EXPIRIMENT-3:

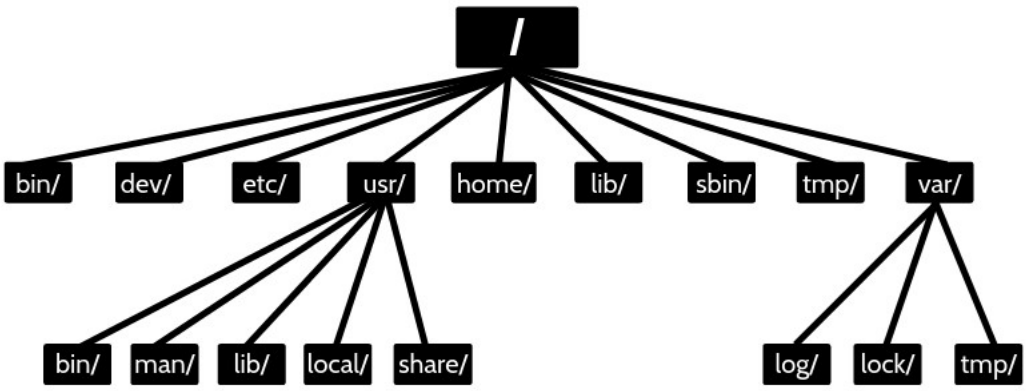
Aim: File system hierarchy in a common Linux distribution, file and device permissions, study of system configuration files in /etc, familiarizing log files for system events, user activity, network events.

Solution :-

THE LINUX FILE HIERARCHY

The Linux File Hierarchy Structure or the Filesystem Hierarchy Standard (FHS) defines the directory structure and directory contents in Unix-like operating systems. It is maintained by the Linux Foundation.

- In the FHS, all files and directories appear under the root directory /, even if they are stored on different physical or virtual devices.
- Some of these directories only exist on a particular system if certain subsystems, such as the X Window System, are installed.
- Most of these directories exist in all UNIX operating systems and are generally used in much the same way; however, the descriptions here are those used specifically for the FHS and are not considered authoritative for platforms other than Linux.



1. **/ – Root**
    - Every single file and directory start from the root directory.
    - Only root user has write privilege under this directory.
    - Please note that /root is root user's home directory, which is not same as /.
2. **/bin – User Binaries**
    - 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.

- For example: ps, ls, ping, grep, cp.

3. **/sbin – System Binaries**

    - Just like /bin, /sbin also contains binary executables.
    - But, the linux commands located under this directory are used typically by system aministrator, for system maintenance purpose.
    - For example: iptables, reboot, fdisk, ifconfig, swapon

4. **/etc – Configuration Files**

    - Contains configuration files required by all programs.
    - This also contains startup and shutdown shell scripts used to start/stop individual programs.
    - For example: /etc/resolv.conf, /etc/logrotate.conf

5. **/dev – Device Files**

    - Contains device files.
    - These include terminal devices, usb, or any device attached to the system.
    - For example: /dev/tty1, /dev/usbmon0

6. **/proc – Process Information**

    - Contains information about system process.
    - This is a pseudo filesystem contains information about running process. For example: /proc/{pid} directory contains information about the process with that particular pid.
    - This is a virtual filesystem with text information about system resources. For example: /proc/uptime

7. **/var – Variable Files**

    - var stands for variable files.
    - Content of the files that are expected to grow can be found under this directory.
    - This includes — system log files (/var/log); packages and database files (/var/lib); emails (/var/mail); print queues (/var/spool); lock files (/var/lock); temp files needed across reboots (/var/tmp);

8. **/tmp – Temporary Files**

    - Directory that contains temporary files created by system and users.
    - Files under this directory are deleted when system is rebooted.

9. **/usr – User Programs**

    - Contains binaries, libraries, documentation, and source-code for second level programs.

