Introduction to GNU/Linux

UNIX concepts: filesystem, users, permissions and processes.

Using the shell. UNIX tools.

Accessing Windows/UNIX from UNIX/Windows.

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[2](http://labor-liber.org/en/gnu-linux/introduction/all#toc-unix_philosophy)UNIX Philosophy

* Rule of Modularity: Write simple parts connected by clean interfaces.
* Rule of Clarity: Clarity is better than cleverness.
* Rule of Composition: Design programs to be connected to other programs.
* Rule of Separation: Separate policy from mechanism; separate interfaces from engines.
* Rule of Simplicity: Design for simplicity; add complexity only where you must.
* Rule of Parsimony: Write a big program only when it is clear by demonstration that nothing else will do.
* Rule of Transparency: Design for visibility to make inspection and debugging easier.
* Rule of Robustness: Robustness is the child of transparency and simplicity.
* Rule of Representation: Fold knowledge into data so program logic can be stupid and robust.
* Rule of Least Surprise: In interface design, always do the least surprising thing.
* Rule of Silence: When a program has nothing surprising to say, it should say nothing.
* Rule of Repair: When you must fail, fail noisily and as soon as possible.
* Rule of Economy: Programmer time is expensive; conserve it in preference to machine time.
* Rule of Generation: Avoid hand-hacking; write programs to write programs when you can.
* Rule of Optimization: Prototype before polishing. Get it working before you optimize it.
* Rule of Diversity: Distrust all claims for "one true way".
* Rule of Extensibility: Design for the future, because it will be here sooner than you think.
* Eric Steven Raymond - The Art of Unix Programming - Basics of the Unix Philosophy -<http://www.faqs.org/docs/artu/ch01s06.html>

[3](http://labor-liber.org/en/gnu-linux/introduction/all#toc-unix_flavors)UNIX Flavors

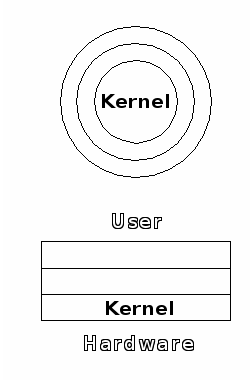
There are many UNIX flavors. Mainly:

* System V
* BSD (Berkeley Software Distribution)

GNU/Linux is a POSIX compliant complete rewrite of Unix, and a blend of System V and BSD.

* UNIX - <http://en.wikipedia.org/wiki/UNIX>
* POSIX, the Single UNIX Specification - <http://en.wikipedia.org/wiki/POSIX>
* Eric Steven Raymond - The Art of Unix Programming - Unix Standards -<http://www.faqs.org/docs/artu/ch17s02.html>

[4](http://labor-liber.org/en/gnu-linux/introduction/all#toc-linux_kernel)Linux Kernel



An operating system is a complex system, made up of a large number of components, or software layers. Ideally, these components are independant from each other, so that the large complex system becomes a set of smaller and more simple components.

The **kernel** of an operating system is its core component ; or its bottom layer, the interface with hardware.

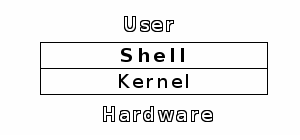
The **Linux** kernel:

* Manages hardware drivers.
* Manages the system's fundamental services: memory, filesystem, network, processes, permissions.

Version numbers:

* Stable releases: Even minor version number (2.**6**.x)
* Development releases: Odd minor version number (2.**7**.x)
* The Linux Kernel Archives - <http://kernel.org/>
* Linux kernel - <http://en.wikipedia.org/wiki/Linux_kernel>

[5](http://labor-liber.org/en/gnu-linux/introduction/all#toc-shell)Shell



Text mode / command line (instructions are given line by line) user interface:

* Command interpreter
  + To launch an application, type its name, and press **Enter**.
  + Many commands (small programs) to browse and edit files, control program execution, display system information, etc.
* Programmable.

The shell is much more flexible and powerful than a graphical user interface.

* GNU BASH, the default GNU/Linux shell - <http://www.gnu.org/software/bash/bash.html>

[6](http://labor-liber.org/en/gnu-linux/introduction/all#toc-shells)Various Shells

* **sh**: Bourne shell, the original and perhaps the simplest Unix shell.
* **csh**: C shell, with a syntax modeled after the C programming language.
* **tcsh**: a superset of the C shell.
* **ksh**: Korn shell, compatible with the Bourne shell, it includes many features of the C shell as well.
* **bash**: Bourne Again shell, largely backward-compatible with sh, it includes ideas drawn from ksh and csh.
* ...
* Unix shells - <http://en.wikipedia.org/wiki/UNIX_shell>
* Differing Shell Features, in Introduction to Linux. Machtelt Garrels - <http://tldp.org/LDP/intro-linux/html/x8224.html>

[7](http://labor-liber.org/en/gnu-linux/introduction/all#toc-x_window)X Window System

The X Window system, or X, or X11:

* Manages some hardware:
  + graphics/video cards,
  + keyboard and mouse.

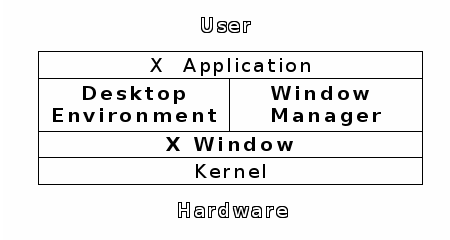
X enables text copy&paste with the mouse: select text using the left button, and copy it elsewhere with the middle button.

* Manages the display of applications in windows.
* Client Server system: a X server on a machine can display a client application running on another machine.

An application server can run a client application for many machines with an X server (e.g. OpenOffice.org).

* X Window System - <http://en.wikipedia.org/wiki/XWindow>

[8](http://labor-liber.org/en/gnu-linux/introduction/all#toc-window_managers_desktop_environments)Window Managers and Desktop Environments



Window Manager

* Manipulation and decoration of windows.
* Generally provides additional elements (menu, taskbar, ...).

Desktop Environment

* Coherence of applications (menus, drag&drop).
* Full-featured file manager (integrated with Web browser).

There is no clear distinction between desktop environments and window managers.

The [freedesktop.org](http://www.freedesktop.org/) project works on interoperability and shared technology for desktop environments for the X Window System.

* <http://www.freedesktop.org/Main/Desktops>

[9](http://labor-liber.org/en/gnu-linux/introduction/all#toc-gnome_kde)The Gnome and KDE Desktop Environments

Desktop environments like Gnome and KDE provide a platform for software applications development, and a large and increasing number of applications with a common look and feel.

GNU Network Object Model Environment (GNOME)

* GTK+ Library: <http://gtk.org/>.
* The name of applications generally begins with "**g**" or "**gnome-**".

K Desktop Environment (KDE)

* Qt Library: <http://www.trolltech.com/products/qt/index.html>.
* The name of applications generally begins with "**k**".
* <http://kde.org/> - <http://kde.org/family/> - <http://en.wikipedia.org/wiki/KDE>
* <http://gnome.org/> - <http://gnome.org/projects/> - <http://en.wikipedia.org/wiki/GNOME>

[10](http://labor-liber.org/en/gnu-linux/introduction/all#toc-switching)Switching between graphical and text mode

GNU/Linux is configured by default to have 7 virtual consoles, with X Window running on the seventh (when it is running).

Switching from X Window to one of the 6 consoles: **Ctrl** + **Alt** + **F1**, ..., **Ctrl** + **Alt**+ **F6**.

Switching from a text console to another text console: **Alt** + **F1**, ..., **Alt** + **F6**.

Switching back to X Window: **Alt** + **F7**.

