SECURITY (COMP0141): UNIX PROCESSES

(MANY OF THESE SLIDES ARE TAKEN FROM ZAKIR DURUMERIC. THANKS ZAKIR!)

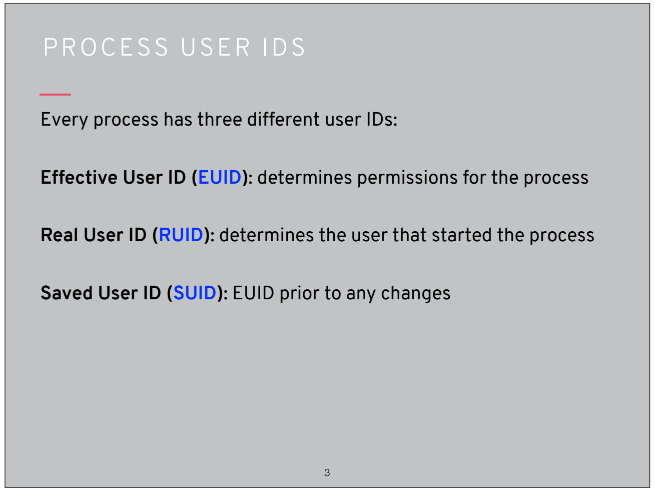
PROCESSES

Processes are isolated (cannot access each others' memory)

Processes run with the user ID (`uid`) of a specific user

- When you run a process, it's with the permissions of your `uid`
- Processes can access any files that you have access to

Processes started by `root` (`uid` 0) can reduce their privileges by changing to a less privileged `uid`



PROCESS USER IDS

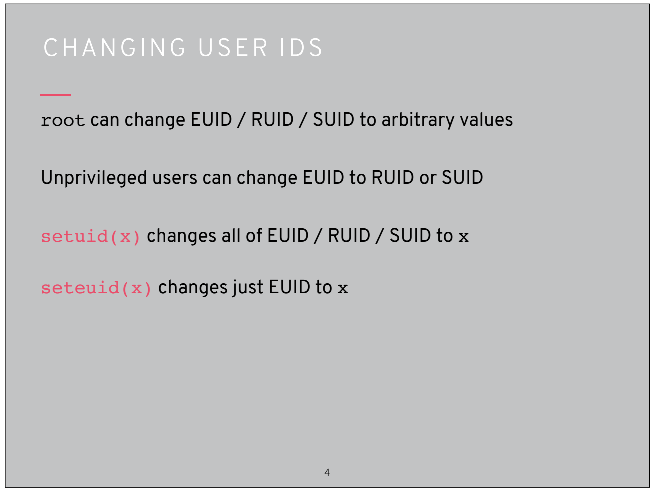
Every process has three different user IDs:

Effective User ID (EUID): determines permissions for the process

Real User ID (RUID): determines the user that started the process

Saved User ID (SUID): EUID prior to any changes

These are typically all the same (the user that started the process)



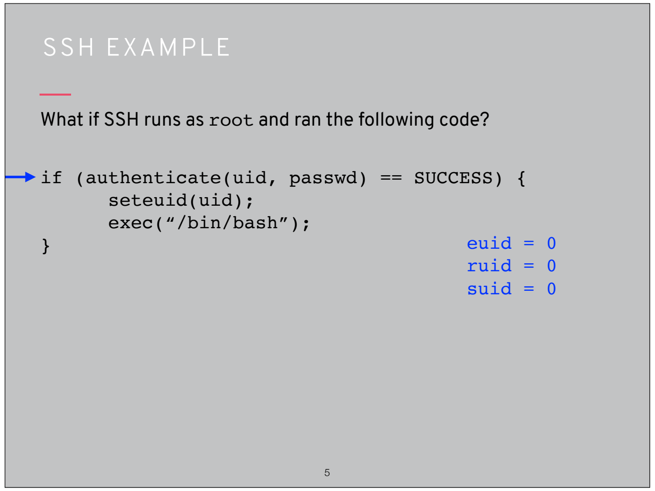
CHANGING USER IDS

`root` can change EUID / RUID / SUID to arbitrary values

Unprivileged users can change EUID to RUID or SUID

`setuid(x)` changes all of EUID / RUID / SUID to `x`

`seteuid(x)` changes just EUID to `x`

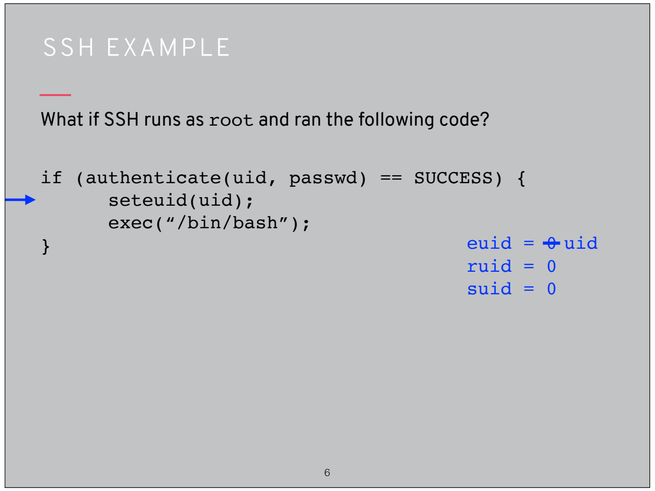


SSH EXAMPLE

What if SSH runs as `root` and ran the following code?

```
→ if (authenticate(uid, passwd) == SUCCESS) {
        seteuid(uid);
        exec("/bin/bash");
  }
```

```
euid = 0
ruid = 0
suid = 0
```



