

Assignment - 3

Linux Files Structure

File System is nothing but the way in which files are named and where they are placed logically for storage and retrieval. Operating systems store files and directories in an organized and structured way. For example, system configuration files would go to one folder, user files to another, log files to another folder.

Commands or scripts will go to a different folder and so on. There are many different types of file systems. In general, improvements have been made to file systems with new releases of operating systems and each new file system has been given a different name. So whenever there is a new release in the operating system, usually it comes with an improved or enhanced file system.

/boot --> Contains file that is used by boot loader (grub.cfg)
/root --> root user home directory. It is not the same as /.
/dev --> System devices (e.g. disk,cdrom,speakers,flashdrive,keyboard etc)
/etc --> Configuration file
/bin->/usr/bin --> Everyday user command
/sbin->/usr/sbin--> System/filesystem command
/opt --> Optional add-on applications (Not part of OS app)
/proc --> Running Processes (Only exists in memory)
/lib-> usr/lib --> C Programming library needed by command and apps
Strace -e open pwd
/tmp --> Directory for temproray files
/home --> Directory for user
/var --> System Logs
/run --> System daemons that start very early (eg systemd and udev) to store temprorary files like PID fles
/mnt --> To mount external filessystem (e.g NFS)
/media --> For cdrom mounts.
/boot --> Contains file that is used by boot loader (grub.cfg)
/root --> root user home directory. It is not same as /.
/dev --> System devices (e.g. disk,cdrom,speakers,flashdrive,keyboard etc)
/etc --> Configruation file
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/lib-> usr/lib --> C Programming library needed by command and apps
Strace -e open pwd
/tmp --> Directory for temproray files

/home --> Directory for user
 /var --> System Logs
 /run --> System daemons that start very early (eg systemd and udev) to store temporary files
 like PID files
 /mnt --> To mount external filesystem (e.g NFS)
 /media --> For cdrom mounts.

/(Root): Primary hierarchy root and root directory of the entire file system hierarchy. Every single file and directory starts from the root directory The only root user has the right to write under this directory /root is the root user's home directory, which is not the same as /

```

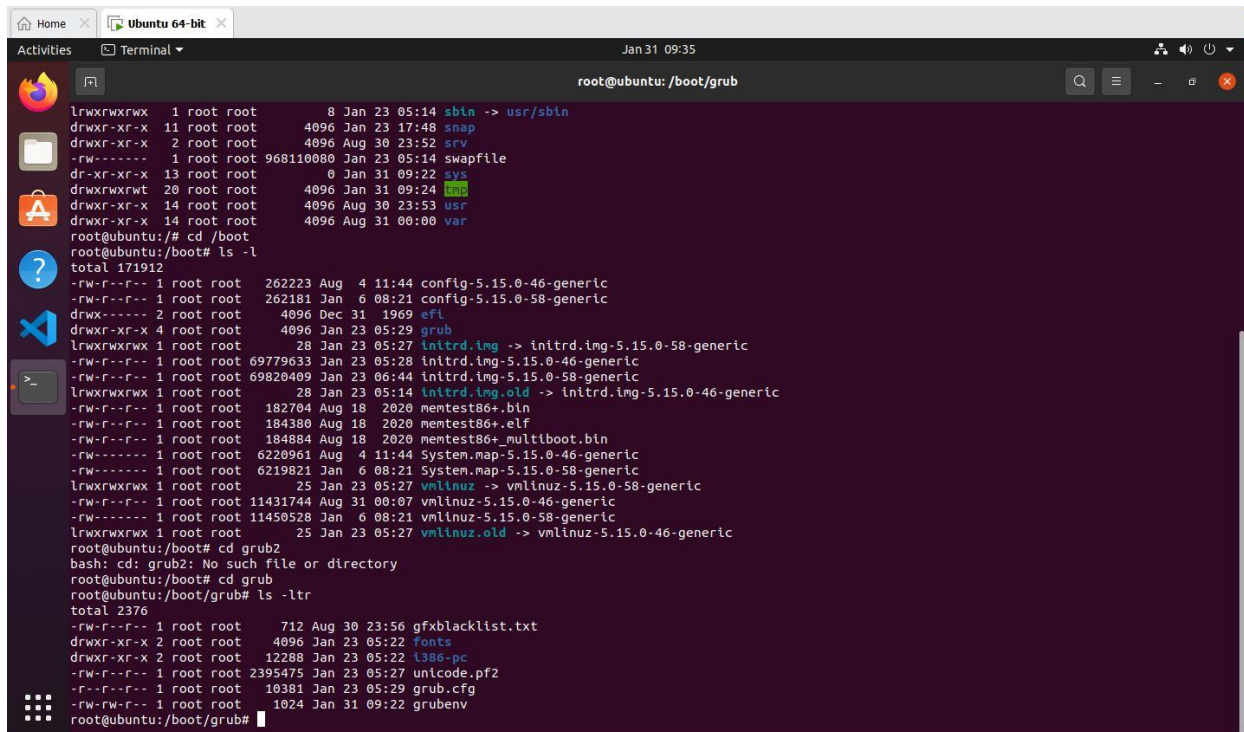
bhushan@ubuntu:~$ whoami
bhushan
bhushan@ubuntu:~$ cd /
bhushan@ubuntu:/$ ls -l
total 945508
lrwxrwxrwx 1 root root 7 Jan 23 05:14 bin -> usr/bin
drwxr-xr-x 4 root root 4096 Jan 23 06:44 boot
drwxr-xr-x 2 root root 4096 Jan 23 05:19 cdrom
drwxr-xr-x 19 root root 4180 Jan 31 04:33 dev
drwxr-xr-x 129 root root 12288 Jan 23 06:47 etc
drwxr-xr-x 3 root root 4096 Jan 23 05:20 home
lrwxrwxrwx 1 root root 7 Jan 23 05:14 lib -> usr/lib
lrwxrwxrwx 1 root root 9 Jan 23 05:14 lib32 -> usr/lib32
lrwxrwxrwx 1 root root 9 Jan 23 05:14 lib64 -> usr/lib64
lrwxrwxrwx 1 root root 10 Jan 23 05:14 libx32 -> usr/libx32
drwx----- 2 root root 16384 Jan 23 05:14 lost+found
drwxr-xr-x 3 root root 4096 Aug 30 23:52 media
drwxr-xr-x 2 root root 4096 Aug 30 23:52 mnt
drwxr-xr-x 2 root root 4096 Jan 23 05:31 opt
dr-xr-xr-x 375 root root 0 Jan 31 04:33 proc
drwx----- 4 root root 4096 Jan 23 19:12 root
drwxr-xr-x 31 root root 820 Jan 31 04:33 run
lrwxrwxrwx 1 root root 8 Jan 23 05:14/sbin -> usr/sbin
drwxr-xr-x 11 root root 4096 Jan 23 17:48 snap
drwxr-xr-x 2 root root 4096 Aug 30 23:52 srv
-rw----- 1 root root 968110080 Jan 23 05:14 swapfile
dr-xr-xr-x 13 root root 0 Jan 31 04:33 sys
drwxrwxrwt 20 root root 4096 Jan 31 04:35 tmp
drwxr-xr-x 14 root root 4096 Aug 30 23:53 usr
drwxr-xr-x 14 root root 4096 Aug 31 00:00 var
bhushan@ubuntu:/$
  