* The Linux keyboard and console HOWTO, Console switching - <http://tldp.org/HOWTO/Keyboard-and-Console-HOWTO-7.html>

[11](http://labor-liber.org/en/gnu-linux/introduction/all#toc-bash_basics)Bash Basics

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* [Prompts](http://labor-liber.org/en/gnu-linux/introduction/all#prompt)
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* [Special Characters](http://labor-liber.org/en/gnu-linux/introduction/all#special_characters)

[12](http://labor-liber.org/en/gnu-linux/introduction/all#toc-login_session_logout)Logging in, Session, Logging out

To use the system, a user must have an account on it. Basically, an account is a **login**, a **password**, and a personal **home directory**.

A user identifies himself to the system by typing his login and password when they are requested (by a virtual console, or by a graphical program called a display manager):

* Logging in in a virtual console gives the user a shell (called a login shell).
* Opening a "**console**" or a "**terminal**" in a graphical user interface means opening a new text window which contains a shell (which is a not a login shell).

Logging in is the beginning of a user **session**. Sessions end when users log out.

**logout**

Terminate a login shell.

**exit**

Terminate a login or a non login shell.

[13](http://labor-liber.org/en/gnu-linux/introduction/all#toc-prompt)Prompts

The **prompt** is a character or a character sequence displayed by the shell when it is waiting for the user's instructions.

* The primary prompt is displayed when the shell is waiting for a new command.
* The secondary prompt is displayed when the shell is expecting the rest of an incomplete instruction.

[14](http://labor-liber.org/en/gnu-linux/introduction/all#toc-command_syntax)Command Syntax

**command** [**options**] [**arguments**]

Convention: Operands which are enclosed in square brackets ( [ ] ) are optional

Most commands have many options.

* Option flags are generally preceded by a hyphen/minus (**-**).
* Options flags are traditionally single letters. They may be stated separately or grouped together (if they are not suffixed or followed by a qualifier).
* A more recent convention allows long options (more than one letter) preceded by two hyphens.

[15](http://labor-liber.org/en/gnu-linux/introduction/all#toc-simple_commands)Simple Commands

**whoami**

Print current user's name.

**passwd**

Change user password.

**echo**

Display a line of text.

**date**

Display or set the system date and time.

**cal** or **ncal**

Display a calendar.

**clear**

Clear the terminal screen.

**uname**

Print information about the current kernel.

[16](http://labor-liber.org/en/gnu-linux/introduction/all#toc-aliases)Aliases

**alias**

List aliases, or define an alias.

alias ls='ls --color'

alias rm='rm -i'

[17](http://labor-liber.org/en/gnu-linux/introduction/all#toc-help)Use Online Help

Many commands have a **--help** option.

**help**

Display list of Bash builtin commands.

**man**

Interface to manual pages.

**info**

Interface to info documents.

**whatis**

Display manual page descriptions.

**apropos** or **man -k**

Search the manual pages' names and descriptions.

And you are free to study and use existing Free code.

[18](http://labor-liber.org/en/gnu-linux/introduction/all#toc-man)Man Pages

A manual (reference) page may have the following sections: NAME, SYNOPSIS, DESCRIPTION, OPTIONS, USAGE, ENVIRONMENT, FILES, SEE ALSO. Manual page**s**are also organised into sections (or directories in **/usr/share/man/**):

| **man pages sections** | |
| --- | --- |
| **Section** | **Type of pages** |
| 1 | Executable programs or shell commands. |
| 2 | System calls (functions provided by the kernel) |
| 3 | Library calls (functions within program libraries) |
| 4 | Special files (usually found in /dev) |
| 5 | File formats and conventions eg /etc/passwd |
| 6 | Games |
| 7 | Miscellaneous (including macro packages and conventions). |
| 8 | System administration commands (usually only for root) |

man 1 crontab

man 5 crontab

* Move in the page with the **Page Down**, **Page Up**, or arrow keys.
* Use **Q** to quit.
* Use **/word** to search for **word**, then **n** to go to its following occurence, and **N** for the previous.

[19](http://labor-liber.org/en/gnu-linux/introduction/all#toc-info)Info Documents

info info

* **?** for an helpful list.
* **Q** to quit.

info --apropos string

[20](http://labor-liber.org/en/gnu-linux/introduction/all#toc-key_combinations)Useful Key Combinations

| **Key Combination** | **Effect** |
| --- | --- |
| **Ctrl** + **C** | Terminate a running program. |
| **Ctrl** + **D** | Equivalent to **exit** or **logout**. EOF (End Of File) character. |
| **Ctrl** + **L** | Equivalent to **clear**. |
| **Ctrl** + **Z** | Suspend current foreground process ([Job Control](http://labor-liber.org/en/gnu-linux/introduction/job_control)). |
| **Shift** + **Page Up** and **Shift** + **Page Down** | Browse terminal buffer (scroll up or down). |
| **Ctrl** + **Alt** + **Backspace** | Kill X Window. |

[21](http://labor-liber.org/en/gnu-linux/introduction/all#toc-special_characters)Special Characters

| **Shell Special Characters** | |
| --- | --- |
| **Character** | **Meaning or Use** |
| **newline space tab** | Word separators |
| **;** | Command separator |
| **&** | Background execution |
| **( )** | Command grouping (subshell) |
| **{ }** | Command block |
| **| > < &** | Redirections |
| **\* ? [ ] ~ !** | Filename metacharacters |
| **`** | Command substitution |
| **$** | Variable (or command) substitution |
| **#** | Comment |
| **\ " '** | Escape or quote other characters |

[22](http://labor-liber.org/en/gnu-linux/introduction/all#toc-command_line)Command Line Features

* [Command Line Editing](http://labor-liber.org/en/gnu-linux/introduction/all#command_line_editing)
* [Command Line History](http://labor-liber.org/en/gnu-linux/introduction/all#command_line_history)
* [Command and File Completion](http://labor-liber.org/en/gnu-linux/introduction/all#completion)
* [Filename Expansion](http://labor-liber.org/en/gnu-linux/introduction/all#filename_expansion)

[23](http://labor-liber.org/en/gnu-linux/introduction/all#toc-command_line_editing)Command Line Editing

| **Keys to move the cursor on the command line** | |
| --- | --- |
| **Key** | **Action** |
| **Home** | Move the cursor at the beginning of the command line. |
| **End** | Move the cursor at the end of the command line. |
| **Arrow Left** | Move the cursor one character to the left. |
| **Arrow Right** | Move the cursor one character to the right. |

**fc**

List or edit and re-execute commands from the history list.

[24](http://labor-liber.org/en/gnu-linux/introduction/all#toc-command_line_history)Command Line History

| **Key (combination)** | **Action** |
| --- | --- |
| **Arrow Up** | Move up |
| **Arrow Down** | Move down |
| **Ctrl** + **R** | Search command history. |

| **Event designators, and lines they reference in the history list.** | |
| --- | --- |
| **Event designator** | **Reference** |
| **!n** | Refer to command line n. |
| **!-n** | Refer to the current command line minus n. |
| **!!** | Refer to the previous command (same as **!-1**). |
| **!string** | Refer to the most recent command starting with string. |
| **!?string?** | Refer to the most recent command containing string. |
| **^string1^string2^** | Repeat the last command, replacing string1 with string2. |

**man history** to know more and learn about Word Designators and Modifiers.

[25](http://labor-liber.org/en/gnu-linux/introduction/all#toc-completion)Command and File Completion

You don't have to type the full names of commands or files. Bash can complete the names for you.

**TAB**

Complete command name or file name.

**TAB** **TAB**

Show command or file completion possibilities.