- /usr/bin contains binary files for user programs. If you can't find a user binary under /bin, look under /usr/bin. For example: at, awk, cc, less, scp
- /usr/sbin contains binary files for system administrators. If you can't find a system binary under /sbin, look under /usr/sbin. For example: atd, cron, sshd, useradd, userdel
- /usr/lib contains libraries for /usr/bin and /usr/sbin
- /usr/local contains users' programs that you install from source. For example, when you install apache from source, it goes under /usr/local/apache2

10. /home – Home Directories

- Home directories for all users to store their personal files.
- For example: /home/john, /home/nikita

11. /boot – Boot Loader Files

- Contains boot loader related files.
- Kernel initrd, vmlinux, grub files are located under /boot
- For example: initrd.img-2.6.32-24-generic, vmlinuz-2.6.32-24-generic

12. /lib – System Libraries

- Contains library files that supports the binaries located under /bin and /sbin
- Library filenames are either ld* or lib*.so.*
- For example: ld-2.11.1.so, libncurses.so.5.7

13. /opt – Optional add-on Applications

- opt stands for optional.
- Contains add-on applications from individual vendors.
- add-on applications should be installed under either /opt/ or /opt/ sub-directory.

14. /mnt – Mount Directory

- Temporary mount directory where sysadmins can mount filesystems.

15. /media – Removable Media Devices

- Temporary mount directory for removable devices.
- For examples, /media/cdrom for CD-ROM; /media/floppy for floppy drives; /media/cdrecorder for CD writer

16. /srv – Service Data

- srv stands for service.
- Contains server specific services related data.
- For example, /srv/cvs contains CVS related data.

FILE AND DEVICE PERMISSIONS

Although there are already a lot of good security features built into Linux-based systems, one very important potential vulnerability can exist when local access is granted that is file permission-based issues resulting from a user not assigning the correct permissions to files and directories. So based upon the need for proper permissions, I will go over the ways to assign permissions and show you some examples where modification may be necessary.

Ownership of Linux files

Every file and directory on your Unix/Linux system is assigned 3 types of owner, given below.

User

A user is the owner of the file. By default, the person who created a file becomes its owner. Hence, a user is also sometimes called an owner.

Group

A user- group can contain multiple users. All users belonging to a group will have the same Linux group permissions access to the file. Suppose you have a project where a number of people require access to a file. Instead of manually assigning permissions to each user, you could add all users to a group, and assign group permission to file such that only this group members and no one else can read or modify the files.

Other

Any other user who has access to a file. This person has neither created the file, nor he belongs to a usergroup who could own the file. Practically, it means everybody else. Hence, when you set the permission for others, it is also referred as set permissions for the world.

Permissions

Every file and directory in your UNIX/Linux system has following 3 permissions defined for all the 3 owners discussed above.

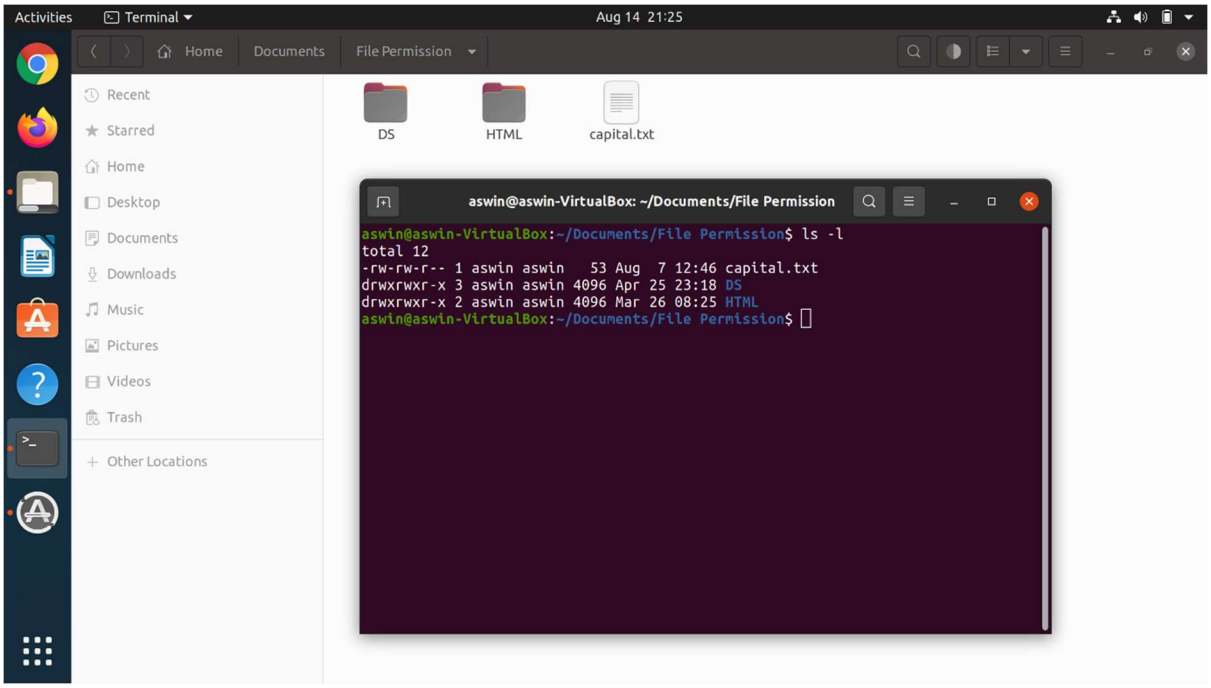
- **Read:** This permission give you the authority to open and read a file. Read permission on a directory gives you the ability to lists its content.

