Filesystem Architecture

Overview of User Home Directories:

1. Each user has a home directory, usually placed under /home.
2. The /root ("slash-root") directory on modern Linux systems is no more than the home directory of the root user (or superuser, or system administrator account).
3. On multi-user systems, the /home directory infrastructure is often mounted as a separate filesystem on its own partition, or even exported (shared) remotely on a network through NFS.

The /bin and /sbin Directories:

1. The /bin directory contains executable binaries, essential commands used to boot the system or in single-user mode, and essential commands required by all system users, such as cat, cp, ls, mv, ps, and rm.
2. Likewise, the /sbin directory is intended for essential binaries related to system administration, such as fsck and ip.
3. Commands that are not essential (theoretically) for the system to boot or operate in single-user mode are placed in the /usr/bin and /usr/sbin directories.

The /proc Filesystem:

1. Certain filesystems, like the one mounted at /proc, are called **pseudo-filesystems** because they have no permanent presence anywhere on the disk.
2. The /proc filesystem contains virtual files (files that exist only in memory) that permit viewing constantly changing kernel data.
3. /proc contains files and directories that mimic kernel structures and configuration information.
4. It does not contain real files, but runtime system information, **e.g**. system memory, devices mounted, hardware configuration, etc.
5. Some important entries in /proc are:
   - /proc/cpuinfo
   - /proc/interrupts
   - /proc/meminfo
   - /proc/mounts
   - /proc/partitions
   - /proc/version
6. /proc has subdirectories as well, including:
   - /proc/<Process-ID-#>
   - /proc/sys
7. The first example shows there is a directory for every process running on the system, which contains vital information about it.
8. The second example shows a virtual directory that contains a lot of information about the entire system, in particular its hardware and configuration.
9. The /proc filesystem is very useful because the information it reports is gathered only as needed and never needs storage on the disk.

The /proc Filesystem

The /dev Directory:

1. The /dev directory contains device nodes, a type of pseudo-file used by most hardware and software devices, except for network devices.
2. The /dev directory follows the below properties
   1. Empty on the disk partition when it is not mounted
   2. Contains entries which are created by the udev system, which creates and manages device nodes on Linux, creating them dynamically when devices are found. The /dev directory contains items such as:
      - /dev/sda1 (first partition on the first hard disk)
      - /dev/lp1 (second printer)
      - /dev/random (a source of random numbers).

The /dev Directory

The /var Directory:

1. The /var directory contains files that are expected to change in size and content as the system is running (var stands for variable), such as the entries in the following directories:
   - System log files: /var/log
   - Packages and database files: /var/lib
   - Print queues: /var/spool
   - Temporary files: /var/tmp.
2. The /var directory may be put on its own filesystem so that growth of the files can be accommodated and any exploding file sizes do not fatally affect the system.
3. Network services directories such as /var/ftp (the FTP service) and /var/www (the HTTP web service) are also found under /var.
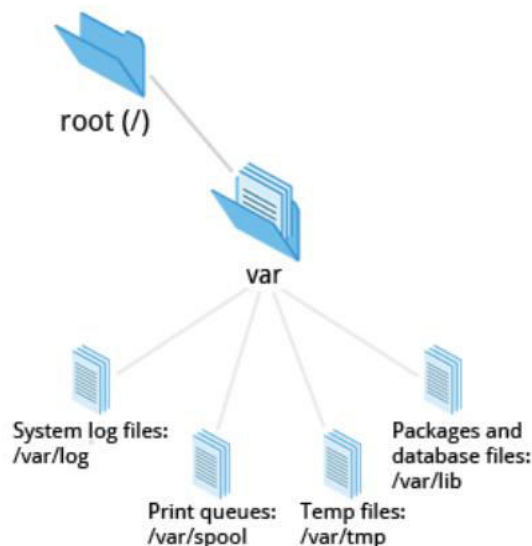
The /var Directory

The /etc Directory:

1. The /etc directory is the home for system configuration files. It contains no binary programs, although there are some executable scripts.
2. For example, /etc/resolv.conf tells the system where to go on the network to obtain host name to IP address mappings (DNS).
3. Files like passwd, shadow and group for managing user accounts are found in the /etc directory.
4. While some distributions have historically had their own extensive infrastructure under /etc (for example, Red Hat and SUSE have used /etc/sysconfig), with the advent of systemd there is much more uniformity among distributions today.
5. Note that /etc is for system-wide configuration files and only the superuser can modify files there.
6. User-specific configuration files are always found under their home directory.

The /boot Directory:

1. The /boot directory contains the few essential files needed to boot the system.
2. For every alternative kernel installed on the system there are four files. Each of these files has a kernel version appended to its name.
   - Vmlinuz - The compressed Linux kernel, required for booting.
   - Initramfs - The initial ram filesystem, required for booting, sometimes called initrd, not initramfs.
   - Config - The kernel configuration file, only used for debugging and bookkeeping.
   - System.map - Kernel symbol table, only used for debugging.
3. The Grand Unified Bootloader (**GRUB**) files such as /boot/grub/grub.conf or /boot/grub2/grub2.cfg are also found under the /boot directory.

The /lib and /lib64 Directories:

1. /lib contains libraries (common code shared by applications and needed for them to run) for the essential programs in /bin and /sbin.
2. These library filenames either start with ld or lib. For example, /lib/libncurses.so.5.9.

Removable media: the /media, /run and /mnt Directories:

1. One often uses removable media, such as USB drives, CDs and DVDs.
2. To make the material accessible through the regular filesystem, it has to be mounted at a convenient location.
3. Most Linux systems are configured so any removable media are automatically mounted when the system notices something has been plugged in.
4. While historically this was done under the /media directory, modern Linux distributions place these mount points under the /run directory.
5. For example, a USB pen drive with a label **myusbdrive** for a user named student would be mounted at /run/media/student/myusbdrive.
6. The /mnt directory has been used since the early days of UNIX for temporarily mounting filesystems.

7. These can be those on removable media, but more often might be network filesystems, which are not normally mounted. Or these can be temporary partitions, or so-called loopback filesystems, which are files which pretend to be partitions.

Additional Directories Under /:

1. There are some additional directories to be found under the root directory:

Directory Name	Usage
/opt	Optional application software packages
/sys	Virtual pseudo-filesystem giving information about the system and the hardware Can be used to alter system parameters and for debugging purposes
/srv	Site-specific data served up by the system Seldom used
/tmp	Temporary files; on some distributions erased across a reboot and/or may actually be a ramdisk in memory
/usr	Multi-user applications, utilities and data

The /usr Directory Tree:

1. The /usr directory tree contains theoretically non-essential programs and scripts (in the sense that they should not be needed to initially boot the system) and has at least the following sub-directories:

Directory Name	Usage
/usr/include	Header files used to compile applications
/usr/lib	Libraries for programs in /usr/bin and /usr/sbin
/usr/lib64	64-bit libraries for 64-bit programs in /usr/bin and /usr/sbin
/usr/sbin	Non-essential system binaries, such as system daemons
/usr/share	Shared data used by applications, generally architecture-independent
/usr/src	Source code, usually for the Linux kernel
/usr/local	Data and programs specific to the local machine; subdirectories include bin, sbin, lib, share, include, etc.
/usr/bin	This is the primary directory of executable commands on the system