BASUDEV GODABARI DEGREE COLLEGE , KESAIBAHAL

Department of Computer Science

"SELF STUDY MODULE"

Module Details :

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- Subject Name : COMPUTER SCIENCE
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UNIT – 2 : STRUCTURE

2.1 **User Management and the File System:** Types of Users, Creating users, Granting rights, User management commands, File quota and various file systems available,

2.2 File System Management and Layout, File permissions, Login process, Managing Disk Quotas, Links (hard links, symbolic links)

You Can use the Following Learning Video link related to above topic :

https://youtu.be/_0Hi6O8AbeA?list=PLVIQHNRLfIP8WncRgkwFqTOzRf_GSgI00

https://youtu.be/QO5NZiYFcO0?list=PLVIQHNRLfIP8WncRgkwFqTOzRf_GSgI00

https://youtu.be/9fu6nlHyk7Q

Look related link for better understanding

You Can also use the following Books :

1 . Sumitabha, Das, Unix Concepts And Applications, Tata McGraw-Hill Education, 2017, 4/Ed.

2 . Nemeth Synder & Hein, Linux Administration Handbook, Pearson Education, 2010, 2/ Ed.

And also you can download any book in free by using the following website.

- https://www.pdfdrive.com/

Unit-II

What is Unix ?

The Unix operating system is a set of programs that act as a link between the computer and the user.

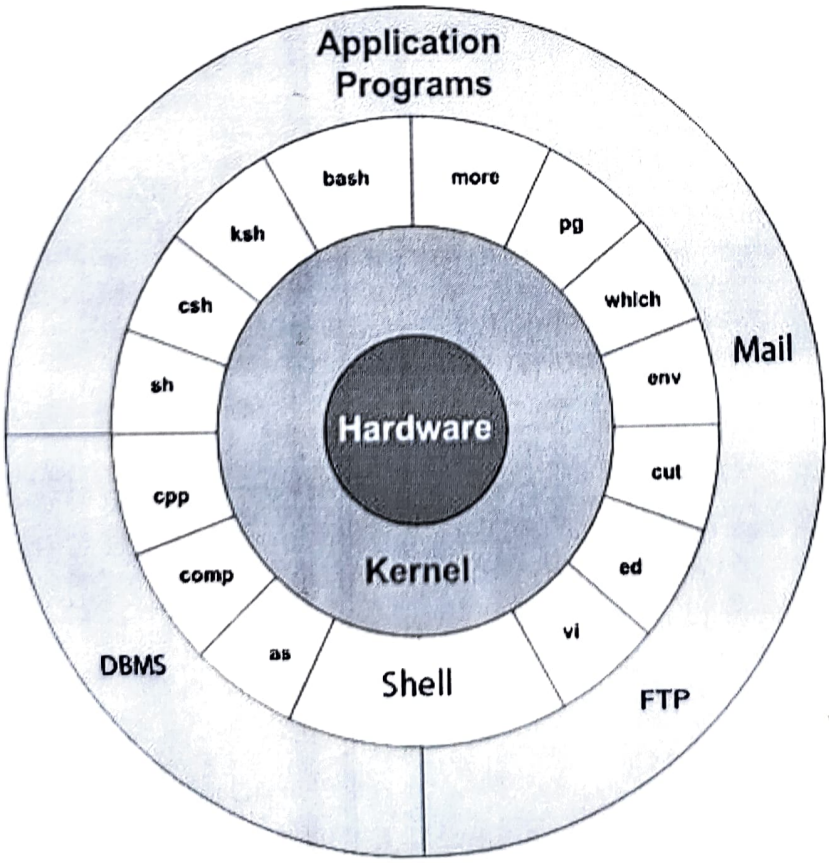
The computer programs that allocate the system resources and coordinate all the details of the computer's internals is called the **operating system** or the **kernel**.

Users communicate with the kernel through a program known as the **shell**. The shell is a command line interpreter; it translates commands entered by the user and converts them into a language that is understood by the kernel.

- Unix was originally developed in 1969 by a group of AT&T employees Ken Thompson, Dennis Ritchie, Douglas McIlroy, and Joe Ossanna at Bell Labs.
- There are various Unix variants available in the market. Solaris Unix, AIX, HP Unix and BSD are a few examples. Linux is also a flavor of Unix which is freely available.
- Several people can use a Unix computer at the same time; hence Unix is called a multiuser system.
- A user can also run multiple programs at the same time; hence Unix is a multitasking environment.

Unix Architecture

Here is a basic block diagram of a Unix system –



The main concept that unites all the versions of Unix is the following four basics –

- **Kernel** – The kernel is the heart of the operating system. It interacts with the hardware and most of the tasks like memory management, task scheduling and file management.
- **Shell** – The shell is the utility that processes your requests. When you type in a command at your terminal, the shell interprets the command and calls the program that you want. The shell uses standard syntax for all commands. C Shell, Bourne Shell and Korn Shell are the most famous shells which are available with most of the Unix variants.
- **Commands and Utilities** – There are various commands and utilities which you can make use of in your day to day activities. **cp**, **mv**, **cat** and **grep**, etc. are few examples of commands and utilities. There are over 250 standard commands plus numerous others provided through 3rd party software. All the commands come along with various options.
- **Files and Directories** – All the data of Unix is organized into files. All files are then organized into directories. These directories are further organized into a tree-like structure called the **filesystem**.