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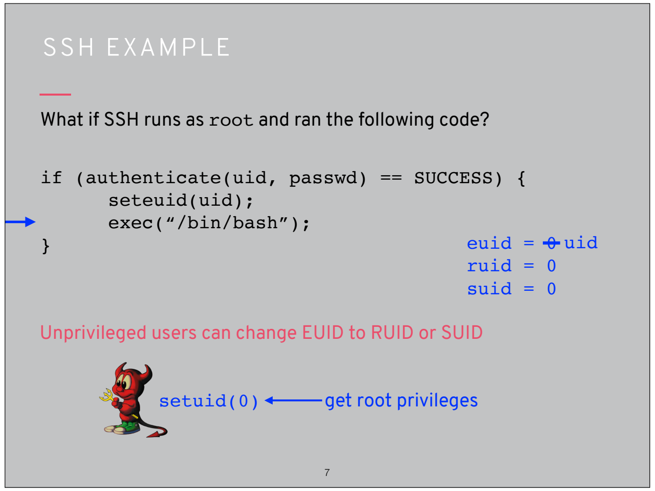

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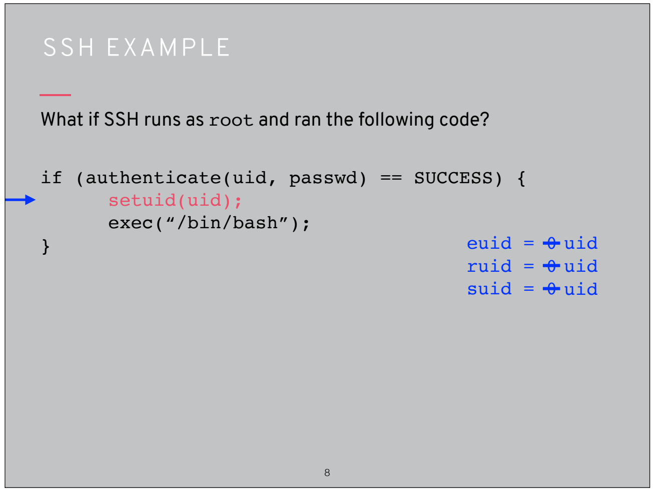
Unprivileged users can change EUID to RUID or SUID

setuid(0) ← get root privileges



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This is what we should do instead to prevent this attack

ELEVATING PRIVILEGES

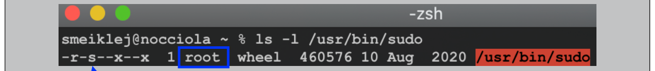
Sometimes we need to elevate our own privileges

Example: Running `passwd` modifies `/etc/shadow`, which only `root` can read/write

UNIX allows you to set EUID of an executable to be the file owner rather than the executing user using the **`setuid` bit**

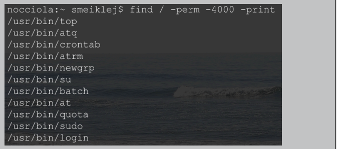
Can you think of another process that users would need to run with the setuid bit?

SETUID BIT



```
smeiklej@nocciola ~ % ls -l /usr/bin/sudo
-r-s--x--x  1 root  wheel  460576 10 Aug  2020 /usr/bin/sudo
```

says that executing user can run with the permissions of the file owner (`euid=root`)

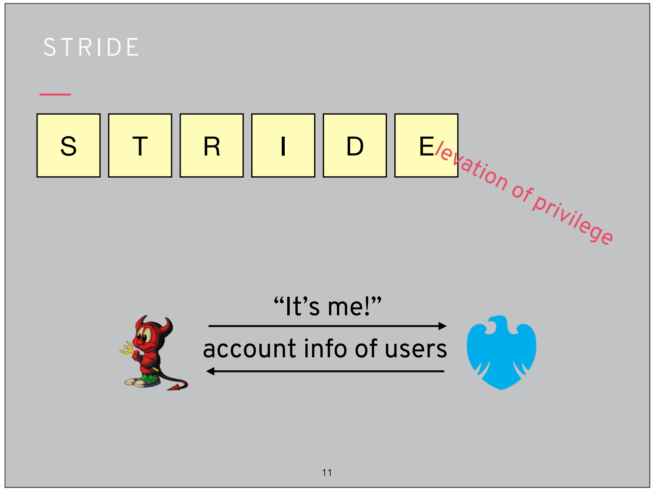


```
nocciola:~ smeiklej$ find / -perm -4000 -print
/usr/bin/top
/usr/bin/atq
/usr/bin/crontab
/usr/bin/atrm
/usr/bin/newgrp
/usr/bin/su
/usr/bin/batch
/usr/bin/at
/usr/bin/quota
/usr/bin/sudo
/usr/bin/login
```

Question: When running `passwd`, how do we know which user's password can be modified?
Answer: The SUID (Saved User ID)

Question: What if `setuid` has a vulnerability?

