</code>	Start the X font server
<code>fc-cache</code>	Install fonts and build font information cache

Main		Latin 1		Latin 2			
BackSpace	ff08	space	0020	questiondown	00bf	Aogonek	01a1
Tab	ff09	exclam	0021	Agrave	00c0	breve	01a2
Linefeed	ff0a	quotedbl	0022	Acute	00c1	Lstroke	01a3
Clear	ff0b	numbersign	0023	Acircumflex	00c2	Lcaron	01a5
Return	ff0d	dollar	0024	Atilde	00c3	Sacute	01a6
Pause	ff13	percent	0025	Adiaeresis	00c4	Scaron	01a9
Scroll_Lock	ff14	ampersand	0026	Aring	00c5	Scedilla	01aa
Sys_Req	ff15	apostrophe	0027	AE	00c6	Tcaron	01ab
Escape	ff1b	quoteright	0027	Ccedilla	00c7	Zacute	01ac
Delete	ffff	parenleft	0028	Egrave	00c8	Zcaron	01ae
Cursor control		parenright	0029	Ecute	00c9	Zabovedot	01af
		asterisk	002a	Ecircumflex	00ca	aogonek	01b1
		plus	002b	Ediaeresis	00cb	ogonek	01b2
Home	ff50	comma	002c	Igrave	00cc	lstroke	01b3
Left	ff51	minus	002d	Iacute	00cd	lcaron	01b5
Up	ff52	period	002e	Icircumflex	00ce	sacute	01b6
Right	ff53	slash	002f	Idiaeresis	00cf	caron	01b7
Down	ff54	0 - 9	0030 - 0039	ETH	00d0	scaron	01b9
Prior	ff55	colon	003a	Eth	00d0	scedilla	01ba
Page_Up	ff55	semicolon	003b	Ntilde	00d1	tcaron	01bb
Next	ff56	less	003c	Ograve	00d2	zacute	01bc
Page_Down	ff56	equal	003d	Oacute	00d3	doubleacute	01bd
End	ff57	greater	003e	Ocircumflex	00d4	zcaron	01be
Begin	ff58	question	003f	Otilde	00d5	zabovedot	01bf
Misc functions		at	0040	Odiaeresis	00d6	Racute	01c0
		A - Z	0041 - 005a	multiply	00d7	Abreve	01c3
Select	ff60	bracketleft	005b	Oslash	00d8	Lacute	01c5
Print	ff61	backslash	005c	Ooblique	00d8	Cacute	01c6
Execute	ff62	bracketright	005d	Ugrave	00d9	Ccaron	01c8
Insert	ff63	asciicircum	005e	Uacute	00da	Eogonek	01ca
Undo	ff65	underscore	005f	Ucircumflex	00db	Ecaron	01cc
Redo	ff66	grave	0060	Udiaeresis	00dc	Dcaron	01cf
Menu	ff67	quoteleft	0060	Yacute	00dd	Dstroke	01d0
Find	ff68	a - z	0061 - 007a	THORN	00de	Nacute	01d1
Cancel	ff69	braceleft	007b	Thorn	00de	Ncaron	01d2
Help	ff6a	bar	007c	ssharp	00df	Odoubleacute	01d5
Break	ff6b	braceright	007d	agrave	00e0	Rcaron	01d8
Mode_switch	ff7e	asciitilde	007e	aacute	00e1	Uring	01d9
script_switch	ff7e	nobreakspace	00a0	acircumflex	00e2	Udoubleacute	01db
Num_Lock	ff7f	exclamdown	00a1	atilde	00e3	Tcedilla	01de
Modifiers		cent	00a2	adiaeresis	00e4	racute	01e0
		sterling	00a3	aring	00e5	abreve	01e3
Shift_L	ffe1	currency	00a4	ae	00e6	lacute	01e5
Shift_R	ffe2	yen	00a5	ccedilla	00e7	cacute	01e6
Control_L	ffe3	brokenbar	00a6	egrave	00e8	ccaron	01e8
Control_R	ffe4	section	00a7	ecute	00e9	eogonek	01ea
Caps_Lock	ffe5	diaeresis	00a8	ecircumflex	00ea	ecaron	01ec
Shift_Lock	ffe6	copyright	00a9	ediaeresis	00eb	dcaron	01ef
Meta_L	ffe7	ordfeminine	00aa	igrave	00ec	dstroke	01f0
Meta_R	ffe8	guillemotleft	00ab	iacute	00ed	nacute	01f1
Alt_L	ffe9	notsign	00ac	icircumflex	00ee	ncaron	01f2
Alt_R	ffea	hyphen	00ad	idiaeresis	00ef	odoubleacute	01f5
Super_L	ffeb	registered	00ae	eth	00f0	rcaron	01f8
Super_R	ffec	macron	00af	ntilde	00f1	uring	01f9
Hyper_L	ffed	degree	00b0	ograve	00f2	udoubleacute	01fb
Hyper_R	ffee	plusminus	00b1	oacute	00f3	tcedilla	01fe
		twosuperior	00b2	ocircumflex	00f4	abovedot	01ff
		threesuperior	00b3	otilde	00f5		
		acute	00b4	odiaeresis	00f6		
		mu	00b5	division	00f7		
		paragraph	00b6	oslash	00f8		
		periodcentered	00b7	ooblique	00f8		
		cedilla	00b8	ugrave	00f9		
		onesuperior	00b9	uacute	00fa		
		masculine	00ba	ucircumflex	00fb		
		guillemotright	00bb	udiaeresis	00fc		
		onequarter	00bc	yacute	00fd		
		onehalf	00bd	thorn	00fe		
		threequarters	00be	ydiaeresis	00ff		

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.

<code>useradd -m jdoe</code>	Create a user account, creating and populating his homedir from <code>/etc/skel</code>
<code>useradd -mc "John Doe" jdoe</code>	Create a user account, specifying his full name
<code>useradd -ms /bin/ksh jdoe</code>	Create a user account, specifying his login shell
<code>useradd -D</code>	Show default values for user account creation, as specified in <code>/etc/login.defs</code> and <code>/etc/default/useradd</code>
<code>usermod -c "Jonas Doe" jdoe</code>	Modify the GECOS field of a user account
<code>usermod -L jdoe</code>	Lock a user account
<code>usermod -U jdoe</code>	Unlock a user account
Many options for <code>usermod</code> are the same as <code>useradd</code> options.	
<code>userdel -r jdoe</code>	Delete a user and his homedir
<code>chfn jdoe</code>	Change the GECOS field of a user
<code>chsh jdoe</code>	Change the login shell of a user
<code>passwd jdoe</code>	Change the password of a user
<code>passwd -l jdoe</code>	Lock a user account
<code>passwd -S jdoe</code>	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
<code>chage -E 2013-02-14 jdoe</code>	Change the password expiration date; account will be locked at that date
<code>chage -d 13111 jdoe</code>	Change the date (in number of days since 1 January 1970) of last password change
<code>chage -d 0 jdoe</code>	Force the user to change password at his next login
<code>chage -M 30 jdoe</code>	Change the max number of days during which a password is valid
<code>chage -m 7 jdoe</code>	Change the min number of days between password changes
<code>chage -W 15 jdoe</code>	Change the number of days before password expiration that the user will be warned
<code>chage -I 3 jdoe</code>	Change the number of days after password expiration before the account is locked
<code>chage -l jdoe</code>	List password aging information for a user
<code>groupadd staff</code>	Create a group
<code>groupmod -n newstaff staff</code>	Change a group name
<code>groupdel staff</code>	Delete a group
<code>gpasswd staff</code>	Set or change the password of a group
<code>gpasswd -a jdoe staff</code>	Add a user to a group
<code>gpasswd -d jdoe staff</code>	Delete a user from a group
<code>gpasswd -A jdoe staff</code>	Add a user to the list of administrators of the group
<code>adduser</code> <code>deluser</code> <code>addgroup</code> <code>delgroup</code> (Debian)	User-friendly front-end commands for user and group management
<code>system-config-users</code> (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.

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

<code>runuser -u jdoe command</code>	Run a command as user jdoe. Can be launched only by the superuser
<code>su jdoe</code>	Run a shell as user jdoe
<code>su</code>	Run a shell as root
<code>su root</code>	
<code>su -c "fdisk -l"</code>	Pass a single command to the shell
<code>su -</code>	Ensure that the spawned shell is a login shell, hence running login scripts and setting the correct environment variables. Recommended option
<code>su -l</code>	
<code>sudo -ujdoe command</code>	Run a command as user jdoe
<code>sudo command</code>	Run a command as root
<code>sudo -uroot command</code>	
<code>sudo -l</code>	List the allowed commands for the current user
<code>sudo !!</code>	Run again the last command, but this time as root
<code>sudoedit /etc/passwd</code>	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
<code>sudo -e /etc/passwd</code>	
<code>visudo</code>	Edit <code>/etc/sudoers</code> , the configuration file that specifies access rights to sudo
Sudo commands are logged via syslog on <code>/var/log/auth.log</code> (Debian) or <code>/var/log/secure</code> (Red Hat).	
<code>sudo su -</code>	Login on an interactive shell as the superuser
<code>sudo -i</code>	
<code>gksu -u root -l</code>	GUI front-ends to <code>su</code> and <code>sudo</code> used to run an X Window command as root. Will pop up a requester prompting the user for root's password
<code>gksudo -u root guicommand</code>	

chvt <i>n</i> CTRL ALT Fn	Make <code>/dev/tty<i>n</i></code> the foreground terminal
vlock away	Lock the virtual console (terminal)
tty echo \$(tty)	Print your terminal device (e.g. <code>/dev/tty1</code> , <code>/dev/pts/1</code>)
stty stty -ixon	Change or display terminal line settings 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 <code>screen</code> command starts an interactive shell screen session, to which you will be able to reattach later
screen -S <i>sessionname</i>	Start a screen session with the specified session name
screen <i>command</i>	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 <i>pid.tty.host</i>	Resume a detached screen session
screen -r <i>sessionowner/pid.tty.host</i>	
screen -R	Resume the last detached screen session
screen -d -R <i>sessionname</i>	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

- CTRL Z Suspend the job
 - bg Send the job to background
 - jobs Show the number of the backgrounded job; let's assume it's *n*
 - disown -h %*n* Detach job *n* from its parent shell
- or
- screen Start a screen session
 - 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.

<code>write jdoe</code>	Write interactively a message to the terminal of user jdoe (must be logged in)
<code>wall</code>	Write interactively a message to the terminal of all logged in users
<code>echo "Hello" | write jdoe</code>	Write a message to the terminal of user jdoe (must be logged in)
<code>echo "Hello" | wall</code>	Write a message to the terminal of all logged in users
<code>talk jdoe</code>	Open an interactive chat session with user jdoe (must be logged in)
<code>mesg y</code>	Allow the other users to message you via <code>write</code> , <code>wall</code> , and <code>talk</code>
<code>chmod g+w \$(tty)</code>	
<code>mesg n</code>	Disallow the other users to message you via <code>write</code> , <code>wall</code> , and <code>talk</code>
<code>chmod g-w \$(tty)</code>	
<code>mesg</code>	Display your current message permission status
<code>mesg</code> works by enabling/disabling the group write permission of your terminal device, which is owned by system group <code>tty</code> . 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.

<code>crontab -e</code>	Edit your user crontab file
<code>crontab -l</code>	List the contents of your crontab file
<code>crontab -e -u jdoe</code>	Edit the crontab file of another user (command available only to the superuser)
<code>/etc/crontab</code>	System-wide crontab file; this is the list of commands to execute periodically
<code>/etc/cron.d/</code>	Directory containing commands to execute periodically, one command per file (which must have the same syntax as <code>/etc/crontab</code>)
<code>/etc/cron.hourly/</code>	Scripts placed in these directories will be automatically executed on the specified periods
<code>/etc/cron.daily/</code>	
<code>/etc/cron.weekly/</code>	
<code>/etc/cron.monthly/</code>	
<code>/var/spool/cron/user</code>	Crontab of <i>user</i>

/etc/crontab							
#	m	h	dom	mon	dow	user command	
	25	6	*	*	1	root foo.sh	every Monday at 6:25 AM
	*/5	16	*	*	*	root /opt/myscript.sh	from 4:00 to 4:55 PM every 5 minutes everyday
	0,30	7	25	12	*	jdoe /home/jdoe/bar.sh	at 7:00 and 7:30 AM on 25 th December
	3	17	*	*	1-5	root baz.sh	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.

