
1878
Western
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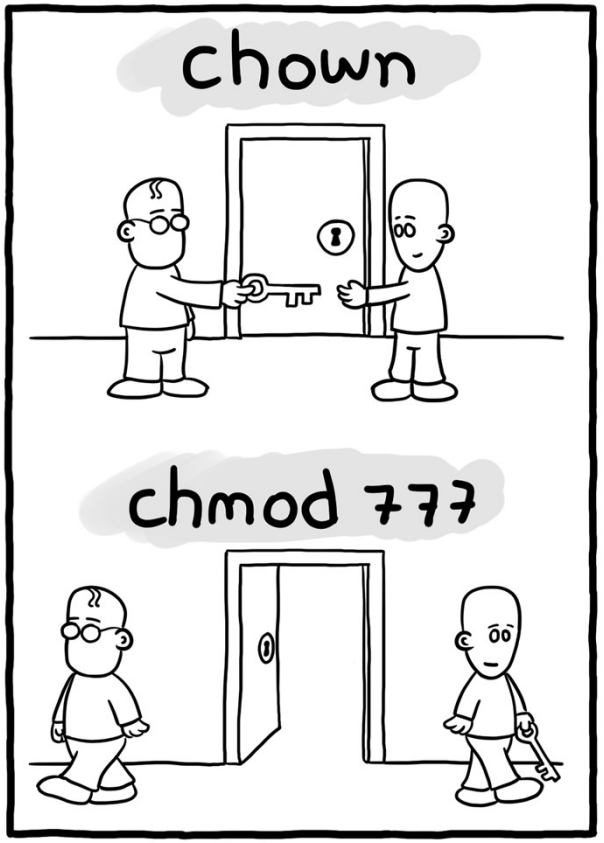
File security and permissions

Winter 2022



https://en.wikipedia.org/wiki/File-system_permissions

File security

- Unix is a multi-user operating system
- A successful multi-user operating system must protect a user's files from other users
  - What if a web server could read password files?
  - What if a basic user could execute a super-user command?

File types

- We've discussed different file types.
  - Directory (represented with "d")
  - Regular files (represented with "-")
  - Links (represented with "l")
  - Others

User categories

- Every file has 3 categories of users with permissions
  - User permissions (or "owner")
  - Group permissions
  - Other permissions (or "world". Not to be confused with "owner")

User categories

- User permissions (or "owner")
  - This is the owner of the file
  - This is a username
  - E.g. wbeldman or root

User categories

- Group permissions
  - A user can be a member of any number of groups
  - A group can contain any number of users
  - On Gaul, everybody has a group identical to their username, and everybody is also a member of "cs-users"

```
[wbeldman@compute ~]$ id wbeldman
uid=2001066(wbeldman) gid=2001066(wbeldman) groups=2001066(wbeldman),2002070(cs-user)
```

User categories

- Other permissions
  - Any user name that does not have user permission or group permissions on a file, falls into this category

File permissions

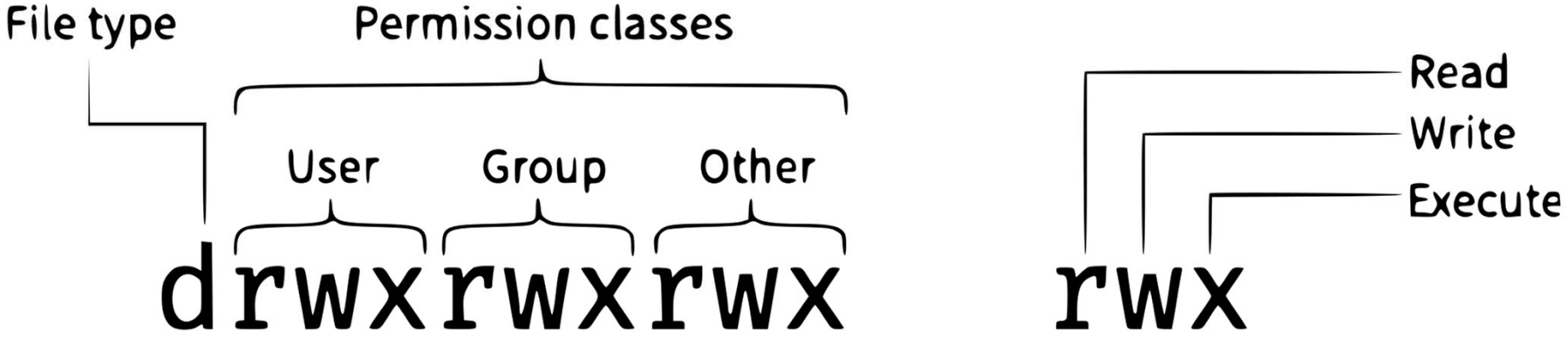
- Each category of users have 6 permissions applied to it:
  - Read or not – The ability to read the contents of the *file* or the *directory*
  - Write or not – The ability to create, update, or remove the *file* or *directory*
  - Execute or not – The ability to execute the *file* or "search" the *directory*