System Bootup

If you have a computer which has the Unix operating system installed in it, then you simply need to turn on the system to make it live.

As soon as you turn on the system, it starts booting up and finally it prompts you to log into the system, which is an activity to log into the system and use it for your day-to-day activities.

Login Unix

When you first connect to a Unix system, you usually see a prompt such as the following –

```
login:
```

To log in

- Have your userid (user identification) and password ready. Contact your system administrator if you don't have these yet.
- Type your userid at the login prompt, then press **ENTER**. Your userid is **case-sensitive**, so be sure you type it exactly as your system administrator has instructed.
- Type your password at the password prompt, then press **ENTER**. Your password is also case-sensitive.
- If you provide the correct userid and password, then you will be allowed to enter into the system. Read the information and messages that comes up on the screen, which is as follows.

```
login : amrood
amrood's password:
Last login: Sun Jun 14 09:32:32 2009 from 62.61.164.73
$
```

You will be provided with a command prompt (sometime called the **$** prompt) where you type all your commands. For example, to check calendar, you need to type the **cal** command as follows –

```
$ cal
     June 2009
Su Mo Tu We Th Fr Sa
    1  2  3  4  5  6
 7  8  9 10 11 12 13
```

```
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30

$
```

Change Password

All Unix systems require passwords to help ensure that your files and data remain your own and that the system itself is secure from hackers and crackers. Following are the steps to change your password –

Step 1 – To start, type password at the command prompt as shown below.

Step 2 – Enter your old password, the one you're currently using.

Step 3 – Type in your new password. Always keep your password complex enough so that nobody can guess it. But make sure, you remember it.

Step 4 – You must verify the password by typing it again.

```
$ passwd
Changing password for amrood
(current) Unix password:******
New UNIX password:*******
Retype new UNIX password:*******
passwd: all authentication tokens updated  successfully

$
```

Note – We have added asterisk (*) here just to show the location where you need to enter the current and new passwords otherwise at your system. It does not show you any character when you type.

Listing Directories and Files

All data in Unix is organized into files. All files are organized into directories. These directories are organized into a tree-like structure called the filesystem.

You can use the **ls** command to list out all the files or directories available in a directory. Following is the example of using **ls** command with **-l** option.

```
$ ls -l
total 19621
drwxrwxr-x  2 amrood amrood     4096 Dec 25 09:59 uml
-rw-rw-r--  1 amrood amrood     5341 Dec 25 08:38 uml.jpg
drwxr-xr-x  2 amrood amrood     4096 Feb 15  2006 univ
drwxr-xr-x  2 root   root       4096 Dec  9  2007 urlspedia
-rw-r--r--  1 root   root     276480 Dec  9  2007 urlspedia.tar
drwxr-xr-x  8 root   root       4096 Nov 25  2007 usr
-rwxr-xr-x  1 root   root       3192 Nov 25  2007 webthumb.php
-rw-rw-r--  1 amrood amrood    20480 Nov 25  2007 webthumb.tar
-rw-rw-r--  1 amrood amrood     5654 Aug  9  2007 yourfile.mid
-rw-rw-r--  1 amrood amrood   166255 Aug  9  2007 yourfile.swf

$
```

Here entries starting with **d**..... represent directories. For example, uml, univ and urlspedia are directories and rest of the entries are files.

Who Are You?

While you're logged into the system, you might be willing to know : **Who am I**?

The easiest way to find out "who you are" is to enter the **whoami** command –

```
$ whoami
 amrood

$
```

Try it on your system. This command lists the account name associated with the current login. You can try **who am i** command as well to get information about yourself.

Who is Logged in?

Sometime you might be interested to know who is logged in to the computer at the same time.

There are three commands available to get you this information, based on how much you wish to know about the other users: **users**, **who**, and **w**.

```
$ users
 amrood bablu qadir

$ who
amrood ttyp0 Oct 8 14:10 (limbo)
bablu  ttyp2 Oct 4 09:08 (calliope)
qadir  ttyp4 Oct 8 12:09 (dent)

$
```

Try the **w** command on your system to check the output. This lists down information associated with the users logged in the system.

Logging Out

When you finish your session, you need to log out of the system. This is to ensure that nobody else accesses your files.

To log out

- Just type the **logout** command at the command prompt, and the system will clean up everything and break the connection.

System Shutdown

The most consistent way to shut down a Unix system properly via the command line is to use one of the following commands –

Sr.No.	Command & Description
1	**halt** Brings the system down immediately
2	**init 0** Powers off the system using predefined scripts to synchronize and clean up the system prior to shutting down
3	**init 6**

	Reboots the system by shutting it down completely and then restarting it
4	**poweroff** Shuts down the system by powering off
5	**reboot** Reboots the system
6	**shutdown** Shuts down the system

You typically need to be the super user or root (the most privileged account on a Unix system) to shut down the system. However, on some standalone or personally-owned Unix boxes, an administrative user and sometimes regular users can do so.

File management

In this chapter, we will discuss in detail about file management in Unix. All data in Unix is organized into files. All files are organized into directories. These directories are organized into a tree-like structure called the filesystem.