```

The /boot/ Directory

The /boot/ directory contains static files required to boot the system, for example, the Linux kernel. These files are essential for the system to boot properly.

Kernel initrd, vmlinuz, grub files are located under /boot

Example: initrd.img-2.6.32-24-generic, vmlinuz-2.6.32-24-generic



```
root@ubuntu: /boot/grub
lrwxrwxrwx 1 root root      8 Jan 23 05:14 sbin -> usr/sbin
drwxr-xr-x 11 root root    4096 Jan 23 17:48 snap
drwxr-xr-x  2 root root    4096 Aug 30 23:52 srv
-rw-r----- 1 root root 968110080 Jan 23 05:14 swapfile
dr-xr-xr-x 13 root root      0 Jan 31 09:22 sys
drwxrwxrwt 20 root root    4096 Jan 31 09:24 tmp
drwxr-xr-x 14 root root    4096 Aug 30 23:53 usr
drwxr-xr-x 14 root root    4096 Aug 31 00:00 var
root@ubuntu:/# cd /boot
root@ubuntu:/boot# ls -l
total 171912
-rw-r--r-- 1 root root    262223 Aug  4 11:44 config-5.15.0-46-generic
-rw-r--r-- 1 root root    262181 Jan  6 08:21 config-5.15.0-58-generic
drwx----- 2 root root    4096 Dec 31 1969 efi
drwxr-xr-x 4 root root    4096 Jan 23 05:29 grub
lrwxrwxrwx 1 root root      28 Jan 23 05:27 initrd.img -> initrd.img-5.15.0-58-generic
-rw-r--r-- 1 root root 69779633 Jan 23 05:28 initrd.img-5.15.0-46-generic
-rw-r--r-- 1 root root 69820409 Jan 23 06:44 initrd.img-5.15.0-58-generic
lrwxrwxrwx 1 root root      28 Jan 23 05:14 initrd.img.old -> initrd.img-5.15.0-46-generic
-rw-r--r-- 1 root root   182704 Aug 18 2020 memtest86+.bin
-rw-r--r-- 1 root root   184380 Aug 18 2020 memtest86+.elf
-rw-r--r-- 1 root root   184884 Aug 18 2020 memtest86+.multiboot.bin
-rw-r----- 1 root root    6220961 Aug  4 11:44 System.map-5.15.0-46-generic
-rw-r----- 1 root root    6219821 Jan  6 08:21 System.map-5.15.0-58-generic
lrwxrwxrwx 1 root root      25 Jan 23 05:27 vmlinuz -> vmlinuz-5.15.0-58-generic
-rw-r--r-- 1 root root 11431744 Aug 31 00:07 vmlinuz-5.15.0-46-generic
-rw-r----- 1 root root 11450528 Jan  6 08:21 vmlinuz-5.15.0-58-generic
lrwxrwxrwx 1 root root      25 Jan 23 05:27 vmlinuz.old -> vmlinuz-5.15.0-46-generic
root@ubuntu:/boot# cd grub2
bash: cd: grub2: No such file or directory
root@ubuntu:/boot# cd grub
root@ubuntu:/boot/grub# ls -ltr
total 2376
-rw-r--r-- 1 root root      712 Aug 30 23:56 gfxblacklist.txt
drwxr-xr-x 2 root root    4096 Jan 23 05:22 fonts
drwxr-xr-x 2 root root    12288 Jan 23 05:22 i386-pc
-rw-r--r-- 1 root root 2395475 Jan 23 05:27 unicode.pf2
-r--r--r-- 1 root root   10381 Jan 23 05:29 grub.cfg
-rw-rw-r-- 1 root root    1024 Jan 31 09:22 grubenv
root@ubuntu:/boot/grub#
```

What is Grub?

