

Linux Operating System



Linux has its roots in Unix and Multics, two projects that shared the goal of developing a robust multi-user operating system.

Unix started as a project at Bell labs in 1970s but later on Bell stopped the project. A group of the staff members, including Ken Thompson and Dennis Ritchie, decided to continue with the project and wrote the entire operating system in C and this made it completely portable. Later on, research and development at Bell Labs (later AT&T) continued with Unix and System Laboratories developed versions of Unix, in partnership with Sun Microsystems. That opened the door for commercial Unix vendors to produce different distributions. Meanwhile, the Computer Systems Research Group at the University of California Berkeley continued to research and work on this operating system. This group produced the Berkeley Software Distribution (BSD), which inspired a range of operating systems. Many of those operating systems are still in use today, such as macOS.

Linux began in 1991 as a personal project by Finnish student Linus Torvalds a student at Berkley. His goal was to create a new free operating system kernel. Nowadays, "Linux" often refers to a group of operating system distributions built around the Linux kernel, example of Linux distributions are RedHat, Ubuntu and CentOS.

Linux is designed to be a multi-user, multi-tasking and portable operating system. It offers a superior performance along with more security and ability to customize it and develop new tools for it (as the kernel is open source).

Linux Structure

Linux is an operating system, basically is a software program that controls hardware and other software resources. An integral part of an operating system is a file system. File system is designed to provide space to store data, name files and logical structure of data on a disk. Filesystems require Application Programming Interface (API) to have access to system function calls that delete, move and create filesystem objects like files and directories. Filesystems also provides a security model to define access rights to files and directories.

Linux supports many different file systems including EXT3, XFS. Each file system has its own metadata structure to define how data gets accessed and stored. Majority of Linux distributions have ext4 as a file system. Previous distributions were ext3 and ext2.

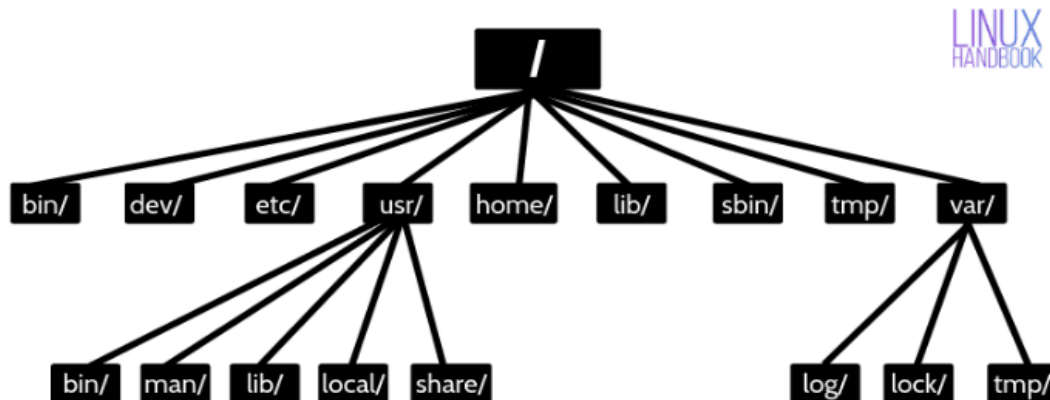
Data files are stored on hard drives. Disk space usually is formatted with a specific file system and divided into partitions. Partitions are logical volume formatted with a specific type of file system that can be mounted on a specific mount point on Linux file system.

Directory structure

Linux directory structure starts at the top (/) root directory. The term "to mount" a filesystem in Linux refers back to the early days of computing when a tape or removable disk pack would need to be physically mounted on an appropriate drive device. After being physically placed on the drive, the filesystem on the disk pack would be logically mounted by the operating system to make the contents available for access by the Operating System and users.

A mount point is simply a directory that is created as part of the root filesystem. So, for example, the home filesystem is mounted on the directory /home. Filesystems can be mounted at mount points on other non-root filesystems but this is less common (Both, 2019).

LINUX DIRECTORY STRUCTURE



Source: <https://linuxhandbook.com/linux-directory-structure/>

Name of the directory	The content
/bin/	Essential command executable files
/boot/	Boot loader
/dev/	Device files
/etc/	System configuration files
/home/	User directories
/lib/	Essential libraries and kernel modules
/opt/	Add-ons and applications
/sbin/	Operating system files
/usr/	User utilities and programs
/var/	Variable files
/proc/	Process information

In Linux, in order to do things, you interact with a special program called Shell (equivalent of cmd in windows). You can type commands with parameters and press enter to run them. Commands are composed of the name itself and arguments. A special kind of arguments are called options that are introduced by – character. They alter the behavior of the command in a particular way. In here we review some of the most important commands in Linux shell.