When you work with Unix, one way or another, you spend most of your time working with files. This tutorial will help you understand how to create and remove files, copy and rename them, create links to them, etc.

In Unix, there are three basic types of files −

- **Ordinary Files** − An ordinary file is a file on the system that contains data, text, or program instructions. In this tutorial, you look at working with ordinary files.
- **Directories** − Directories store both special and ordinary files. For users familiar with Windows or Mac OS, Unix directories are equivalent to folders.
- **Special Files** − Some special files provide access to hardware such as hard drives, CD-ROM drives, modems, and Ethernet adapters. Other special files are similar to aliases or shortcuts and enable you to access a single file using different names.

Listing Files

To list the files and directories stored in the current directory, use the following command −

```
$ls
```

Here is the sample output of the above command −

```
$ls

bin         hosts   lib      res.03
ch07        hw1     pub      test_results
ch07.bak    hw2     res.01   users
docs        hw3     res.02   work
```

The command **ls** supports the **-l** option which would help you to get more information about the listed files −

```
$ls -l
total 1962188

drwxrwxr-x  2 amrood amrood      4096 Dec 25 09:59 uml
-rw-rw-r--  1 amrood amrood      5341 Dec 25 08:38 uml.jpg
drwxr-xr-x  2 amrood amrood      4096 Feb 15  2006 univ
drwxr-xr-x  2 root   root       4096 Dec  9  2007 urlspedia
-rw-r--r--  1 root   root     276480 Dec  9  2007 urlspedia.tar
drwxr-xr-x  8 root   root       4096 Nov 25  2007 usr
drwxr-xr-x  2    200    300     4096 Nov 25  2007 webthumb-1.01
-rwxr-xr-x  1 root   root       3192 Nov 25  2007 webthumb.php
-rw-rw-r--  1 amrood amrood     20480 Nov 25  2007 webthumb.tar
-rw-rw-r--  1 amrood amrood      5654 Aug  9  2007 yourfile.mid
-rw-rw-r--  1 amrood amrood    166255 Aug  9  2007 yourfile.swf
drwxr-xr-x 11 amrood amrood      4096 May 29  2007 zlib-1.2.3
$
```

Here is the information about all the listed columns –

- **First Column** – Represents the file type and the permission given on the file. Below is the description of all type of files.
- **Second Column** – Represents the number of memory blocks taken by the file or directory.
- **Third Column** – Represents the owner of the file. This is the Unix user who created this file.
- **Fourth Column** – Represents the group of the owner. Every Unix user will have an associated group.
- **Fifth Column** – Represents the file size in bytes.
- **Sixth Column** – Represents the date and the time when this file was created or modified for the last time.
- **Seventh Column** – Represents the file or the directory name.

In the **ls -l** listing example, every file line begins with a **d**, **-**, or **l**. These characters indicate the type of the file that's listed.

Sr.No.	Prefix & Description
1	**-** Regular file, such as an ASCII text file, binary executable, or hard link.
2	**b** Block special file. Block input/output device file such as a physical hard drive.
3	**c** Character special file. Raw input/output device file such as a physical hard drive.
4	**d**

Directory file that contains a listing of other files and directories.

5 **l**

Symbolic link file. Links on any regular file.

6 **p**

Named pipe. A mechanism for interprocess communications.

7 **s**

Socket used for interprocess communication.

Metacharacters

Metacharacters have a special meaning in Unix. For example, * and ? are metacharacters. We use * to match 0 or more characters, a question mark (?) matches with a single character.

For Example –

```
$ls ch*.doc
```

Displays all the files, the names of which start with **ch** and end with **.doc** –

```
ch01-1.doc    ch010.doc  ch02.doc     ch03-2.doc
ch04-1.doc    ch040.doc  ch05.doc     ch06-2.doc
ch01-2.doc ch02-1.doc c
```

Here, * works as meta character which matches with any character. If you want to display all the files ending with just **.doc**, then you can use the following command –

```
$ls *.doc
```

Hidden Files

An invisible file is one, the first character of which is the dot or the period character (.). Unix programs (including the shell) use most of these files to store configuration information.

Some common examples of the hidden files include the files –

- **.profile** – The Bourne shell (sh) initialization script
- **.kshrc** – The Korn shell (ksh) initialization script
- **.cshrc** – The C shell (csh) initialization script
- **.rhosts** – The remote shell configuration file

To list the invisible files, specify the **-a** option to **ls** –

```
$ ls -a

.          .profile       docs       lib        test_results
..         .rhosts        hosts      pub        users
.emacs     bin            hw1        res.01     work
.exrc      ch07           hw2        res.02
.kshrc     ch07.bak       hw3        res.03
```

$

- **Single dot (.)** – This represents the current directory.
- **Double dot (..)** – This represents the parent directory.

Creating Files

You can use the **vi** editor to create ordinary files on any Unix system. You simply need to give the following command –

```
$ vi filename
```

The above command will open a file with the given filename. Now, press the key **i** to come into the edit mode. Once you are in the edit mode, you can start writing your content in the file as in the following program –

```
This is unix file....I created it for the first time.....
I'm going to save this content in this file.
```

Once you are done with the program, follow these steps –

- Press the key **esc** to come out of the edit mode.
- Press two keys **Shift + ZZ** together to come out of the file completely.