- **Write:** The write permission gives you the authority to modify the contents of a file. The write permission on a directory gives you the authority to add, remove and rename files stored in the directory. Consider a scenario where you have to write permission on file but do not have write permission on the directory where the file is stored. You will be able to modify the file contents. But you will not be able to rename, move or remove the file from the directory.

- **Execute:** In Windows, an executable program usually has an extension ".exe" and which you can easily run. In Unix/Linux, you cannot run a program unless the execute permission is set. If the execute permission is not set, you might still be able to see/modify the program code(provided read & write permissions are set), but not run it.

Let's see file permissions in Linux with examples:

ls -l used to list information about files and directories within the file system.



If the first '-' implies that we have selected a file. Else, if it were a directory, d would have been shown.

The characters are pretty easy to remember.

r read permission
w write permission
x execute permission
- no permission

The first part of the code is **'rw-'**. This suggests that the owner 'Home' can:

- Read the file
- Write or edit the file
- He cannot execute the file since the execute bit is set to '-'.

The second part is **'rw-'.** It for the user group 'Home' and group-members can:

- Read the file
- Write or edit the file

The third part is for the world which means any user. It says **'r--'.** This means the user can only:

- Read the file

Changing file/directory permissions with 'chmod' command

We can use the '**chmod'** command which stands for 'change mode'. Using the command, we can set permissions (read, write, execute) on a file/directory for the owner, group and the world**.**

Syntax:

```
chmod permissions filename
```

There are 2 ways to use the command:

1. Absolute mode
2. Symbolic mode

Absolute (Numeric) Mode

In this mode, file permissions are not represented as characters but a three-digit octal number**.**