File permissions

- (*symlinks* do not have permissions. They take on the permissions of whatever they are linked to)
- Permission is either granted (represented by a letter) or not granted (represented by "-")
  - r or -
  - w or -
  - x or -

File permissions

- Therefore, there are 2^{3*3} or 8^3 or 512 possible permission combinations for each file



File permissions

- Some examples
  - ---------- - A regular file with no permissions granted
  - -rwxrwxrwx - A regular file with all permissions granted for all users
  - -rwx------ - A regular file with read, write, and execute permissions for the owner. No other permissions for anyone else

File permissions

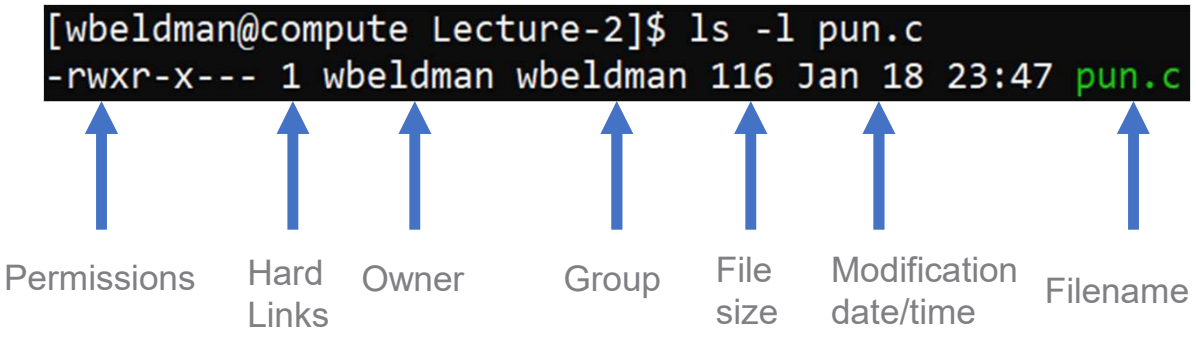
- Some examples
  - -rwxr--r-- - A regular file with read, write, and execute permissions for the owner. Read permissions only for all users
  - -r--r--r-- - A regular file with read permissions for all users
  - drwx------ - A directory with read, write, and execute permissions for the owner. No other permissions for anyone else

File permissions

- Important commands we use to manage permissions
  - ls -l
  - stat
  - chmod
  - chown
  - umask

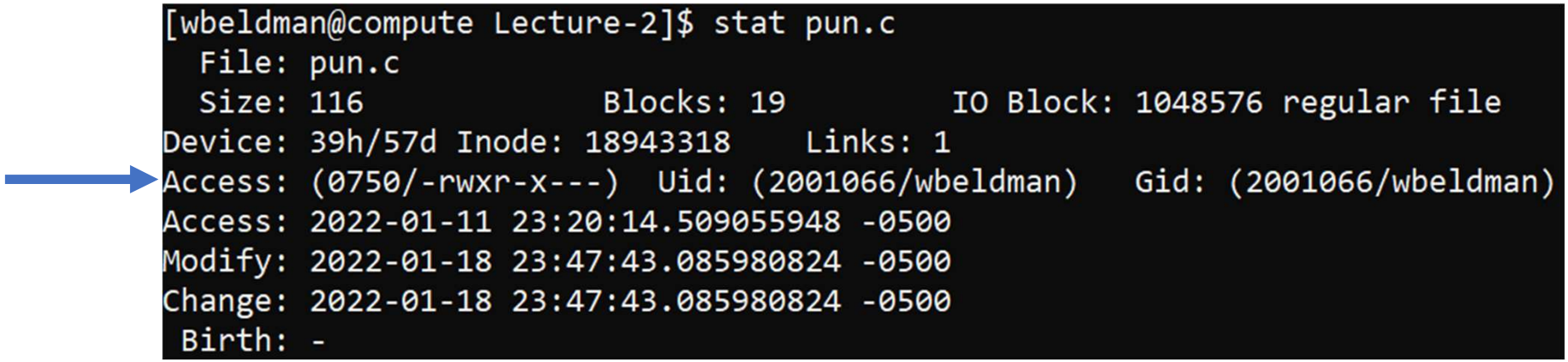
ls -l

- We used "ls" to view files. Use "ls -l" to view files in "long" format
- Long format will display (among other things) file permissions and user/group assignments



stat

- stat <filename> for detailed information about <filename>
- stat will display (among other things) file permissions and user/group assignments