The GRUB is a tool for booting and loading operating system kernels and the default bootloader for systems based on the Linux kernel. GRUB uses kernel parameters to know where the kernel is located and other important parameters to use.

The grub. cfg file is the GRUB configuration file. It is generated by the grub2-mkconfig program using a set of primary configuration files and the grub default file as a source for user configuration specifications. The GRUB menu interface configuration file is /boot/grub/grub. conf. The commands to set the global preferences for the menu interface are placed at the top of the file, followed by stanzas for each operating kernel or operating system listed in the menu.

A **bootloader** is a program written in machine code that loads the operating system into RAM during the boot process. A bootloader is used as a separate program in the program memory that executes when a new application needs to be reloaded into the rest of program memory. The bootloader will use a serial port, USB port, or some other means to load the application.

/bin : Essential command binaries that need to be available in single-user mode; for all users, e.g., cat, ls, cp. It Contains binary executables, Common linux commands you need to use in single-user modes are located under this directory. Commands used by all the users of the system are located here e.g. ps, ls, ping, grep, cp

/sbin/:

The /sbin/ directory stores binaries essential for booting, restoring, recovering, or repairing the system. The binaries in /sbin/ require root privileges to use. In addition, /sbin/ contains binaries

used by the system before the `/usr/` directory is mounted; any system utilities used after `/usr/` is mounted are typically placed in `/usr/sbin/`.

At a minimum, the following programs should be stored in `/sbin/`:

- `arp`
- `clock`
- `halt`
- `init`
- `fsck.*`
- `grub`
- `ifconfig`
- `mingetty`
- `mkfs.*`
- `mkswap`
- `reboot`
- `route`
- `shutdown`

`/dev/`

The `/dev/` directory contains device nodes that represent the following device types:

- devices attached to the system;
- virtual devices provided by the kernel.

These device nodes are essential for the system to function properly. The `udev` daemon creates and removes device nodes in `/dev/` as needed.

Devices in the `/dev/` directory and subdirectories are defined as either character (providing only a serial stream of input and output, for example, mouse or keyboard) or block (accessible randomly, for example, a hard drive or a floppy drive). If GNOME or KDE is installed, some storage devices are automatically detected when connected (such as with a USB) or inserted (such as a CD or DVD drive), and a pop-up window displaying the contents appears.

Examples of common files in the `/dev` directory

File	Description
/dev/hda	The master device on the primary IDE channel.
/dev/hdb	The slave device on the primary IDE channel.
/dev/tty0	The first virtual console.
/dev/tty1	The second virtual console.
/dev/sda	The first device on the primary SCSI or SATA channel.
/dev/lp0	The first parallel port.
/dev/ttyS0	Serial port.

```

drwxr-xr-x 11 root root      4096 Aug 30 23:56 x11
-rw-r--r--  1 root root        642 Sep 23 2019 xattr.conf
drwxr-xr-x  6 root root      4096 Aug 30 23:54 xdg
drwxr-xr-x  2 root root      4096 Aug 30 23:57 xml
-rw-r--r--  1 root root        477 Feb 10 2022 zsh_command_not_found
root@ubuntu:/etc# cd /bin
root@ubuntu:/bin# ls -l
total 166272
-rwxr-xr-x 1 root root      59736 Sep  5 2019 '['
-rwxr-xr-x 1 root root     31248 May 19 2020 aa-enabled
-rwxr-xr-x 1 root root     35344 May 19 2020 aa-exec
-rwxr-xr-x 1 root root     22912 Apr 14 2021 aconnect
-rwxr-xr-x 1 root root     19016 Nov 28 2019 acpi_listen
-rwxr-xr-x 1 root root      7415 Oct 26 2021 add-apt-repository
-rwxr-xr-x 1 root root     30952 Feb  7 2022 addpart
-rwxr-xr-x 1 root root     47552 Apr 14 2021 alsabat
-rwxr-xr-x 1 root root     85296 Apr 14 2021 alsaloop
-rwxr-xr-x 1 root root     72432 Apr 14 2021 alsamixer
-rwxr-xr-x 1 root root     14720 Apr 14 2021 alsatplg
-rwxr-xr-x 1 root root     31528 Apr 14 2021 alsaucm
-rwxr-xr-x 1 root root     31112 Apr 14 2021 amidi
-rwxr-xr-x 1 root root     63952 Apr 14 2021 amixer
-rwxr-xr-x 1 root root      2668 Mar 22 2020 amuFormat.sh
-rwxr-xr-x 1 root root       274 Oct  1 2017 apg
-rwxr-xr-x 1 root root     26696 Oct  1 2017 apgbfm
-rwxr-xr-x 1 root root     84408 Apr 14 2021 aplay
-rwxr-xr-x 1 root root     27016 Apr 14 2021 aplaymidi
-rwxr-xr-x 1 root root      2558 Dec  4 2019 apport-bug
-rwxr-xr-x 1 root root     13367 May 10 2022 apport-cli
lrwxrwxrwx 1 root root        10 Jan 23 05:14 apport-collect -> apport-bug
-rwxr-xr-x 1 root root      2068 May 10 2022 apport-unpack
-rwxr-xr-x 1 root root     14648 Feb 28 2020 appres
-rwxr-xr-x 1 root root     67816 Mar 14 2020 appstreamcli
lrwxrwxrwx 1 root root        6 Jan 23 05:14 apropos -> whatis
-rwxr-xr-x 1 root root     18824 May 24 2022 apt
lrwxrwxrwx 1 root root       18 Jan 23 05:14 apt-add-repository -> add-apt-repository
-rwxr-xr-x 1 root root     88536 May 24 2022 apt-cache
-rwxr-xr-x 1 root root     31192 May 24 2022 apt-cdrom
-rwxr-xr-x 1 root root     27016 May 24 2022 apt-config
-rwxr-xr-x 1 root root      1039 Dec  2 2020 aptdcon
-rwxr-xr-x 1 root root     27104 May 24 2022 apt-extracttemplates