[26](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filename_expansion)Filename Expansion

**\***

zero or more characters

**?**

exactly one character

**[abcde]**

exactly one character listed

**[a-e]**

exactly one character in the given range

**[!abcde]**

any character that is not listed

**[!a-e]**

any character that is not in the given range

**{debian,linux}**

exactly one entire word in the options given

[27](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filesystem)Filesystem

* [Everything is a File](http://labor-liber.org/en/gnu-linux/introduction/all#everything_is_a_file)
* [Filesystem File Types](http://labor-liber.org/en/gnu-linux/introduction/all#filesystem_file_types)
* [File Attributes](http://labor-liber.org/en/gnu-linux/introduction/all#file_attributes)
* [The Filesystem Tree](http://labor-liber.org/en/gnu-linux/introduction/all#tree)
* [Path to a File](http://labor-liber.org/en/gnu-linux/introduction/all#path_to_a_file)

[28](http://labor-liber.org/en/gnu-linux/introduction/all#toc-everything_is_a_file)Everything is a File

The system's operations on a file, a directory, a CD drive, ..., a screen, are fundamentally identical.

* Read
* Write

Files and directories, physical devices, and even streams of data or network connections are files (of a different type), so that:

* **The system can be organised as a single tree structure** of directories.
* **The UNIX permission model uses this concept of files**.

[29](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filesystem_file_types)Filesystem File Types

| **File types and their corresponding character in the first column of the output of ls -l.** | |
| --- | --- |
| **File Type** | **First column of ls -l output** |
| Regular file | **-** |
| Block device | **b** |
| Character device | **c** |
| Directory | **d** |
| Symbolic link | **l** |
| FIFO (named pipe) | **p** |
| Socket | **s** |

[30](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_attributes)File Attributes

The system stores information about files in a structure known as an inode. This information includes:

* The file's type (regular file, directory, symbolic link),
* The file's size (in bytes),
* **ctime**, the time the file's inode was last modified,
* **mtime**, the time the file's content was last modified,
* **atime**, the time the file was last accessed (read, executed),

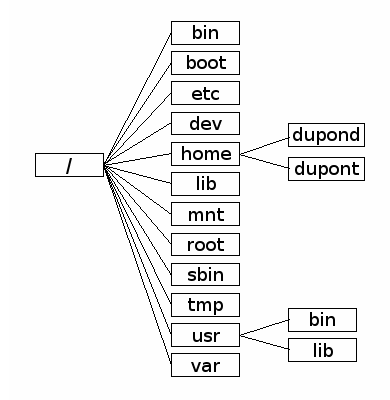
and file permissions:

* The file's owner (**UID**),
* The file's group (**GID**),
* The file's mode bits or permissions bits.

**stat**

Display file or filesystem status.

[31](http://labor-liber.org/en/gnu-linux/introduction/all#toc-tree)The Filesystem Tree



**/** is the root directory.

* **/bin**: Essential binaries for all users.
* **/boot**: Static files of the boot loader.
* **/dev**: Device files.
* **/etc**: System-wide configuration files.
* **/home**: Contains the users' home directory.
* **/lib**: Essential shared libraries and kernel modules.
* **/mnt**: Mount point for a temporarily mounted filesystem.
* **/proc**: Kernel and process information virtual filesystem.
* **/root**: Home directory of the **root** user.
* **/sbin**: Essential binaries for the **root** user.
* **/tmp**: Temporary files.
* **/usr**: Shareable, read-only data.
* **/var**: Variable files. This includes spool directories and files, administrative and logging data, and transient and temporary files.
* Filesystem Hierarchy Standard (FHS) - <http://www.pathname.com/fhs/>
* The FHS is part of the Linux Standard Base - <http://www.linuxbase.org/>

[32](http://labor-liber.org/en/gnu-linux/introduction/all#toc-path_to_a_file)Path to a File

Every directory always contains two special files:

**.**

Current directory

**..**

Parent directory (of the current directory).

Absolute Path to a File

**/home/user/directory/file.txt**

Relative Path to a File

Relative to the current directory.

**./directory/file.txt** is the same as **directory/file.txt** or**../user/directory/file.txt** when the current directory is **/home/user/**.

[33](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filesystem_commands)Filesystem Commands

* [Exploring the Filesystem](http://labor-liber.org/en/gnu-linux/introduction/all#explore_the_filesystem)
* [Finding Files](http://labor-liber.org/en/gnu-linux/introduction/all#find_files)
* [Creating, Copying, Moving and Removing Files](http://labor-liber.org/en/gnu-linux/introduction/all#create_copy_move_remove_files)
* [Symbolic Links](http://labor-liber.org/en/gnu-linux/introduction/all#symbolic_links)

[34](http://labor-liber.org/en/gnu-linux/introduction/all#toc-explore_the_filesystem)Exploring the Filesystem

**cd**

Change (current) Directory.

**df**

Report filesystem disk space usage.

**du**

Estimate file space usage.

**ls**

List directory contents.

**pwd**

Print Working (current) Directory.

[35](http://labor-liber.org/en/gnu-linux/introduction/all#toc-find_files)Finding Files

**find**

Search for files in a directory hierarchy.

**locate**

List files in database that match a pattern. The database is periodically updated by **updatedb**.

**which**

Locate a command.

**whereis**

Locate the binary, source, and manual page files for a command.

* Findutils - <http://www.gnu.org/software/findutils/>

[36](http://labor-liber.org/en/gnu-linux/introduction/all#toc-create_copy_move_remove_files)Creating, Copying, Moving and Removing Files

**cp**

copy files and directories

**mkdir**

Make (create) directory

**mv**

Move and/or rename files.

**rm**

Remove (delete) files or directories.

**rmdir**

Remove empty directories.

**touch**

Change file timestamps.

[37](http://labor-liber.org/en/gnu-linux/introduction/all#toc-symbolic_links)Symbolic Links

**ln**

Make links between files. By default, it makes "hard links". With the **-s** option, it makes symbolic (or "soft") links.

A "hard link" is another name for an existing file. The link and the original are indistinguishable (they share the same inode). **Caution**: the link can be removed without removing the file with **unlink**, but **rm** will remove the link and the file.

A symbolic link, on the other hand, refers to a different file. Most operations (opening, reading, writing, and so on) are passed the symbolic link file, the kernel automatically "dereferences" the link and operates on the target of the link. But some operations (e.g. removing) work on the link file itself, rather than on its target.

[38](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filesystem_mounting)Filesystem Mounting

* [Filesystem Types](http://labor-liber.org/en/gnu-linux/introduction/all#filesystems)
* [Mounting](http://labor-liber.org/en/gnu-linux/introduction/all#mount)
* [Devices](http://labor-liber.org/en/gnu-linux/introduction/all#devices)

[39](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filesystems)Filesystem Types

A filesystem is the methods and data structures that an operating system uses to keep track of files on a disk or partition; that is, the way the files are organized on the disk.

| **Filesystem Types** | |
| --- | --- |
| **Filesystem** | **Description** |
| **ext2** | Linux native filesystem. |
| **ext3** | **ext2** plus journaling. |
| **reiserfs** | Robust and journaling filesystem. |
| **iso9660** | The standard CD-ROM filesystem. |
| **fat** and **vfat** | Microsoft Windows **fat and fat32.** |
| **ntfs** | Microsoft Windows (NT, ...) |

**sync**

Flush filesystem buffers to disk.