<pre>at 5:00pm tomorrow myscript.sh at -f mylistofcommands.txt 5:00pm tomorrow echo "rm file" | at now+2 minutes</pre>	Execute a command once at the specified time (absolute or relative)
<pre>at -l atq</pre>	List the scheduled jobs
<pre>at -d 3 atrm 3</pre>	Remove job number 3 from the list

<code>bc</code>	Calculator
<code>cal</code>	Calendar
<code>units</code>	Converter of quantities between different units
<code>banner</code> <code>figlet</code>	Print a message in large letters
<code>sensors</code>	Print sensor chips information (e.g. temperature)
<code>beep</code>	Produce a beep from the machine's speakers
<code>speaker-test</code>	Speaker test tone generator for the ALSA (Advanced Linux Sound Architecture) framework
<code>on_ac_power</code>	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)
<code>ipcalc</code>	IP addresses calculator
<code>pwgen</code>	Password generator
<code>aspell</code>	Spell checker
<code>cloc</code>	Count lines of source code and comments on a project' files
<code>gnome-terminal</code>	GNOME shell terminal (GUI application)

Locale environment variables

LANG	Language, stored in <code>/etc/default/locale</code> .
LANGUAGE	When scripting, it is recommended to set <code>LANG=C</code> 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`

<code>locale</code>	Show locale environment variables
<code>locale-gen it_IT.UTF-8</code>	Generate a locale by compiling a list of locale definition files
<code>apt-get install manpages-it language-pack-it</code>	Install a different locale (system messages and manpages)
<code>iconv -f IS6937 -t IS8859 filein > fileout</code>	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.

<code>date</code>	Show current date and time
<code>date -d "9999 days ago"</code>	Calculate a date and show it
<code>date -d "1970/01/01 + 4242"</code>	
<code>date +"%F %H:%M:%S"</code>	Show current date in the format specified
<code>date +"%s"</code>	Show current date in Unix time format (seconds elapsed since 00:00:00 1/1/1970)
<code>date -s "20130305 23:30:00"</code>	Set the date
<code>date 030523302013</code>	Set the date, in the format <i>MMDDhhmmYYYY</i>
<code>timedatectl</code>	Show current date and time
<code>timedatectl set-time 2013-03-05</code>	Set the date
<code>timedatectl set-time 23:30</code>	
<code>timedatectl list-timezones</code>	List all possible timezones
<code>zdump GMT</code>	Show current date and time in the GMT timezone
<code>tzselect</code>	Set the timezone
<code>tzconfig</code>	
<code>dpkg-reconfigure tzdata</code> (Debian)	
<code>timedatectl set-timezone <i>timezone</i></code> (Red Hat)	
<code>/etc/timezone</code> (Debian)	Timezone
<code>/etc/localtime</code> (Red Hat)	Timezone, a symlink to the appropriate timezone file in <code>/usr/share/zoneinfo/</code>
<code>ntpd</code>	NTP daemon, keeps the clock in sync with Internet time servers
<code>ntpd -q</code>	Synchronize the time once and quit
<code>ntpd -g</code>	Force NTP to start even if clock is off by more than the panic threshold (1000 secs)
<code>ntpd -n -g -q</code>	Start NTP as a non-daemon, force set the clock, and quit
<code>ntpq -p <i>timeserver</i></code>	Print the list of peers for the time server
<code>ntpdate <i>timeserver</i></code>	Synchronizes the clock with the specified time server
<code>ntpdate -b <i>timeserver</i></code>	Brutally set the clock, without waiting for a slow adjusting
<code>ntpdate -q <i>timeserver</i></code>	Query the time server without setting the clock
The <code>ntpdate</code> command is deprecated and will be phased out in future Linux releases.	
<code>hwclock --show</code>	Show the hardware clock
<code>hwclock -r</code>	
<code>hwclock --hctosys</code>	Set the system time from the hardware clock
<code>hwclock -s</code>	
<code>hwclock --systohc</code>	Set the hardware clock from system time
<code>hwclock -w</code>	
<code>hwclock --utc</code>	Indicate that the hardware clock is kept in Coordinated Universal Time
<code>hwclock --localtime</code>	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

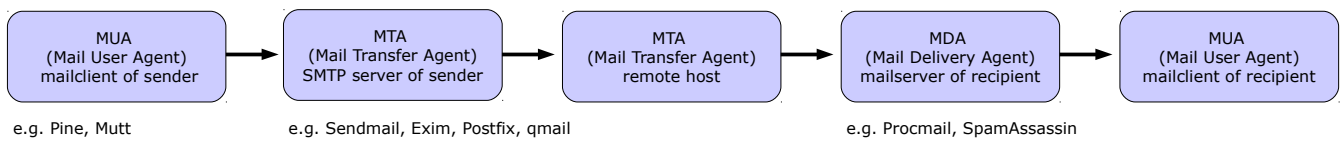
```

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

† = 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.



<code>~/ .forward</code>	Mail address(es) to which forward the user's mail, or mail commands
<code>/etc/aliases</code> <code>/etc/mail/aliases</code>	Aliases database for users on the local machine. Each line has syntax <code>alias: user</code>
<code>/var/spool/mail/user</code>	Inbox for <code>user</code> on the local machine
<code>/var/log/mail.log</code> (Debian) <code>/var/log/maillog</code> (Red Hat)	Mail logs
<code>mail</code> <code>mailx</code>	Commands to send mail
<code>mailx -s "Subject" \ -S smtp="mailserver.foobar.com:25" \ jdoe@example.org < messagefile</code>	Send a mail message to <code>jdoe@example.org</code> , using an external SMTP server
<code>uencode binaryfile | mail jdoe@example.org</code>	Send a binary file to <code>jdoe@example.org</code> (not recommended because many mailclients will display the received attachment inline)
<code>mutt -a binaryfile -- jdoe@example.org < /dev/null</code>	Send a binary file to <code>jdoe@example.org</code> 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.	<code>\$HOME/Mail/myfolder</code>
Maildir	Each mail folder is a directory, and contains the subdirectories <code>/cur</code> , <code>/new</code> , and <code>/tmp</code> . Each email message is stored in its own file with a unique filename ID. The process that delivers an email message writes it to a file in the <code>tmp/</code> directory, and then moves it to <code>new/</code> . The moving is commonly done by hard linking the file to <code>new/</code> and then unlinking the file from <code>tmp/</code> , which guarantees that a MUA will not see a partially written message as it never looks in <code>tmp/</code> . When the MUA finds mail messages in <code>new/</code> it moves them to <code>cur/</code> . 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	<code>\$HOME/Mail/myfolder/</code>

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=10jReS-0005kT-Jj QUIT 221 Bye	HELO abc.example.org EHLO abc.example.org MAIL FROM: alice@example.org RCPT TO: bob@foobar.com DATA QUIT RSET HELP NOOP VRFY jdoe@example.org EXPN mailinglist	Initiate the conversation and identify client host to server Like HELO, but tell server to use Extended SMTP Specify mail sender Specify mail recipient Specify data to send. Ended with a dot on a single line Disconnect List all available commands Empty command Verify the existence of an e-mail address (this command should not be implemented, for security reasons) 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/genericdomain.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):
`dfnnn` Mail body
`qfnnn` Message envelope with headers and routing information
`Qfnnn` Message envelope if abandoned
`hfnnn` Message envelope if held / quarantined by a milter (i.e. mail filter)
`tfnnn` Temporary file
`lfnnn` Lock file
`nfnnn` Backup file
`xfnnn` Transcript of delivery attempts

`newaliases` Update the aliases database; must be run after any change to `/etc/aliases`
`sendmail -bi`

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

`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.

<code>/etc/exim.conf</code>	Exim4 configuration file
<code>/usr/local/etc/exim/configure</code> (FreeBSD)	
<code>exim4 -bp</code>	Examine the mail queue
<code>exim4 -M <i>messageID</i></code>	Attempt delivery of message
<code>exim4 -Mrm <i>messageID</i></code>	Remove a message from the mail queue
<code>exim4 -Mvh <i>messageID</i></code>	See the headers of a message in the mail queue
<code>exim4 -Mvb <i>messageID</i></code>	See the body of a message in the mail queue
<code>exim4 -Mvc <i>messageID</i></code>	See a message in the mail queue
<code>exim4 -qf <i>domain</i></code>	Force a queue run of all queued messages for a <i>domain</i>
<code>exim4 -Rff <i>domain</i></code>	Attempt delivery of all queued messages for a <i>domain</i>
<code>exim4 -bV</code>	Show version and other info
<code>exinext</code>	Give the times of the next queue run
<code>exigrep</code>	Search through Exim logfiles
<code>exicyclog</code>	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
qmgr	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
<code>/var/spool/postfix/incoming</code>	Incoming queue. All new mail entering the Postfix queue is written here by the cleanup daemon. Under normal conditions this queue is nearly empty
<code>/var/spool/postfix/active</code>	Active queue. Contains messages ready to be sent. The queue manager places messages here from the incoming queue as soon as they are available
<code>/var/spool/postfix/deferred</code>	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
<code>/var/spool/postfix/bounce</code>	Message delivery status report about why mail is bounced (non-delivered mail)
<code>/var/spool/postfix/defer</code>	Message delivery status report about why mail is delayed (non-delivered mail)
<code>/var/spool/postfix/trace</code>	Message delivery status report (delivered mail)
<code>postfix reload</code>	Reload configuration
<code>postconf -e 'mydomain = example.org'</code>	Edit a setting in the Postfix configuration
<code>postconf -l</code>	List supported mailbox lock methods
<code>postconf -m</code>	List supported database types
<code>postconf -v</code>	Increase logfile verbosity
<code>postmap dbtype:textfile</code>	Manage Postfix lookup tables, creating a hashed map file of database type <i>dbtype</i> from <i>textfile</i>
<code>postmap hash:/etc/postfix/transport</code>	Regenerate the transport database
<code>postalias</code>	Convert <code>/etc/aliases</code> into the aliases database file <code>/etc/aliases.db</code>
<code>postsuper</code>	Operate on the mail queue
<code>postqueue</code>	Unprivileged mail queue manager

<code>/etc/postfix/main.cf</code> Postfix main configuration file	
<code>mydomain = example.org</code>	This system's domain
<code>myorigin = \$mydomain</code>	Domain from which all sent mail will appear to originate
<code>myhostname = foobar.\$mydomain</code>	This system's hostname
<code>inet_interfaces = all</code>	Network interface addresses that this system receives mail on. Value can also be <code>localhost</code> , <code>all</code> , or <code>loopback-only</code>
<code>proxy_interfaces = 1.2.3.4</code>	Network interface addresses that this system receives mail on by means of a proxy or NAT unit
<code>mynetworks = 10.3.3.0/24 !10.3.3.66</code>	Networks the SMTP clients are allowed to connect from
<code>mydestination = \$myhostname, localhost, \$mydomain, example.com, hash:/etc/postfix/otherdomains</code>	Domains for which Postfix will accept received mail. Value can also be a lookup database file e.g. a hashed map
<code>relayhost = 10.6.6.6</code>	Relay host to which Postfix should send all mail for delivery, instead of consulting DNS MX records
<code>relay_domains = \$mydestination</code>	Sources and destinations for which mail will be relayed. Can be empty if Postfix is not intended to be a mail relay
<code>virtual_alias_domains = virtualex.org</code> <code>virtual_alias_maps = /etc/postfix/virtual</code> or <code>virtual_alias_domains = hash:/etc/postfix/virtual</code>	Set up Postfix to handle mail for virtual domains too. The <code>/etc/postfix/virtual</code> file is a hashed map, each line of the file containing the virtual domain email address and the destination real domain email address: <code>jdoo@virtualex.org john.doe@example.org</code> <code>ksmith@virtualex.org kim.smith</code> <code>@virtualex.org root</code> 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
<code>mailbox_command = /usr/bin/procmail</code>	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.

<code>/etc/postfix/master.cf</code> Postfix master daemon configuration file	
<pre># 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 lmtpl unix - - n - - lmtpl</pre>	
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"
```

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

<code>/etc/procmailrc</code> and <code>~/procmailrc</code> Procmail recipes	
<code>PATH=\$HOME/bin:/usr/bin:/bin:/usr/sbin:/sbin MAILDIR=\$HOME/Mail DEFAULT=\$MAILDIR/Inbox LOGFILE=\$HOME/.procmaillog</code>	Common parameters, non specific to Procmail
<code>:0h: or :0: * ^From: .* (alice|bob)@foobar\.org \$DEFAULT</code>	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
<code>:0: * ^From: .*owner@listserv\.com * ^Subject:.*Linux \$MAILDIR/Geekstuff1</code>	Conditions: match sender address and subject headers Destination: specified mailfolder, in mbox format
<code>:0 * ^From: .*owner@listserv\.com * ^Subject:.*Linux \$MAILDIR/Geekstuff2/</code>	Flag: file locking not necessary because using Maildir format Conditions: match sender address and subject headers Destination: specified mailfolder, in Maildir format
<code># Blacklisted by SpamAssassin :0 * ^X-Spam-Status: Yes /dev/null</code>	Flag: file locking not necessary because blackholing to <code>/dev/null</code> Condition: match SpamAssassin's specific header Destination: delete the message
<code>:0B: * hacking \$MAILDIR/Geekstuff</code>	Flag: match body of message instead of headers
<code>:0HB: * hacking \$MAILDIR/Geekstuff</code>	Flag: match either headers or body of message
<code>:0: * > 256000 | /root/myprogram</code>	Condition: match messages larger than 256 Kb Destination: pipe message through the specified program
<code>:0fw * ^From: .*@foobar\.org | /root/myprogram</code>	Flags: use the pipe as a filter (modifying the message), and tell Procmail to wait that the filter finished processing the message
<code>:0c * ^Subject:.*administration ! secretary@domain.com :0: \$MAILDIR/Forwarded</code>	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.

