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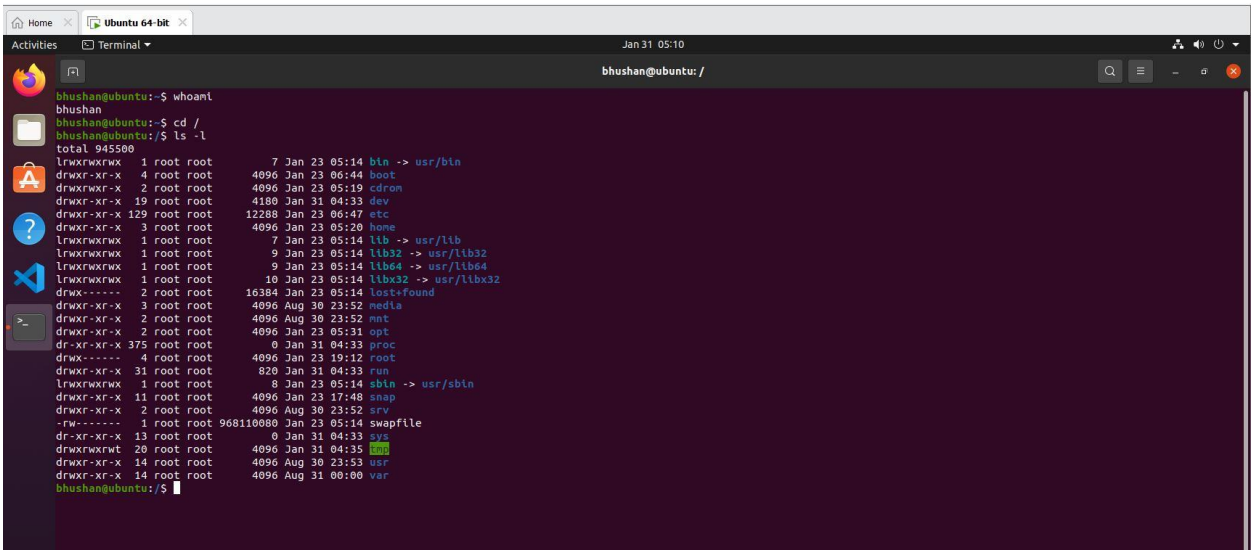
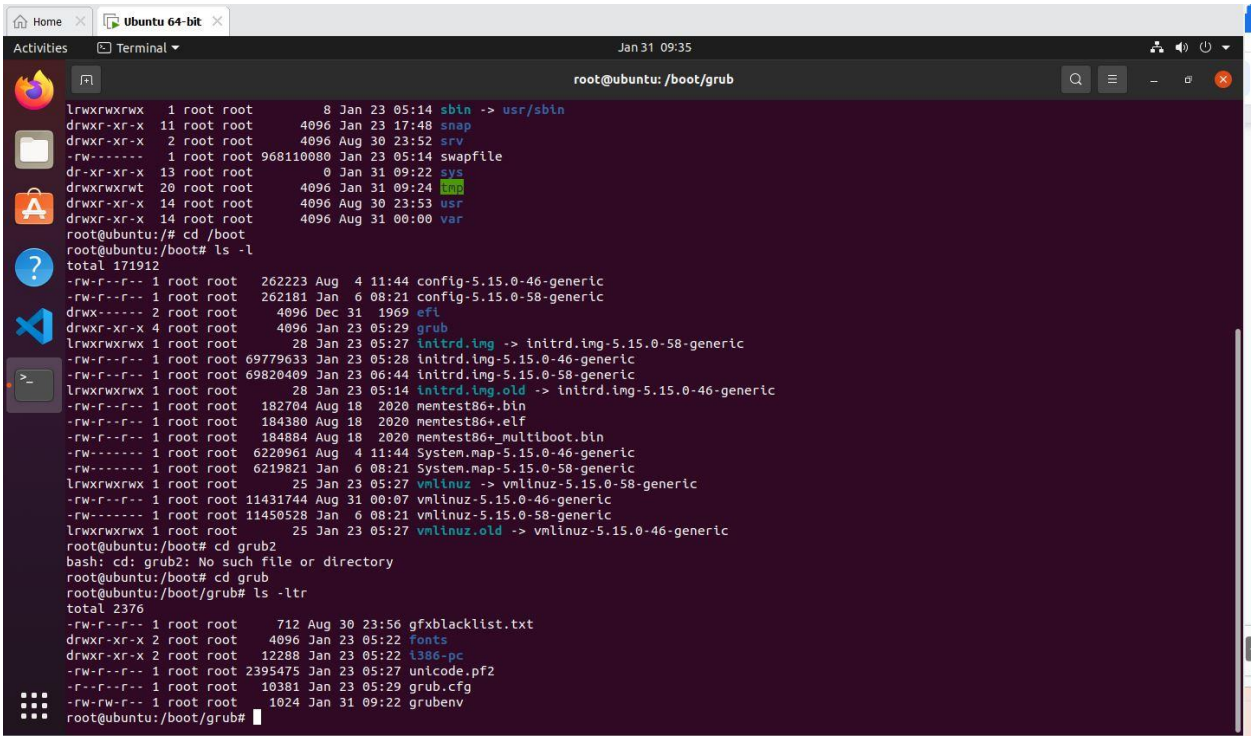
/ (Root): Primary hierarchy root and root directory of the entire file system hierarchy. Every single file and directory starts from the root directory The only root user has the right to write under this directory /root is the root user's home directory, which is not the same as /