* The Linux System Administrator's Guide - <http://tldp.org/LDP/sag/html/>
* Filesystems HOWTO - <http://www.tldp.org/HOWTO/Filesystems-HOWTO.html>
* File system - <http://en.wikipedia.org/wiki/File_system>

[40](http://labor-liber.org/en/gnu-linux/introduction/all#toc-mount)Mounting

To gain access to files on a device, you must first tell it where in the directory tree you would like those files to appear (mount point). This process is called mounting a filesystem.

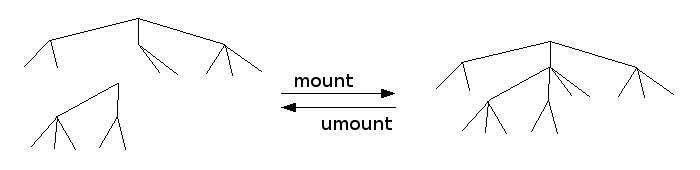
* Devices must be mounted before they can be accessed.
* Devices must be unmounted before they can be "ejected" (you should not eject a mounted floppy).

**mount**

Mount a filesystem.

**umount**

Unmount a filesystem.



The system administrator can control which file systems are mounted at boot time, pre-determine the mount points for specific file systems, and allow some file systems to be mounted by normal users. This is configured in **/etc/fstab**, which includes the following fields:

1. device
2. mount point
3. filesystem type
4. options
   * **noauto**: not done at boot time
   * **ro**: read-only device
   * **users**: any user can mount it

[41](http://labor-liber.org/en/gnu-linux/introduction/all#toc-devices)Devices

**/dev/hda1**

First partition of the master IDE drive on the primary IDE controller.

**/dev/hda2**

Second partition of the master IDE drive on the primary IDE controller.

**/dev/hdb1**

First partition of the slave drive on the secondary IDE controller.

**/dev/sda1**

First partition of the first SCSI device.

**/dev/sdb1**

First partition of the second SCSI device.

**/dev/fd0**

Primary floppy drive

**/dev/cdrom**

CD drive.

**/dev/null**

Garbage black hole. Anything sent to **/dev/null** will disappear.

* Hard disk drive partitioning - <http://en.wikipedia.org/wiki/Hard_disk_drive_partitioning>
* Linux Partition HOWTO - <http://www.tldp.org/HOWTO/Partition/>
* The Linux System Administrator's Guide - <http://tldp.org/LDP/sag/html/>

[42](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_names_and_extensions)File Names and Extensions

* [File Extensions](http://labor-liber.org/en/gnu-linux/introduction/all#file_extensions)
* [File Names](http://labor-liber.org/en/gnu-linux/introduction/all#file_names)
* [Regular Files Special Names](http://labor-liber.org/en/gnu-linux/introduction/all#regular_files_special_names)

[43](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_extensions)File Extensions

Files may contain (human readable) text, binary data, or both. Files may be meant to be executed, processed by an application, or edited in a simple text editor.

A file does not need any extension (like a **.exe** suffix) to be executed (it needs [execution permission](http://labor-liber.org/en/gnu-linux/introduction/permissions)).

Applications may need to identify the type of files. File extensions are often used for this purpose.

**file**

Determine file type.

[44](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_names)File Names

* 1 to 255 characters long,
* Lower case and upper case characters are different.  
  Example : **file.txt** and **File.txt** are different files.
* File names can contain any character but "**/**".

However, file names should only contain the following characters:  
"**a**", ... "**z**", "**A**", ... "**Z**", "**0**", ... "**9**", "**-**", "**\_**", "**.**" because:

* Many characters have special meaning for the shell, and must be "escaped" with a preceding "**\**".
* Using only ASCII characters, file names remain the same across operating systems and and whatever the character set used.

For example, in a graphical user interface, one can click on a file name which contains a space character; but in a shell, such a file has to be written**file\ name\ with\ spaces.txt** or **"file name with spaces.txt"** or**'file name with spaces.txt'**.

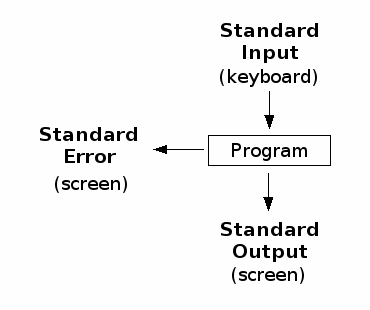
[45](http://labor-liber.org/en/gnu-linux/introduction/all#toc-regular_files_special_names)Regular Files Special Names

* "**~**" is the current user's home directory.
* Files whose name begins with "**.**" are hidden files. Most of these files are configuration files, located in the user's home directory.
* Files whose name ends with "**~**" are backup files which are automatically created by some editing tools. They contain the file's former version.

[46](http://labor-liber.org/en/gnu-linux/introduction/all#toc-input_output_redirection)Input/Output Redirection

* [Input/Output](http://labor-liber.org/en/gnu-linux/introduction/all#input_output)
* [Redirections](http://labor-liber.org/en/gnu-linux/introduction/all#redirection)
* [Redirections Examples](http://labor-liber.org/en/gnu-linux/introduction/all#redirection_examples)
* [Building Command Lines From Standard Input](http://labor-liber.org/en/gnu-linux/introduction/all#xargs)

[47](http://labor-liber.org/en/gnu-linux/introduction/all#toc-input_output)Input/Output



In general, a command (a program):

* Gets data to process from **standard input** or **stdin**(default: keyboard).
* Returns processed data to **standard output** or **stdout**(default: screen).
* If program execution causes errors, error messages are sent to **standard error** or **stderr**(default: screen).

These three are files, and are always open. As all open files, they are assigned to a file descriptor (an integer).

| **File descriptors for stdin, stdout and stderr.** | |
| --- | --- |
| **File** | **File descriptor** |
| **/dev/stdin** or **/dev/fd/0** | 0 |
| **/dev/stdout** or **/dev/fd/1** | 1 |
| **/dev/stderr** or **/dev/fd/2** | 2 |

[48](http://labor-liber.org/en/gnu-linux/introduction/all#toc-redirection)Redirections

**Redirection**

Capturing output from a file or a command (or program or script) and sending it as input to another file or command (or program or script).

**|**

(pipe) redirects standard output of a program as standard input of another.

**>**

redirects standard output to a file (and overwrites the file if it already exists).

**<**

uses a file as standard input.

**>>**

Appends standard output to a file.

**<** Input\_data\_file program1 **|** program2 **>** Output\_data\_file

A "filter" is a program which reads data from standard input, processes it in some way, and sends the processed data to standard output.

[49](http://labor-liber.org/en/gnu-linux/introduction/all#toc-redirection_examples)Redirections Examples

**2> file**

Direct standard error to file

**2>> file**

Append standard error to file.

**2>&1**

Print standard error messages to standard output.

**1>&2**

Print standard output messages to standard error.

[50](http://labor-liber.org/en/gnu-linux/introduction/all#toc-xargs)Building Command Lines From Standard Input

**xargs**

Build and execute command lines from standard input.

Read remaining arguments from standard input instead of specifying them and execute the command.

cd /bin

ls | xargs whatis

[51](http://labor-liber.org/en/gnu-linux/introduction/all#toc-viewing_and_editing_files)Viewing and Editing Files

* [Viewing Files: Pagers](http://labor-liber.org/en/gnu-linux/introduction/all#pagers)
* [Editors](http://labor-liber.org/en/gnu-linux/introduction/all#editors)
* [VI Essentials](http://labor-liber.org/en/gnu-linux/introduction/all#vi)

[52](http://labor-liber.org/en/gnu-linux/introduction/all#toc-pagers)Viewing Files: Pagers

**more**

Pager.

**less**

Pager with more features than **more**.