	<code>imapd</code>	Courier IMAP daemon configuration
<code>/usr/lib/courier-imap/etc/</code>	<code>imapd-ssl</code>	Courier IMAPS daemon configuration
or		
<code>/etc/courier/</code>	<code>pop3d</code>	Courier POP3 daemon configuration
	<code>pop3d-ssl</code>	Courier POP3S daemon configuration
<code>/usr/lib/courier-imap/share/</code>		Directory for public and private keys
<code>mkimapdcert</code>		Generate a certificate for the IMAPS service
<code>mkpop3dcert</code>		Generate a certificate for the POP3 service
<code>makealiases</code>		Create system aliases in <code>/usr/lib/courier/etc/aliases.dat</code> , which is made by processing a <code>/usr/lib/courier/etc/aliases/system</code> text file:
		<pre> root : postmaster mailer-daemon : postmaster MAILER-DAEMON : postmaster uucp : postmaster postmaster : admin </pre>

<code>/usr/lib/courier-imap/etc/pop3d</code> Courier POP configuration file	
<code>ADDRESS=0</code>	Address to listen on. 0 means all addresses
<code>PORT=127.0.0.1.900,192.168.0.1.900</code>	Port number connections are accepted on. Accept connections on port 900 on IP addresses 127.0.0.1 and 192.168.0.1
<code>POP3AUTH="LOGIN CRAM-MD5 CRAM-SHA1"</code>	POP authentication advertising SASL (Simple Authentication and Security Layer) capability, with CRAM-MD5 and CRAM-SHA1
<code>POP3AUTH_TLS="LOGIN PLAIN"</code>	Also advertise SASL PLAIN if SSL is enabled
<code>MAXDAEMONS=40</code>	Maximum number of POP3 servers started
<code>MAXPERIP=4</code>	Maximum number of connections to accept from the same IP address
<code>PIDFILE=/var/run/courier/pop3d.pid</code>	PID file
<code>TCPDOPTS="-nodnslookup -noidentlookup"</code>	Miscellaneous <code>couriertcpd</code> options that shouldn't be changed
<code>LOGGEROPTS="-name=pop3d"</code>	<code>courierlogger</code> options
<code>POP3_PROXY=0</code>	Enable or disable proxying
<code>PROXY_HOSTNAME=myproxy</code>	Override value from <code>gethostname()</code> when checking if a proxy connection is required
<code>DEFDOMAIN="@example.com"</code>	Optional default domain. If the username does not contain the first character of <code>DEFDOMAIN</code> , then it is appended to the username. If <code>DEFDOMAIN</code> and <code>DOMAINSEP</code> are both set, then <code>DEFDOMAIN</code> is appended only if the username does not contain any character from <code>DOMAINSEP</code>
<code>POP3DSTART=YES</code>	Flag intended to be read by the system startup script
<code>MAILDIRPATH=Maildir</code>	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 <code>service</code> parameter depending on the connection's port. This only works with authentication modules that use the <code>service</code> 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 <code>couriertcpd</code> will save its process ID
TCPDOPTS="-nodnslookup -noidentlookup"	Miscellaneous <code>couriertcpd</code> options that shouldn't be changed
LOGGEROPTS="-name=imapd"	<code>courierlogger</code> options
DEFDOMAIN="@example.com"	Optional default domain. If the username does not contain the first character of <code>DEFDOMAIN</code> , then it is appended to the username. If <code>DEFDOMAIN</code> and <code>DOMAINSEP</code> are both set, then <code>DEFDOMAIN</code> is appended only if the username does not contain any character from <code>DOMAINSEP</code>
IMAP_CAPABILITY="IMAP4rev1 UIDPLUS \ CHILDREN NAMESPACE THREAD=ORDEREDSUBJECT \ THREAD=REFERENCES SORT QUOTA IDLE"	Specifies what most of the response should be to the <code>CAPABILITY</code> 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 <code>CAPABILITY</code> 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 <code>IDLE</code> mode
IMAP_CHECK_ALL_FOLDERS=0	Enable or disable server check for mail in every folder
IMAP_UMASK=022	Set the <code>umask</code> of the server process. This value is passed to the <code>umask</code> 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 <code>ulimit -d</code> 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=\n/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, <code>\$SENDER</code> , being saved in the <code>X-IMAP-Sender</code> 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.

<code>/etc/dovecot.conf</code>	Dovecot configuration file
<code>base_dir = /var/run/dovecot/</code>	Base directory where to store runtime data
<code>protocols = imaps pop3s</code>	Protocols to serve. If Dovecot should use <code>dovecot-auth</code> , this can be set to <code>none</code>
<code>listen = *, [::]</code>	Network interfaces to accept connections on. Here, listen to all IPv4 and IPv6 interfaces
<code>disable_plaintext_auth = yes</code>	Disable LOGIN command and all other plaintext authentications unless SSL/TLS is used (LOGINDISABLED capability)
<code>shutdown_clients = yes</code>	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
<code>log_path = /dev/stderr</code>	Log file to use for error messages, instead of sending them to syslog. Here, log to stderr
<code>info_log_path = /dev/stderr</code>	Log file to use for informational and debug messages. Default value is the same as <code>log_path</code>
<code>syslog_facility = mail</code>	Syslog facility to use if logging to syslog
<code>login_dir = /var/run/dovecot/login</code>	Directory where the authentication process places authentication UNIX sockets, to which the login process needs to be able to connect
<code>login_chroot = yes</code>	Chroot login process to the <code>login_dir</code>
<code>login_user = dovecot</code>	User to use for the login process. This user is used to control access for authentication process, and not to access mail messages
<code>login_process_size = 64</code>	Maximum login process size, in Mb
<code>login_process_per_connection = yes</code>	If yes, each login is processed in its own process (more secure); if no, each login process processes multiple connections (faster)
<code>login_processes_count = 3</code>	Number of login processes to keep for listening for new connections
<code>login_max_processes_count = 128</code>	Maximum number of login processes to create
<code>login_max_connections = 256</code>	Maximum number of connections allowed per each login process. This setting is used only if <code>login_process_per_connection = no</code> ; once the limit is reached, the process notifies master so that it can create a new login process
<code>login_greeting = Dovecot ready.</code>	Greeting message for clients
<code>login_trusted_networks = \ 10.7.7.0/24 10.8.8.0/24</code>	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. <code>disable_plaintext_auth</code> is also ignored for these networks
<code>mbox_read_locks = fcntl mbox_write_locks = dotlock fcntl</code>	Locking methods to use for locking mailboxes in mbox format. Possible values are: <code>dotlock</code> Create <code>mailbox.lock</code> file; oldest and NSF-safe method <code>dotlock_try</code> Same as <code>dotlock</code> , but skip if failing <code>fcntl</code> Recommended; works with NFS too if <code>lockd</code> is used <code>flock</code> May not exist in all systems; doesn't work with NFS <code>lockf</code> May not exist in all systems; doesn't work with NFS
<code>maildir_stat_dirs = no</code>	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
<code>dbox_rotate_size = 2048 dbox_rotate_min_size = 16</code>	Maximum and minimum file size, in Kb, of a mailbox in dbox format until it is rotated
<code>!include /etc/dovecot/conf.d/*.conf</code>	Include configuration file
<code>!include_try /etc/dovecot/extra.conf</code>	Include optional configuration file, do not give error if file not found

/etc/dovecot.conf Dovecot configuration file	
<pre>mail_location = \ mbox:~/mail:INBOX=/var/spool/mail/%u or mail_location = maildir:~/Maildir</pre>	<p>Mailbox location, in mbox or Maildir format. Variables:</p> <ul style="list-style-type: none"> %u username %n user part in <i>user@domain</i>, same as %u if there is no domain %d domain part in <i>user@domain</i>, empty if there is no domain %h home directory
<pre>namespace shared { separator = / prefix = shared/%u/ location = maildir:%h/Maildir:\ INDEX=~/.Maildir/shared/%u inbox = no hidden = no subscriptions = no list = children }</pre>	<p>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</p> <p>Hierarchy separator to use. Should be the same for all namespaces; it depends on the underlying mail storage format</p> <p>Prefix required to access this namespace; must be different for each. Here, mailboxes are visible under <i>shared/user@domain/</i>; the variables %n, %d and %u are expanded to the destination user</p> <p>Mailbox location for other users' mailboxes; it is in the same format as <code>mail_location</code> which is also the default for it. <code>%variable</code> and <code>~/</code> expand to the logged in user's data; <code>%%variable</code> expands to the destination user's data</p> <p>There can be only one INBOX, and this setting defines which namespace has it</p> <p>Define whether the namespace is hidden i.e. not advertised to clients via NAMESPACE extension</p> <p>Namespace handles its own subscriptions; if set to <code>no</code>, the parent namespace handles them and Dovecot uses the default namespace for saving subscriptions. If <code>prefix</code> is empty, this should be set to <code>yes</code></p> <p>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</p>
<pre>mail_uid = 666 mail_gid = 666</pre>	<p>UID and GID used to access mail messages</p>
<pre>mail_privileged_group = mail</pre>	<p>Group to enable temporarily for privileged operations; currently this is used only with INBOX when its initial creation or a dotlocking fails</p>
<pre>mail_access_groups = tmpmail</pre>	<p>Supplementary groups to grant access to for mail processes; typically these are used to set up access to shared mailboxes</p>
<pre>lock_method = fcntl</pre>	<p>Locking method for index files. Can be <code>fcntl</code>, <code>flock</code>, or <code>dotlock</code></p>
<pre>first_valid_uid = 500 last_valid_uid = 0</pre>	<p>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</p>
<pre>first_valid_gid = 1 last_valid_gid = 0</pre>	<p>Valid GID range for users; default is non-root/wheel. Users having non-valid primary GID are not allowed to login</p>
<pre>max_mail_processes = 512</pre>	<p>Maximum number of running mail processes. When this limit is reached, new users are not allowed to login</p>
<pre>mail_process_size = 256</pre>	<p>Maximum mail process size, in Mb</p>
<pre>valid_chroot_dirs =</pre>	<p>List of directories under which chrooting is allowed for mail processes</p>
<pre>mail_chroot =</pre>	<p>Default chroot directory for mail processes. Usually not needed as Dovecot does not allow users to access files outside their mail directory</p>
<pre>mailbox_idle_check_interval = 30</pre>	<p>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</p>

/etc/dovecot.conf Dovecot configuration file	
<pre>protocol pop3 { listen = *:110 login_executable = /usr/libexec/dovecot/pop3-login mail_executable = /usr/libexec/dovecot/pop3 pop3_no_flag_updates = no pop3_lock_session = no pop3_uidl_format = %08Xu%08Xv }</pre>	<p>Block with options for the POP3 protocol</p> <p>Network interfaces to accept POP3 connections on</p> <p>Location of the POP3 login executable</p> <p>Location of the POP3 mail executable</p> <p>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 <code>new/</code> to <code>cur/</code>, with mbox format do not write <code>Status-</code> headers</p> <p>Whether to keep the mailbox locked for the whole POP3 session</p> <p>POP3 UIDL (Unique Mail Identifier) format to use</p>
<pre>protocol imap { listen = *:143 ssl_listen = *:993 login_executable = /usr/libexec/dovecot/imap-login mail_executable = /usr/libexec/dovecot/imap mail_max_userip_connections = 10 imap_idle_notify_interval = 120 }</pre>	<p>Block with options for the IMAP protocol</p> <p>Network interfaces to accept IMAP and IMAPS connections on</p> <p>Location of the IMAP login executable</p> <p>Location of the IMAP mail executable</p> <p>Maximum number of IMAP connections allowed for a user from each IP address</p> <p>How many seconds to wait between "OK Still here" notifications when client is IDLE</p>
<pre>ssl = yes</pre>	<p>SSL/TLS support. Possible values are <code>yes</code>, <code>no</code>, <code>required</code></p>
<pre>ssl_cert_file = /etc/ssl/certs/dovecot-cert.pem</pre>	<p>Location of the SSL certificate</p>
<pre>ssl_key_file = /etc/ssl/private/dovecot-key.pem</pre>	<p>Location of private key</p>
<pre>ssl_key_password = blgs3cr3t</pre>	<p>Password of private key, if it is password-protected. Since <code>/etc/dovecot.conf</code> is usually world-readable, it is better to place this setting into a root-owned 0600 file instead and include it via the setting <code>!include_try /etc/dovecot/dovecot-passwd.conf</code>. Alternatively, Dovecot can be started with <code>dovecot -p blgs3cr3t</code></p>
<pre>ssl_ca_file = /etc/dovecot/cafile.pem</pre>	<p>List of trusted SSL certificate authorities; the file contains the CA certificates followed by the CRLs</p>
<pre>ssl_verify_client_cert = yes</pre>	<p>Request client to send a certificate</p>
<pre>ssl_cipher_list = ALL:!LOW:!SSLv2</pre>	<p>List of SSL ciphers to use</p>
<pre>verbose_ssl = yes</pre>	<p>Show protocol level SSL errors</p>