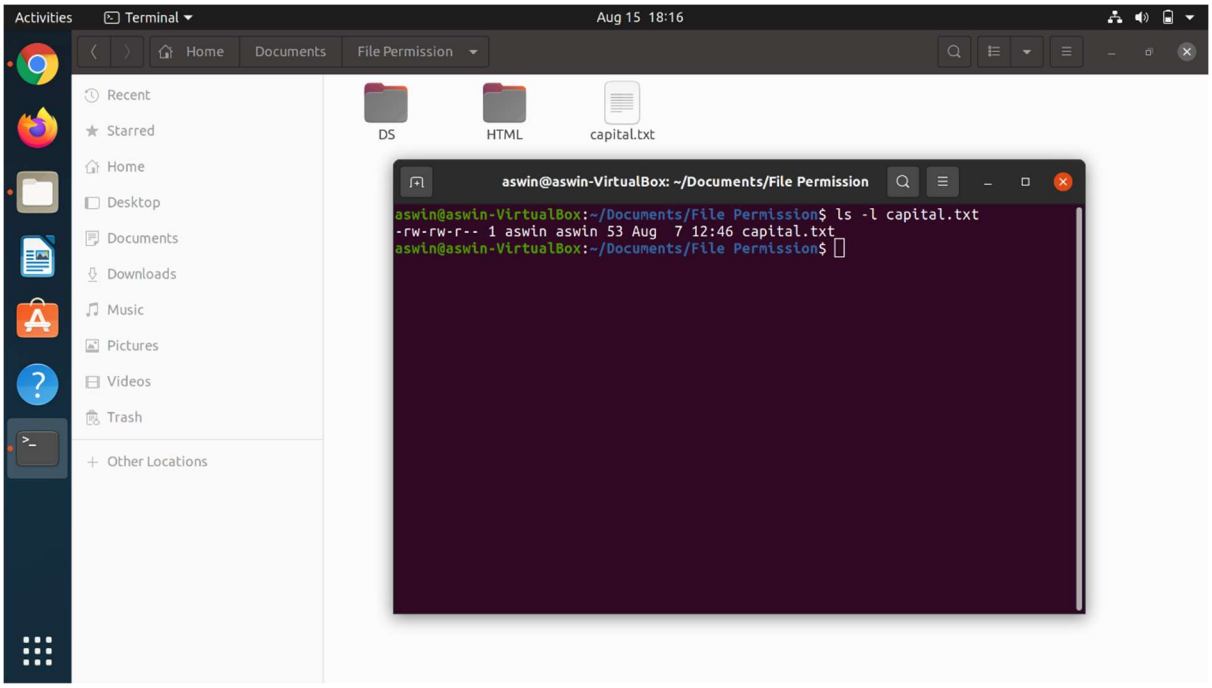
The table below gives numbers for all for permissions types.\

Number	Permission Type	Symbol
0	No Permission	---
1	Execute	--x
2	Write	-w-
3	Execute + Write	-wx
4	Read	r--
5	Read + Execute	r-x

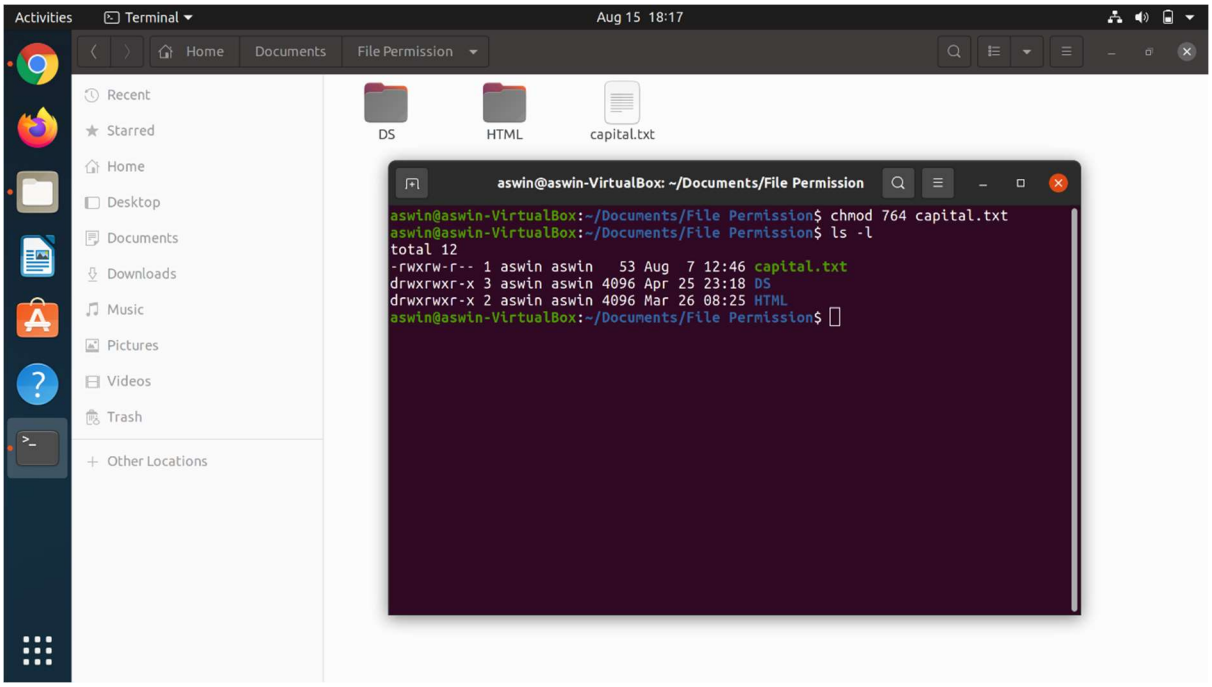
6	Read +Write	rw-
7	Read + Write +Execute	rwx

Let's see the chmod permissions command in action.