You will now have a file created with **filename** in the current directory.

```
$ vi filename
$
```

Editing Files

You can edit an existing file using the **vi** editor. We will discuss in short how to open an existing file –

```
$ vi filename
```

Once the file is opened, you can come in the edit mode by pressing the key **i** and then you can proceed by editing the file. If you want to move here and there inside a file, then first you need to come out of the edit mode by pressing the key **Esc**. After this, you can use the following keys to move inside a file –

- **l** key to move to the right side.
- **h** key to move to the left side.
- **k** key to move upside in the file.
- **j** key to move downside in the file.

So using the above keys, you can position your cursor wherever you want to edit. Once you are positioned, then you can use the **i** key to come in the edit mode. Once you are done with the editing in your file, press **Esc** and finally two keys **Shift + ZZ** together to come out of the file completely.

Display Content of a File

You can use the **cat** command to see the content of a file. Following is a simple example to see the content of the above created file –

```
$ cat filename
This is unix file....I created it for the first time.....
```

```
I'm going to save this content in this file.
$
```

You can display the line numbers by using the **-b** option along with the **cat** command as follows –

```
$ cat -b filename
1   This is unix file....I created it for the first time.....
2   I'm going to save this content in this file.
$
```

Counting Words in a File

You can use the **wc** command to get a count of the total number of lines, words, and characters contained in a file. Following is a simple example to see the information about the file created above –

```
$ wc filename
2  19 103 filename
$
```

Here is the detail of all the four columns –

- **First Column** – Represents the total number of lines in the file.
- **Second Column** – Represents the total number of words in the file.
- **Third Column** – Represents the total number of bytes in the file. This is the actual size of the file.
- **Fourth Column** – Represents the file name.

You can give multiple files and get information about those files at a time. Following is simple syntax –

```
$ wc filename1 filename2 filename3
```

Copying Files

To make a copy of a file use the **cp** command. The basic syntax of the command is –

```
$ cp source_file destination_file
```

Following is the example to create a copy of the existing file **filename**.

```
$ cp filename copyfile
$
```

You will now find one more file **copyfile** in your current directory. This file will exactly be the same as the original file **filename**.

Renaming Files

To change the name of a file, use the **mv** command. Following is the basic syntax –

```
$ mv old_file new_file
```

The following program will rename the existing file **filename** to **newfile**.

```
$ mv filename newfile
$
```

The **mv** command will move the existing file completely into the new file. In this case, you will find only **newfile** in your current directory.

Deleting Files

To delete an existing file, use the **rm** command. Following is the basic syntax –

```
$ rm filename
```

Caution – A file may contain useful information. It is always recommended to be careful while using this **Delete** command. It is better to use the **-i** option along with **rm** command.

Following is the example which shows how to completely remove the existing file **filename**.

```
$ rm filename
$
```

You can remove multiple files at a time with the command given below –

```
$ rm filename1 filename2 filename3
$
```

Standard Unix Streams

Under normal circumstances, every Unix program has three streams (files) opened for it when it starts up –

- **stdin** – This is referred to as the *standard input* and the associated file descriptor is 0. This is also represented as STDIN. The Unix program will read the default input from STDIN.
- **stdout** – This is referred to as the *standard output* and the associated file descriptor is 1. This is also represented as STDOUT. The Unix program will write the default output at STDOUT
- **stderr** – This is referred to as the *standard error* and the associated file descriptor is 2. This is also represented as STDERR. The Unix program will write all the error messages at STDERR.
- A directory is a file the solo job of which is to store the file names and the related information. All the files, whether ordinary, special, or directory, are contained in directories.
- Unix uses a hierarchical structure for organizing files and directories. This structure is often referred to as a directory tree. The tree has a single root node, the slash character (*/*), and all other directories are contained below it.

Home Directory

- The directory in which you find yourself when you first login is called your home directory.
- You will be doing much of your work in your home directory and subdirectories that you'll be creating to organize your files.
- You can go in your home directory anytime using the following command –
- `$cd ~`
- `$`
- Here ~ indicates the home directory. Suppose you have to go in any other user's home directory, use the following command –

- $cd ~username
- $
- To go in your last directory, you can use the following command –
- $cd -
- $

Absolute/Relative Pathnames

- Directories are arranged in a hierarchy with root (/) at the top. The position of any file within the hierarchy is described by its pathname.
- Elements of a pathname are separated by a /. A pathname is absolute, if it is described in relation to root, thus absolute pathnames always begin with a /.
- Following are some examples of absolute filenames.
- /etc/passwd
- /users/sjones/chem/notes
- /dev/rdsk/0s3
- A pathname can also be relative to your current working directory. Relative pathnames never begin with /. Relative to user amrood's home directory, some pathnames might look like this –
- chem/notes
- personal/res
- To determine where you are within the filesystem hierarchy at any time, enter the command **pwd** to print the current working directory –
- $pwd
- /user0/home/amrood
-
- $

Listing Directories

- To list the files in a directory, you can use the following syntax –
- $ls dirname
- Following is the example to list all the files contained in **/usr/local** directory –
- $ls /usr/local
-
- X11 bin gimp jikes sbin
- ace doc include lib share
- atalk etc info man ami

Creating Directories

- We will now understand how to create directories. Directories are created by the following command –
- $mkdir dirname
- Here, directory is the absolute or relative pathname of the directory you want to create. For example, the command –
- $mkdir mydir
- $
- Creates the directory **mydir** in the current directory. Here is another example –
- $mkdir /tmp/test-dir

- $
- This command creates the directory **test-dir** in the **/tmp** directory. The **mkdir** command produces no output if it successfully creates the requested directory.
- If you give more than one directory on the command line, **mkdir** creates each of the directories. For example, –

```
$mkdir docs pub
$
```

- Creates the directories docs and pub under the current directory.