```

/etc/

The /etc/ directory is reserved for configuration files that are local to the machine. It should contain no binaries; any binaries should be moved to /bin/ or /sbin/.

For example, the /etc/skel/ directory stores "skeleton" user files, which are used to populate a home directory when a user is first created. Applications also store their configuration files in this directory and may reference them when executed. The /etc/exports file controls which file systems export to remote hosts.

```
Home x Ubuntu 64-bit x
Activities Terminal Jan 31 09:37
root@ubuntu: /etc

drwxr-xr-x 2 root root 12288 Jan 23 05:22 i386-pc
-rw-r--r-- 1 root root 2395475 Jan 23 05:27 unicode.pf2
-r--r--r-- 1 root root 10381 Jan 23 05:29 grub.cfg
-rw-rw-r-- 1 root root 1024 Jan 31 09:22 grubenv
root@ubuntu:/boot/grub# cd /root
root@ubuntu:~# cd
root@ubuntu:~# pwd
/root
root@ubuntu:~# ls -l
total 4
drwx----- 3 root root 4096 Jan 23 05:30 snap
root@ubuntu:~# cd /etc
root@ubuntu:/etc# ls -l
total 1068
drwxr-xr-x 3 root root 4096 Aug 30 23:56 acpi
-rw-r--r-- 1 root root 3028 Aug 30 23:52 adduser.conf
drwxr-xr-x 3 root root 4096 Aug 30 23:53 alsa
drwxr-xr-x 2 root root 4096 Jan 23 18:52 alternatives
-rw-r--r-- 1 root root 401 Jul 16 2019 anacrontab
-rw-r--r-- 1 root root 433 Oct 1 2017 apg.conf
drwxr-xr-x 5 root root 4096 Aug 30 23:54 apm
drwxr-xr-x 3 root root 4096 Aug 30 23:56 apparmor
drwxr-xr-x 6 root root 4096 Jan 23 06:38 apparmor.d
drwxr-xr-x 4 root root 4096 Aug 30 23:56 appport
-rw-r--r-- 1 root root 769 Jan 18 2020 appstream.conf
drwxr-xr-x 7 root root 4096 Jan 23 05:30 apt
drwxr-xr-x 3 root root 4096 Aug 30 23:56 avahi
-rw-r--r-- 1 root root 2319 Feb 25 2020 bash.bashrc
-rw-r--r-- 1 root root 45 Jan 25 2020 bash_completion
drwxr-xr-x 2 root root 4096 Jan 23 17:44 bash_completion.d
-rw-r--r-- 1 root root 367 Apr 14 2020 bindresvport.blacklist
drwxr-xr-x 2 root root 4096 Apr 22 2020 binfmt.d
drwxr-xr-x 2 root root 4096 Aug 30 23:56 bluetooth
-rw-r----- 1 root root 33 Aug 30 23:56 brlapi.key
drwxr-xr-x 7 root root 4096 Aug 30 23:55 brltty
-rw-r--r-- 1 root root 26916 Mar 3 2020 brltty.conf
drwxr-xr-x 3 root root 4096 Aug 30 23:52 ca-certificates
-rw-r--r-- 1 root root 6824 Jan 23 06:40 ca-certificates.conf
6821 Aug 30 23:53 ca-certificates.conf.dpkg-old
drwxr-xr-x 4 root root 4096 Aug 30 23:56 calendar
drwxr-xr-x 2 root root 4096 Aug 30 23:56 chatp...
```