Sudo is a classic example since this is all about temporarily elevating our privileges. But what if there is a vulnerability in the setuid process?



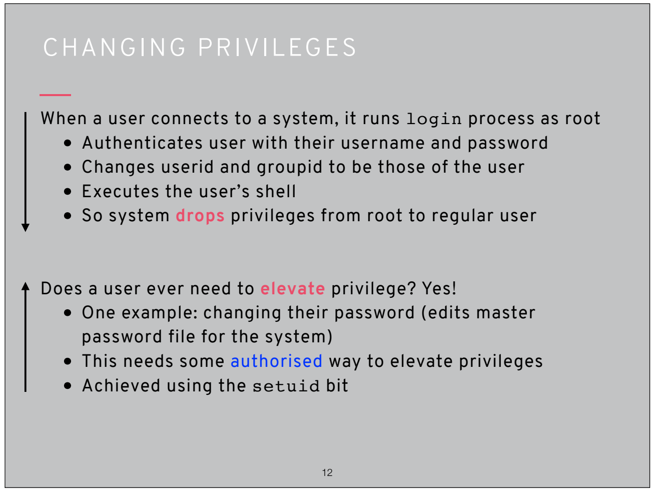
STRIDE

S T R I D E*levation of privilege*

“It’s me!” →

account info of users ←

This is a classic example of (unauthorised) elevation of privilege



CHANGING PRIVILEGES

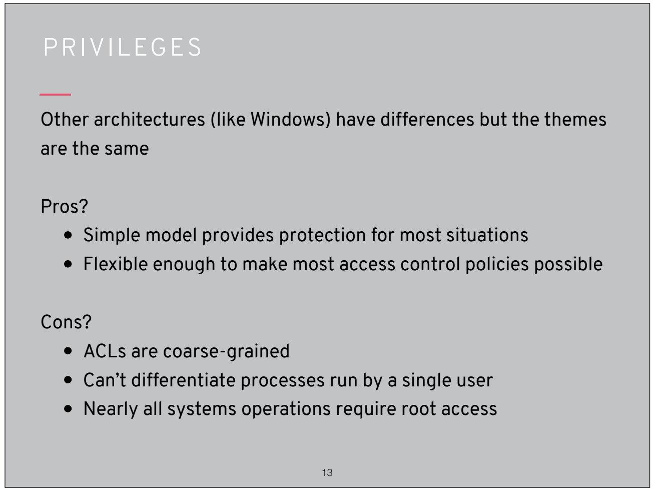
When a user connects to a system, it runs `login` process as root

- Authenticates user with their username and password
- Changes userid and groupid to be those of the user
- Executes the user’s shell
- So system **drops** privileges from root to regular user

Does a user ever need to **elevate** privilege? Yes!

- One example: changing their password (edits master password file for the system)
- This needs some authorised way to elevate privileges
- Achieved using the `setuid` bit

In summary, for the sake of functionality it is necessary for systems to allow both the (temporary) upgrade and downgrade of privileges



PRIVILEGES

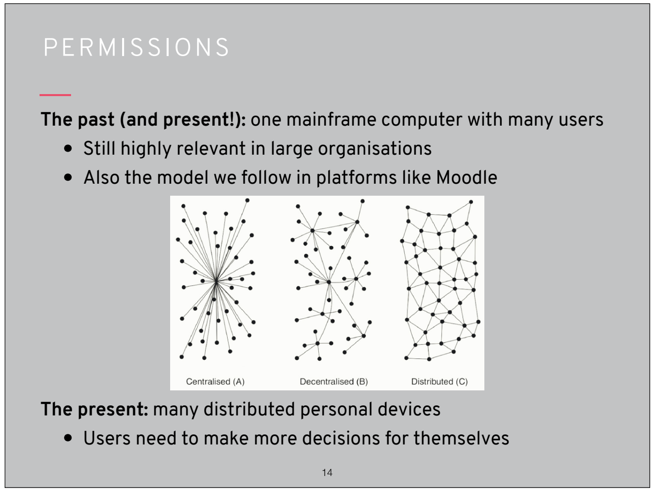
Other architectures (like Windows) have differences but the themes are the same

Pros?

- Simple model provides protection for most situations
- Flexible enough to make most access control policies possible

Cons?

- ACLs are coarse-grained
- Can't differentiate processes run by a single user
- Nearly all systems operations require root access



PERMISSIONS

The past (and present!): one mainframe computer with many users

- Still highly relevant in large organisations
- Also the model we follow in platforms like Moodle

Centralised (A)
Decentralised (B)
Distributed (C)

The present: many distributed personal devices

- Users need to make more decisions for themselves

This approach to permissions works well in a centralised filesystem but breaks down quickly in a more user-oriented computing ecosystem