Creating Parent Directories

- We will now understand how to create parent directories. Sometimes when you want to create a directory, its parent directory or directories might not exist. In this case, **mkdir** issues an error message as follows –

```
$mkdir /tmp/amrood/test
mkdir: Failed to make directory "/tmp/amrood/test";
No such file or directory
$
```

- In such cases, you can specify the **-p** option to the **mkdir** command. It creates all the necessary directories for you. For example –

```
$mkdir -p /tmp/amrood/test
$
```

- The above command creates all the required parent directories.

Removing Directories

- Directories can be deleted using the **rmdir** command as follows –

```
$rmdir dirname
$
```

- **Note** – To remove a directory, make sure it is empty which means there should not be any file or sub-directory inside this directory.
- You can remove multiple directories at a time as follows –

```
$rmdir dirname1 dirname2 dirname3
$
```

- The above command removes the directories dirname1, dirname2, and dirname3, if they are empty. The **rmdir** command produces no output if it is successful.

Changing Directories

- You can use the **cd** command to do more than just change to a home directory. You can use it to change to any directory by specifying a valid absolute or relative path. The syntax is as given below –

```
$cd dirname
$
```

- Here, **dirname** is the name of the directory that you want to change to. For example, the command –

```
$cd /usr/local/bin
$
```

- Changes to the directory **/usr/local/bin**. From this directory, you can **cd** to the directory **/usr/home/amrood** using the following relative path –

```
$cd ../../home/amrood
$
```

Renaming Directories

- The **mv (move)** command can also be used to rename a directory. The syntax is as follows –

```
$mv olddir newdir
$
```

- You can rename a directory **mydir** to **yourdir** as follows –

```
$mv mydir yourdir
$
```

The directories . (dot) and .. (dot dot)

- The **filename .** (dot) represents the current working directory; and the **filename ..** (dot dot) represents the directory one level above the current working directory, often referred to as the parent directory.
- If we enter the command to show a listing of the current working directories/files and use the **-a option** to list all the files and the **-l option** to provide the long listing, we will receive the following result.

```
$ls -la
drwxrwxr-x    4    teacher    class    2048    Jul 16 17.56 .
drwxr-xr-x    60   root                1536    Jul 13 14:18 ..
----------    1    teacher    class    4210    May 1 08:27 .profile
-rwxr-xr-x    1    teacher    class    1948    May 12 13:42 memo
$
```

File Permission

- **Owner permissions** – The owner's permissions determine what actions the owner of the file can perform on the file.
- **Group permissions** – The group's permissions determine what actions a user, who is a member of the group that a file belongs to, can perform on the file.
- **Other (world) permissions** – The permissions for others indicate what action all other users can perform on the file.

The Permission Indicators

While using **ls -l** command, it displays various information related to file permission as follows –

```
$ls -l /home/amrood
-rwxr-xr--  1 amrood   users 1024  Nov 2 00:10  myfile
drwxr-xr--- 1 amrood   users 1024  Nov 2 00:10  mydir
```

Here, the first column represents different access modes, i.e., the permission associated with a file or a directory.

The permissions are broken into groups of threes, and each position in the group denotes a specific permission, in this order: read (r), write (w), execute (x) –

- The first three characters (2-4) represent the permissions for the file's owner. For example, **-rwxr-xr--** represents that the owner has read (r), write (w) and execute (x) permission.
- The second group of three characters (5-7) consists of the permissions for the group to which the file belongs. For example, **-rwxr-xr--** represents that the group has read (r) and execute (x) permission, but no write permission.
- The last group of three characters (8-10) represents the permissions for everyone else. For example, **-rwxr-xr--** represents that there is **read (r)** only permission.

File Access Modes

The permissions of a file are the first line of defense in the security of a Unix system. The basic building blocks of Unix permissions are the **read**, **write**, and **execute** permissions, which have been described below –

Read

Grants the capability to read, i.e., view the contents of the file.

Write

Grants the capability to modify, or remove the content of the file.

Execute

User with execute permissions can run a file as a program.

Directory Access Modes

Directory access modes are listed and organized in the same manner as any other file. There are a few differences that need to be mentioned –

Read

Access to a directory means that the user can read the contents. The user can look at the **filenames** inside the directory.

Write

Access means that the user can add or delete files from the directory.

Execute

Executing a directory doesn't really make sense, so think of this as a traverse permission.

A user must have **execute** access to the **bin** directory in order to execute the **ls** or the **cd** command.

Changing Permissions

To change the file or the directory permissions, you use the **chmod** (change mode) command. There are two ways to use chmod — the symbolic mode and the absolute mode.

Using chmod in Symbolic Mode

The easiest way for a beginner to modify file or directory permissions is to use the symbolic mode. With symbolic permissions you can add, delete, or specify the permission set you want by using the operators in the following table.

