# File Permissions in Linux/Unix with Example

Linux is a clone of UNIX, the **multi-user operating system** which can be accessed by many users simultaneously. Linux can also be used in mainframes and servers without any modifications. But this raises security concerns as an unsolicited or **malign user** can **corrupt, change or remove crucial data**. For effective security, Linux divides authorization into 2 levels.

1. Ownership
2. Permission

The concept of **permissions** and **ownership** is crucial in Linux. Here, we will discuss both of them. Let us start with the **Ownership.**

## 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 access permissions 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.

Now, the big question arises how does **Linux distinguish** between these three user types so that a user 'A' cannot affect a file which contains some other user 'B's' vital information/data. It is like you do not want your colleague, who works on your Linux computer, to view your images. This is where **Permissions** set in, and they define **user behavior**.

Let us understand the **Permission system** on Linux.

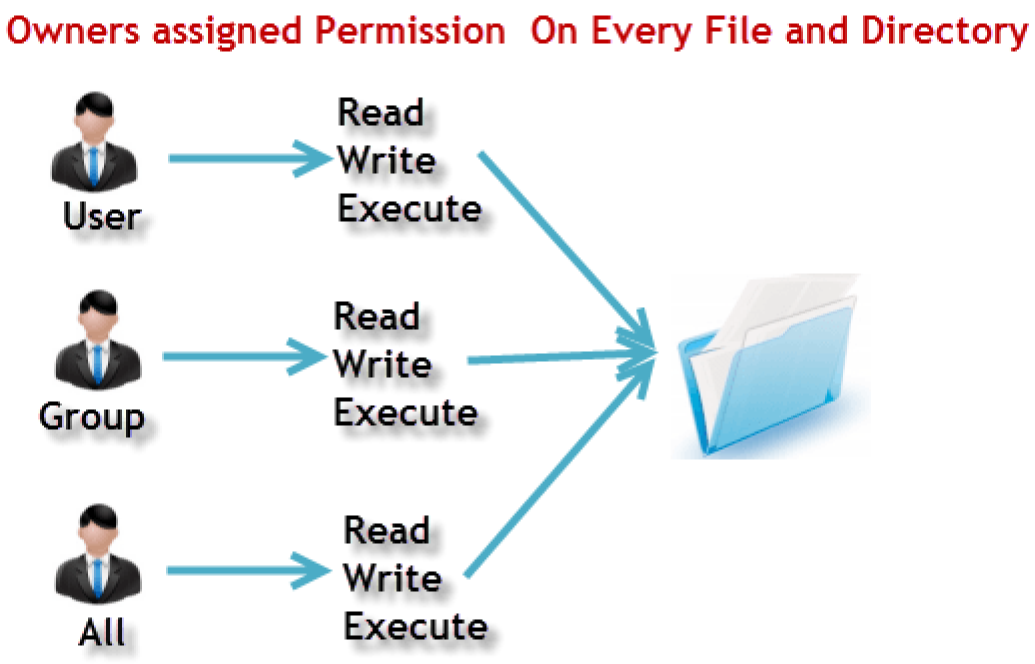
## Permissions

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.

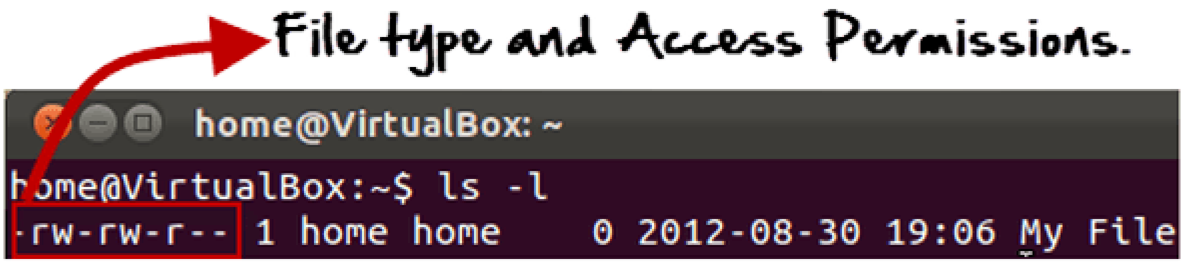
- **Execute:** In Windows, an executable program usually has an extension ".exe" and which you can easily run. In Unix/Linux, you cannot run a program unless the execute permission is set. If the execute permission is not set, you might still be able to see/modify the program code(provided read & write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



