2.11.1 Filesystem Hierarchy Standard (FHS)

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Filesystem Hierarchy Standard (FHS) 0:00-0:50

As a Linux administrator, it's very important that you be familiar with the Linux FileSystem Hierarchy Standard, or just the FHS.

The FHS provides Linux software developers and system administrators with a standard directory structure for the file system. This ensures consistency between all the various Linux distributions. Where there are so many distributions, can you imagine the mess that would occur if every distribution used its own proprietary file system structure? It would be a disaster. If you moved between distributions, you wouldn't be able to find anything.

Fortunately, we have the FHS to keep everybody in line. The FHS defines the directories that should appear underneath the root directory, as well as the directories that should appear under /usr and /var. Let's take a look at what they are.

The /bin Directory 0:51-1:11

First, we have the bin directory and as you can see here, bin exists at the root of the file system. The bin directory contains executable files necessary to manage and run the Linux system including your shell executable files, such as for the bash shell. It also includes file system management utilities like cp and rm and so on.

The /boot Directory 1:12-1:19

Also at the root of the file system, we have the /boot directory. This directory contains your boot loader files which are required in order for your system to boot up.

The /dev Directory 1:20-6:23

Also at the root of the file system is the dev directory. The dev directory is different from most of the other directories in the Linux file system. Dev contains special files that represent the various hardware devices that are installed in your system. For example, the first hard disk drive in your system is called sda. The second one is called sdb. Well, both of these devices are represented by files in the /dev directory. Here's sda.

Now, the partitions on each drive are identified by adding another number to the end of the disk name. For example, the first partition on the first hard drive in the system is sda1. The second partition on that same disk is sda2 and so on. Here's the important thing to remember, anytime that you need to access a piece of hardware in the Linux system, you access it using one of these files in /dev. For example, let's say I wanted to write data to a particular file and that file resides on the first partition, in the first hard drive in the system. Well, I would write that data to /dev/sda1. By writing it to this device file, it actually gets redirected and saved on the physical hard disk drive.

Now, be aware there are actually two different types of device files stored in /dev. The first ones are character-oriented device files. These are used for devices that send or receive data sequentially, one character at a time. For example, character-oriented device files might be used to send data to a printer, or to receive data from a mouse, or to send data to a backup tape drive. The important thing to remember is that these types of devices, which are represented by character-oriented device files, usually don't support random access to the data that they manage. You send it to the device sequentially, a character at a time. In addition to character-oriented device files, we also have block-oriented device files within /dev.

Block-oriented device files are used for hardware devices that manage data in blocks. This would include devices such as your hard disk drive, or your flash drive that's connected to the system. The key thing to remember about block-oriented devices, as opposed to character-oriented devices, is the fact that they support random access to the data that they manage, meaning that I can access any data point I want on the hard disk drive and read it immediately. Whereas with an old tape drive, I actually have to fast forward the tape until I get to the place on the tape where the data that I want resides.

There are many different types of hardware devices represented by the device files in /dev. Some of the more commonly used ones are listed here. If you have an older system that still has a floppy disk in it, then you access the floppy drive by using /dev/fd0. That would be the first floppy disk drive in the system. For your optical drive, your first optical drive in the system, you access it using /dev/sr0. If you had two optical drives, the second one would be /dev/sr1. If you need to access data or send data on a serial port it's done through /dev/ttyS0, with a capital S. The second serial port would be ttyS1 and so on. Likewise if we're going to send data to a parallel port printer, we would send it to /dev/lp0 for the first parallel port.

As we talked about earlier, your hard disk drives are represented by files in /dev. The first hard disk drive in the system is /dev/sda. The second drive in the system is /dev/sdb and so on. Likewise, each partition on each device has its own unique device file as well. The first partition on the first hard drive is /dev/sda1. The second partition is sda2 and so on.

The important thing to understand is the fact that the physical hardware in the Linux system is addressed by applications and services running on the system through all of the files in /dev. If you need to save a file to a disk, it goes to the appropriate file in /dev. If you need to send a print job to a printer, again it goes through a file in /dev. If you need to access a file on a DVD, it comes in through a file in /dev.

It's also important to remember that there are some device files in /dev that do not have any connection to a physical hardware device. They're used for virtual system resources. For example, the /dev/random device file is not connected to any particular piece of hardware. Instead, it's used to connect to a virtual random number generator in the system. So, if you need to generate random numbers for a program, you can access those random numbers using /dev/random.

The /etc Directory 6:24-7:05

Moving on, the next directory you need to be familiar with in the FHS directory structure is the /etc directory, which we affectionately call the /etc directory. If you hear someone say etc, they're talking about /etc. The /etc directory is very important because it contains the text-based configuration files that are used to configure not only your Linux system, but also all of the services and daemons and applications that are running on the system. Because they're text files, you can actually edit these files with the text editor, and then customize how your Linux system behaves.