Sr.No.	Chmod operator & Description
1	+ Adds the designated permission(s) to a file or directory.
2	- Removes the designated permission(s) from a file or directory.
3	= Sets the designated permission(s).

Here's an example using **testfile**. Running **ls -1** on the testfile shows that the file's permissions are as follows –

```
$ls -l testfile
-rwxrwxr--  1 amrood   users 1024  Nov 2 00:10  testfile
```

Then each example **chmod** command from the preceding table is run on the testfile, followed by **ls –l**, so you can see the permission changes –

```
$chmod o+wx testfile
$ls -l testfile
-rwxrwxrwx  1 amrood   users 1024  Nov 2 00:10  testfile
$chmod u-x testfile
$ls -l testfile
-rw-rwxrwx  1 amrood   users 1024  Nov 2 00:10  testfile
$chmod g = rx testfile
$ls -l testfile
-rw-r-xrwx  1 amrood   users 1024  Nov 2 00:10  testfile
```

Here's how you can combine these commands on a single line –

```
$chmod o+wx,u-x,g = rx testfile
$ls -l testfile
-rw-r-xrwx  1 amrood   users 1024  Nov 2 00:10  testfile
```

Using chmod with Absolute Permissions

The second way to modify permissions with the chmod command is to use a number to specify each set of permissions for the file.

Each permission is assigned a value, as the following table shows, and the total of each set of permissions provides a number for that set.

Number	Octal Permission Representation	Ref

0	No permission	---
1	Execute permission	--x
2	Write permission	-w-
3	Execute and write permission: 1 (execute) + 2 (write) = 3	-wx
4	Read permission	r--
5	Read and execute permission: 4 (read) + 1 (execute) = 5	r-x
6	Read and write permission: 4 (read) + 2 (write) = 6	rw-
7	All permissions: 4 (read) + 2 (write) + 1 (execute) = 7	rwx

Here's an example using the testfile. Running **ls -1** on the testfile shows that the file's permissions are as follows −

```
$ls -l testfile
-rwxrwxr--  1 amrood   users 1024  Nov 2 00:10  testfile
```

Then each example **chmod** command from the preceding table is run on the testfile, followed by **ls –l**, so you can see the permission changes −

```
$ chmod 755 testfile
$ls -l testfile
-rwxr-xr-x  1 amrood   users 1024  Nov 2 00:10  testfile
$chmod 743 testfile
$ls -l testfile
-rwxr---wx  1 amrood   users 1024  Nov 2 00:10  testfile
$chmod 043 testfile
$ls -l testfile
----r---wx  1 amrood   users 1024  Nov 2 00:10  testfile
```

Changing Owners and Groups

While creating an account on Unix, it assigns a **owner ID** and a **group ID** to each user. All the permissions mentioned above are also assigned based on the Owner and the Groups.

Two commands are available to change the owner and the group of files −

- **chown** − The **chown** command stands for **"change owner"** and is used to change the owner of a file.
- **chgrp** − The **chgrp** command stands for **"change group"** and is used to change the group of a file.

Changing Ownership

The **chown** command changes the ownership of a file. The basic syntax is as follows –

```
$ chown user filelist
```

The value of the user can be either the **name of a user** on the system or the **user id (uid)** of a user on the system.

The following example will help you understand the concept –

```
$ chown amrood testfile
$
```

Changes the owner of the given file to the user **amrood**.

NOTE – The super user, root, has the unrestricted capability to change the ownership of any file but normal users can change the ownership of only those files that they own.

Changing Group Ownership

The **chgrp** command changes the group ownership of a file. The basic syntax is as follows –

```
$ chgrp group filelist
```

The value of group can be the **name of a group** on the system or **the group ID (GID)** of a group on the system.

Following example helps you understand the concept –

```
$ chgrp special testfile
$
```

Changes the group of the given file to **special** group.

SUID and SGID File Permission

Often when a command is executed, it will have to be executed with special privileges in order to accomplish its task.

As an example, when you change your password with the **passwd** command, your new password is stored in the file **/etc/shadow**.

As a regular user, you do not have **read** or **write** access to this file for security reasons, but when you change your password, you need to have the write permission to this file. This means that the **passwd** program has to give you additional permissions so that you can write to the file **/etc/shadow**.

Additional permissions are given to programs via a mechanism known as the **Set User ID (SUID)** and **Set Group ID (SGID)** bits.

When you execute a program that has the SUID bit enabled, you inherit the permissions of that program's owner. Programs that do not have the SUID bit set are run with the permissions of the user who started the program.

This is the case with SGID as well. Normally, programs execute with your group permissions, but instead your group will be changed just for this program to the group owner of the program.

The SUID and SGID bits will appear as the letter **"s"** if the permission is available. The SUID **"s"** bit will be located in the permission bits where the owners' **execute** permission normally resides.

For example, the command –

```
$ ls -l /usr/bin/passwd
-r-sr-xr-x  1   root   bin  19031 Feb 7 13:47  /usr/bin/passwd*
$
```

Shows that the SUID bit is set and that the command is owned by the root. A capital letter **S** in the execute position instead of a lowercase **s** indicates that the execute bit is not set.