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, vmlinux, grub files are located under /boot
Example: initrd.img-2.6.32-24-generic, vmlinuz-2.6.32-24-generic



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/

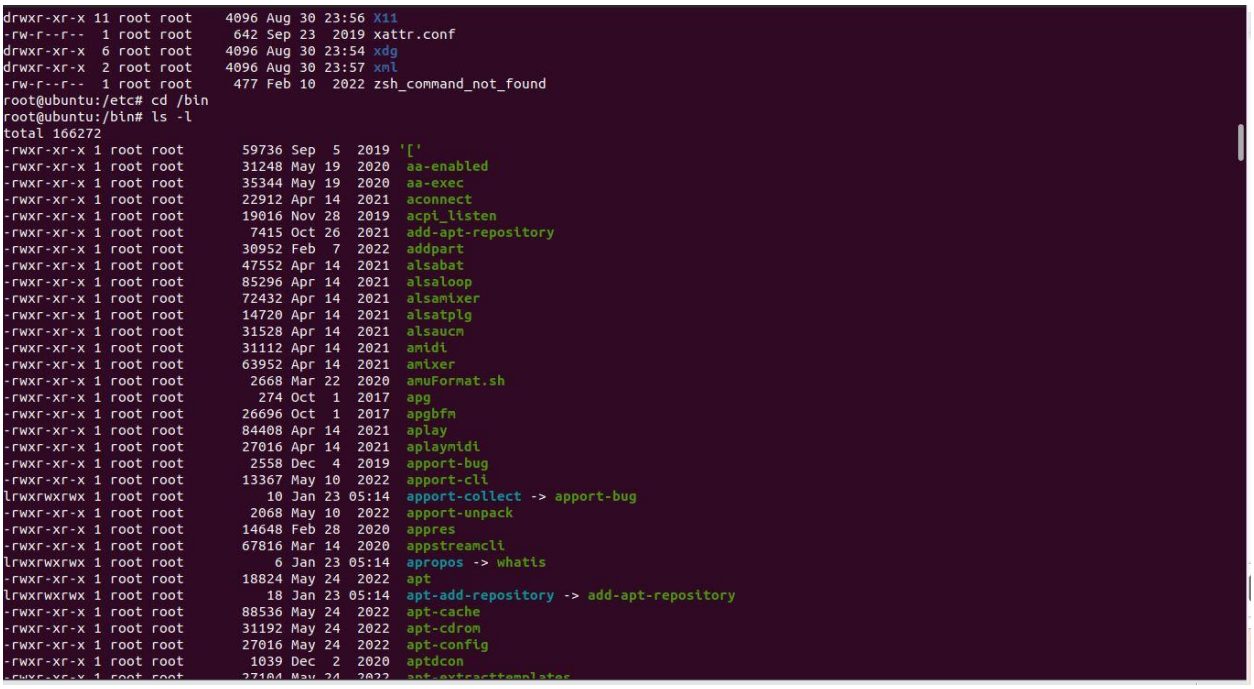
The /dev/ directory contains device nodes that represent the following device types:

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

These device nodes are essential for the system to function properly. The udevd 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