1. Checking current file permissions



2. chmod 764 and checking file permission again



In the above-given terminal window, we have changed the permissions of the file 'sample to '764'.

'764' absolute code says the following:

Owner can read, write and execute

Usergroup can read and write

World can only read

This is shown as '-rwxrw-r—

Symbolic Mode

In the Absolute mode, you change permissions for all 3 owners. In the symbolic mode, you can modify permissions of a specific owner. It makes use of mathematical symbols to modify the Unix file permissions.

Operator	**Description**
+	Adds a permission to a file or directory
-	Removes the permission
=	Sets the permission and overrides the permissions set earlier.

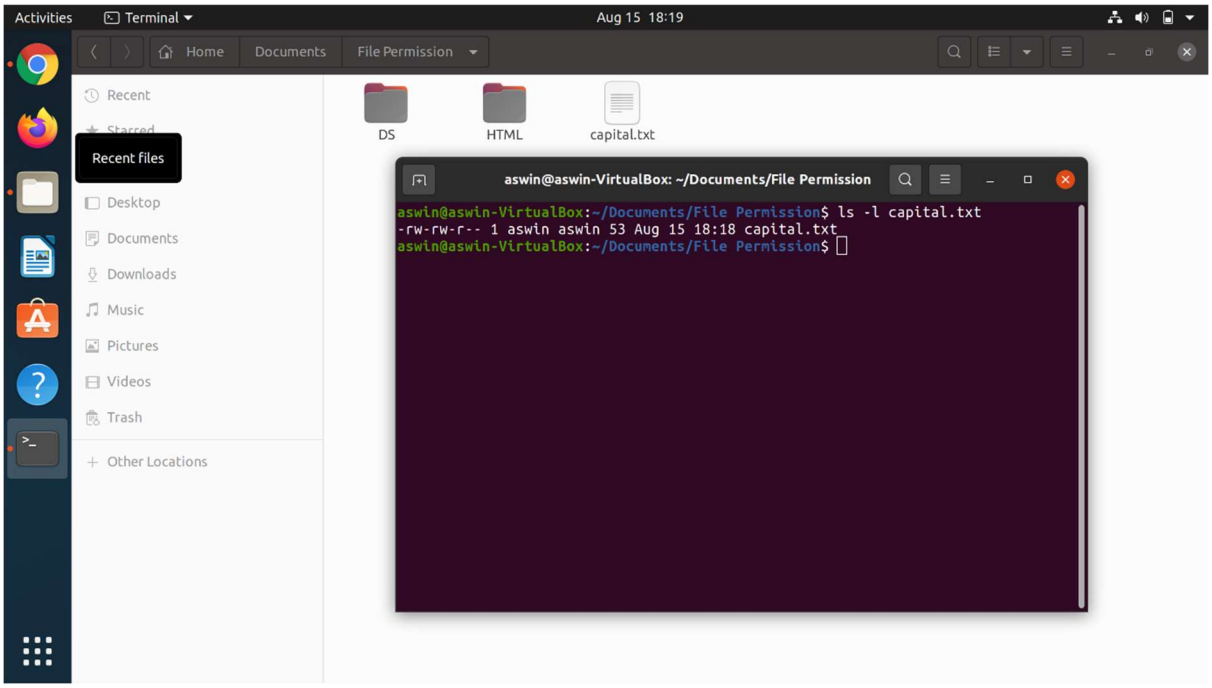
The various owners are represented as:

User Denotations:

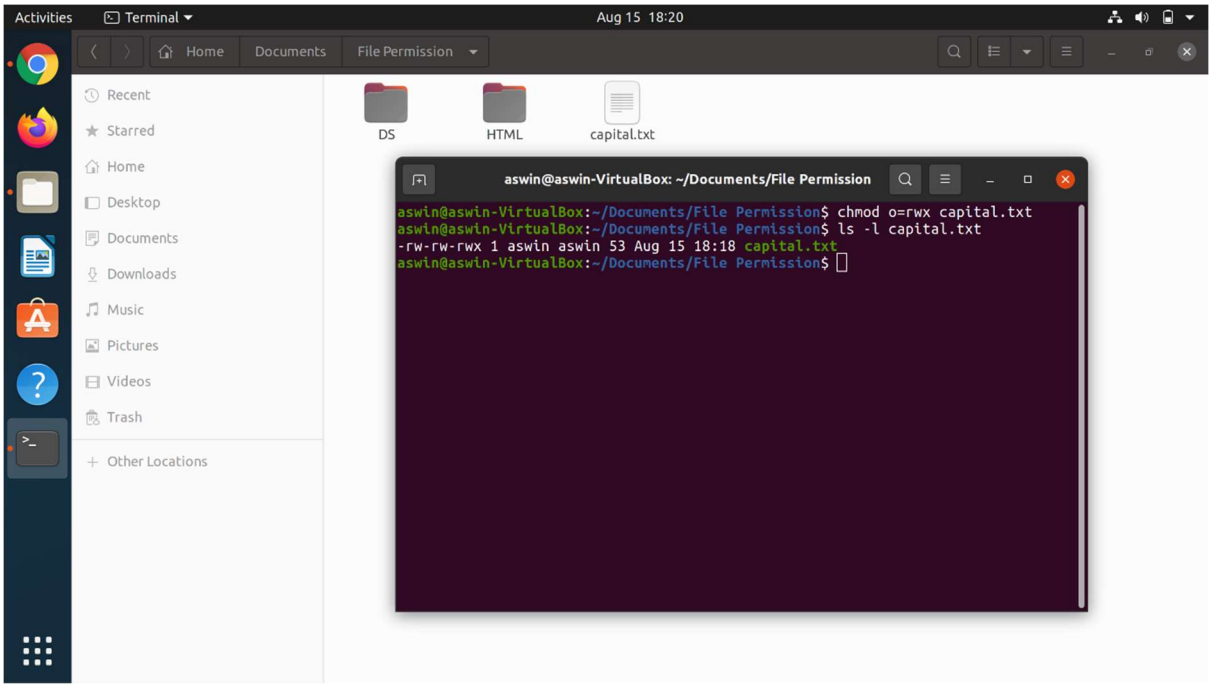
u	user/owner
g	group
o	other
a	all

We will not be using permissions in numbers like 755 but characters like rwx. Let's look into an example:

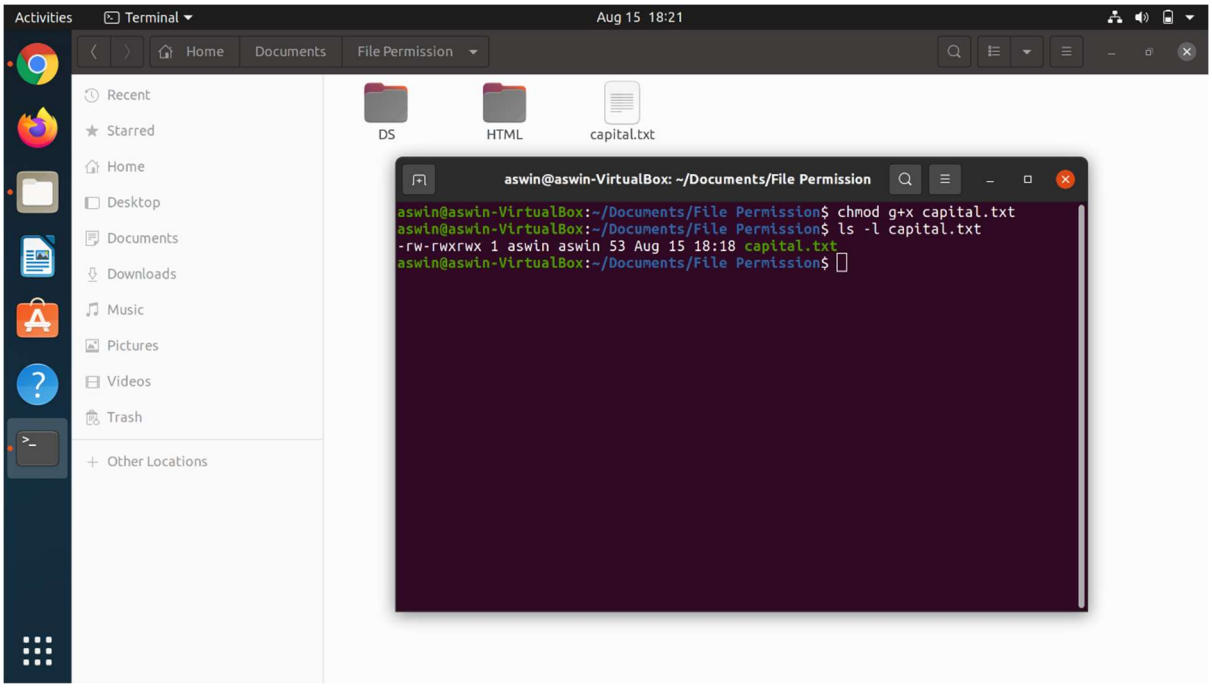
1. current file permissions



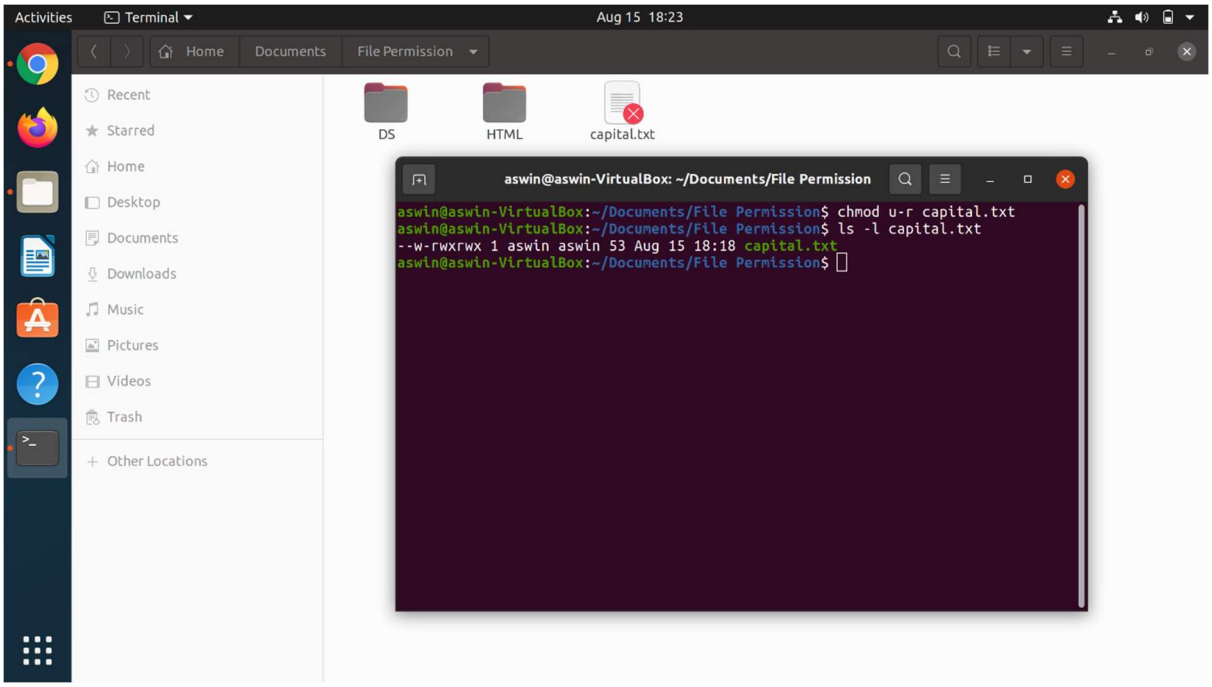
2. Setting permission to ‘other’ users



3. Adding ‘execute’ permission to usergroups



4. Removing ‘read’ permission for ‘user’



/etc : Host-specific system configuration

Purpose

The /etc hierarchy contains configuration files. A "configuration file" is a local file used to control the operation of a program; it must be static and cannot be an executable binary.