If the sticky bit is enabled on the directory, files can only be removed if you are one of the following users –

- The owner of the sticky directory
- The owner of the file being removed
- The super user, root

To set the SUID and SGID bits for any directory try the following command –

```
$ chmod ug+s dirname
$ ls -l
drwsr-sr-x 2 root root  4096 Jun 19 06:45 dirname
$
```

A variable is a character string to which we assign a value. The value assigned could be a number, text, filename, device, or any other type of data.

For example, first we set a variable TEST and then we access its value using the **echo** command –

```
$TEST="Unix Programming"
$echo $TEST
```

It produces the following result.

```
Unix Programming
```

Note that the environment variables are set without using the **$** sign but while accessing them we use the $ sign as prefix. These variables retain their values until we come out of the shell.

When you log in to the system, the shell undergoes a phase called **initialization** to set up the environment. This is usually a two-step process that involves the shell reading the following files –

- /etc/profile
- profile

The process is as follows –

- The shell checks to see whether the file **/etc/profile** exists.
- If it exists, the shell reads it. Otherwise, this file is skipped. No error message is displayed.
- The shell checks to see whether the file **.profile** exists in your home directory. Your home directory is the directory that you start out in after you log in.
- If it exists, the shell reads it; otherwise, the shell skips it. No error message is displayed.

As soon as both of these files have been read, the shell displays a prompt –

```
$
```

This is the prompt where you can enter commands in order to have them executed.

Note – The shell initialization process detailed here applies to all **Bourne** type shells, but some additional files are used by **bash** and **ksh**.

The .profile File

The file **/etc/profile** is maintained by the system administrator of your Unix machine and contains shell initialization information required by all users on a system.

The file **.profile** is under your control. You can add as much shell customization information as you want to this file. The minimum set of information that you need to configure includes –

- The type of terminal you are using.
- A list of directories in which to locate the commands.
- A list of variables affecting the look and feel of your terminal.

You can check your **.profile** available in your home directory. Open it using the vi editor and check all the variables set for your environment.

Setting the Terminal Type

Usually, the type of terminal you are using is automatically configured by either the **login** or **getty** programs. Sometimes, the auto configuration process guesses your terminal incorrectly.

If your terminal is set incorrectly, the output of the commands might look strange, or you might not be able to interact with the shell properly.

To make sure that this is not the case, most users set their terminal to the lowest common denominator in the following way –

```
$TERM=vt100
$
```

Setting the PATH

When you type any command on the command prompt, the shell has to locate the command before it can be executed.

The PATH variable specifies the locations in which the shell should look for commands. Usually the Path variable is set as follows –

```
$PATH=/bin:/usr/bin
$
```

Here, each of the individual entries separated by the colon character **(:)** are directories. If you request the shell to execute a command and it cannot find it in any of the directories given in the PATH variable, a message similar to the following appears –

```
$hello
hello: not found
$
```

There are variables like PS1 and PS2 which are discussed in the next section.

PS1 and PS2 Variables

The characters that the shell displays as your command prompt are stored in the variable *PS1*. You can change this variable to be anything you want. As soon as you change it, it'll be used by the shell from that point on.

For example, if you issued the command –

```
$PS1='=>'
=>
=>
=>
```

Your prompt will become =>. To set the value of **PS1** so that it shows the working directory, issue the command –

```
=>PS1="[\u@\h \w]\$"
[root@ip-72-167-112-17 /var/www/tutorialspoint/unix]$
[root@ip-72-167-112-17 /var/www/tutorialspoint/unix]$
```

The result of this command is that the prompt displays the user's username, the machine's name (hostname), and the working directory.

There are quite a few **escape sequences** that can be used as value arguments for PS1; try to limit yourself to the most critical so that the prompt does not overwhelm you with information.

Sr.No.	Escape Sequence & Description
1	**\t** Current time, expressed as HH:MM:SS
2	**\d** Current date, expressed as Weekday Month Date
3	**\n** Newline
4	**\s** Current shell environment
5	**\W** Working directory
6	**\w** Full path of the working directory
7	**\u**

Current user's username

8 **\h**

Hostname of the current machine

9 **\#**

Command number of the current command. Increases when a new command is entered

10 **\$**

If the effective UID is 0 (that is, if you are logged in as root), end the prompt with the # character; otherwise, use the $ sign

You can make the change yourself every time you log in, or you can have the change made automatically in PS1 by adding it to your **.profile** file.

When you issue a command that is incomplete, the shell will display a secondary prompt and wait for you to complete the command and hit **Enter** again.

The default secondary prompt is **>** (the greater than sign), but can be changed by re-defining the **PS2** shell variable –

Following is the example which uses the default secondary prompt –

```
$ echo "this is a
> test"
this is a
test
$
```

The example given below re-defines PS2 with a customized prompt –

```
$ PS2="secondary prompt->"
$ echo "this is a
secondary prompt->test"
this is a
test
$
```

Environment Variables

Following is the partial list of important environment variables. These variables are set and accessed as mentioned below –

Sr.No.	Variable & Description
1	**DISPLAY** Contains the identifier for the display that **X11** programs should use by default.