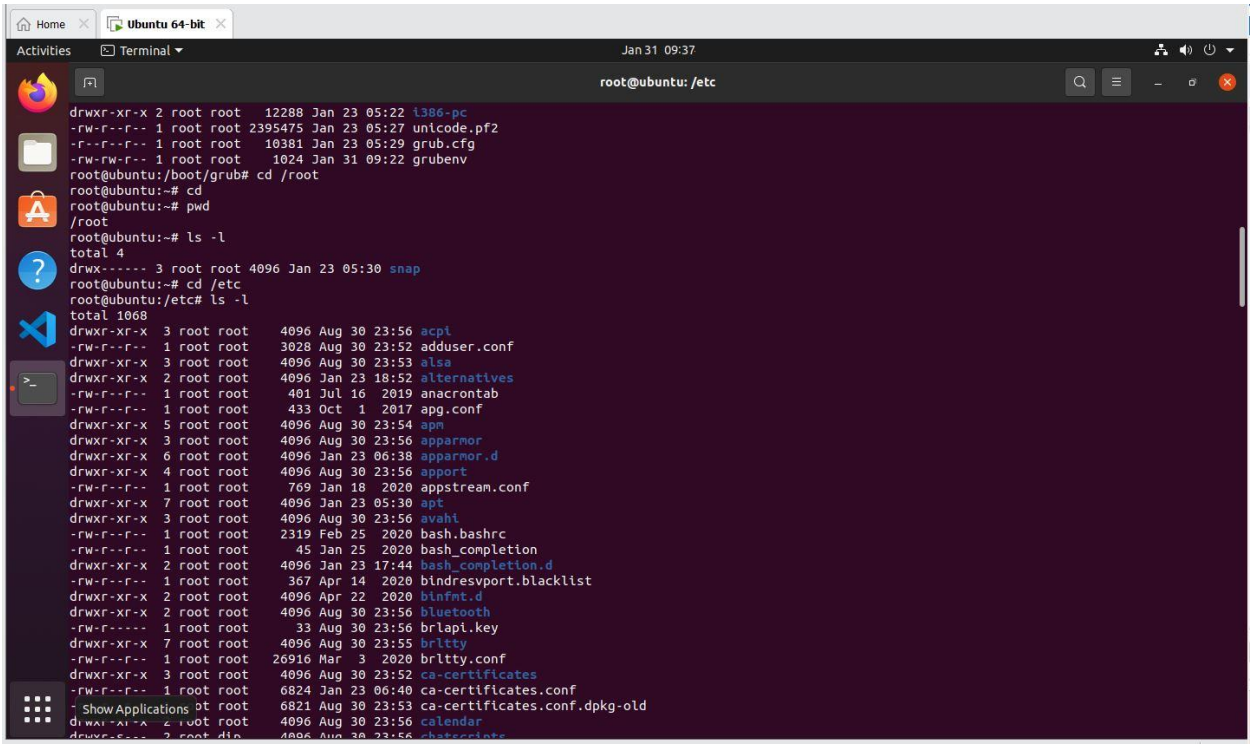
File	Description
/dev/hda	The master device on the primary IDE channel.
/dev/hdb	The slave device on the primary IDE channel.
/dev/tty0	The first virtual console.
/dev/tty1	The second virtual console.
/dev/sda	The first device on the primary SCSI or SATA channel.
/dev/lp0	The first parallel port.
/dev/ttyS0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