**Let's see this in action**

**ls - l** on terminal gives

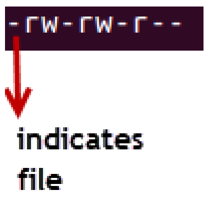
```
ls - l
```



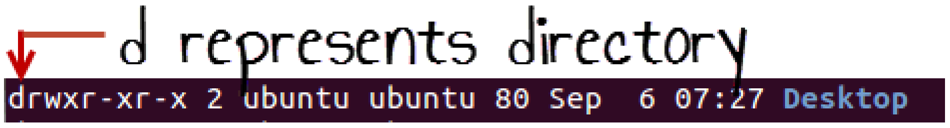
```
home@VirtualBox:~$ ls -l
-rw-rw-r-- 1 home home     0 2012-08-30 19:06 My File
```

Here, we have highlighted **'-rw-rw-r--'**and this weird looking code is the one that tells us about the permissions given to the owner, user group and the world.

Here, the first '**-**' implies that we have selected a file.p>



Else, if it were a directory, **d** would have been shown.



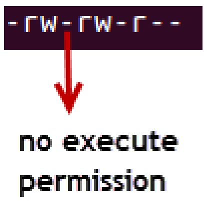
```
drwxr-xr-x 2 ubuntu ubuntu 80 Sep  6 07:27 Desktop
```

The characters are pretty easy to remember.

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

Let us look at it this way.

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



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

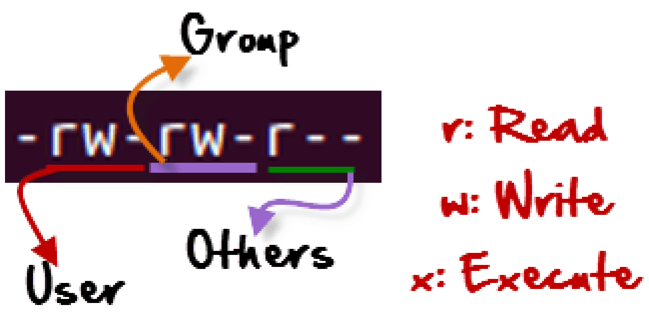
**By design, many Linux distributions like Fedora, CentOS, Ubuntu, etc. will add users to a group of the same group name as the user name**. Thus, a user 'tom' is added to a group named 'tom'.

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

Say you do not want your colleague to see your personal images. This can be achieved by changing file permissions.

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**

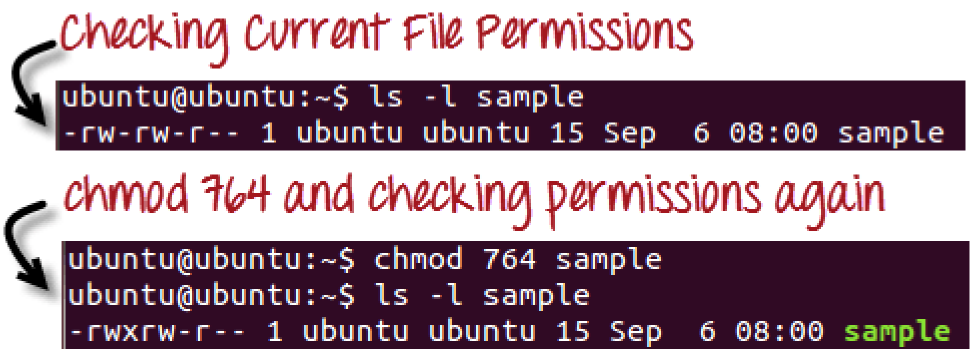
## Absolute(Numeric) Mode

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 |

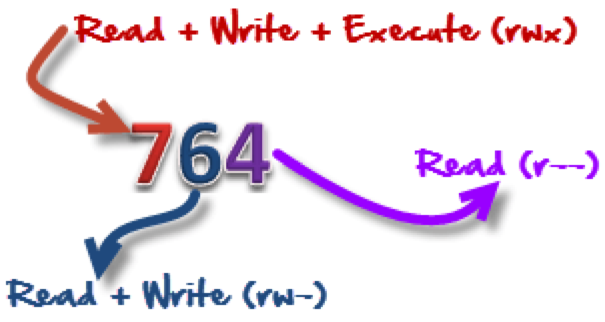
Let's see the chmod command in action.