/etc/dovecot.conf Dovecot configuration file	
<code>auth_executable = /usr/libexec/dovecot/dovecot-auth</code>	Location of the authentication executable
<code>auth_process_size = 256</code>	Max authentication process size, in Mb
<code>auth_username_chars = abcde ... VWXYZ01234567890.-_@</code>	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
<code>auth_realms =</code>	List of realms for SASL authentication mechanisms that need them. If empty, multiple realms are not supported
<code>auth_default_realm = example.org</code>	Default realm/domain to use if none was specified
<code>auth_anonymous_username = anonymous</code>	Username to assign to users logging in with ANONYMOUS SASL mechanism
<code>auth_verbose = no</code>	Whether to log unsuccessful authentication attempts and the reasons why they failed
<code>auth_debug = no</code>	Whether to enable more verbose logging (e.g. SQL queries) for debugging purposes
<code>auth_failure_delay = 2</code>	Delay before replying to failed authentications, in seconds
<pre> auth default { mechanisms = plain login cram-md5 passdb passwd-file { args = /etc/dovecot.deny deny = yes } passdb pam { args = cache_key=%u%r dovecot } passdb passwd { blocking = yes args = } passdb shadow { blocking = yes args = } passdb bsdauth { cache_key = %u args = } passdb sql { args = /etc/dovecot/dovecot-sql.conf } passdb ldap { args = /etc/dovecot/dovecot-ldap.conf } socket listen { master { path = /var/run/dovecot/auth-master mode = 0600 user = group = } client { path = /var/run/dovecot/auth-client mode = 0660 } } } </pre>	<p>Accepted authentication mechanisms</p> <p>Deny login to the users listed in <code>/etc/dovecot.deny</code> (file contains one user per line)</p> <p>PAM authentication block. Enable authentication matching (username and remote IP address) for PAM.</p> <p>System users e.g. NSS or <code>/etc/passwd</code></p> <p>Shadow passwords for system users e.g. NSS or <code>/etc/passwd</code></p> <p>PAM-like authentication for OpenBSD</p> <p>SQL database</p> <p>LDAP database</p> <p>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 <code>dovecot-auth</code> (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</p>

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 <code>vsftpd</code> daemon operates with multiple processes that run as a non-privileged user in a chrooted jail.																
Pure-FTP	<p>A free, easy-to-use FTP server.</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;"><code>pure-ftpd</code></td> <td style="padding: 2px;">Pure-FTP daemon</td> </tr> <tr> <td style="padding: 2px;"><code>pure-ftpwho</code></td> <td style="padding: 2px;">Show clients connected to the Pure-FTP server</td> </tr> <tr> <td style="padding: 2px;"><code>pure-mrtginfo</code></td> <td style="padding: 2px;">Show connections to the Pure-FTP server as a MRTG graph</td> </tr> <tr> <td style="padding: 2px;"><code>pure-statsdecode</code></td> <td style="padding: 2px;">Show Pure-FTP log data</td> </tr> <tr> <td style="padding: 2px;"><code>pure-pw</code></td> <td style="padding: 2px;">Manage Pure-FTP virtual accounts</td> </tr> <tr> <td style="padding: 2px;"><code>pure-pwconvert</code></td> <td style="padding: 2px;">Convert the system user database to a Pure-FTP virtual accounts database</td> </tr> <tr> <td style="padding: 2px;"><code>pure-quotacheck</code></td> <td style="padding: 2px;">Manage Pure-FTP quota database</td> </tr> <tr> <td style="padding: 2px;"><code>pure-uploadscript</code></td> <td style="padding: 2px;">Run a command on the Pure-FTP server to process an uploaded file</td> </tr> </table>	<code>pure-ftpd</code>	Pure-FTP daemon	<code>pure-ftpwho</code>	Show clients connected to the Pure-FTP server	<code>pure-mrtginfo</code>	Show connections to the Pure-FTP server as a MRTG graph	<code>pure-statsdecode</code>	Show Pure-FTP log data	<code>pure-pw</code>	Manage Pure-FTP virtual accounts	<code>pure-pwconvert</code>	Convert the system user database to a Pure-FTP virtual accounts database	<code>pure-quotacheck</code>	Manage Pure-FTP quota database	<code>pure-uploadscript</code>	Run a command on the Pure-FTP server to process an uploaded file
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/etc/vsftpd/vsftpd.conf Very Secure FTP server configuration file

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

<code>cupsd</code>	CUPS (Common Unix Printing System) daemon. Administration of printers is done via web interface on <code>http://localhost:631</code>
<code>/etc/cups/cupsd.conf</code>	CUPS configuration file
<code>/etc/cups/printers.conf</code>	Database of available local CUPS printers
<code>/etc/printcap</code>	Database of printer capabilities, for old printing applications
<code>/var/spool/cups/</code>	Printer spooler for data awaiting to be printed
<code>/var/log/cups/error_log</code>	CUPS error log
<code>/var/log/cups/page_log</code>	Information about printed pages
<code>/etc/init.d/cupsys start</code>	Start the CUPS service
<code>gnome-cups-manager</code>	Run the CUPS Manager graphical application
<code>cupsenable printer0</code>	Enable a CUPS printer
<code>cupsdisable printer0</code>	Disable a CUPS printer
<code>cupsaccept printer0</code>	Accept a job sent on a printer queue
<code>cupsreject -r "Rejected" printer0</code>	Reject a job sent on a printer queue, with an informational message
<code>cupstestppd LEXC510.ppd</code>	Test the conformance of a PPD file to the format specification
<code>cupsaddsmb printer0</code>	Export a printer to Samba (for use with Windows clients)
<code>cups-config --cflags</code>	Show the necessary compiler options
<code>cups-config --datadir</code>	Show the default CUPS data directory
<code>cups-config --ldflags</code>	Show the necessary linker options
<code>cups-config --libs</code>	Show the necessary libraries to link to
<code>cups-config --serverbin</code>	Show the default CUPS binaries directory that stores filters and backends
<code>cups-config --serverroot</code>	Show the default CUPS configuration file directory
<code>lpstat</code>	Show CUPS status information
<code>lpadmin</code>	Administer CUPS printers
<code>lpadmin -p printer0 -P LEXC750.ppd</code>	Specify a PPD (Adobe PostScript Printer Description) file to associate to a printer
<code>lp -d printer0 file</code>	Print a file on the specified printer
<code>lpq</code>	View the default print queue
<code>lpq -P printer0</code>	View a specific print queue
<code>lpq jdoe</code>	View the print queue of a specific user
<code>lprm -P printer0 5</code>	Delete a specific job from a printer queue
<code>lprm -P printer0 jdoe</code>	Delete all jobs from a specific user from a printer queue
<code>lprm -P printer0 -</code>	Delete all jobs from a printer queue
<code>lpc</code>	Manage print queues
<code>a2ps file.txt</code>	Convert a text file to PostScript
<code>ps2pdf file.ps</code>	Convert a file from PostScript to PDF
<code>mpage file.ps</code>	Print a PostScript document on multiple pages per sheet on a PostScript printer
<code>gv file.ps</code>	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 (\geq 48-bit routing prefix + \leq 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 7 th 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		
					.12		
				.16			
				.20			
				.24			
				.28			
			.32				
			.36				
			.40				
			.44				
			.48				
			.52				
			.56				
			.60				
		.64	.64	.64	.64	.64	
					.72		
					.80		
					.88		
				.96			
				.104			
				.112			
				.120			
			.96	.96	.128	.128	
					.136		
					.144		
					.152		
				.160			
				.168			
				.176			
				.184			
	.128	.128	.128	.128	.128	.128	
					.136		
					.144		
					.152		
				.160			
				.168			
				.176			
				.184			
			.160	.160	.192	.192	
					.200		
					.208		
					.216		
				.192	.192	.224	.224
						.232	
						.240	
						.248	
		.224	.224		.224	.224	.224
						.232	
						.240	
						.248	
				.240	.240	.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	Transport	TCP, UDP	Segment (TCP), Datagram (UDP)
4	Transport			
3	Network	Internet	IPv4, IPv6, ICMP	Packet
2	Data Link	Network Access	Ethernet, Wi-Fi, PPP	Frame
1	Physical			

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	Set the hostname
hostnamectl set-hostname --static "mylinuxbox" (RHEL 7)	
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 <i>command bridge</i>	Manage the Ethernet bridge configuration in the Linux kernel
ethtool <i>option device</i>	Query or control network driver and hardware settings
ethtool eth0	View hardware settings of eth0

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

<pre>dig example.org</pre>	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 <code>/etc/resolv.conf</code>
<pre>host example.org</pre>	Perform a DNS lookup for the specified domain or hostname. Does honor <code>/etc/resolv.conf</code>
<pre>nslookup example.org (deprecated)</pre>	Perform a DNS lookup for the specified domain or hostname
<pre>dig @10.7.7.7 -t MX example.org</pre>	Perform a DNS lookup for the MX record of the domain
<pre>host -t example.org 10.7.7.7</pre>	example.org, querying nameserver 10.7.7.7
<pre>dig example.org any</pre>	Get all DNS records for a domain
<pre>host -a example.org</pre>	
<pre>dig -x 203.0.113.1</pre>	Perform a reverse DNS lookup for the IP address 203.0.113.1
<pre>host 203.0.113.1</pre>	
<pre>whois example.org</pre>	Query the WHOIS service for an Internet resource, usually a domain name
<pre>ping 10.0.0.2</pre>	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)
<pre>fping -a 10.0.0.2 10.0.0.7 10.0.0.8</pre>	Ping multiple hosts in parallel and report which ones are alive
<pre>bing 10.0.0.10 10.0.0.11</pre>	Calculate point-to-point throughput between two remote hosts
<pre>traceroute 10.0.0.3</pre>	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)
<pre>tracpath 10.0.0.3</pre>	Simpler <code>traceroute</code>
<pre>mtr 10.0.0.3</pre>	<code>traceroute</code> and <code>ping</code> combined
<pre>telnet 10.0.0.4 23</pre>	Establish a telnet connection to the specified host and port (if port is omitted, use default port 23)
<pre>ftp 10.0.0.5</pre>	Establish an interactive FTP connection with host 10.0.0.5
<pre>wget --no-clobber --html-extension \ --page-requisites --convert-links \ --recursive --domains example.org \ --no-parent www.example.org/foobar</pre>	Download a whole website <code>www.example.org/foobar</code>
<pre>curl -XPUT 10.0.0.6 -d'data'</pre>	Send a HTTP PUT command with <code>data</code> to 10.0.0.6
<pre>curl -o file.html www.example.org/file.html</pre>	Download a file via HTTP

<code>netstat</code>	Display network connections
<code>netstat --tcp</code>	Display active TCP connections
<code>netstat -t</code>	
<code>netstat -l</code>	Display only listening sockets
<code>netstat -a</code>	Display all listening and non-listening sockets
<code>netstat -n</code>	Display network connections, without resolving hostnames or portnames
<code>netstat -p</code>	Display network connections, with PID and name of program to which each socket belongs
<code>netstat -i</code>	Display network interfaces
<code>netstat -s</code>	Display protocol statistics
<code>netstat -r</code>	Display kernel routing tables (equivalent to <code>route -e</code>)
<code>netstat -c</code>	Display network connections continuously
<code>ss</code>	Display socket statistics (similar to <code>netstat</code>)
<code>ss -t -a</code>	Display all TCP sockets
<code>nmap 10.0.0.1</code>	Scan for open ports (TCP SYN scan) on remote host 10.0.0.1
<code>nmap -sS 10.0.0.1</code>	
<code>nmap -sP 10.0.0.1</code>	Do a ping sweep (ICMP ECHO probes) on remote host
<code>nmap -sU 10.0.0.1</code>	Scan UDP ports on remote host
<code>nmap -sV 10.0.0.1</code>	Do a service and version scan on open ports
<code>nmap -p 1-65535 10.0.0.1</code>	Scan all ports (1-65535) on remote host, not only the common ports
<code>nmap -O 10.0.0.1</code>	Find which operating system is running on remote host (OS fingerprinting)
<code>ngrep</code>	Filter data payload of network packets matching a specified regex
<code>nload</code>	Display a graph of the current network usage
<code>iptraf</code>	IP LAN monitor (ncurses UI)
<code>iptraf-ng</code>	
<code>netserver</code>	Run a network performance benchmark server
<code>netperf</code>	Do network performance benchmarks by connecting to a netserver
<code>iperf -s</code>	Run a network throughput benchmark server
<code>iperf -c server</code>	Perform network throughput tests in client mode, by connecting to an iperf server