/etc/

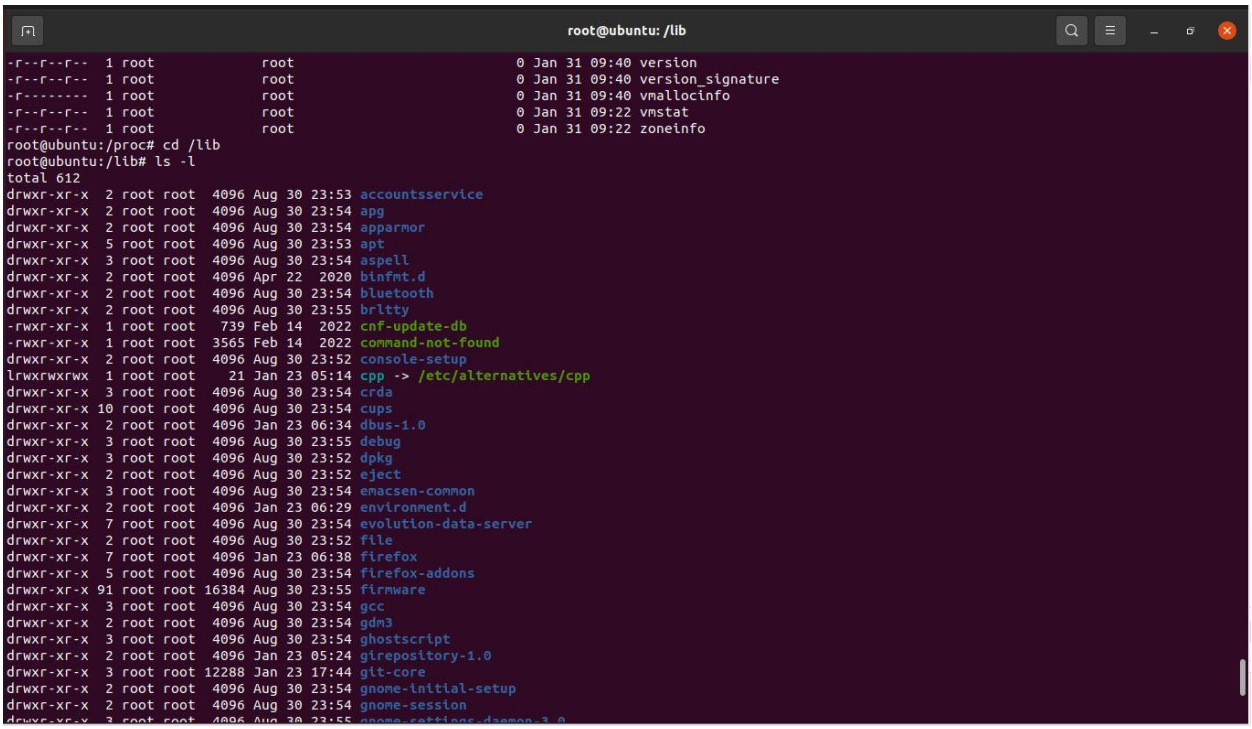
The /etc/ directory is reserved for configuration files that are local to the machine. It should contain no binaries; any binaries should be moved to /bin/ or /sbin/.

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.



/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.

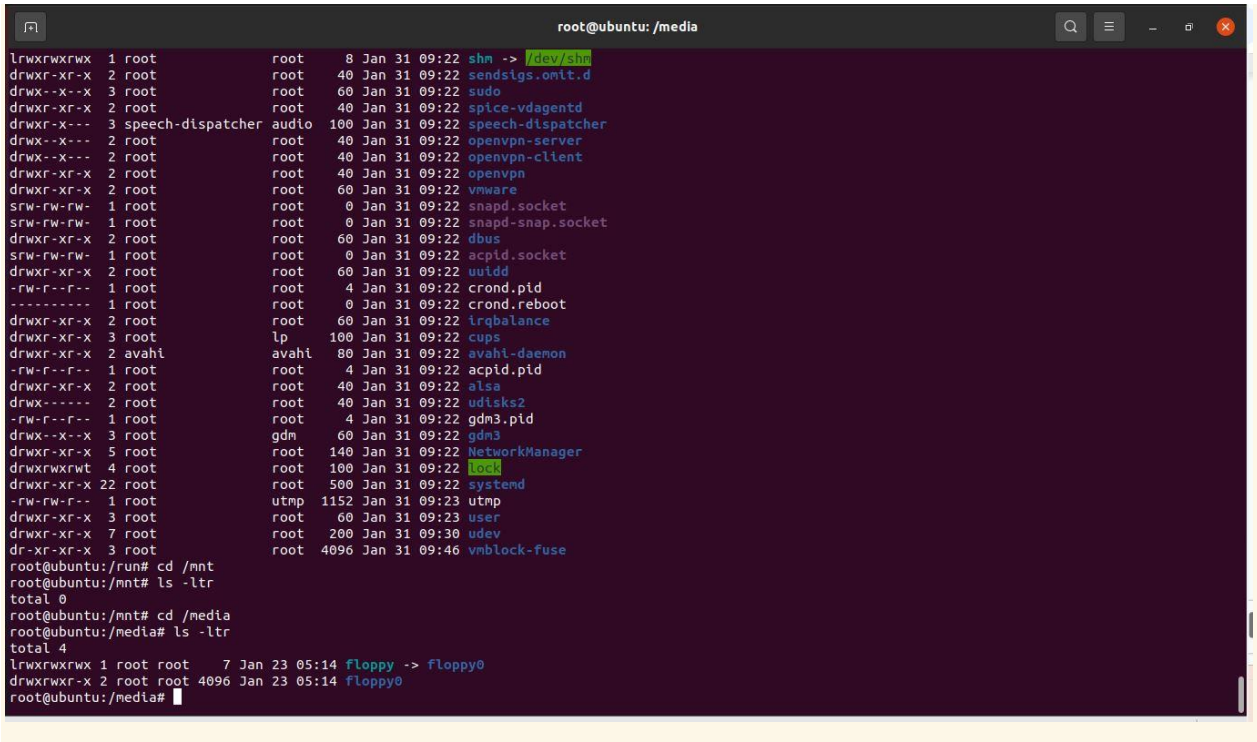


/media/

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.