Checking Current File Permissions
chmod 764 and checking permissions again

```
ubuntu@ubuntu:~$ ls -l sample
-rw-rw-r-- 1 ubuntu ubuntu 15 Sep  6 08:00 sample
```

```
ubuntu@ubuntu:~$ chmod 764 sample
ubuntu@ubuntu:~$ ls -l sample
-rwxrw-r-- 1 ubuntu ubuntu 15 Sep  6 08:00 sample
```

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

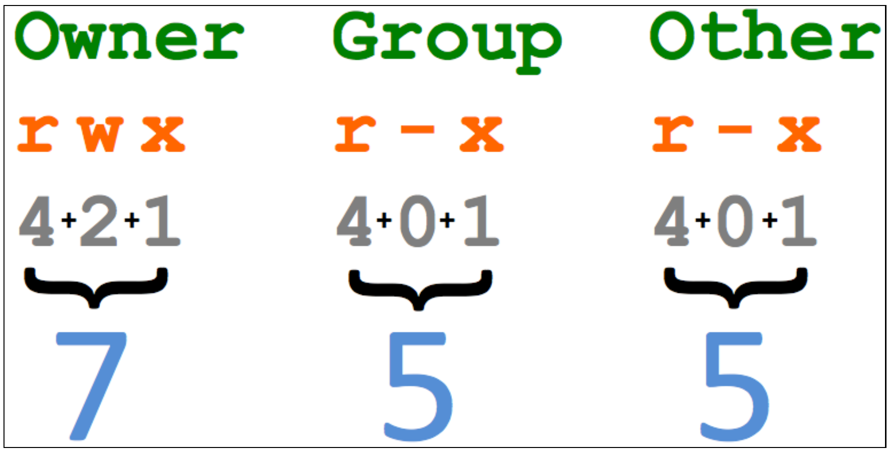


'764' absolute code says the following:

- Owner can read, write and execute
- Usergroup can read and write
- World can only read

**This is shown as  -rwxrw-r—**

**Another Example: 755**



This is how you can change the permissions on file by assigning an absolute number.

## Symbolic Mode

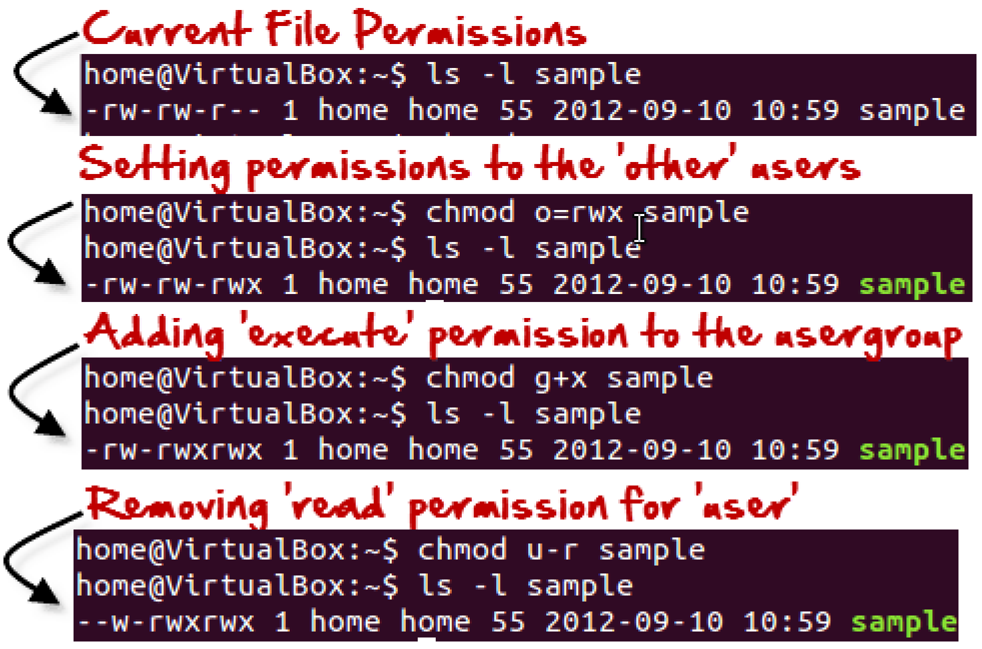
In the Absolute mode, you change permissions for all 3 owners. In the symbolic mode, you can modify permissions of a specific owner. It makes use of mathematical symbols to modify the file permissions.