/lib/ Directory

The /lib/ directory should only contain libraries needed to execute the binaries in /bin/ and /sbin/. These shared library images are used to boot the system or execute commands within the root file system.

```
root@ubuntu: /lib

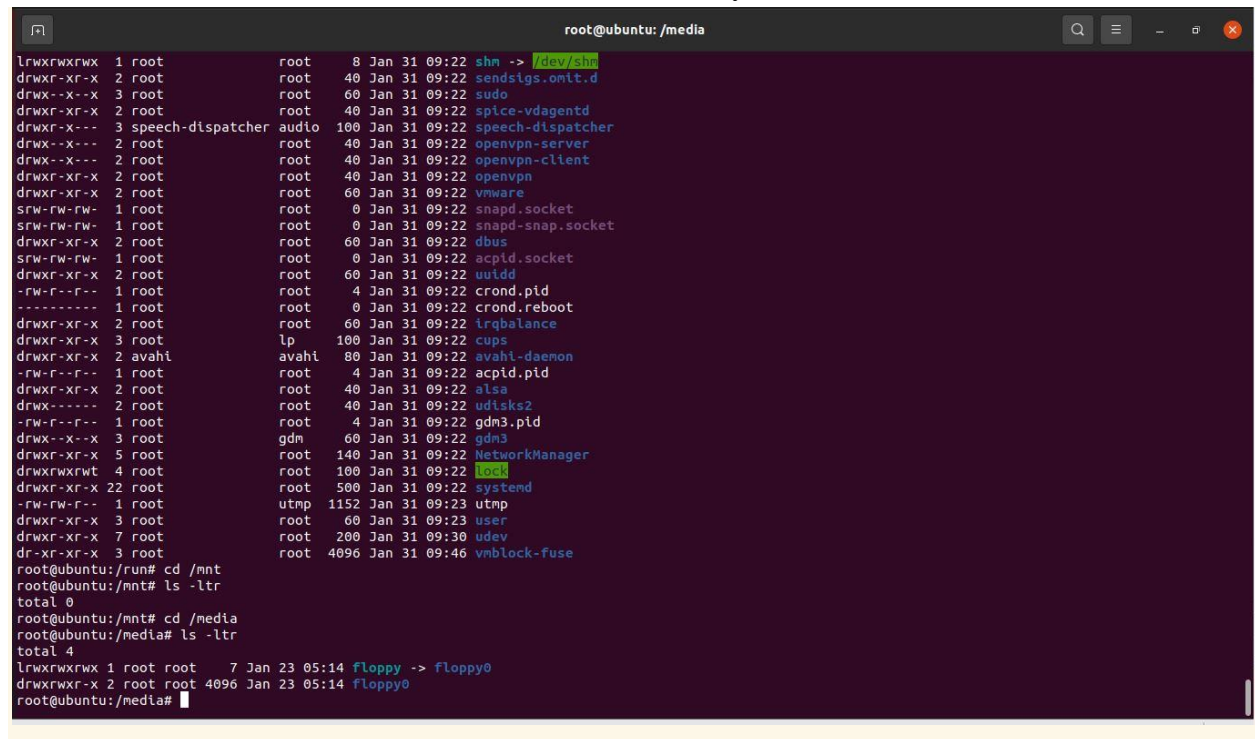
-r--r--r-- 1 root root 0 Jan 31 09:40 version
-r--r--r-- 1 root root 0 Jan 31 09:40 version_signature
-r----- 1 root root 0 Jan 31 09:40 vmlinuxinfo
-r--r--r-- 1 root root 0 Jan 31 09:22 vmstat
-r--r--r-- 1 root root 0 Jan 31 09:22 zoneinfo
root@ubuntu:/proc# cd /lib
root@ubuntu:/lib# ls -l
total 612
drwxr-xr-x 2 root root 4096 Aug 30 23:53 accountsservice
drwxr-xr-x 2 root root 4096 Aug 30 23:54 apg
drwxr-xr-x 2 root root 4096 Aug 30 23:54 apparmor
drwxr-xr-x 5 root root 4096 Aug 30 23:53 apt
drwxr-xr-x 3 root root 4096 Aug 30 23:54 aspell
drwxr-xr-x 2 root root 4096 Apr 22 2020 binfmt.d
drwxr-xr-x 2 root root 4096 Aug 30 23:54 bluetooth
drwxr-xr-x 2 root root 4096 Aug 30 23:55 brltty
-rwxr-xr-x 1 root root 739 Feb 14 2022 cnf-update-db
-rwxr-xr-x 1 root root 3565 Feb 14 2022 command-not-found
drwxr-xr-x 2 root root 4096 Aug 30 23:52 console-setup
lrwxrwxrwx 1 root root 21 Jan 23 05:14 cpp -> /etc/alternatives/cpp
drwxr-xr-x 3 root root 4096 Aug 30 23:54 crda
drwxr-xr-x 10 root root 4096 Aug 30 23:54 cups
drwxr-xr-x 2 root root 4096 Jan 23 06:34 dbus-1.0
drwxr-xr-x 3 root root 4096 Aug 30 23:55 debug
drwxr-xr-x 3 root root 4096 Aug 30 23:52 dpkg
drwxr-xr-x 2 root root 4096 Aug 30 23:52 eject
drwxr-xr-x 3 root root 4096 Aug 30 23:54 emacsen-common
drwxr-xr-x 2 root root 4096 Jan 23 06:29 environment.d
drwxr-xr-x 7 root root 4096 Aug 30 23:54 evolution-data-server
drwxr-xr-x 2 root root 4096 Aug 30 23:52 file
drwxr-xr-x 7 root root 4096 Jan 23 06:38 firefox-addons
drwxr-xr-x 5 root root 4096 Aug 30 23:54 firmware
drwxr-xr-x 91 root root 16384 Aug 30 23:55 firmware
drwxr-xr-x 3 root root 4096 Aug 30 23:54 gcc
drwxr-xr-x 2 root root 4096 Aug 30 23:54 gdm3
drwxr-xr-x 3 root root 4096 Aug 30 23:54 ghostscript
drwxr-xr-x 2 root root 4096 Jan 23 05:24 girepository-1.0
drwxr-xr-x 3 root root 12288 Jan 23 17:44 git-core
drwxr-xr-x 2 root root 4096 Aug 30 23:54 gnome-initial-setup
drwxr-xr-x 2 root root 4096 Aug 30 23:54 gnome-session
drwxr-xr-x 3 root root 4096 Aug 30 23:55 gnome-settings-daemon-3.0
```


/media/

The /media/ directory contains subdirectories used as mount points for removable media, such as USB storage media, DVDs, and CD-ROMs.