2	**HOME** Indicates the home directory of the current user: the default argument for the cd **built-in** command.
3	**IFS** Indicates the **Internal Field Separator** that is used by the parser for word splitting after expansion.
4	**LANG** LANG expands to the default system locale; LC_ALL can be used to override this. For example, if its value is **pt_BR**, then the language is set to (Brazilian) Portuguese and the locale to Brazil.
5	**LD_LIBRARY_PATH** A Unix system with a dynamic linker, contains a colonseparated list of directories that the dynamic linker should search for shared objects when building a process image after exec, before searching in any other directories.
6	**PATH** Indicates the search path for commands. It is a colon-separated list of directories in which the shell looks for commands.
7	**PWD** Indicates the current working directory as set by the cd command.
8	**RANDOM** Generates a random integer between 0 and 32,767 each time it is referenced.
9	**SHLVL** Increments by one each time an instance of bash is started. This variable is useful for determining whether the built-in exit command ends the current session.
10	**TERM** Refers to the display type.
11	**TZ** Refers to Time zone. It can take values like GMT, AST, etc.

12 **UID**

Expands to the numeric user ID of the current user, initialized at the shell startup.

Following is the sample example showing few environment variables –

```
$ echo $HOME
/root
]$ echo $DISPLAY

$ echo $TERM
xterm
$ echo $PATH
/usr/local/bin:/bin:/usr/bin:/home/amrood/bin:/usr/local/bin
$
```

A **Shell** provides you with an interface to the Unix system. It gathers input from you and executes programs based on that input. When a program finishes executing, it displays that program's output.

Shell is an environment in which we can run our commands, programs, and shell scripts. There are different flavors of a shell, just as there are different flavors of operating systems. Each flavor of shell has its own set of recognized commands and functions.

Shell Prompt

The prompt, **$**, which is called the **command prompt**, is issued by the shell. While the prompt is displayed, you can type a command.

Shell reads your input after you press **Enter**. It determines the command you want executed by looking at the first word of your input. A word is an unbroken set of characters. Spaces and tabs separate words.

Following is a simple example of the **date** command, which displays the current date and time –

```
$date
Thu Jun 25 08:30:19 MST 2009
```

You can customize your command prompt using the environment variable PS1 explained in the Environment tutorial.

Shell Types

In Unix, there are two major types of shells –

- **Bourne shell** – If you are using a Bourne-type shell, the **$** character is the default prompt.
- **C shell** – If you are using a C-type shell, the % character is the default prompt.

The Bourne Shell has the following subcategories –

- Bourne shell (sh)
- Korn shell (ksh)
- Bourne Again shell (bash)
- POSIX shell (sh)

The different C-type shells follow –

- C shell (csh)
- TENEX/TOPS C shell (tcsh)

The original Unix shell was written in the mid-1970s by Stephen R. Bourne while he was at the AT&T Bell Labs in New Jersey.

Bourne shell was the first shell to appear on Unix systems, thus it is referred to as "the shell".

Bourne shell is usually installed as **/bin/sh** on most versions of Unix. For this reason, it is the shell of choice for writing scripts that can be used on different versions of Unix.

In this chapter, we are going to cover most of the Shell concepts that are based on the Borne Shell.

Shell Scripts

The basic concept of a shell script is a list of commands, which are listed in the order of execution. A good shell script will have comments, preceded by **#** sign, describing the steps.

There are conditional tests, such as value A is greater than value B, loops allowing us to go through massive amounts of data, files to read and store data, and variables to read and store data, and the script may include functions.

We are going to write many scripts in the next sections. It would be a simple text file in which we would put all our commands and several other required constructs that tell the shell environment what to do and when to do it.

Shell scripts and functions are both interpreted. This means they are not compiled.

Example Script

Assume we create a **test.sh** script. Note all the scripts would have the **.sh** extension. Before you add anything else to your script, you need to alert the system that a shell script is being started. This is done using the **shebang** construct. For example –

```
#!/bin/sh
```

This tells the system that the commands that follow are to be executed by the Bourne shell. *It's called a shebang because the # symbol is called a hash, and the ! symbol is called a bang.*

To create a script containing these commands, you put the shebang line first and then add the commands –

```
#!/bin/bash
pwd
ls
```

Shell Comments

You can put your comments in your script as follows –

```
#!/bin/bash

# Author : Zara Ali
# Copyright (c) Tutorialspoint.com
# Script follows here:
```

```
pwd
ls
```

Save the above content and make the script executable –

```
$chmod +x test.sh
```

The shell script is now ready to be executed –

```
$./test.sh
```

Upon execution, you will receive the following result –

```
/home/amrood
index.htm  unix-basic_utilities.htm  unix-directories.htm
test.sh    unix-communication.htm    unix-environment.htm
```

Note – To execute a program available in the current directory, use **./program_name**

Extended Shell Scripts

Shell scripts have several required constructs that tell the shell environment what to do and when to do it. Of course, most scripts are more complex than the above one.

The shell is, after all, a real programming language, complete with variables, control structures, and so forth. No matter how complicated a script gets, it is still just a list of commands executed sequentially.

The following script uses the **read** command which takes the input from the keyboard and assigns it as the value of the variable PERSON and finally prints it on STDOUT.

```
#!/bin/sh

# Author : Zara Ali
# Copyright (c) Tutorialspoint.com
# Script follows here:

echo "What is your name?"
read PERSON
echo "Hello, $PERSON"
```

Here is a sample run of the script –

```
$./test.sh
What is your name?
Zara Ali
Hello, Zara Ali
$
```