<code>tcpdump -ni eth0</code>	Sniff all network traffic on interface eth0, suppressing DNS resolution
<code>tcpdump ip host 10.0.0.2 tcp port 25</code>	Sniff network packets on TCP port 25 from and to 10.0.0.2
<code>tcpdump ether host '45:67:89:ab:cd:ef'</code>	Sniff traffic from and to the network interface having MAC address 45:67:89:ab:cd:ef
<code>tcpdump 'src host 10.0.0.2 and \ (tcp port 80 or tcp port 443)'</code>	Sniff HTTP and HTTPS traffic having as source host 10.0.0.2
<code>tcpdump -ni eth0 not port 22</code>	Sniff all traffic on eth0 except that belonging to the SSH connection
<code>tcpdump -vvnn -i eth0 arp</code>	Sniff ARP traffic on eth0, on maximum verbosity level, without converting host IP addresses and port numbers to names
<code>tcpdump ip host 10.0.0.2 and \ not 10.0.0.9</code>	Sniff IP traffic between 10.0.0.2 and any other host except 10.0.0.9
<code>dhcpcdump -i eth0</code>	Sniff all DHCP packets on interface eth0

<pre>nc ncat (Red Hat) netcat (SUSE)</pre>	Netcat, "the Swiss Army knife of networking", a very flexible generic TCP/IP client/server
<pre>nc -z 10.0.0.7 22 ncat 10.0.0.7 22</pre>	Scan for a listening SSH daemon on remote host 10.0.0.7
<pre>nc -l -p 25</pre>	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
<pre>nc 10.0.0.7 389 < file</pre>	Push the content of <i>file</i> to port 389 on remote host 10.0.0.7
<pre>echo "GET / HTTP/1.0\r\n\r\n" | nc 10.0.0.7 80</pre>	Connect to web server 10.0.0.7 and issue a HTTP GET
<pre>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</pre>	Start a minimal web server, serving the specified HTML page to any connected client
<pre>nc -v -n -z -w1 -r 10.0.0.7 1-1023</pre>	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
<pre>echo "" | nc -v -n -w1 10.0.0.7 1-1023</pre>	Retrieve the greeting banner of any network service that might be running on remote host 10.0.0.7

<code>/etc/hosts</code>	Mappings between IP addresses and hostnames, for name resolution <pre>127.0.0.1 localhost.localdomain localhost 10.2.3.4 myhost.domain.org myhost</pre>
<code>/etc/nsswitch.conf</code>	Sources that must be used by various system library lookup functions <pre>passwd: files nisplus nis shadow: files nisplus nis group: files nisplus nis hosts: files dns nisplus nis</pre>
<code>/etc/host.conf</code>	Sources for name resolution, for systems before glibc2. Obsolete, superseded by <code>/etc/nsswitch.conf</code> <pre>order hosts,bind multi on</pre>
<code>/etc/resolv.conf</code>	Domain names that must be appended to bare hostnames, and DNS servers that will be used for name resolution <pre>search domain1.org domain2.org nameserver 192.168.3.3 nameserver 192.168.4.4</pre>
<code>/etc/networks</code>	Mappings between network addresses and names <pre>loopback 127.0.0.0 mylan 10.2.3.0</pre>
<code>/etc/network/interfaces</code> (Debian)	List and configuration of all network interfaces <pre>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</pre>
<code>/etc/hostname</code> (Debian)	Hostname of the local machine
<code>/sys/class/net</code>	List of all network interfaces in the system
<code>/etc/services</code>	List of service TCP/UDP port numbers
<code>/etc/protocols</code>	List of available protocols
<code>/etc/ethers</code>	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	<i>network or host</i>	destination network or host
	0.0.0.0	default route
Gateway	<i>host</i>	gateway
	0.0.0.0	no gateway needed, network is directly connected
	*	
	-	rejected route
Genmask	<i>network mask</i>	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).

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

iptables rules file	
<pre>*filter :INPUT ACCEPT [0:0] :FORWARD ACCEPT [0:0] :OUTPUT ACCEPT [0:0] COMMIT</pre>	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.

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

<code>systemctl status firewalld</code>	Check the status of the firewall
<code>firewall-cmd --state</code>	
<code>firewall-config</code>	Firewall management GUI
<code>firewall-cmd --reload</code>	Reload firewall configuration; this applies all permanent changes and cancels all temporary changes. Current connections are not terminated
<code>firewall-cmd --complete-reload</code>	Reload firewall configuration, stopping all current connections
<code>firewall-cmd --runtime-to-permanent</code>	Transform all temporary changes to permanent
<code>firewall-cmd --list-all-zones</code>	List all zones and their full settings
<code>firewall-cmd --get-default-zone</code>	Show the default zone
<code>firewall-cmd --set-default-zone=home</code>	Set "home" as the default zone
<code>firewall-cmd --get-active-zones</code>	Show the active zones i.e. zones bound to either an interface or a source
<code>firewall-cmd --get-zones</code>	Show all available zones
<code>firewall-cmd --get-zone-of-interface=eth0</code>	Show the zone assigned to eth0
<code>firewall-cmd --new-zone=test</code>	Create a new zone called "test"
<code>firewall-cmd --zone=home --change-interface=eth0</code>	Assign temporarily eth0 to the "home" zone
<code>firewall-cmd --zone=home --change-interface=eth0 --permanent</code>	Assign permanently eth0 to the "home" zone
<code>firewall-cmd --zone=home --list-all</code>	List temporary settings of the "home" zone
<code>firewall-cmd --zone=home --list-all --permanent</code>	List permanent settings of the "home" zone
<code>firewall-cmd --zone=home --add-source=10.1.1.0/24</code>	Assign 10.1.1.0/24 to the "home" zone
<code>firewall-cmd --zone=home --list-sources</code>	List sources bound to the "home" zone

<code>firewall-cmd --zone=trusted --add-service=ssh</code>	Add the SSH service to the "trusted" zone
<code>firewall-cmd --zone=trusted --add-port=22/tcp</code>	
<code>firewall-cmd --zone=trusted --add-service={ssh,http,https}</code>	Add the SSH, HTTP, and HTTPS services to the "trusted" zone
<code>firewall-cmd --zone=trusted --list-services</code>	Show temporary and permanent services bound to the "trusted" zone
<code>firewall-cmd --zone=trusted --list-ports</code>	Show temporary and permanent ports open on the "trusted" zone
<code>firewall-cmd --get-icmptypes</code>	Show all known types of ICMP messages
<code>firewall-cmd --add-icmp-block=echo-reply</code>	Block a specific ICMP message type
<code>firewall-cmd --query-icmp-block=echo-reply</code>	Tell if a specific ICMP message type is blocked
<code>firewall-cmd --list-icmp-block</code>	Show the list of blocked ICMP message types
<code>/usr/lib/firewalld/services/service.xml</code>	Predefined configuration of <i>service</i>
<code>/etc/firewalld/services/service.xml</code>	User-defined configuration of <i>service</i>
<code>firewall-cmd --direct --add-rule ipv4 filter INPUT 0 \</code> <code>-p tcp --dport 22 -j ACCEPT</code>	Set up a direct rule (in iptables format) to accept SSH connections
<code>firewall-offline-cmd rule</code>	Set up a direct rule when firewalld is not running
<code>firewall-cmd --direct --get-all-rules</code>	Show all direct rules
<code>/etc/firewalld/direct.xml</code>	User-defined direct rules
<code>firewall-cmd --permanent --add-rich-rule='rule'</code>	Set up a rich rule
<code>firewall-cmd --list-rich-rules</code>	List all rich rules
<code>man firewalld.richlanguage</code>	Show the manpage about rich rules
<code>firewall-cmd --zone=external --add-masquerade</code>	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
<code>firewall-cmd --zone=external --add-forward-port=\</code> <code>port=22:proto=tcp:toport=2222</code>	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.)

<code>ssh root@remotehost</code>	Connect to a remote host via SSH (Secure Shell) and login as the root user
<code>ssh -v root@remotehost</code> <code>ssh -vv root@remotehost</code> <code>ssh -vvv root@remotehost</code>	Connect via SSH, specifying increasing levels of verbosity
<code>ssh -p 2222 root@remotehost</code> <code>ssh root@remotehost /root/mycommand</code>	SSH as root using port 2222 instead of standard port 22 Execute a command on a remote host
<code>sftp root@remotehost</code>	FTP-like tool for secure file transfer
<code>scp myfile root@remotehost:/tmp/myfile2</code> <code>scp root@remotehost:/tmp/myfile2 myfile</code> <code>scp jdoe@host1:/tmp/myfile root@host2:/root/myfile2</code>	Non-interactive secure file copy. Can transfer files from local to remote, from remote to local, or between two remote hosts
<code>sshpass -p p455w0rd ssh root@remotehost</code>	Connect to a remote host using the specified password
<code>pssh -i -H "host1 host2 host3" /root/mycommand</code>	Execute a command in parallel on a group of remote hosts
<code>ssh-keygen -t rsa -b 2048</code>	Generate interactively a 2048-bit RSA key pair; will prompt for a passphrase
<code>ssh-keygen -t dsa</code>	Generate a DSA key pair
<code>ssh-keygen -p -t rsa</code>	Change passphrase of the private key
<code>ssh-keygen -q -t rsa -f /etc/ssh/id_rsa -N '' -C ''</code>	Generate a RSA key with no passphrase (for non-interactive use) and no comment
<code>ssh-keygen -lf /etc/ssh/id_rsa.pub</code>	View key length and fingerprint of a public key
<code>ssh-agent</code>	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 <code>ssh</code> , <code>sftp</code> , and <code>scp</code>
<code>eval `ssh-agent`</code>	Show the PID of <code>ssh-agent</code> and set appropriate environment variables
<code>ssh-add</code>	Add the default private keys to the <code>ssh-agent</code> cache
<code>ssh-add ~/.ssh/id_rsa</code>	Add a specific private key to the <code>ssh-agent</code> cache
<code>ssh-copy-id root@remotehost</code>	Use locally available keys to authorize, via public key authentication, login of root on a remote host. Copies root's local public key <code>~/.ssh/id_rsa.pub</code> to <code>~/.ssh/authorized_keys</code> 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 &`

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

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

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

<code>openssl x509 -text -in certif.crt -noout</code>	Read a certificate
<code>openssl req -text -in request.csr -noout</code>	Read a Certificate Signing Request
<code>openssl req -new -key private.key -out request.csr</code>	Generate a Certificate Signing Request (in PEM format) for the public key of a key pair
<code>openssl req -new -nodes -keyout private.key \ -out request.csr -newkey rsa:2048</code>	Create a 2048-bit RSA key pair and generate a Certificate Signing Request for it
<code>openssl req -x509 -newkey rsa:2048 -nodes \ -keyout private.key -out certif.crt -days validity</code>	Generate a self-signed root certificate (and create a new CA private key)
<code>openssl ca -config ca.conf -in request.csr \ -out certif.crt -days validity -verbose</code>	Generate a self-signed certificate
<code>openssl ca -config ca.conf -genctrl -revoke certif.crt \ -crl_reason why</code>	Revoke a certificate
<code>openssl ca -config ca.conf -genctrl -out crlist.crl</code>	Generate a Certificate Revocation List containing all revoked certificates so far
<code>openssl x509 -in certif.pem -outform DER \ -out certif.der</code>	Convert a certificate from PEM to DER
<code>openssl pkcs12 -export -in certif.pem \ -inkey private.key -out certif.pfx -name friendlyname</code>	Convert a certificate from PEM to PKCS#12 including the private key
<code>cat cert.crt cert.key > cert.pem</code>	Create a PEM certificate from CRT and private key
<code>openssl dgst -hashfunction -out file.hash file</code>	Generate the digest of a file
<code>openssl dgst -hashfunction file | cmp -b file.hash</code>	Verify the digest of a file (no output means that digest verification is successful)
<code>openssl dgst -hashfunction -sign private.key \ -out file.sig file</code>	Generate the signature of a file
<code>openssl dgst -hashfunction -verify public.key \ -signature file.sig file</code>	Verify the signature of a file
<code>openssl enc -e -cipher -in file -out file.enc -salt</code>	Encrypt a file
<code>openssl enc -d -cipher -in file.enc -out file</code>	Decrypt a file
<code>openssl genpkey -algorithm RSA -cipher 3des \ -pkeyopt rsa_keygen_bits:2048 -out key.pem</code>	Generate a 2048-bit RSA key pair protected by TripleDES passphrase
<code>openssl pkey -text -in private.key -noout</code>	Examine a private key
<code>openssl pkey -in old.key -out new.key -cipher</code>	Change the passphrase of a private key
<code>openssl pkey -in old.key -out new.key</code>	Remove the passphrase from a private key
1. <code>openssl s_client -connect www.website.com:443 > tmpfile</code>	Retrieve and inspect a SSL certificate from a website
2. CTRL C	
3. <code>openssl x509 -in tmpfile -text</code>	
<code>openssl list-message-digest-commands</code>	List all available hash functions
<code>openssl list-cipher-commands</code>	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 " <i>Certificate name</i> "	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"