Next, we have the /home directory, which contains subdirectories that serve as home directories for each user account on your system.

The /media Directory 7:06-7:43

We also have the /media directory that used by some Linux distributions to mount external devices such as an optical drive or a connected USB drive. For example, if I were to insert an optical disk into the optical drive on my Linux system, I would first would need to mount it in a directory in the file system before I would be able to access the data that's on it. To do this, I would select an existing directory somewhere in the files system, such as /media and mount the device into that directory. Then, when I use the CD command that the shell prompt to change into that directory, I actually access the data that's on that optical device.

The /mnt Directory 7:44-8:26

Now, some distributions used the /mnt directory to do the same thing. Some distributions will use mnt instead of media to mount external devices like our optical drives and USB drives. It's also used by most distributions for temporarily mounting local and remote file systems. For example, if I had a server somewhere in my network that had an NFS mount defined on it, basically a shared directory, I could mount it in my /mnt directory over the network. Then, when I switched to /mnt, I'm actually accessing the data on the server in the shared folder, somewhere else on the network. It's essentially like mapping a drive in Windows.

The /opt Directory 8:27-8:38

We also have the /opt directory. For some applications when you install them on your system, they will put some of their files in the /opt directory. It doesn't happen very often, but it does happen on occasion.

The /proc Directory 8:39-10:37

The next directory we need to look at is the /proc directory. The /proc is different from all the other directories we've looked at thus far. That's because /proc doesn't actually exist. It's not an actual directory on the hard disk drive. Instead, it's what we call a pseudo file system. Meaning that it's dynamically created whenever it's accessed and it plays a key role.

You use /proc to access information about the various processes running on your system, as well as system information. Notice over here that within /proc there are whole bunch of directories that are identified with a number and not a name. These directory names, these numbers, are actually process ID numbers, or PIDs. Every process running on the system has a PID number assigned to it and has a corresponding subdirectory in /proc that's named with the PID number of the process. This is extremely useful because you can actually access information about a running process on the system by viewing that data within one of these directories. For example, if I wanted to view information about a process with the PID number of 7610, I would go into the 7610 directory and there view information about that running process.

In addition to viewing process information, you can also view information about the hardware in your system in /proc. For example, there's a file here called cpuinfo. If I were to view cpuinfo with the cat command, I would find out what type of CPU is installed in this system. Likewise, if I were to use the cat command to view the interrupts file, I could see which devices in the system are using which interrupts. If I want to see how memory's being used, utilized in the system, I could using the cat command to view the meminfo file. If I want to see what modules are loaded onto the system, modules are the equivalent of drivers on Linux, then I would use the cat command to view the modules file.

The /root Directory 10:38-11:03

The next directory you need to be familiar with is the root directory. The root directory is the root user's home directory. Now, you'll note that root user, which is the super user on the system. The root user's directory is not in the same location as the standard user's home directories. The standard user's home directories are in /home. Root has its own directory located at the root of the file system name /root.

The /sbin Directory 11:04-11:15

You also have a directory named /sbin at the root of the file system. It contains important system administration utilities, like fdisk, ifconfig, init, makefs, shutdown, halt, and so on.

The /srv Directory 11:16-11:44

We also have a directory at the root of the file system named /srv, which is for server. It contains subdirectories where the various services running on your systems save their files. For example, if I installed a Web server on my Linux system, then my Web servers files that it serves to Web clients on the browser are stored in /srv. If I installed an FTP server on the system, then the files that are transferred back and forth between clients and the FTP service, would also be stored in /srv.

The /tmp Directory 11:45-12:15

Next, we have the /tmp directory. This directory contains the temporary files that are created by the system, or created by you for that matter. There is one important thing you've got to remember about this directory, and that is the fact that the Linux kernel automatically clears out older files from the directory on a periodic basis. That means you shouldn't save anything in /tmp that you actually want to save. How do I know this? I made that mistake once a long time ago. I've never made it since.

The /usr Directory 12:16-12:27

Next, we have the /usr directory, which most people call just the user directory, and it contains application files. In fact, most of the application files used by your system are stored in a subdirectory within /usr.

The /var Directory 12:28-12:37

Then finally we have the /var directory and it contains variable date, including your system log files. It also contains your mail spool files for each individual user account.

Summary 12:38-12:48

So, that's the Filesystem Hierarchy Standard in a nutshell. Just remember that the FHS defines the directories that appear in the Linux file system and also identifies what type of data should be saved in those directories.