/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/packagename/. In most cases, such packages follow a predictable subdirectory structure; most store their binaries in /opt/packagename/bin/ and their man pages in /opt/packagename/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  zenity
-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  zip
-rwxr-xr-x 1 root root       93816 Apr 21  2017  zipcloak
-rwxr-xr-x 1 root root       50718 Oct  5 03:27  zipdetails
-rwxr-xr-x 1 root root        2953 Oct  7 10:09  zipgrep
-rwxr-xr-x 2 root root      186664 Oct  7 10:09  zipinfo
-rwxr-xr-x 1 root root       89488 Apr 21  2017  zipnote
-rwxr-xr-x 1 root root       93584 Apr 21  2017  zipsplit
-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
```

/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.

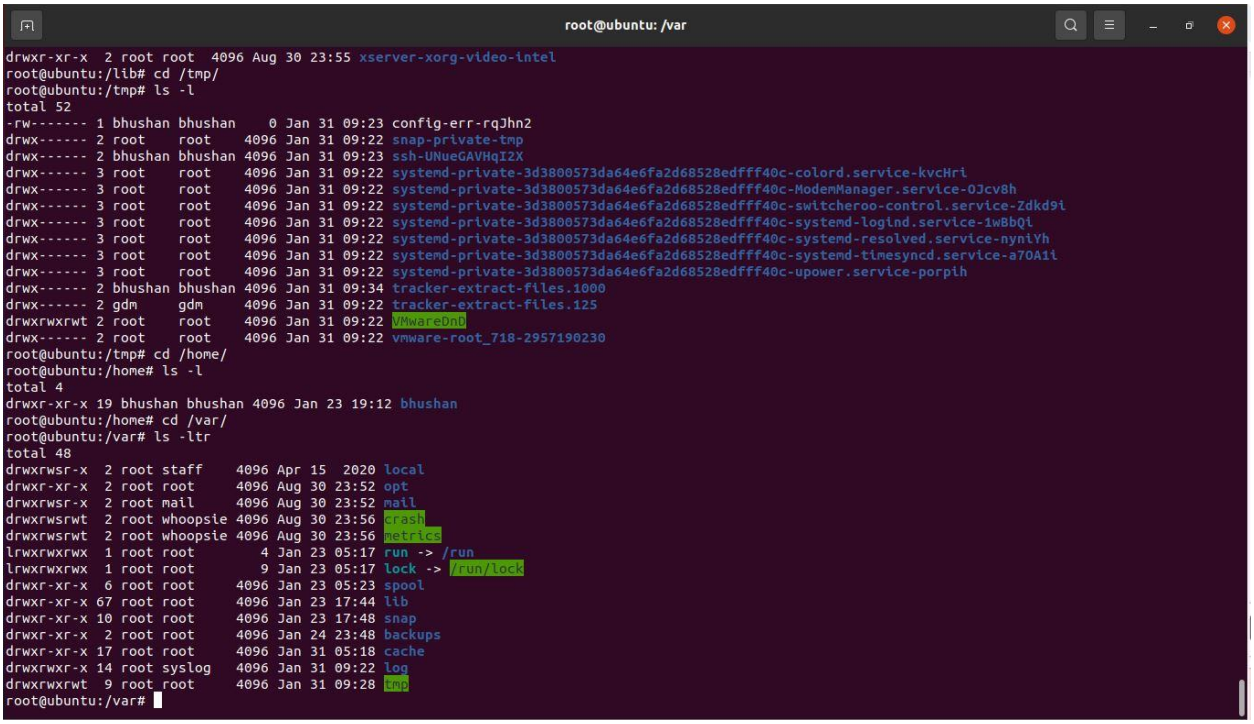
The /usr/ directory should also contain a /local/ subdirectory. As per the FHS, this subdirectory is used by the system administrator when installing software locally, and should be safe from being overwritten during system updates. The /usr/local directory has a structure similar to /usr/, and contains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



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.