* Move in the page with the **Page Down**, **Page Up**, or arrow keys.
* Use **Q** to quit.
* Use **/word** to search for **word**, then **n** to go to its following occurence, and **N** for the previous.

[53](http://labor-liber.org/en/gnu-linux/introduction/all#toc-editors)Editors

**vi** is a powerful text editor, available on any UNIX like system. **vim** stands for Vi IMproved. With **gvim** or **kvim**, you can use the mouse.

**emacs** is another powerful programmers text editor, and much more.

There are others:

* **nedit**
* **kedit** (KDE)
* **gedit** (Gnome)
* **hexedit**: hexadecimal or ASCII editor

[54](http://labor-liber.org/en/gnu-linux/introduction/all#toc-vi)VI Essentials

**vi**(**m**) basically has two modes of operation:

* command mode,
* Insert mode.

**Command mode** is the initial mode. The commands you type are displayed in the status (bottom) line (only some of them in **vi**). They are executed with **Enter**.

Press **a**, **A**, **i**, **I**, **o** or **0** to enter **Insert mode**. Press **Esc** to return to command mode.

**vimtutor** is an interactive **vim** tutorial (25 to 30 minutes).

[55](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_commands)File Commands

* [File Information](http://labor-liber.org/en/gnu-linux/introduction/all#file_information)
* [Archives and Backups](http://labor-liber.org/en/gnu-linux/introduction/all#archive_compress_backup)
* [Comparing Text Files](http://labor-liber.org/en/gnu-linux/introduction/all#compare_text_files)
* [Checking File Integrity](http://labor-liber.org/en/gnu-linux/introduction/all#check_file_integrity)
* [Concatenating, Splitting and Joining Files](http://labor-liber.org/en/gnu-linux/introduction/all#concatenate_split_join_files)
* [Sorting and Removing Duplicate Lines](http://labor-liber.org/en/gnu-linux/introduction/all#sort_uniq)
* [Dumping Files](http://labor-liber.org/en/gnu-linux/introduction/all#dumping_files)

[56](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_information)File Information

**file**

Determine file type.

**stat**

Display file or filesystem status.

**wc**

Print the number of newlines, words, and bytes in files.

[57](http://labor-liber.org/en/gnu-linux/introduction/all#toc-archive_compress_backup)Archives and Backups

**tar**

GNU version of the tar archiving utility.

**gzip**

Compress or expand files.

**gunzip**

Compress or expand files.

**bzip2**

A block-sorting file compressor.

**bunzip2**

A block-sorting file compressor.

**zip**

Package and compress (archive) files.

**unzip**

List, test or extract compressed files in a ZIP archive.

**unrar**

Extract files from rar archives.

**rsync**

Remote copy and update.

[58](http://labor-liber.org/en/gnu-linux/introduction/all#toc-compare_text_files)Comparing Text Files

**diff**

Compare (two) files line by line.

**patch**

Apply a **diff** file to an original.

**zdiff**

Compare gzip compressed files.

**bzdiff**

Compare bzip2 compressed files.

**diff3**

Compare three files line by line.

**pdiff**

Produce a pretty comparison between files.

**diffpp**

Pretty-print diff outputs with GNU enscript.

**wdiff**

Display word differences between text files.

**sdiff**

Side-by-side merge of file differences.

**comm**

Compare two sorted files line by line.

* Diffutils - <http://www.gnu.org/software/diffutils/>

[59](http://labor-liber.org/en/gnu-linux/introduction/all#toc-check_file_integrity)Checking File Integrity

**cksum**

Checksum and count the bytes in a file.

**md5sum**

Generates or checks MD5 message digests.

**sha1sum**

Generates or checks SHA1 message digests.

[60](http://labor-liber.org/en/gnu-linux/introduction/all#toc-concatenate_split_join_files)Concatenating, Splitting and Joining Files

**cat**

Concatenate files and print on standard output.

**tac**

Concatenate and print files in reverse.

**rev**

Reverse the order of characters in every line.

**split**

Split a file into pieces.

**csplit**

Split a file into sections determined by context lines.

**join**

Join lines of two files on a common field.

[61](http://labor-liber.org/en/gnu-linux/introduction/all#toc-sort_uniq)Sorting and Removing Duplicate Lines

**sort**

Sort lines of text files.

**uniq**

Remove duplicate lines from a sorted file.

cat \*.txt | sort | uniq > result-file

[62](http://labor-liber.org/en/gnu-linux/introduction/all#toc-dumping_files)Dumping Files

**head**

output the first part of files.

**tail**

output the last part of files.

**od**

Dump files in octal and other formats.

**hexdump**

ASCII, decimal, hexadecimal, octal dump.

[63](http://labor-liber.org/en/gnu-linux/introduction/all#toc-tools)UNIX Tools

* [Regular expressions](http://labor-liber.org/en/gnu-linux/introduction/all#regular_expressions)
* [Filters](http://labor-liber.org/en/gnu-linux/introduction/all#filters)
* [Text Formatting and Pretty Printing](http://labor-liber.org/en/gnu-linux/introduction/all#text_formatting_print)
* [sed](http://labor-liber.org/en/gnu-linux/introduction/all#sed)
* [There's more than one way to do it](http://labor-liber.org/en/gnu-linux/introduction/all#more_than_one_way_to_do_it)

[64](http://labor-liber.org/en/gnu-linux/introduction/all#toc-regular_expressions)Regular expressions

Filename expansion belongs to the shell. There is a more general and widely used tool for matching strings, called regular expressions. There are mainly three flavors:

* basic,
* extended,
* perl.

| **Regular Expressions** | |
| --- | --- |
| **Expression** | **Match** |
| **.** | Matches any single character. |
| **\*** | Matches the last character or expression 0 or more times. |
| **+** | Matches the last character or expression 1 or more times. |
| **?** | Matches the last character or expression 0 or 1 time. |
| **^** | Matches the beginning of a line. |
| **$** | Match the end of a line. |
| **[abcde]** | Matches exactly one character listed. |
| **[a-e]** | Matches exactly one character in the given range. |
| **[^abcde]** | any character that is not listed |
| **[^a-e]** | any character that is not in the given range |
| **\** | Escapes special characters. |

* <http://www.zvon.org/other/PerlTutorial/Output/contents.html>

[65](http://labor-liber.org/en/gnu-linux/introduction/all#toc-filters)Filters

**grep**

Print lines matching a pattern.

**pcregrep**

A grep with Perl-compatible regular expressions.

**agrep**

Search a file for a string or regular expression, with approximate matching capabilities.

**expand**

**Convert tabs to spaces.**

**unexpand**

**Convert spaces to tabs.**

**tr**

**Translate or delete characters.**

**flip**

**Convert text file line endings between Unix and DOS formats.**

**cut**

**Remove sections from each line of files.**

**paste**

**Merge lines of files.**

[66](http://labor-liber.org/en/gnu-linux/introduction/all#toc-text_formatting_print)Text Formatting and Pretty Printing

**fold**

**Wrap each input line to fit in specified width**

**fmt**

**Simple optimal text formatter.**

**nl**

**(same as cat -n)**

**pr**

**Convert text files for printing**

**a2ps**

**GNU a2ps is a filter which generates PostScript from various formats, with pretty-printing features, strong support for many alphabets, and customizable layout.**