<code>gpg --gen-key</code>	Generate a key pair
<code>gpg --import alice.asc</code>	Import Alice's public key into your keyring
<code>gpg --list-keys</code>	List the keys contained into your keyring
<code>gpg --list-secret-keys</code>	List your private keys contained into your keyring
<code>gpg --list-public-keys</code>	List the public keys contained into your keyring
<code>gpg --export -o keyring_backup.gpg</code>	Export your whole keyring to a file
<code>gpg --export-secret-key -a "You" -o private.key</code>	Export your private key (username You) to a file
<code>gpg --export-public-key -a "Alice" -o alice.pub</code>	Export Alice's public key to a file
<code>gpg --edit-key "Alice"</code>	Sign Alice's public key
<code>gpg -e -u "You" -r "Alice" file.txt</code>	Sign a file (with your private key) and encrypt it to Alice (i.e. with Alice's public key)
<code>gpg -d file.txt.gpg</code>	Decrypt a file (with your own public key)

<code>md5sum</code>	Print a digest of a file generated by the relevant hashing algorithm
<code>shasum</code>	
<code>sha224sum</code>	
<code>sha256sum</code>	
<code>sha384sum</code>	
<code>sha512sum</code>	

<code>openvpn --genkey --secret <i>keyfile</i></code>	Generate a shared secret keyfile for OpenVPN authentication. The keyfile must be copied on both server and client
<code>openvpn server.conf</code>	Start the VPN on the server side. The encrypted VPN tunnel uses UDP port 1194
<code>openvpn client.conf</code>	Start the VPN on the client side
<code>/etc/openvpn/server.conf</code>	Server-side configuration file: <pre>dev tun ifconfig <i>server_IP</i> <i>client_IP</i> keepalive 10 60 ping-timer-rem persist-tun persist-key secret <i>keyfile</i></pre>
<code>/etc/openvpn/client.conf</code>	Client-side configuration file: <pre>remote <i>server_public_IP</i> dev tun ifconfig <i>client_IP</i> <i>server_IP</i> keepalive 10 60 ping-timer-rem persist-tun persist-key secret <i>keyfile</i></pre>

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 <code>clear</code>)
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 <code>logout</code>)
CTRL ALT DEL		Send a SIGINT to reboot the machine (same as <code>shutdown -r now</code>); specified in <code>/etc/inittab</code> and <code>/etc/init/control-alt-delete</code>
CTRL ALT F1 ... F6		Switch between text consoles (same as <code>chvt n</code>)

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 `udev` daemon which will pass the `uevent` through a set of rules stored in `/etc/udev/rules.d/*.rules` and `/lib/udev/rules.d/*.rules`.

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

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

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

<code>/lib/modules/X.Y.Z/*.ko</code>	Kernel modules for kernel version X.Y.Z
<code>/lib/modules/X.Y.Z/modules.dep</code>	Modules dependencies. This file needs to be recreated (via the command <code>depmod -a</code>) after a reboot or a change in module dependencies
<code>/etc/modules.conf</code>	Modules configuration file
<code>/etc/conf.modules</code> (deprecated)	
<code>/usr/src/linux/</code>	Contains the kernel source code to be compiled
<code>/usr/src/linux/.config</code>	Kernel configuration file
<code>freeramdisk</code>	Free the memory used for the <code>initrd</code> image. This command must be run directly after unmounting <code>/initrd</code>
<code>mkinitrd initrd_image kernel_version</code>	Create a <code>initrd</code> image file (Red Hat)
<code>mkinitramfs</code>	Create a <code>initrd</code> image file according to the configuration file <code>/etc/initramfs-tools/initramfs.conf</code> (Debian)
<code>dracut</code>	Create initial ramdisk images for preloading modules
<code>dbus-monitor</code>	Monitor messages going through a D-Bus message bus
<code>dbus-monitor --session</code>	Monitor session messages (default)
<code>dbus-monitor --system</code>	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

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

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

Kernel compile	
Download	Download kernel source code <code>linux-X.Y.Z.tar.bz2</code> from http://www.kernel.org to the base of the kernel source tree <code>/usr/src/linux</code>
Clean	<code>make clean</code> Delete most generated files
	<code>make mrproper</code> Delete all generated files and kernel configuration
	<code>make distclean</code> Delete temporary files, patch leftover files, and similar
Configure	<code>make config</code> Terminal-based (options must be set in sequence)
	<code>make menuconfig</code> ncurses UI
	<code>make xconfig</code> <code>make gconfig</code> GUI
	<code>make oldconfig</code> 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 <code>/usr/src/linux/.config</code> config file containing instructions for the compile
Build	<code>make bzImage</code> Compile the kernel
	<code>make modules</code> Compile the kernel modules
	<code>make all</code> Compile kernel and kernel modules
	<code>make -j2 all</code> will speed up compilation by allocating 2 simultaneous compile jobs
Modules install	<code>make modules_install</code> Install the previously built modules present in <code>/lib/modules/X.Y.Z</code>
Kernel install	<code>make install</code> Install the kernel automatically
	To install the kernel by hand: Copy the new compiled kernel and other files into the boot partition <code>cp /usr/src/linux/arch/boot/bzImage /boot/vmlinuz-X.Y.Z (kernel)</code> <code>cp /usr/src/linux/arch/boot/System.map-X.Y.Z /boot</code> <code>cp /usr/src/linux/arch/boot/config-X.Y.Z /boot (config options used for this compile)</code> Create an entry in GRUB to boot on the new kernel
Package	Optionally, the kernel can be packaged for install on other machines
	<code>make rpm-pkg</code> Build source and binary RPM packages
	<code>make binrpm-pkg</code> Build binary RPM package
	<code>make deb-pkg</code> Builds binary DEB package

Kernel patching	
Download	Download and decompress the patch to <code>/usr/src</code>
Patch	<code>patch -p1 < file.patch</code> Apply the patch
	<code>patch -Rp1 < file.patch</code> 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.

<code>lsmod</code>	List the modules that are currently loaded into the kernel
<code>insmod module</code>	Insert a module into the kernel. If the module requires another module or if it does not detect compatible hardware, insertion will fail
<code>rmmod module</code>	Remove a module from the kernel. If the module is in use by another module, it is necessary to remove the latter first
<code>modinfo module</code>	Display the list of parameters accepted by the module
<code>depmod -a</code>	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.

<code>modprobe module option=value</code>	Insert a module into the running kernel, with the specified parameters. Prerequisite modules will be inserted automatically
<code>modprobe -a</code>	Insert all modules
<code>modprobe -t directory</code>	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
<code>modprobe -r module</code>	Remove a module
<code>modprobe -c module</code>	Display module configuration
<code>modprobe -l</code>	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: <code>kernel /vmlinuz ro root=/dev/vg0/root vga=0x33c</code>				
Device driver provided as a kernel module	Edit module configuration in <code>/etc/modprobe.conf</code> or <code>/etc/modprobe.d/</code> (Red Hat): <table> <tr> <td><code>alias eth0 3c59x</code></td> <td>Specify that <code>eth0</code> uses the <code>3c59x.ko</code> driver module</td> </tr> <tr> <td><code>options 3c509 irq=10,11</code></td> <td>Assign IRQ 10 and 11 to 3c509 devices</td> </tr> </table>	<code>alias eth0 3c59x</code>	Specify that <code>eth0</code> uses the <code>3c59x.ko</code> driver module	<code>options 3c509 irq=10,11</code>	Assign IRQ 10 and 11 to 3c509 devices
<code>alias eth0 3c59x</code>	Specify that <code>eth0</code> uses the <code>3c59x.ko</code> driver module				
<code>options 3c509 irq=10,11</code>	Assign IRQ 10 and 11 to 3c509 devices				