To run the following commands and exercise if you have access to a mac or Linux you can run them in a terminal directly but for the windows users you have to install cygwin to run the exercises. The installation process is straightforward. Beside the standard tools, selected by default, you should also install the dos2unix-tools (for line-break conversion between Windows and UNIX)

Moving around and Navigation

If you open a terminal in a Linux environment, you will have access to shell and you can issue commands. You can either use menu or press CTL+Alt+T. After opening a terminal you see a black page that has a \$ sign in the left top corner.

\$ The dollar sign is a **prompt**

You can write commands in front of prompt and press enter to execute them. An example of that is cd (change directory) which is the command to change the directory and navigate the file system structure.

One important note here is about **unknown commands** and path. Sometimes you can issue a command with proper format but still you receive an error message telling you the command not found. The cause of this might be a couple of reasons.). In all cases is because every command in Linux is an executable binary file. System needs to know where to look for the file in order to execute it and if it is not aware of the location or the file does not exist will give you such an error.

First reason might be that the program file for the command might not be installed. However, this cannot be the case for the general commands. In any case the cause of the error is that in Linux every command is an executable binary file. System needs to know where to look for the file in order to execute it and if it is not aware of the location will give you such an error. To rectify this situation, either you change your current path to where the binary file is then run the command again or you put the path inside environmental variable so operating system knows where the default location to look for the executable files is.

Let's start with learning some basics about path and navigation in Linux.

Paths

Directories and absolute paths (i.e. exact position in the system) are always prefixed with a /. / is the "root" or base directory.

```
cd ./Documents
```

~ means home directory so the following command takes you to home directory

```
cd ~
```

dot (.) represents your current directory

The following command shows your current directory

```
cd .
```

NOTE: there is a space between cd and the dot

(..) represents the parent directory.

Input/Output Redirection

To direct the output of a command and write it to a file you can use > sign, e.g. `$ ls >> file_list.txt` would write the directory listing to a file.

```
...> filename
```

>> : Redirect the output and append it to the file

```
...>> filename
```

Pipe operator(|): Connect Standard output of a command with Standard input of the next command

```
cat filename|sort
```

Useful Commands

To see the current user

```
whoami
```

To see current directory (print working directory)

```
pwd
```

To see the content of the current directory

```
ls
```

To see all files including hidden one

```
ls -a
```

To list all details of the content of a directory

```
ls -l
```

To make a directory in your current location

```
mkdir directoryname
```

To see the Linux distribution and version

```
cat /etc/issue          OR  
cat /proc/version
```

To get help

```
man command          OR  
info command
```

Less Command

It lets you to browse page by page the content of a file or output of a command.

```
ls -l | less
```

q : quit less

> : Go to end of file

To change the access right and issue commands as an Administrator

For the security reason, always is the best not to login using admin credential but whenever you need to do something like to install software that requires an admin right switch to the admin role. To do so you issue the following command.

```
sudo su
```

Alternatively you can mix both in one line and write a command like the following one that updates the yum package (yum is the primary tools to install and update programs in some Linux distributions such as RedHat and Ubuntu)

```
sudo yum update
```

Read and Write files

The default editor in Linux is "vi" which is a command based editor. However, if your file is a small one you can issue a command called "cat" to see the content in a terminal.

```
cat test.txt
```

Remove a file

```
rm testfile
```

You can also use "nano" to have a more powerful and user friendly editor. It is installed on most Linux distributions by default. Here is some basic operations in nano:

CTL+x=exit and save

CTL+o=save

Installing Programs

To install, update and remove software RedHat uses yum command.

```
yum install httpd
```

The above command installs Apache (httpd), a Linux webserver.

Unzipping files

Unzipping gz compress files in the current directory

```
tar -zxvf yourfile.tar.gz
```

Troubleshooting

Sometimes after installing a program you still not sure if it up and running. To check all running processes such as Http and open ports, issue ss command

```
ss -t1
```

If you do not see the process and would like to check the issue

```
cat /etc/issue      OR  
/var/log/httpd
```

Learning more...

There are many good Linux resources and tutorials on the Web. Here are some links:

<https://www.w3schools.in/operating-system-tutorial/linux-operating-system/>

<http://linuxcommand.org/index.php>

<http://www.theunixschool.com/>

<http://www.tldp.org/LDP/abs/html/textproc.html>