It is recommended that files be stored in subdirectories of `/etc` rather than directly in `/etc`.

Requirements

No binaries may be located under `/etc`.

The following directories, or symbolic links to directories are required in `/etc`:

Directory	Description
`opt`	Configuration for /opt

Specific Options

The following directories, or symbolic links to directories must be in /etc, if the corresponding subsystem is installed:

Directory	Description
`X11`	Configuration for the X Window system (optional)
`sgml`	Configuration for SGML (optional)
`xml`	Configuration for XML (optional)

The following files, or symbolic links to files, must be in /etc if the corresponding subsystem is installed:

File	Description
`csh.login`	Systemwide initialization file for C shell logins (optional)
`exports`	NFS filesystem access control list (optional)
`fstab`	Static information about filesystems (optional)
`ftpusers`	FTP daemon user access control list (optional)

File	Description
`gateways`	File which lists gateways for routed (optional)
`gettydefs`	Speed and terminal settings used by getty (optional)
`group`	User group file (optional)
`host.conf`	Resolver configuration file (optional)
`hosts`	Static information about host names (optional)
`hosts.allow`	Host access file for TCP wrappers (optional)
`hosts.deny`	Host access file for TCP wrappers (optional)
`hosts.equiv`	List of trusted hosts for rlogin, rsh, rcp (optional)
`hosts.lpd`	List of trusted hosts for lpd (optional)
`inetd.conf`	Configuration file for inetd (optional)
`inittab`	Configuration file for init (optional)
`issue`	Pre-login message and identification file (optional)
`ld.so.conf`	List of extra directories to search for shared libraries (optional)
`motd`	Post-login message of the day file (optional)
`mtab`	Dynamic information about filesystems (optional)
`mtools.conf`	Configuration file for mtools (optional)
`networks`	Static information about network names (optional)
`passwd`	The password file (optional)
`printcap`	The lpd printer capability database (optional)
`profile`	Systemwide initialization file for sh shell logins (optional)
`protocols`	IP protocol listing (optional)
`resolv.conf`	Resolver configuration file (optional)
`rpc`	RPC protocol listing (optional)
`securetty`	TTY access control for root login (optional)
`services`	Port names for network services (optional)

File	Description
`shells`	Pathnames of valid login shells (optional)
`syslog.conf`	Configuration file for syslogd (optional)

Linux log files

Log files are the records that Linux stores for administrators to keep track and monitor important events about the server, kernel, services, and applications running on it. In this post, we'll go over the top Linux log files server administrators should monitor.

Log files are a set of records that Linux maintains for the administrators to keep track of important events. They contain messages about the server, including the kernel, services and applications running on it.

Linux provides a centralized repository of log files that can be located under the /var/log directory.

The log files generated in a Linux environment can typically be classified into four different categories:

- Application Logs
- Event Logs
- Service Logs
- System Logs\

Common Linux log files names and usage

```
/var/log/messages       : General message and system related stuff
/var/log/auth.log       : Authenication logs
/var/log/kern.log       : Kernel logs
/var/log/cron.log       : Crond logs (cron job)
/var/log/maillog        : Mail server logs
/var/log/qmail/         : Qmail log directory (more files inside this directory)
/var/log/httpd/         : Apache access and error logs directory
/var/log/lighttpd/      : Lighttpd access and error logs directory
/var/log/nginx/         : Nginx access and error logs directory
/var/log/apt/           : Apt/apt-get command history and logs directory
/var/log/boot.log       : System boot log
/var/log/mysqld.log     : MySQL database server log file
/var/log/secure or /var/log/auth.log   : Authentication log
/var/log/utmp or /var/log/wtmp         : Login records file
/var/log/yum.log or /var/log/dnf.log   : Yum/Dnf command log file.
```