/mnt/

The /mnt/ directory is reserved for temporarily mounted file systems, such as NFS file system mounts. For all removable storage media, use the /media/ directory. Automatically detected removable media will be mounted in the /media directory.



```
root@ubuntu: /media
lrwxrwxrwx 1 root root      8 Jan 31 09:22 shm -> /dev/shm
drwxr-xr-x 2 root root     40 Jan 31 09:22 sendsigs.omit.d
drwx--x--x 3 root root     60 Jan 31 09:22 sudo
drwxr-xr-x 2 root root     40 Jan 31 09:22 spice-vdagentd
drwxr-x--- 3 speech-dispatcher audio 100 Jan 31 09:22 speech-dispatcher
drwx--x--- 2 root root     40 Jan 31 09:22 openvpn-server
drwx--x--- 2 root root     40 Jan 31 09:22 openvpn-client
drwxr-xr-x 2 root root     40 Jan 31 09:22 openvpn
drwxr-xr-x 2 root root     60 Jan 31 09:22 vmware
srw-rw-rw- 1 root root      0 Jan 31 09:22 snapd.socket
srw-rw-rw- 1 root root      0 Jan 31 09:22 snapd-snap.socket
drwxr-xr-x 2 root root     60 Jan 31 09:22 dbus
srw-rw-rw- 1 root root      0 Jan 31 09:22 acpid.socket
drwxr-xr-x 2 root root     60 Jan 31 09:22 uuldd
-rw-r--r-- 1 root root      4 Jan 31 09:22 crond.pid
----- 1 root root      0 Jan 31 09:22 crond.reboot
drwxr-xr-x 2 root root     60 Jan 31 09:22 irqbalance
drwxr-xr-x 3 root root    100 Jan 31 09:22 cups
drwxr-xr-x 2 avahi avahi    80 Jan 31 09:22 avahi-daemon
-rw-r--r-- 1 root root      4 Jan 31 09:22 acpid.pid
drwxr-xr-x 2 root root     40 Jan 31 09:22 alsa
drwx----- 2 root root     40 Jan 31 09:22 udisks2
-rw-r--r-- 1 root root      4 Jan 31 09:22 gdm3.pid
drwx--x--x 3 root gdm     60 Jan 31 09:22 gdm3
drwxr-xr-x 5 root root    140 Jan 31 09:22 NetworkManager
drwxrwxrwt 4 root root    100 Jan 31 09:22 lock
drwxr-xr-x 22 root root   500 Jan 31 09:22 systemd
-rw-rw-r-- 1 root utmp    1152 Jan 31 09:23 utmp
drwxr-xr-x 3 root root     60 Jan 31 09:23 user
drwxr-xr-x 7 root root    200 Jan 31 09:30 udev
dr-xr-xr-x 3 root root   4096 Jan 31 09:46 vmblock-fuse

root@ubuntu:/run# cd /mnt
root@ubuntu:/mnt# ls -ltr
total 0
root@ubuntu:/mnt# cd /media
root@ubuntu:/media# ls -ltr
total 4
lrwxrwxrwx 1 root root      7 Jan 23 05:14 floppy -> floppy0
drwxrwxr-x 2 root root   4096 Jan 23 05:14 floppy0
root@ubuntu:/media#
```