[67](http://labor-liber.org/en/gnu-linux/introduction/all#toc-sed)sed

**sed**

**Stream editor. Filter text in a pipeline.**

**Examples:**

**sed "1,32 d" file.txt**

**Delete lines 1 through 32**

**sed 's/[ ^t]\*$//' file.txt**

**Delete trailing whitespace (spaces/tabs) from end of each line.**

**Delete both leading and trailing whitespace from each line.**

**sed 's/^[ ^t]\*//;s/[ ^t]\*$//' file.txt**

**sed 's/foo/bar/g' file.txt**

**Replace all instances of "foo" with "bar".**

**sed '/^Delete/d' file.txt**

**Delete lines starting with "Delete".**

**sed --in-place 's/^\(.\{20\}\).\*/\1/g' file**

**Replace all lines with only their first 20 characters.**

* **sed, a stream editor -**[**http://www.gnu.org/software/sed/manual/sed.html**](http://www.gnu.org/software/sed/manual/sed.html)
* [**http://sed.sourceforge.net/**](http://sed.sourceforge.net/)

[68](http://labor-liber.org/en/gnu-linux/introduction/all#toc-more_than_one_way_to_do_it)There's more than one way to do it

| **sed emulating UNIX commands** | |
| --- | --- |
| **UNIX command** | **sed equivalent** |
| **cat** | **sed ':'** |
| **tac** | **sed '1!G;h;$!d'** |
| **grep** | **sed '/patt/!d'** |
| **grep -v** | **sed '/patt/d'** |
| **head** | **sed '10q'** |
| **tail** | **sed -e ':a' -e '$q;N;11,$D;ba'** |
| **tail -f** | **sed -u '/./!d'** |
| **cut -c 10** | **sed 's/\(.\)\{10\}.\*/\1/'** |
| **cut -d: -f4** | **sed 's/\(\([^:]\*\):\)\{4\}.\*/\2/'** |
| **tr A-Z a-z** | **sed 'y/ABCDEFGHIJKLMNOPQRSTUVWXYZ/abcdefghijklmnopqrstuvwxyz/'** |
| **wc -l** | **sed -n '$='** |
| **uniq** | **sed 'N;/^\(.\*\)\n\1$/!P;D'** |
| **rev** | **sed '/\n/!G;s/\(.\)\(.\*\n\)/&\2\1/;//D;s/.//'** |
| **basename** | **sed 's,.\*/,,'** |
| **dirname** | **sed 's,[^/]\*$,,'** |
| **cp orig new** | **sed 'w new' orig** |

* **SED emulating UNIX commands -**[**http://sed.sourceforge.net/local/docs/emulating\_unix.txt**](http://sed.sourceforge.net/local/docs/emulating_unix.txt)

[69](http://labor-liber.org/en/gnu-linux/introduction/all#toc-users_and_permissions)Users and Permissions

* [**The root User**](http://labor-liber.org/en/gnu-linux/introduction/all#root)
* [**Users and Groups**](http://labor-liber.org/en/gnu-linux/introduction/all#users_groups)
* [**Permissions**](http://labor-liber.org/en/gnu-linux/introduction/all#permissions)
* [**Octal and Binary Modes**](http://labor-liber.org/en/gnu-linux/introduction/all#octal_binary)
* [**File and Directory Permissions**](http://labor-liber.org/en/gnu-linux/introduction/all#file_and_directory_permissions)
* [**Special Permissions**](http://labor-liber.org/en/gnu-linux/introduction/all#special_permissions)
* [**Default Permissions**](http://labor-liber.org/en/gnu-linux/introduction/all#default_permissions_umask)
* [**Setting Permissions**](http://labor-liber.org/en/gnu-linux/introduction/all#setting_permissions)

[70](http://labor-liber.org/en/gnu-linux/introduction/all#toc-root)The root User

**The super user, root can do anything he wants, including erasing the system.**

**An average user does not have the necessary permissions to modify any system file. Any software he uses can't either, as it inherits the user's permissions (alhough there are exceptions).**

**The use of the system as the root user must be strictly limited to system administration tasks.**

[71](http://labor-liber.org/en/gnu-linux/introduction/all#toc-users_groups)Users and Groups

**A running program (a process) has the same permissions as the user who executes it.**

**There are exceptions to this rule, but it explains why there are more users of the system than root ant its real users (see /etc/passwd).**

**Users usually belong to one or more groups (see /etc/group).**

**Users and groups names are human-friendly identifiers. The systems uses integers: UIDs and GIDs.**

**id**

**Print real and effective UIDs and GIDs.**

**su**

**Change user ID or become super-user.**

**Every file has:**

* **a user, the file's owner,**
* **a group of users (the file's owner must be a member of this group).**

[72](http://labor-liber.org/en/gnu-linux/introduction/all#toc-permissions)Permissions

**There are three sorts of permissions:**

* **Read (r)**
* **Write (w)**
* **Execute (x)**

**And each file has permissions defined for three types of users:**

* **the user (owner) of the file,**
* **the group of the file,**
* **other users.**

**They appear as follows in colums 2 to 10 of the output of ls -l. The letter is replaced by a hyphen (-) where the permission is not set.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **user** | | | **group** | | | **others** | | |
| **r** | **w** | **x** | **r** | **w** | **x** | **r** | **w** | **x** |

[73](http://labor-liber.org/en/gnu-linux/introduction/all#toc-octal_binary)Octal and Binary Modes

|  |  |  |  |
| --- | --- | --- | --- |
| **Permission** | **Read** | **Write** | **eXecute** |
| **Letter** | **r** | **w** | **x** |
| **Octal valuee** | **4** | **2** | **1** |

| **Octal digit** | **Text equivalent** | **Binary value** | **Meaning** |
| --- | --- | --- | --- |
| **0** | **---** | **000** | **No permission** |
| **1** | **--x** | **001** | **Execute** |
| **2** | **-w-** | **010** | **Write** |
| **3** | **-wx** | **011** | **Write + Execute** |
| **4** | **r--** | **100** | **Read** |
| **5** | **r-x** | **101** | **Read + Execute** |
| **6** | **rw-** | **110** | **Read + Write** |
| **7** | **rwx** | **111** | **Read + Write + Execute** |

[74](http://labor-liber.org/en/gnu-linux/introduction/all#toc-file_and_directory_permissions)File and Directory Permissions

|  |  |  |
| --- | --- | --- |
| **File and Directory Permissions** | | |
| **Permissions** | **on a File** | **on a Directory** |
| **Read** | **Read the file.** | **List the contents of the directory.** |
| **Write** | **Modify the file (can be emptied, but not deleted)** | **Create, delete or rename files in the directory.** |
| **Execute** | **Execute the file (the program)** | **Access to the contents of the directory. Read, write to or execute a file in the directory.** |

[75](http://labor-liber.org/en/gnu-linux/introduction/all#toc-special_permissions)Special Permissions

|  |  |  |
| --- | --- | --- |
| **Special permissions on files and directories: SetUID, SetGID and Sticky bit.** | | |
| **Special Permissions** | **on a File** | **on a Directory** |
| **SUID or Set User ID** | **A program is executed with the file owner's permissions (rather than with the permissions of the user who executes it).** | **Files created in the directory inherit itsUID.** |
| **SGID or Set Group ID** | **The effective group of an executing program is the file owner group.** | **Files created in the directory inherit itsGID.** |
| **Sticky (bit)** | **A program sticks in memory after execution.** | **Any user can create files, but only the owner of a file can delete it.** |

| **Permissions as output in columns 2 to 10 of ls -l and their meaning.** | |
| --- | --- |
| **Permissions** | **Meaning** |
| **--S------** | **SUID is set, but user (owner) execute is not set.** |
| **--s------** | **SUID and user execute are both set.** |
| **-----S---** | **SGID is set, but group execute is not set.** |
| **-----s---** | **SGID and group execute are both set.** |
| **--------T** | **Sticky bit is set, bot other execute is not set.** |
| **--------t** | **Sticky bit and other execute are both set.** |