chown

- chown <newuser>:<newgroup> <filename> to change owner or group of a file to a different user or group
  - chown <newuser> <filename> - if you want to change the owner only
  - chown :<newgroup> <filename> - if you want to do group only.
- chgrp is an alternative to updating group only

chown

- Permissions are not inherited by directories higher in the tree. It is possible for a file to have wide permissions but it is still protected by narrow permissions higher in the directory structure

```
[wbeldman@compute Lecture-2]$ ls -ld /home/wbeldman/Lectures/Lecture-2
drwxr-x--- 2 wbeldman wbeldman 5 Jan 18 23:47 /home/wbeldman/Lectures/Lecture-2
[wbeldman@compute Lecture-2]$ ls -l /home/wbeldman/Lectures/Lecture-2/pun.c
-rwxrwxrwx 1 wbeldman wbeldman 116 Jan 18 23:47 /home/wbeldman/Lectures/Lecture-2/pun.c
```

Permissions on the Lecture-2 directory prevents pun.c from being read by others even though they are assigned permission to read pun.c itself

chown

- It is not safe to depend on directories higher in the tree to protect your files from other users. It is safer to just ensure all your files and directories have the right permissions
- Use
  chown -R <newuser>:<newgroup> <directory>
  to recursively assign an owner and group to every file and directory under <directory>

chmod

- chown updates owner and group on a file only
- chmod updates permissions for all categories of users on a file
- chmod <options> <filename>
  - Just like chown, use -R to apply the permissions recursively

chmod

- <options>
  - There are two modes to supply for <options>
    - Symbolic mode
    - Numeric mode

chmod – symbolic mode

- Symbolic mode uses the following format
  - u/g/o/a – User, group, others, or all
  - +/-/= – Add, subtract, or set permissions
  - r/w/x – Read, write, or execute

chmod – symbolic mode

- Symbolic mode examples
  - chmod u=rwx <filename> - Set user permissions to read, write, and execute. Keep group and other permissions the same
  - chmod g-wx <filename> - Remove write and execute from the group. Keep user and other permissions the same

chmod – symbolic mode

- Symbolic mode examples
  - chmod o+r <filename> - Add read permissions to all other users. Keep user and group permissions the same
  - chmod a=r <filename> - Set user, group, and other permissions to read. Keep write and execute permissions on user, group, and others the same

chmod – symbolic mode

- Symbolic mode examples
  - chmod ug=rwx <filename> - Set user and group to read, write, and execute. Keep other permissions the same
  - chmod u=rwx,go-x <filename> - Set user to read, write, and execute. Remove execute from group and others. All other group and other permissions stay the same

chmod – numeric mode

- Recall that a permission is either granted or not granted
- This tells us that binary (1 or 0) representation makes sense here
- We use octal (base-8) numbers to represent numbers in binary to indicate which permissions are enabled or disabled

chmod – numeric mode

- Translating octal mode to symbolic mode

Binary	Numeric (octal)	Symbolic	English
000	0	---	No permissions
001	1	--x	Execute only
010	2	-w-	Write only
011	3	-wx	Write and execute
100	4	r--	Read only
101	5	r-x	Read and execute
110	6	rw-	Read and write
111	7	rwx	Read, write, and execute

chmod – numeric mode

- We use 4 octal numbers in this order
  - First number is for special permissions for special files. It is 0 by default, optional, usually omitted, and rarely ever used
  - Second is for the user/owner
  - Third is for the group
  - Fourth is for others/world

chmod – numeric mode

- By combining 4 octal numbers, we explicitly set permissions on a file
- Numeric mode requires that you explicitly define all permissions for all categories of users in one command. You cannot ask chmod to keep existing permissions in place like we can with symbolic mode
- (All the following examples will omit the optional first octal number)

chmod – numeric mode

- Numeric mode examples
  - chmod 700 <filename> - Set user permissions to read, write, and execute. Remove all group and other permissions
  - chmod 740 <filename> - Set user permissions to read, write, and execute. Set group to read only. Remove all permissions from other

chmod – numeric mode

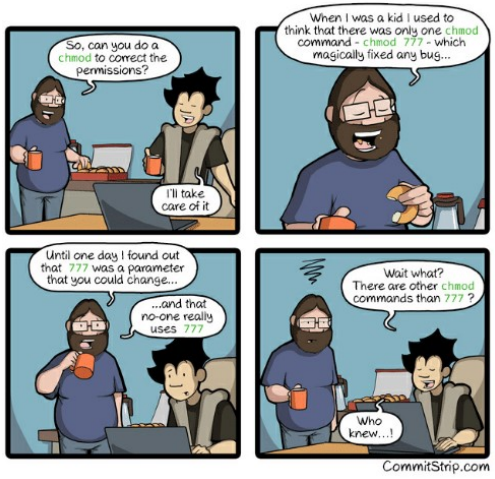
- Numeric mode examples
  - chmod 004 <filename> - Set others to read. Remove all user and group permissions
  - chmod 444 <filename> - Set user, group, and other permissions to read. Remove write and execute permissions for all

chmod – symbolic mode

- Symbolic mode examples
  - chmod 770 <filename> - Set user and group to read, write, and execute. Remove other permissions
  - chmod 777 <filename> - Set user, group, and others to read, write, and execute.