/opt/

The /opt/ directory is normally reserved for software and add-on packages that are not part of the default installation. A package that installs to /opt/ creates a directory bearing its name, for example /opt/package/. In most cases, such packages follow a predictable subdirectory structure; most store their binaries in /opt/package/bin/ and their man pages in /opt/package/man/.


```

-rwxr-xr-x 1 root root 51592 Feb 28 2020 xwininfo
-rwxr-xr-x 1 root root 35120 Feb 28 2020 xwud
lrwxrwxrwx 1 root root 31 Jan 23 05:14 x-www-browser -> /etc/alternatives/x-www-browser
-rwxr-xr-x 1 root root 18712 Jan 11 15:54 xxd
-rwxr-xr-x 1 root root 80384 Apr 8 2022 xz
lrwxrwxrwx 1 root root 2 Jan 23 05:14 xzcat -> xz
lrwxrwxrwx 1 root root 6 Jan 23 05:14 xzcmp -> xzdiff
-rwxr-xr-x 1 root root 6632 Apr 8 2022 xzdiff
lrwxrwxrwx 1 root root 6 Jan 23 05:14 xzegrep -> xzgrep
lrwxrwxrwx 1 root root 6 Jan 23 05:14 xzfgrep -> xzgrep
-rwxr-xr-x 1 root root 5902 Apr 8 2022 xzgrep
-rwxr-xr-x 1 root root 1802 Apr 8 2022 xzless
-rwxr-xr-x 1 root root 2161 Apr 8 2022 xzmore
-rwxr-xr-x 1 root root 63720 Apr 6 2021 yelp
-rwxr-xr-x 1 root root 39256 Sep 5 2019 yes
lrwxrwxrwx 1 root root 8 Jan 23 05:14 ypdomainname -> hostname
-rwxr-xr-x 1 root root 1984 Apr 8 2022 zcat
-rwxr-xr-x 1 root root 1678 Apr 8 2022 zcmp
-rwxr-xr-x 1 root root 5898 Apr 8 2022 zdiff
-rwxr-xr-x 1 root root 26840 Apr 6 2022 zdump
-rwxr-xr-x 1 root root 29 Apr 8 2022 zegrep
-rwxr-xr-x 1 root root 135960 Feb 27 2020 zentity
-rwxr-xr-x 1 root root 29 Apr 8 2022 zfgrep
-rwxr-xr-x 1 root root 2081 Apr 8 2022 zforce
-rwxr-xr-x 1 root root 8103 Apr 8 2022 zgrep
-rwxr-xr-x 1 root root 216256 Apr 21 2017 zlp
-rwxr-xr-x 1 root root 93816 Apr 21 2017 zlpcloak
-rwxr-xr-x 1 root root 50718 Oct 5 03:27 zlpdetails
-rwxr-xr-x 1 root root 2953 Oct 7 10:09 zlpgrep
-rwxr-xr-x 2 root root 186664 Oct 7 10:09 zlpinfo
-rwxr-xr-x 1 root root 89488 Apr 21 2017 zlpnote
-rwxr-xr-x 1 root root 93584 Apr 21 2017 zlpnsplit
-rwxr-xr-x 1 root root 26952 Jan 30 2020 zjsdecode
-rwxr-xr-x 1 root root 2206 Apr 8 2022 zless
-rwxr-xr-x 1 root root 1842 Apr 8 2022 zmore
-rwxr-xr-x 1 root root 4577 Apr 8 2022 znew
root@ubuntu:/bin# cd /opt
root@ubuntu:/opt# ls -l
total 0
root@ubuntu:/opt#

```

/proc/

The /proc/ directory contains special files that either extract information from the kernel or send information to it. Examples of such information include system memory, CPU information, and hardware configuration.

```

root@ubuntu:/bin# cd /opt
root@ubuntu:/opt# ls -l
total 0
root@ubuntu:/opt# cd /proc
root@ubuntu:/proc# ls -l
total 0
dr-xr-xr-x 9 root root 0 Jan 31 09:22 1
dr-xr-xr-x 9 root root 0 Jan 31 09:22 10
dr-xr-xr-x 9 root root 0 Jan 31 09:22 100
dr-xr-xr-x 9 root root 0 Jan 31 09:22 101
dr-xr-xr-x 9 root root 0 Jan 31 09:22 102
dr-xr-xr-x 9 root root 0 Jan 31 09:22 103
dr-xr-xr-x 9 root root 0 Jan 31 09:22 104
dr-xr-xr-x 9 root root 0 Jan 31 09:22 105
dr-xr-xr-x 9 root root 0 Jan 31 09:22 106
dr-xr-xr-x 9 root root 0 Jan 31 09:22 107
dr-xr-xr-x 9 root root 0 Jan 31 09:22 108
dr-xr-xr-x 9 root root 0 Jan 31 09:22 109
dr-xr-xr-x 9 root root 0 Jan 31 09:22 11
dr-xr-xr-x 9 root root 0 Jan 31 09:22 110
dr-xr-xr-x 9 root root 0 Jan 31 09:22 1101
dr-xr-xr-x 9 root root 0 Jan 31 09:22 111
dr-xr-xr-x 9 root root 0 Jan 31 09:22 112
dr-xr-xr-x 9 root root 0 Jan 31 09:22 113
dr-xr-xr-x 9 root root 0 Jan 31 09:22 114
dr-xr-xr-x 9 root root 0 Jan 31 09:22 115
dr-xr-xr-x 9 root root 0 Jan 31 09:22 116
dr-xr-xr-x 9 root root 0 Jan 31 09:22 117
dr-xr-xr-x 9 root root 0 Jan 31 09:22 118
dr-xr-xr-x 9 root root 0 Jan 31 09:22 119
dr-xr-xr-x 9 root root 0 Jan 31 09:22 12
dr-xr-xr-x 9 root root 0 Jan 31 09:22 120
dr-xr-xr-x 9 root root 0 Jan 31 09:22 121
dr-xr-xr-x 9 root root 0 Jan 31 09:22 122
dr-xr-xr-x 9 root root 0 Jan 31 09:22 123
dr-xr-xr-x 9 root root 0 Jan 31 09:22 124
dr-xr-xr-x 9 root root 0 Jan 31 09:22 125
dr-xr-xr-x 9 root root 0 Jan 31 09:22 126
dr-xr-xr-x 9 root root 0 Jan 31 09:22 127
dr-xr-xr-x 9 root root 0 Jan 31 09:22 128
dr-xr-xr-x 9 root root 0 Jan 31 09:22 129

```

/srv/

The `/srv/` directory contains site-specific data served by a Red Hat Enterprise Linux system. This directory gives users the location of data files for a particular service, such as FTP, WWW, or CVS. Data that only pertains to a specific user should go in the `/home/` directory.

`/sys/`

The `/sys/` directory utilizes the new `sysfs` virtual file system specific to the 2.6 kernel. With the increased support for hot plug hardware devices in the 2.6 kernel, the `/sys/` directory contains information similar to that held by `/proc/`, but displays a hierarchical view of device information specific to hot plug devices.