[76](http://labor-liber.org/en/gnu-linux/introduction/all#toc-default_permissions_umask)Default Permissions

**System calls to create new files and directories have default or base permissions:**

* **Directories: (octal) 0777 or rwxrwxrwx.**
* **Files: (octal) 0666 or rw-rw-rw-.**

**The first octal digit is for special permissions. The next three are for user, group and others.**

**Before creating the file or directory, the base permissions are compared to a mask that will "mask out" permission bits to determine the final permissions for the object being created.**

**The calculation to determine the final permissions is to take the binary of the base permissions and perform a logical AND operation on the ones complement representation of the binary umask.**

**umask**

**Display or set file creation mask.**

**The usual umask is 0022, which results in 0755 for directories, and 0644 for regular files.**

**0 0 2 2 0 7 7 7 0 6 6 6**

**000000010010 000111111111 000110110110**

**111111111111 111111101101 111111101101**

**------------ ------------ ------------**

**111111101101 000111101101 000110100100**

**0 7 5 5 0 6 4 4**

[77](http://labor-liber.org/en/gnu-linux/introduction/all#toc-setting_permissions)Setting Permissions

**chmod**

**change permissions of a file**

**chown**

**change file owner and group**

**chgrp**

**change group ownership**

**chmod u+x file**

**chmod 744 file**

[78](http://labor-liber.org/en/gnu-linux/introduction/all#toc-shell_variables_and_custimization)Shell Variables and Custimization

* [**Local and Environment Variables**](http://labor-liber.org/en/gnu-linux/introduction/all#local_and_environment_variables)
* [**Environment Variables**](http://labor-liber.org/en/gnu-linux/introduction/all#environment_variables)
* [**DISPLAY**](http://labor-liber.org/en/gnu-linux/introduction/all#display)
* [**Bash Configuration Files**](http://labor-liber.org/en/gnu-linux/introduction/all#bash_configuration_files)

[79](http://labor-liber.org/en/gnu-linux/introduction/all#toc-local_and_environment_variables)Local and Environment Variables

**Variables are prefixed by a dollar sign ($). A value is assigned to a variable through an equals sign (=) (no whitespace on either side of it).**

**MY\_VARIABLE='my value'**

**echo $MY\_VARIABLE**

**By default, variables are seen only within the shell itself. To pass variables to other programs invoked within the shell, they have to be exported to the environment.**

**set**

**Display ot set shell variables.**

**printenv**

**Display environment variables.**

**env**

**Run a program in a modified environment.**

**export**

**Export a local variable to the environment.**

[80](http://labor-liber.org/en/gnu-linux/introduction/all#toc-environment_variables)Environment Variables

**The behaviour of many programs can be altered by environment variables.**

| **Important environment variables.** | |
| --- | --- |
| **Variable** | **Meaning** |
| **PATH** | **Colon-separated list of directories to search for each command.** |
| **EDITOR** | **Default editor.** |
| **DISPLAY** | **In the X window system, a display consists (simplified) of a keyboard, a mouse and a screen.** |
| **PS1** | **Prompt displayed before each new command.** |

[81](http://labor-liber.org/en/gnu-linux/introduction/all#toc-display)DISPLAY

**You have a X Window server running on your machine, at hostname. You can run a client application on a remote machine, at rhostname, and view it on the local machine.**

**On the remote client:**

**export DISPLAY=hostname:0**

**(or in general hostname:D.S where S is the screen and D is the display.)**

**On the server:**

**xhost + rhostname**

**xhost -**

**Xhost is a very insecure mechanism. Use ssh -X to do this more easily and securely.**

* **Remote X Apps mini-HOWTO -**[**http://tldp.org/HOWTO/Remote-X-Apps.html**](http://tldp.org/HOWTO/Remote-X-Apps.html)**or in one page at**[**http://www.faqs.org/docs/Linux-mini/Remote-X-Apps.html**](http://www.faqs.org/docs/Linux-mini/Remote-X-Apps.html)

[82](http://labor-liber.org/en/gnu-linux/introduction/all#toc-bash_configuration_files)Bash Configuration Files

**/etc/profile**

**The systemwide initialization file, executed for login shells.**

**/etc/bash.bashrc**

**The systemwide per-interactive-shell startup file.**

**~/.bash\_profile, ~/.bash\_login or ~/.profile**

**The personal initialization file, executed for login shells.**

**~/.bashrc**

**The individual per-interactive-shell startup file.**

[83](http://labor-liber.org/en/gnu-linux/introduction/all#toc-processes)Processes

* [**Process Types**](http://labor-liber.org/en/gnu-linux/introduction/all#process_types)
* [**Process Attributes**](http://labor-liber.org/en/gnu-linux/introduction/all#process_attributes)
* [**Monitoring Processes**](http://labor-liber.org/en/gnu-linux/introduction/all#monitor_processes)
* [**Killing Processes**](http://labor-liber.org/en/gnu-linux/introduction/all#kill_process)
* [**Process Priority**](http://labor-liber.org/en/gnu-linux/introduction/all#process_priority)
* [**Job Control Commands**](http://labor-liber.org/en/gnu-linux/introduction/all#job_control)

[84](http://labor-liber.org/en/gnu-linux/introduction/all#toc-process_types)Process Types

* **init is the parent of all processes.**
* **Daemons are processes that run continuously. init is a daemon.**
* **Batch processes are queued into a spooler area, where they wait to be executed on a FIFO basis.**
* **Interactive processes are initialized and controlled through a terminal session.**
* **Introduction to Linux. A Hands on Guide. Machtelt Garrels -**[**http://tldp.org/LDP/intro-linux/html/**](http://tldp.org/LDP/intro-linux/html/)

[85](http://labor-liber.org/en/gnu-linux/introduction/all#toc-process_attributes)Process Attributes

* **PID or process ID, an integer.**
* **PPID or parent process ID, an integer.**
* **Nice number, the degree of friendliness of the process towards other processes (process priority is calculated from nice numbers and recent CPU usage).**
* **TTY, the terminal to which the process is connected.**
* **RUID, or real user ID. The user issuing the command.**
* **EUID, or effective user ID. The one determining access permissions to system resources.**
* **RGID, or real group owner. The group of the user who started the process.**
* **EGID, or effective group owner. Different from RGID when SGID has been applied to a file.**

[86](http://labor-liber.org/en/gnu-linux/introduction/all#toc-monitor_processes)Monitoring Processes

**top**

**Display a dynamic real-time view of a running system.**

**ps**

**Report a snapshot of the current processes.**

**pstree**

**Display a tree of processes.**

**time**

**Run programs and summarize system resource usage.**

[87](http://labor-liber.org/en/gnu-linux/introduction/all#toc-kill_process)Killing Processes

**A program can be killed by sending it a termination signal.**

**kill**

**Send a signal to a process.**

**killall**

**Kill processes by name.**

**xkill**

**Kill a client by its X resource.**

**kill -15 is the default, and orders the process to terminate in an clean way.**

**kill -9 sends a termination signal which can't be ignored.**

[88](http://labor-liber.org/en/gnu-linux/introduction/all#toc-process_priority)Process Priority

**Process priority is calculated from the nice number, and recent CPU usage of the process.**

**nice**

**Run a program with modified scheduling priority.**

**renice**

**Alter priority of running processes.**

[89](http://labor-liber.org/en/gnu-linux/introduction/all#toc-job_control)Job Control Commands

**Job control means switching between several jobs or processes.**

**A foreground job occupies the terminal which initialized it. It can be put in the background, so that the terminal can accept new commands.**