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

`/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
sysctl -p
```

List all available kernel tuning options

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 method 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
 rndc 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" {
    algorithm dsa;
    secret "HYZur46fftdUQ43BJKI093t4t78lqp";
};

acl "mynetwork" {10.7.0.0/24};
// Alias definition
// Built-in ACLs: any, none, localhost, localnets

options {
    directory "/var/named";
    version "0.0";
    listen-on port 53 {10.7.0.1; 127.0.0.1};
    blackhole {172.17.17.0/24};
    allow-query {mynetwork};
    allow-query-on {any};
    allow-query-cache {any};
    allow-recursion {mynetwork};
    allow-recursion-on {mynetwork};
    allow-transfer {10.7.0.254};
    allow-update {any};
    recursive-clients 1000;
    dnssec-enable yes;
    dialup no;

    forward first;
    forwarders {10.7.0.252; 10.7.0.253};
};

// 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 "240.123.224.in-addr.arpa" IN {
    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";
    masters {10.7.0.254};
};
zone "0.7.10.in-addr.arpa" IN {
    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	

<code>apachectl</code>	(Red Hat)	Manage the Apache webserver
<code>httpd</code>	(Red Hat)	
<code>apache2ctl</code>	(Debian)	
<code>apachectl start</code>		Start the Apache webserver daemon
<code>apachectl status</code>		Display a brief status report
<code>apachectl fullstatus</code>		Display a detailed status report
<code>apachectl graceful</code>		Gracefully restart Apache; currently open connections are not aborted
<code>apachectl graceful-stop</code>		Gracefully stop Apache; currently open connections are not aborted
<code>apachectl configtest</code>		Test the configuration file, reporting any syntax error
<code>apachectl -t</code>		
<code>apachectl -M</code>		List all loaded and shared modules

<code>/var/www/html</code>		Default document root directory
<code>\$HOME/public_html</code>		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.

<code>/etc/httpd/conf/httpd.conf</code>	(Red Hat)	Apache configuration file
<code>/etc/apache2/httpd.conf</code>	(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`.

<code>/etc/ssl/openssl.cnf</code>		Configuration file for OpenSSL
<code>/etc/httpd/conf.d/ssl.conf</code>	(Red Hat)	Configuration file for the <code>mod_ssl</code> 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 <code>MaxRequestWorkers</code> . Worker MPM: in conjunction with <code>ThreadLimit</code> , max configured value for <code>MaxRequestWorkers</code>
ThreadsPerChild 25	Worker MPM: number of threads created by each child process
ThreadLimit 64	Worker MPM: max configured value for <code>ThreadsPerChild</code>
LoadModule mime_module modules/mod_mime.so	Load the module <code>mime_module</code> by linking in the object file or library <code>modules/mod_mime.so</code>
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 <code>root</code>
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 <code>http://www.mysite.org/image/</code> to the directory <code>/mydir/pub/image</code> 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 <code>ServerRoot</code>
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 <code>conf/mime.types</code>
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 <code>temp</code> 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 <code>.htaccess</code> 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 <i>address:port</i> 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 "|rotatelog 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 <i>user:encryptedpassword</i> 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: <i>group: user1 user2 user3</i>
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`

<code>smbd</code>	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
<code>nmbd</code>	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
<code>/etc/smb/</code>	Samba directory
<code>/etc/samba/</code> (RHEL 7 onwards)	
<code>/etc/samba/lmhosts</code>	Samba NetBIOS hosts file
<code>/etc/samba/netlogon</code>	User logon directory
<code>smbd -V</code> <code>smbclient -V</code>	Show the version of the Samba server
<code>testparm</code>	Check the Samba configuration file and report any error
<code>smbpasswd jdoe</code>	Change the Samba password of user jdoe
<code>smbpasswd -a ksmith</code>	Create a new Samba user ksmith and set his password
<code>nmblookup smbserver</code>	Look up the NetBIOS name of a server and map it to an IP address
<code>nmblookup -U winsserver -R WORKGROUP#1B</code>	Query recursively a WINS server for the Domain Master Browser for the specified workgroup
<code>nmblookup -U winsserver -R WORKGROUP#1D</code>	Query recursively a WINS server for the Domain Controller for the specified workgroup
<code>net</code>	Tool for administration of Samba and remote CIFS servers
<code>net rpc shutdown -r -S smbserver -U root%password</code>	Reboot a CIFS server
<code>net rpc service list -S smbserver</code>	List available services on a CIFS server
<code>net status sessions</code>	Show active Samba sessions
<code>net status shares</code>	Show Samba shares
<code>net rpc info</code>	Show information about the domain
<code>net groupmap list</code>	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	
<code>credentials=file</code>	Mount the share as the user defined in the credentials <i>file</i>
<code>username=user</code>	Mount the share as <i>user</i>
<code>password=password</code>	Specify the mount user's <i>password</i>

/etc/samba/smb.conf Samba configuration	
<pre>[global] workgroup = MYWORKGROUP server string = Linux Samba Server %L hosts allow = 10.9.9.0/255.255.255.0 security = user encrypt passwords = yes smb passwd file = /etc/samba/smbpasswd unix password sync = yes username map = /etc/samba/smbusers netbios name = Mysambabox netbios aliases = Mysambabox1 wins support = yes logon server = yes log file = /var/log/samba/log.%m max log size = 1000 syslog only = no syslog = 0 panic action = \ /usr/share/samba/panic-action %d</pre>	<p>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</p> <p>Make Samba join the specified workgroup</p> <p>Describe server to the clients</p> <p>Allow only the specified machines to connect to the server</p> <p>Set up user-level authentication</p> <p>Use encrypted passwords</p> <p>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: <code>passwd newuser</code> <code>smbpasswd newuser</code></p> <p>When the password of a client user (e.g. under Windows) is changed, change the Linux and Samba password too</p> <p>Map each Samba server user name to client user name(s). The file <code>/etc/samba/smbusers</code> is structured as follows: <code>root = Administrator Admin</code> <code>jdoue = "John Doe"</code> <code>kgreen = "Kim Green"</code></p> <p>Set NetBIOS name and alias</p> <p>Make Samba play the role of a WINS server. Note: There should be only one WINS server on a network</p> <p>Enable logon support. Logon script parameters will be defined in a <code>[netlogon]</code> section</p> <p>Use a separate logfile for each machine that connects</p> <p>Maximum size of each logfile, in Kb</p> <p>Whether to log only via Syslog</p> <p>Log everything to the logfiles <code>/var/log/smb/log.smbd</code> and <code>/var/log/smb/log.nmbd</code>, and log a minimum amount of information to Syslog. This parameter can be set to a higher value to have Syslog log more information</p> <p>Mail a backtrace to the sysadmin in case Samba crashes</p>
<pre>[netlogon] comment = Netlogon for Windows clients path = /home/netlogon logon script = %U.bat browseable = no writeable = no guest ok = no</pre>	<p>Section defining a logon script</p> <p>Specifies a per-user script e.g. <code>/home/netlogon/jdoe.bat</code> will be called when user <code>jdoe</code> logs in. It is also possible to specify a per-clientname script <code>%m.bat</code>, which will be called when a specific machine logs in.</p> <p>Guest access to the service (i.e. access without entering a password) is disabled</p>
<pre>[Canon LaserJet 3] printer name = lp comment = Canon LaserJet 3 main printer path = /var/spool/lpd/samba printable = yes writeable = no</pre>	<p>Section defining a printer accessible via the network</p>

/etc/samba/smb.conf Samba configuration	
<pre>[public] comment = Public Storage on %L path = /home/samba browsable = yes writeable = yes</pre>	<p>Section defining a public share accessible on read/write by anyone</p> <p>Describe the public share to users</p> <p>Path of the public share on the server</p> <p>Whether to show the public share when browsing</p> <p>Whether to allow all users to write in this directory</p>
<pre>[homes] comment = %U's home directory on %L from %m browseable = no writeable = yes</pre>	<p>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</p> <p>Describe the share to the user</p> <p>Whether to show the homes share when browsing</p> <p>Whether to allow the user to write in his home directory</p>
<pre>[foobar] path = /foobar comment = Share Foobar on %L from %m browsable = yes writeable = yes valid users = jdoe, kgreen, +geeks invalid users = csmith read list = bcameron write list = fcastle</pre>	<p>Section defining a specific share</p> <p>Path of the share on the server</p> <p>Describe the share to users</p> <p>Whether to show the share when browsing</p> <p>Whether to allow the users to write in this share</p> <p>Allow access only to users jdoe and kgreen, and local group geeks</p> <p>Deny access to user csmith</p> <p>Allow read-only access to user bcameron</p> <p>Allow read-write access to user fcastle</p>

Samba share access (defined in the configuration file)	
User-level authentication	
<pre>[global] security = user guest account = nobody map to guest = Never</pre>	<p>Set up user-level authentication</p> <p>Map the guest account to the system user nobody (default)</p> <p>Specify how incoming requests are mapped to the guest account:</p> <p>Bad User redirect from an invalid user to guest account on server</p> <p>Bad Password redirect from an invalid password to guest account on server</p> <p>Never reject unauthenticated users</p>
Server-level authentication	
<pre>[global] security = server password server = srv1 srv2</pre>	<p>Set up server-level authentication</p> <p>Authenticate to server srv1, or to server srv2 if srv1 is unavailable</p>
Domain-level authentication	
<pre>[global] security = ADS realm = KRB_REALM</pre>	<p>Set up domain-level authentication as an Active Directory member server</p> <p>Join the specified realm.</p> <p>Kerberos must be installed and an administrator account must be created:</p> <pre>net ads join -U Administrator%password</pre>
Share-level authentication	
<pre>[global] security = share [foobar] path = /foobar username = quux only user = yes</pre>	<p>Set up share-level authentication</p> <p>Define a foobar share accessible to any user which can supply quux's password. The user quux must be created on the system:</p> <pre>useradd -c "Foobar account" -d /tmp -m -s /sbin/nologin quux</pre> <p>and added to the Samba password file:</p> <pre>smbpasswd -a quux</pre>

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)		
%G	Primary group of session username	%S	Name of the current service, if any
%h	Samba server hostname	%P	Root directory of the current service, if any
%M	Client hostname	%u	Username of the current service, if any
%L	NetBIOS name of the server	%g	Primary group name of username
%m	NetBIOS name of the client	%H	Home directory of username
%d	Process ID of the current server process	%N	Name of the NIS home directory server as obtained from the NIS <code>auto.map</code> entry. Same as %L if Samba was not compiled with the <code>--with-automount</code> option
%a	Architecture of remote machine	%p	Path of service's home directory as obtained from the NIS <code>auto.map</code> entry. The NIS <code>auto.map</code> entry is split up as %N:%p
%I	IP address of client machine		
%i	Local IP address to which a client connected		
%T	Current date and time		
%D	Domain or workgroup of the current user		
%w	Winbind separator		
%(var)	Value of the environment variable <i>var</i>		

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.

<code>rpc.nfsd</code> <code>rpc.mountd</code> <code>rpc.lockd</code> <code>rpc.statd</code>	NFS daemons																
<code>/etc/exports</code>	List of the filesystems to be exported (via the command <code>exportfs</code>)																
<code>/var/lib/nfs/xtab</code>	List of exported filesystems, maintained by <code>exportfs</code>																
<code>/proc/fs/nfs/exports</code>	Kernel export table (can be examined via the command <code>cat</code>)																
<code>exportfs -ra</code>	Export or reexport all directories. When exporting, fills the kernel export table <code>/proc/fs/nfs/exports</code> . When reexporting, removes those entries in <code>/var/lib/nfs/xtab</code> that are deleted from <code>/etc/exports</code> (therefore synchronizing the two files), and removes those entries from <code>/proc/fs/nfs/exports</code> that are no longer valid																
<code>exportfs -ua</code>	Unexport all directories. Removes from <code>/proc/fs/nfs/exports</code> all those entries that are listed in <code>/var/lib/nfs/xtab</code> , and clears the latter file																
<code>showmount</code>	Show the remote client hosts currently having active mounts																
<code>showmount --directories</code>	Show the directories currently mounted by a remote client host																
<code>showmount --exports</code>	Show the filesystems currently exported i.e. the active export list																
<code>showmount --all</code>	Show both remote client hosts and directories																
<code>showmount -e nfsserver</code>	Show the shares a NFS server has available for mounting																
<code>rpcinfo -p nfsserver</code>	Probe the portmapper on a NFS server and display the list of all registered RPC services there																
<code>rpcinfo -t nfsserver nfs</code>	Test a NFS connection by sending a null pseudo request (using TCP)																
<code>rpcinfo -u nfsserver nfs</code>	Test a NFS connection by sending a null pseudo request (using UDP)																
<code>nfsstat</code>	Display NFS/RPC client/server statistics.																
Options:	<table border="1"> <thead> <tr> <th></th> <th>NFS</th> <th>RPC</th> <th>both</th> </tr> </thead> <tbody> <tr> <th>server</th> <td>-sn</td> <td>-sr</td> <td>-s</td> </tr> <tr> <th>client</th> <td>-cn</td> <td>-cr</td> <td>-c</td> </tr> <tr> <th>both</th> <td>-n</td> <td>-r</td> <td>-nr</td> </tr> </tbody> </table>		NFS	RPC	both	server	-sn	-sr	-s	client	-cn	-cr	-c	both	-n	-r	-nr
	NFS	RPC	both														
server	-sn	-sr	-s														
client	-cn	-cr	-c														
both	-n	-r	-nr														
<code>mount -t nfs nfsserver:/share /usr</code>	Command to be run on a client to mount locally a remote NFS share. NFS shares accessed frequently should be added to <code>/etc/fstab</code> e.g. <code>nfsserver:/share /usr nfs intr 0 0</code>																

/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	<table border="0"> <tr> <td>ro</td> <td>Read-only access (default)</td> </tr> <tr> <td>rw</td> <td>Read and write access. The client may choose to mount read-only anyway</td> </tr> <tr> <td>sync</td> <td>Reply to requests only after the changes made by these requests have been committed to stable storage</td> </tr> <tr> <td>async</td> <td>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</td> </tr> <tr> <td>root_squash</td> <td>Requests by user <code>root</code> on client will be done as user <code>nobody</code> on server (default)</td> </tr> <tr> <td>no_root_squash</td> <td>Requests by user <code>root</code> on client will be done as same user <code>root</code> on server</td> </tr> <tr> <td>all_squash</td> <td>Requests by a non-root user on client will be done as user <code>nobody</code> on server</td> </tr> <tr> <td>no_all_squash</td> <td>Requests by a non-root user on client will be attempted as same user on server (default)</td> </tr> </table>	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 <code>root</code> on client will be done as user <code>nobody</code> on server (default)	no_root_squash	Requests by user <code>root</code> on client will be done as same user <code>root</code> on server	all_squash	Requests by a non-root user on client will be done as user <code>nobody</code> on server	no_all_squash	Requests by a non-root user on client will be attempted as same user on server (default)