chmod – numeric mode

- "chmod 777"

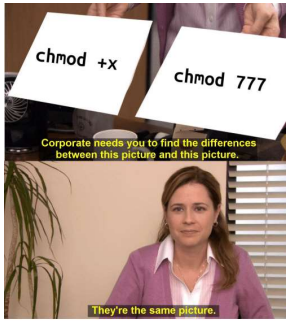


-chmod 777:)

Just work already

```
Installing
----------

To install Symbiose you just need to unzip files on your web server and chmod al
l of them to 0777. If a HTTP 500 error occurs, chmod */.htaccess*, */sbin/* and
*/index.php* to 0755.
```



My knowledge on chmod when I was new to Linux.

umask

- When programs create new files or directories, what permissions are used?
  - The running user owns the file and the default group is assigned
  - Permissions are set by the program
    - Before POSIX standardization, users were at the mercy of the programs they ran

umask

- To give users more control, umask was introduced to allow users to force certain permissions to stay off
- umask also uses symbolic or numeric mode
- The final file permissions is a bitwise AND between the default permissions and the complement of the user's mask
  - (P&(~Q))

umask

- If using numeric mode, the digits are the opposite of what you would expect. This can be surprising and confusing!
  - This is because the mask dictates what bits to force off and leaves the rest up to the running program
- If using numeric mode, note that there are 4 digits. Again, the first is almost always 0 and rarely used

umask

- umask - To view the existing umask setting in numeric mode
- umask -S - To view the existing umask setting in symbolic mode
- umask <mode> - To set the umask value where <mode> can be either numeric or symbolic mode

umask

- umask example
  - The touch command creates files with the permissions: a=rw or 666
  - My default umask value is u=rwx,g=,o= or 0077 so the complement is 7700

	Permissions	Octal	Binary
touch (P)	- rw- rw- rw-	0666	000 110 110 110
umask (~Q)	- rwx --- ---	7700	111 111 000 000
Permissions (P&(~Q))	- rw- --- ---	0600	000 110 000 000

umask

- umask example

```
[wbeldman@compute ~]$ umask -S
u=rwx,g=,o=
[wbeldman@compute ~]$ touch test.txt
[wbeldman@compute ~]$ ls -l test.txt
-rw------- 1 wbeldman wbeldman 0 Jan 28 22:58 test.txt
[wbeldman@compute ~]$
```

umask

- umask example
  - The touch command creates files with the permissions: a=rw or 666
  - Let's set the umask value to u=r,g=,o= or 0377 so the complement is 7400

	Permissions	Octal	Binary
touch (P)	- rw- rw- rw-	0666	000 110 110 110
umask (~Q)	- r-- --- ---	7400	111 100 000 000
Permissions (P&(~Q))	- r-- --- ---	0400	000 100 000 000

umask

- umask example

```
[wbeldman@compute ~]$ umask 0377
[wbeldman@compute ~]$ umask -S
u=r,g=,o=
[wbeldman@compute ~]$ touch test.txt
[wbeldman@compute ~]$ ls -l test.txt
-r-------- 1 wbeldman wbeldman 0 Jan 28 23:05 test.txt
```

umask

- umask example
  - The touch command creates files with the permissions: a=rw or 666
  - Let's try umask value of u=rw,g=rw,o=r or 0113 so the complement is 7664

	Permissions	Octal	Binary
touch (P)	- rw- rw- rw-	0666	000 110 110 110
umask (~Q)	- rw- rw- r--	7664	111 110 110 100
Permissions (P&(~Q))	- rw- rw- r--	0400	000 110 110 100

umask

- umask example

```
[wbeldman@compute ~]$ umask 0113
[wbeldman@compute ~]$ umask -S
u=rw,g=rw,o=r
[wbeldman@compute ~]$ touch test.txt
[wbeldman@compute ~]$ ls -l test.txt
-rw-rw-r-- 1 wbeldman wbeldman 0 Jan 28 23:20 test.txt
```

umask

- By default, most programs create files with permissions set to 666 and directories with permissions set to 777
- 0077 is the default mask on Gaul
  - That is, permit rwx on user/owner if a program tries, but NEVER allow rwx on a group or other/world. A sensible default

umask

- You've been using this command all along. It gets run by you automatically every time you log in. Check your ~/.profile file
- To temporarily set it to something different use umask with symbolic mode.
  - If you want to use octal mode, think of what you want to permit, find the complement, and use that.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