`/usr/`

The `/usr/` directory is for files that can be shared across multiple machines. The `/usr/` directory is often on its own partition and is mounted read-only. The `/usr/` directory usually contains the following subdirectories:

`/usr/bin`

This directory is used for binaries.

`/usr/etc`

This directory is used for system-wide configuration files.

`/usr/games`

This directory stores games.

`/usr/include`

This directory is used for C header files.

`/usr/kerberos`

This directory is used for Kerberos-related binaries and files.

`/usr/lib`

This directory is used for object files and libraries that are not designed to be directly utilized by shell scripts or users. This directory is for 32-bit systems.

`/usr/lib64`

This directory is used for object files and libraries that are not designed to be directly utilized by shell scripts or users. This directory is for 64-bit systems.

`/usr/libexec`

This directory contains small helper programs called by other programs.

`/usr/sbin`

This directory stores system administration binaries that do not belong to `/sbin/`.

`/usr/share`

This directory stores files that are not architecture-specific.

`/usr/src`

This directory stores source code.

`/usr/tmp` linked to `/var/tmp`

This directory stores temporary files.

The `/usr/` directory should also contain a `/local/` subdirectory. As per the FHS, this subdirectory is used by the system administrator when installing software locally, and should be safe from being overwritten during system updates. The `/usr/local` directory has a structure similar to `/usr/`, and contains the following subdirectories:

- `/usr/local/bin`
- `/usr/local/etc`
- `/usr/local/games`
- `/usr/local/include`
- `/usr/local/lib`
- `/usr/local/libexec`
- `/usr/local/sbin`
- `/usr/local/share`
- `/usr/local/src`

`/var/`

Since the FHS requires Linux to mount `/usr/` as read-only, any programs that write log files or need `spool/` or `lock/` directories should write them to the `/var/` directory. The FHS states `/var/` is for variable data, which includes spool directories and files, logging data, transient and temporary files.

Below are some of the directories found within the `/var/` directory depending on what is installed on the system:

- `/var/account/`
- `/var/arpwatch/`
- `/var/cache/`
- `/var/crash/`

```
root@ubuntu: /var
drwxr-xr-x  2 root root  4096 Aug 30 23:55 xserver-xorg-video-intel
root@ubuntu:/lib# cd /tmp/
root@ubuntu:/tmp# ls -l
total 52
-rw----- 1 bhushan bhushan    0 Jan 31 09:23 config-err-rqJhn2
drwx----- 2 root    root    4096 Jan 31 09:22 snap-private-tmp
drwx----- 2 bhushan bhushan 4096 Jan 31 09:23 ssh-UNueGAVHqI2X
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-colord.service-kvcHri
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-ModemManager.service-0Jcv8h
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-switcheroo-control.service-Zdkd9i
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-systemd-logind.service-1wBbQl
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-systemd-resolved.service-nynlYh
drwx----- 3 root    root    4096 Jan 31 09:22 systemd-private-3d3800573da64e6fa2d68528edfff40c-systemd-timesyncd.service-a70A1l
drwx----- 2 bhushan bhushan 4096 Jan 31 09:34 tracker-extract-files.1000
drwx----- 2 gdm     gdm     4096 Jan 31 09:22 tracker-extract-files.125
drwxrwxrwt  2 root    root    4096 Jan 31 09:22 VMwareDnD
drwxrwxrwt  2 root    root    4096 Jan 31 09:22 vmware-root_718-2957190230
root@ubuntu:/tmp# cd /home/
root@ubuntu:/home# ls -l
total 4
drwxr-xr-x 19 bhushan bhushan 4096 Jan 23 19:12 bhushan
root@ubuntu:/home# cd /var/
root@ubuntu:/var# ls -ltr
total 48
drwxrwsr-x  2 root staff  4096 Apr 15  2020 local
drwxr-xr-x  2 root root    4096 Aug 30 23:52 opt
drwxrwsr-x  2 root mail    4096 Aug 30 23:52 mail
drwxrwxrwt  2 root whoopsie 4096 Aug 30 23:56 crash
drwxrwxrwt  2 root whoopsie 4096 Aug 30 23:56 metrics
lrwxrwxrwx  1 root root      4 Jan 23 05:17 run -> /run
lrwxrwxrwx  1 root root      9 Jan 23 05:17 lock -> /run/lock
drwxr-xr-x  6 root root    4096 Jan 23 05:23 spool
drwxr-xr-x 67 root root    4096 Jan 23 17:44 lib
drwxr-xr-x 10 root root    4096 Jan 23 17:48 snap
drwxr-xr-x  2 root root    4096 Jan 24 23:48 backups
drwxr-xr-x 17 root root    4096 Jan 31 05:18 cache
drwxrwxr-x 14 root syslog  4096 Jan 31 09:22 log
drwxrwxrwt  9 root root    4096 Jan 31 09:28 tmp
root@ubuntu:/var#
```

To create a new variable and assign a value, you can use the export command. For example, export MYVAR="Hello World" would create a new variable named "MYVAR" and assign the value "Hello World" to it. To modify the value of a variable, you can simply assign a new value to it. For example, MYVAR="Hello again" would change the value of the variable "MYVAR" to "Hello again". To remove a variable, you can use the unset command followed by the variable name. For example, unset MYVAR would remove the variable "MYVAR" from the shell environment.