| 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


Current File Permissions
Setting permissions to the 'other' users
Adding 'execute' permission to the usergroup
Removing 'read' permission for 'user'

```
home@VirtualBox:~$ ls -l sample
-rw-rw-r-- 1 home home 55 2012-09-10 10:59 sample
```

```
home@VirtualBox:~$ chmod o=rwx sample
home@VirtualBox:~$ ls -l sample
-rw-rw-rwx 1 home home 55 2012-09-10 10:59 sample
```

```
home@VirtualBox:~$ chmod g+x sample
home@VirtualBox:~$ ls -l sample
-rw-rwxrwx 1 home home 55 2012-09-10 10:59 sample
```

```
home@VirtualBox:~$ chmod u-r sample
home@VirtualBox:~$ ls -l sample
--w-rwxrwx 1 home home 55 2012-09-10 10:59 sample
```

## Changing Ownership and Group

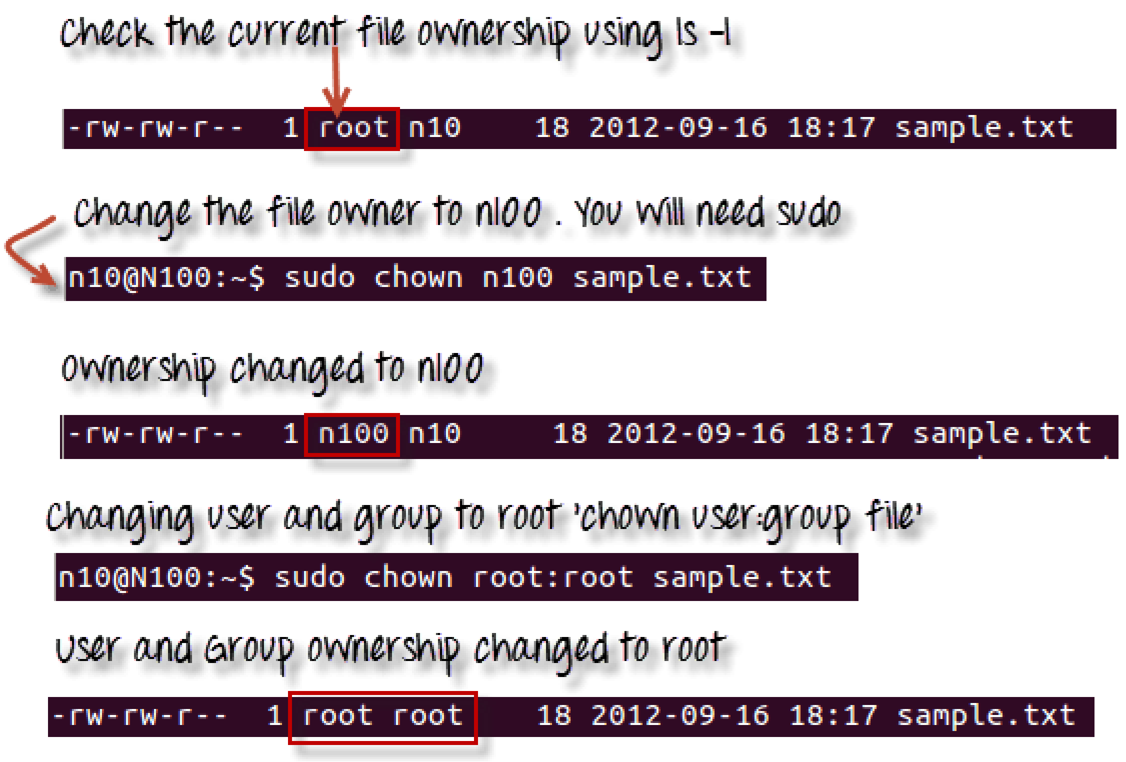
For changing the ownership of a file/directory, you can use the following command:

```
chown user
```

In case you want to change the user as well as group for a file or directory use the command

```
chown user:group filename
```

Let's see this in action


Check the current file ownership using ls -l
Change the file owner to n100 . You will need sudo
ownership changed to n100
Changing user and group to root 'chown user:group file'
User and Group ownership changed to root

```
-rw-rw-r--  1 root n10     18 2012-09-16 18:17 sample.txt
```

```
n10@N100:~$ sudo chown n100 sample.txt
```

```
-rw-rw-r--  1 n100 n10      18 2012-09-16 18:17 sample.txt
```