**command &**

**Run command in the background.**

**Ctrl + C**

**Terminate a process running in the foreground.**

**Ctrl + Z**

**Suspend a process running in the foreground.**

**bg**

**Reactivate a suspended program in the background.**

**fg**

**Place a job in the foreground, and make it the current job.**

**jobs**

**Lists processes in the background. Each one has a number n and can be referred to by %n.**

[90](http://labor-liber.org/en/gnu-linux/introduction/all#toc-scheduling)Scheduling

* [**Scheduling Occasional Tasks**](http://labor-liber.org/en/gnu-linux/introduction/all#at)
* [**Scheduling Repetitive Tasks**](http://labor-liber.org/en/gnu-linux/introduction/all#cron)

[91](http://labor-liber.org/en/gnu-linux/introduction/all#toc-at)Scheduling Occasional Tasks

**at**

**Executes commands at a specified time.**

**at hh:mm mm/dd/yy**

**at> echo "File created using the at utility" > atfile**

**at> ^D**

**at now + 1 hour**

**atq**

**Lists the user's pending jobs. Equivalent to at -l.**

**atrm**

**Deletes jobs, identified by their job number.**

**batch**

**Executes commands when system load levels permit.**

[92](http://labor-liber.org/en/gnu-linux/introduction/all#toc-cron)Scheduling Repetitive Tasks

**The cron daemon examines crontab files every minute, and checks if the command in each line should be run in the current minute.**

**crontab**

**Maintain crontab files.**

**crontab -e**

**minute hour day\_of\_month month day\_of\_week command**

1. **minute (0 to 59)**
2. **hour (0 to 23)**
3. **day of month (1 to 31)**
4. **month (1 to 12, or jan, feb, etc)**
5. **day of week (0 to 7, 0 or 7 is Sunday, or sun, mon, etc)**
6. **command (or script)**
7. **newline**

[93](http://labor-liber.org/en/gnu-linux/introduction/all#toc-script)Scripting

* [**Special Characters**](http://labor-liber.org/en/gnu-linux/introduction/all#special_chars)
* [**Hello World**](http://labor-liber.org/en/gnu-linux/introduction/all#hello_world)

[94](http://labor-liber.org/en/gnu-linux/introduction/all#toc-special_chars)Special Characters

| **Shell Special Characters** | |
| --- | --- |
| **Character** | **Meaning or Use** |
| **newline space tab** | **Word separators** |
| **;** | **Command separator** |
| **&** | **Background execution** |
| **( )** | **Command grouping (subshell)** |
| **{ }** | **Command block** |
| **| > < &** | **Redirections** |
| **\* ? [ ] ~ !** | **Filename metacharacters** |
| **`** | **Command substitution** |
| **$** | **Variable (or command) substitution** |
| **#** | **Comment** |
| **\ " '** | **Escape or quote other characters** |

[95](http://labor-liber.org/en/gnu-linux/introduction/all#toc-hello_world)Hello World

**File hello.sh:**

**#!/bin/bash**

**echo Hello World**

**The first line can be ommitted to run the script using a non interactive shell: bash hello.sh.**

**Execute permission must be set to simply run it: ./hello.sh.**

**If the directory which contains the file is in the PATH environment variable, you don't need the path: hello.sh.**

* **GNU Bash Online Manual -**[**http://www.gnu.org/software/bash/manual/bash.html**](http://www.gnu.org/software/bash/manual/bash.html)
* **Bash Guide for Beginners -**[**http://tldp.org/LDP/Bash-Beginners-Guide/html/**](http://tldp.org/LDP/Bash-Beginners-Guide/html/)
* **BASH Programming - Introduction HOWTO -**[**http://tldp.org/HOWTO/Bash-Prog-Intro-HOWTO.html**](http://tldp.org/HOWTO/Bash-Prog-Intro-HOWTO.html)
* **Advanced Bash-Scripting Guide. An in-depth exploration of the art of shell scripting -**[**http://tldp.org/LDP/abs/html/**](http://tldp.org/LDP/abs/html/)

[96](http://labor-liber.org/en/gnu-linux/introduction/all#toc-accessing)Accessing Windows/UNIX from UNIX/Windows

* [**Character Code Issues**](http://labor-liber.org/en/gnu-linux/introduction/all#character_codes)
* [**Newlines**](http://labor-liber.org/en/gnu-linux/introduction/all#newline)
* [**Solutions**](http://labor-liber.org/en/gnu-linux/introduction/all#solutions)

[97](http://labor-liber.org/en/gnu-linux/introduction/all#toc-character_codes)Character Code Issues

**Character codes map characters to numbers encoded as one or more bytes.**

**ASCII**

**ASCII is the safest character repertoire in data transfer.**

**ISO Latin 1 or ISO 8859-1**

**Western European languages.**

**ISO Latin 9 or ISO 8859-15**

**Slight modification of ISO8859-1 to includes the Euro symbol.**

**ISO 10646**

**International standard which defines UCS.**

**Unicode**

**The more practical definition of UCS. Unicode imposes additional constraints on implementations to ensure that they treat characters uniformly across platforms and applications.**

* **A tutorial on character code issues -**[**http://www.cs.tut.fi/~jkorpela/chars.html**](http://www.cs.tut.fi/~jkorpela/chars.html)

[98](http://labor-liber.org/en/gnu-linux/introduction/all#toc-newline)Newlines

| **Operating System** | **Hexadecimal Newline Character(s)** |
| --- | --- |
| **Microsoft Windows** | **0D 0A** |
| **Apple Macintosh OS 9 and earlier** | **0D** |
| **UNIXes, GNU/Linux, Mac OS X and higher** | **0A** |

**flip**

**Convert text file line endings between Unix and DOS formats.**

[99](http://labor-liber.org/en/gnu-linux/introduction/all#toc-solutions)Solutions

* **Samba: Transparent access through the filesystem.**
* **FTP (File Transfer Protocol)**
* **HTTP (HyperText Transfer Protocol)**
* **SSH (Secure Shell).**

[100](http://labor-liber.org/en/gnu-linux/introduction/all#toc-more_information)More Information

* [**Use Online Help**](http://labor-liber.org/en/gnu-linux/introduction/all#online_help)
* [**Resources**](http://labor-liber.org/en/gnu-linux/introduction/all#resources)

[101](http://labor-liber.org/en/gnu-linux/introduction/all#toc-online_help)Use Online Help

**Many commands have a --help option.**

**help**

**Display list of Bash builtin commands.**

**man**

**Interface to manual pages.**

**info**

**Interface to info documents.**

**whatis**

**Display manual page descriptions.**

**apropos or man -k**

**Search the manual pages' names and descriptions.**

**And you are free to study and use existing Free code.**

[102](http://labor-liber.org/en/gnu-linux/introduction/all#toc-resources)Resources

* **The Linux Documentation Project. HOWTOs, Guides, FAQs, online magazines (and man pages) -**[**http://tldp.org/**](http://tldp.org/)
* **Linux Dictionary -**[**http://tldp.org/LDP/Linux-Dictionary/html/index.html**](http://tldp.org/LDP/Linux-Dictionary/html/index.html)
* **Coreutils -**[**http://www.gnu.org/software/coreutils/**](http://www.gnu.org/software/coreutils/)
  + **Fileutils -**[**http://www.gnu.org/software/fileutils/**](http://www.gnu.org/software/fileutils/)
  + **Shellutils -**[**http://www.gnu.org/software/shellutils/**](http://www.gnu.org/software/shellutils/)
  + **Textutils -**[**http://www.gnu.org/software/textutils/**](http://www.gnu.org/software/textutils/)
* [**http://www.google.com/linux**](http://www.google.com/linux)