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 <code>root</code> on client will be done as user <code>nobody</code> on server (default)																
no_root_squash	Requests by user <code>root</code> on client will be done as same user <code>root</code> on server																
all_squash	Requests by a non-root user on client will be done as user <code>nobody</code> 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	
<code>rsize=nnn</code>	Size for read transfers (from server to client)
<code>wsize=nnn</code>	Size for write transfers (from client to server)
<code>nfsvers=n</code>	Use NFS version <i>n</i> for transport
<code>retry=n</code>	Keep retrying a mount attempt for <i>n</i> minutes before giving up
<code>timeo=n</code>	A mount attempt times out after <i>n</i> tenths of a second
<code>intr</code>	User can interrupt a mount attempt
<code>nointr</code>	User cannot interrupt a mount attempt (default)
<code>hard</code>	The system will try a mount indefinitely (default)
<code>soft</code>	The system will try a mount until an RPC timeout occurs
<code>bg</code>	Try a mount in the foreground, all retries occur in the background
<code>fg</code>	All mount attempts occur in the foreground (default)
<code>tcp</code>	Connect using TCP
<code>udp</code>	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.

<code>/etc/dhcpd.conf</code>	Configuration file for the DHCP server
<code>/etc/sysconfig/dhcrelay</code> (SUSE)	Configuration file for the DHCP relay agent
<code>/var/lib/dhcpd/dhcpd.leases</code>	DHCP current leases

<code>/etc/dhcpd.conf</code>	DHCP server configuration
<pre>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;</pre>	Global parameters for DNS, mail, NTP, and news servers specification
<pre>shared-network geek-net { default-lease-time 86400; max-lease-time 172800; 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; } }</pre>	<p>Definition of a network</p> <p>Time, in seconds, that will be assigned to a lease if a client does not ask for a specific expiration time</p> <p>Maximum time, in seconds, that can be assigned to a lease if a client asks for a specific expiration time</p> <p>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</p>
<pre>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"; } }</pre>	<p>Definition of a group</p> <p>Definition of different hosts to whom static IP addresses will be assigned to, depending on their MAC address</p>

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 <i>service</i>
	sufficient	If this module succeeds, 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 <i>service</i> fails
	requisite	If this module fails, <i>service</i> fails and control returns to the application that invoked <i>service</i>
	include	Include modules from another PAM service file
module	PAM module and its options, e.g.:	
	pam_unix.so	Standard UNIX authentication module via <code>/etc/passwd</code> and <code>/etc/shadow</code>
	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 a 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)	
<pre>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 -</pre>	<p>This LDIF file will change the email address of jdoe, add a picture, and delete the description attribute for the entry</p>

<code>slapd</code>	Standalone OpenLDAP daemon
<code>/var/lib/ldap/</code>	Files constituting the OpenLDAP database
<code>/etc/openldap/slapd.conf</code> <code>/usr/local/etc/openldap/slapd.conf</code>	OpenLDAP configuration file
<code>slapcat -l file.ldif</code>	Dump the contents of an OpenLDAP database to a LDIF file
<code>slapadd -l file.ldif</code>	Import an OpenLDAP database from a LDIF file
<code>slapindex</code>	Regenerate OpenLDAP's database indexes
<code>yum install openldap openldap-clients \ authconfig sssd nss-pam-ldapd authconfig-gtk</code>	Install the OpenLDAP client (on RHEL 7)
<code>authconfig --enableldap --enableldapauth \ --ldapserver=ldap://ldapserver \ --ldapsbasedn="dc=example,dc=org" \ --enablenesssd --update</code>	Set up the LDAP client to connect to a <i>ldapserver</i> . This will update the configuration files <code>/etc/sss/sss.conf</code> and <code>/etc/openldap/ldap.conf</code>
<code>getent group <i>groupname</i></code>	Get entries about <i>groupname</i> from NSS libraries
<code>authconfig-gtk</code> <code>system-config-authentication</code>	OpenLDAP configuration GUI
<code>sss</code> (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).

<pre>setenforce 0 echo 0 > /selinux/enforce setenforce 1 echo 1 > /selinux/enforce getenforce cat /selinux/enforce sestatus -v</pre>	<p>Enter permissive mode</p> <p>Enter enforcing mode</p> <p>Display current mode</p>
<pre>chcon context file chcon --reference=file0 file restorecon -f file</pre>	<p>Change the security context of <i>file</i> to the specified <i>context</i></p> <p>Change the security context of <i>file</i> to the same as the reference file <i>file0</i></p> <p>Restore the security context of <i>file</i> to the system default</p>
<pre>ls -Z ps -eZ getsebool boolean setsebool boolean=value</pre>	<p>List files and their security context</p> <p>List processes and their security context</p> <p>Get the value of a SELinux boolean</p> <p>Set the value of a SELinux boolean</p>
<pre>tar --selinux [other args] star -xattr -H=exustar [other args]</pre>	<p>Create or extract archives that retain the security context of files</p>
<pre>semanage</pre>	<p>Manage SELinux policies</p>
<pre>/etc/selinux/config (symlinked in /etc/sysconfig/selinux)</pre>	<p>SELinux mode can be configured permanently inside this file.</p> <pre># 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</pre>
<pre>/selinux/</pre>	<p>Pseudo filesystem, created by SELinux, containing commands used by the kernel for its operations.</p>
<pre>/var/log/audit/audit.log /var/log/messages</pre>	<p>AVC denials are logged on this file if <code>auditd</code> is running</p> <p>AVC denials are logged on this file if <code>rsyslogd</code> is running</p>
<pre>sealert -a logfile grep nnnnn.mmm:pp logfile | audit2why</pre>	<p>Analyze a SELinux logfile and display SELinux policy violations</p> <p>Diagnostic a specific AVC event entry from a SELinux logfile:</p> <pre>type=AVC msg=audit(nnnnn.mmm:pp): avc: denied (...)</pre>

KVM (Kernel-based Virtual Machine) is a virtualization infrastructure for the Linux kernel that allows it to function as an hypervisor.

<code>/etc/libvirt/qemu/</code>	Directory containing the XML files that define VMs properties. <code>libvirtd</code> must be restarted after modifying a XML file
<code>/var/lib/libvirt/</code>	Directory containing files related to the VMs
<code>virt-manager</code>	KVM GUI
<code>virt-install --prompt</code>	Interactive command-line program to create a VM
<code>virt-install -n <i>vmname</i> -r 2048 \</code> <code>--disk path=/var/lib/libvirt/images/<i>vmname</i>.img \</code> <code>-l /root/vmstuff/inst/ \</code> <code>-x "ks=/root/vmstuff/kickstart.cfg"</code>	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
<code>virt-clone --prompt</code>	Interactive command-line program to clone a VM. A VM must be shut off or paused before it can be cloned
<code>virt-clone -o <i>vmname</i> -n <i>vmclonename</i></code>	Clone a VM
<code>virsh</code>	Interface for VM management
<code>virsh list --all</code>	List all VMs present on the system
<code>virsh start <i>vmname</i></code>	Start a VM
<code>virsh destroy <i>vmname</i></code>	Brutally shut down a VM
<code>virsh shutdown <i>vmname</i></code>	Gracefully shut down a VM
<code>virsh autostart <i>vmname</i></code>	Set a VM to be automatically started when the system boots. Done by symlinking the VM to <code>/etc/libvirt/qemu/autostart/</code>
<code>virsh autostart --disable <i>vmname</i></code>	Disable the autostart of a VM at system boot
<code>virsh edit <i>vmname</i></code>	Edit the XML file defining a VM's properties
<code>virt-what</code>	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.

<code>system-config-kickstart</code>	GUI tool to create a Kickstart file
<code>ksvalidator <i>ksfile</i></code>	Check the validity of a Kickstart file
<code>/root/anaconda-ks.cfg</code>	Kickstart file describing the current system. This file was automatically generated during the installation of the current system
<code>ksverdiff -f RHEL6 -t RHEL7</code>	Show the differences in the Kickstart syntax between RHEL 6 and RHEL 7

<code>git init</code>	Initialize the current directory as a repository
<code>git clone <i>repoaddress</i></code>	Clone a remote repository. <i>repoaddress</i> 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
<code>git checkout <i>branch</i></code>	Start working into an already existing <i>branch</i>
<code>git checkout -B <i>branch</i></code>	Create <i>branch</i> and start working into it
<code>git pull</code>	Pull the changes from the remote repository branch to the local branch
<code>git add <i>file</i></code>	Add <i>file</i> to the content staged for the next commit (hence starting to track it)
<code>git rm <i>file</i></code>	Remove <i>file</i> from the content staged for the next commit
<code>git status</code>	See the status (e.g. files changed but not yet staged) of the current branch
<code>git commit -am "<i>Message</i>"</code>	Commit all staged files in the current branch
<code>git push</code>	Push the local commits from the current branch to the remote repository
<code>git push origin <i>branch</i></code>	Push the local commits from <i>branch</i> to the remote repository
<code>git merge <i>branch</i></code>	Merge changes made on <i>branch</i> to the master branch
<code>git diff <i>checksum1 checksum2</i></code>	Compare two commits
<code>git branch</code>	Show local branches
<code>git branch -r</code>	Show remote branches
<code>git branch -a</code>	Show remote and local branches

Tag	Attributes	
<h1>...<h6> Heading		<code>align=left|center|right|justify</code> Heading alignment †

 Line break	Line break and carriage return	
<hr> Horizontal line		<code>align=left|center|right</code> Line alignment † <code>noshade</code> Solid rendering instead of 3D † <code>size=npixels</code> Line height <code>width=npixels|percent%</code> Line width
<p> Paragraph <div> Section		<code>align=left|center|right|justify</code> Paragraph or section alignment †
 Group	Group of elements	
<a> Anchor	Hyperlink	<code>charset=encoding</code> Character encoding of target URL <code>coords=left,top,right,bottom|cx,cy,radius|x1,y1,...,xn,yn</code> Coordinates of region; depends on shape <code>href=url</code> Target URL for the link <code>hreflang=language</code> Language of document at the target URL <code>name=section</code> Name of anchor for document bookmarking <code>rel|rev=alternate|stylesheet|start|next|prev|contents|index|glossary|copyright|chapter|section|subsection|appendix|help|bookmark</code> Relationship between this document and the target URL (<code>rel</code>) or vice versa (<code>rev</code>) <code>shape=rectangle|circle|polygon</code> Shape of region <code>target=_blank|_parent|_self|_top</code> Destination of target URL <code>type=mimetype</code> MIME type of target URL
<dl> Definition list		
<dt> Definition term		
<dd> Definition description	Description of a definition term	

† = deprecated

Tag	Attributes	
<i> Italic		
 Bold		
<s> Strike-through	Strike-through text †	
<u> Underlined	Underlined text †	
<big> Bigger		
<small> Smaller		
<sub> Subscript		
<sup> Superscript		
<tt> Teletype	Monospaced text	
 Emphasized		
 Strong		
 Deleted	Deleted/inserted text	<code>cite=url</code> URL to document explaining deletion/insertion
<ins> Inserted		<code>datetime=yyyy-mm-dd</code> When the text was deleted/inserted
<pre> Preformatted		<code>width=ncharacters</code> 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		<code>cite=url</code> URL to document containing the quote
<q> Short quotation		
<address> Address	Address block	
<abbr> Abbreviation		
<acronym> Acronym		
<dfn> Definition	Definition term	
 Font	Font †	<code>color=rgb(r,g,b)|#rrggbb|color</code> Text color <code>face=fontname</code> Text font <code>size=[1...7]|[-6...+6]</code> Text size
<bdo> Bidirectional override		<code>dir=ltr|rtl</code> 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	<code>class=class|style</code> Class of the element <code>id=id</code> Unique ID of the element <code>style=styledef</code> Inline style definition <code>title=tooltip</code> Text of the tooltip to display <code>dir=ltr|rtl</code> Direction of text: left-to-right or right-to-left <code>lang=language</code> Language of the content <code>accesskey=character</code> Keyboard shortcut for the element <code>tabindex=ntab</code> N of tab for the element

† = deprecated

Tag	Attributes	
 Image	align=top|bottom|left|middle|right alt=alternatetext border=npixels height=npixels|percent% hspace=npixels ismap=url longdesc=url src=url usemap=url vspace=npixels width=npixels|percent%	Image alignment with respect to surrounding text † Description of the image for text-only browsers Border width around the image † Image height Blank space on the left and right side of image † URL for server-side image map URL containing a long description of the image URL of the image URL for client-side image map Blank space on top and bottom of image † Image width
<map> Image map	id=id name=name	Unique ID for the map tag Unique name for the map tag
<area> Area of image map	alt=alternatetext coords=left,top,right,bottom| cx,cy,radius|x1,y1,...,xn,yn href=url nohref=true|false shape=rectangle|circle|polygon target=_blank|_parent|_self|_top	Description of area for text-only browsers Coordinates of clickable area; depends on shape Target URL of area Excludes or includes the area from image map Shape of area Destination of target URL

† = deprecated

Tag	Attributes	
<table> Table	align=left center right bgcolor=rgb(<i>r,g,b</i>) #rrggbb color border=npixels cellpadding=npixels percent% cellspacing=npixels percent% frame=void above below lhs rhs hsides vsides box border rules=none groups rows cols all summary=summary width=npixels percent%	Table alignment † Table background color † Border width Space around the content of each cell Space between cells Visibility of sides of the table border Horizontal or vertical divider lines Summary of the table for text-only browsers Table width
<tr> Table row	align=left center right justify char bgcolor=rgb(<i>r,g,b</i>) #rrggbb color char=character charoff=npixels percent% valign=top middle bottom baseline	Horizontal text alignment Row background color † Character to align text on, if align=char Alignment offset to first character, if align=char Vertical text alignment
<td> Table cell <th> Table header	abbr=content align=left center right justify char axis=category bgcolor=rgb(<i>r,g,b</i>) #rrggbb color char=character charoff=npixels percent% colspan=ncolumns headers=headerid height=npixels nowrap rowspan=nrows scope=col colgroup row rowgroup valign=top middle bottom baseline width=npixels percent%	Abbreviated content in a cell Horizontal text alignment Cell name Cell background color † Character to align text on, if align=char Alignment offset to first character, if align=char Number of columns this cell spans on Cell header information for text-only browsers Cell height † Text in cell stays on a single line † Number of rows this cell spans on Target for cell header information Vertical text alignment Cell width †
 Ordered list	compact=compact start=firstnumber type=A|a|I|i|1	List must be more compact † Number to start the list on † List numbers type †
 Unordered list	compact=compact type=disc|square|circle	List must be more compact † List type †
 List item	type=disc|square|circle|A|a|I|i|1 value=itemno	List item type † List item value †

† = deprecated

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.