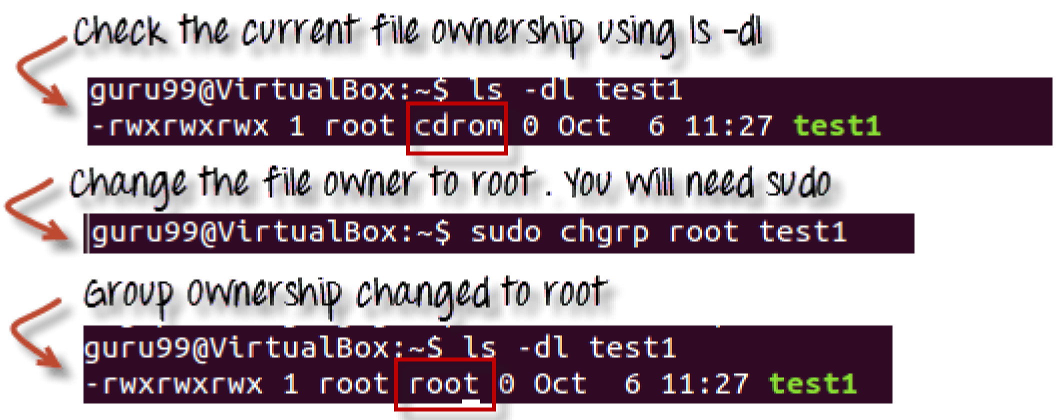
```
n10@N100:~$ sudo chown root:root sample.txt
```

```
-rw-rw-r--  1 root root    18 2012-09-16 18:17 sample.txt
```

In case you want to change group-owner only, use the command

```
chgrp group_name filename
```

'**chgrp'** stands for change group.


Check the current file ownership using ls -dl
Change the file owner to root . You will need sudo
Group ownership changed to root

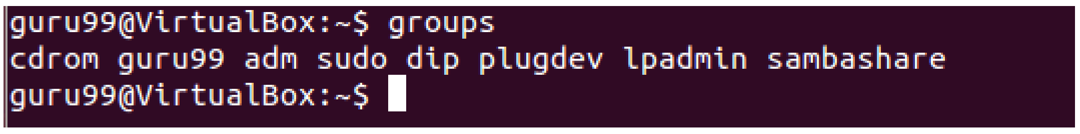
```
guru99@VirtualBox:~$ ls -dl test1
-rwxrwxrwx 1 root cdrom 0 Oct  6 11:27 test1
```

```
guru99@VirtualBox:~$ sudo chgrp root test1
```

```
guru99@VirtualBox:~$ ls -dl test1
-rwxrwxrwx 1 root root 0 Oct  6 11:27 test1
```

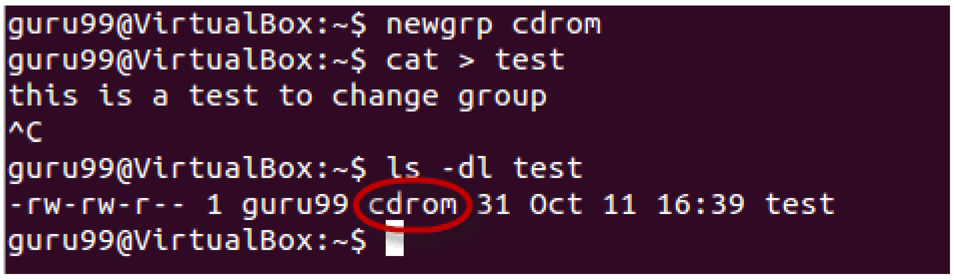
**Tip**

- The file /etc/group contains all the groups defined in the system
- You can use the command "groups" to find all the groups you are a member of



```
guru99@VirtualBox:~$ groups
cdrom guru99 adm sudo dip plugdev lpadmin sambashare
guru99@VirtualBox:~$ 
```

- You can use the command newgrp to work as a member a group other than your default group



```
guru99@VirtualBox:~$ newgrp cdrom
guru99@VirtualBox:~$ cat > test
this is a test to change group
^C
guru99@VirtualBox:~$ ls -dl test
-rw-rw-r-- 1 guru99 cdrom 31 Oct 11 16:39 test
guru99@VirtualBox:~$ 
```

- You cannot have 2 groups owning the same file.
- You do not have nested groups in Linux. One group cannot be sub-group of other
- x- eXecuting a directory means Being allowed to "enter" a dir and gain possible access to sub-dirs