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UNIX file permissions

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Outline

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- Unix access control
 - Principals, subjects and objects
 - Permissions
 - Access control decisions

Principals and Subjects

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- A **subject** is a program executing on behalf of some **principals** and operating on system resources (**objects**)
- A **principal** may at any time be idle or have one or more **subjects** associated

Linux Principals

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- Principals are **users** and **groups**
- Users have a **username** and a **user identifier** (UID)
- Groups have a **group name** and a **group identifier** (GID)
- UID and GID are 32bit numbers (16 before kernel 2.4)

UID	username
0	root
1	daemon
2	bin

GID	group name
0	root
4	adm
8	mail

User accounts

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- User accounts are stored in `/etc/passwd`

```
user:  $6$y4QdtE/[...]:  1000:  1000:  User,,,,:  /home/user:  /bin/bash
1           2           3           4           5           6           7
```

1. **Username**
2. **Password:** stored as digest (hashed)
3. **User ID**
4. **Group ID:** user's primary group
5. **ID string:** user's full name
6. **Home directory**
7. **Login shell:** the program started after successful log in

Superuser

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- The superuser is a special privileged principal with UID 0 (usually associated with the username **root**).
- The superuser can become any other user.
- All security checks are turned off for the superuser, who can do almost everything with a few exceptions, e.g.
 - cannot write to a filesystem mounted as read-only (but can remount it as writable)
 - cannot read passwords (they are digested using a hash function)

Groups

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- Users belong to one **or more** groups

```
adm:  x:  4:  syslog,user
      1   2   3       4
```

- User account are stored in `/etc/group`
 1. **Group name**
 2. **Password:** lets the user change to a new group ID (`newgrp`)
 3. **Group ID**
 4. **List of users** (user's primary group is stored in `/etc/passwd`)
- Only superuser can add groups and members

Linux Subjects

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- Subject are **processes**
- Each process is associated with
 - a **real** UID/GID (**ruid/rgid**): the real UID is inherited from the parent process. Typically it is the UID of the user that launched the process.
 - an **effective** UID/GID (**euid/egid**): the effective UID is inherited from the parent process or from the file being executed.
This UID is used to grant access rights to a process.
 - a **saved** UID/GID: this allows a process to switch between the effective UID and real UID, vice versa.

Linux Objects

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- The objects of access control include files, directories, memory devices, and I/O devices.
- In Linux almost all objects are modeled as files (organized in a tree-structured file system).
- Each object has
 - owner
 - group
 - 12 permission bits: rwx for owner, rwx for group, and rwx for others and suid, sgid, sticky
 - In this example, 000 for suid, sgid, sticky; 110 100 100 for users

```
-rw-r--r-- 1 root adm 9 mag 4 15:43 flag.txt
```

Permissions on directories

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- Read (r): find which files are in the directory, e.g. for executing ls
- Write (w): add files and delete files
- Execute (x): make the directory the current directory (cd) and open files inside
- Nothing (-): permission unavailable for that group

Permissions on files (non-dir)

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- Read: reading the content of a file
- Write: changing the content of a file
- Execute: loading the file in memory and execute

The suid, sgid, sticky bits

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	suid	sgid	sticky bit
Non-executable files	-	-	not used anymore
Executable files	change euid when executing the file	change egid when executing the file	not used anymore
directories	-	new files inherit group of the directory	only a owner of a file can delete

Other issues on objects

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- Only the owner can change the permission bits
- Only the superuser can change the owner

SUID to root

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- When root owns an executable file and the SUID bit is set, the process will get superuser status during execution.
- Important SUID programs
 - `/bin/passwd` (change password)
 - `/bin/login` (user login program)
 - `/bin/su` (change UID program)
- SUID programs need to be written very carefully so that their privileges cannot be misused, and they only do what is intended.

Access control decisions

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Access control uses the effective UID/GID.

- If the subject's UID owns the file, it checks the owner permission bits
- If the subject's UID does not own the file but its GID does, it checks the group permission bits
- If the subject's UID and GID do not own the file, it checks the "others" permission bits (also called world)

Managing Linux Permissions

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➤ Check permissions on current directory

```
user@host:~$ ls -l
```

```
drwxr--r-- 1 root adm  9 mag  4 15:43 documents
-rw-r--r-- 1 root root  9 mag  4 14:32 flag.txt
-r-xr-xr-x 1 root adm  9 mag  4 15:46 random
```

Managing Linux Permissions

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➤ Check permissions on current directory

```
root@host:~$ ls -l
drwxr--r-- 1 root adm  9 mag  4 15:43 documents
-rw-r--r-- 1 root root  9 mag  4 14:32 flag.txt
-r-xr-xr-x 1 root adm  9 mag  4 15:46 random
```

➤ Changing ownership with chown

```
root@host:~$ chown user.group flag.txt
drwxr--r-- 1 root adm  9 mag  4 15:43 documents
-rw-r--r-- 1 user group  9 mag  4 14:32 flag.txt
-r-xr-xr-x 1 root adm  9 mag  4 15:46 random
```

Managing Linux Permissions

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➤ Changing permissions with chmod

➤ Remove execution from everyone

```
root@host:~$ chmod -x random
```

```
-r--r--r-- 1 root adm 9 mag 4 15:46 random
```

➤ Add execution to group (g) and world (o), but NOT user (u)

```
root@host:~$ chmod go+x random
```

```
-r--r-xr-x 1 root adm 9 mag 4 15:46 random
```

Managing Linux Permissions

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- Changing permissions with chmod
 - Setting explicit permissions (sum of bits, r=4, w=2, x=1)
 - Owner gets read and write (4 + 2 + 0) = 6
 - Group gets read (4 + 0 + 0) = 4
 - World gets execution (0 + 0 + 1) = 1

```
root@host:~$ chmod 641 random
```

```
-rw-r---x 1 root adm 9 mag 4 15:46 random
```

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