CSE 127: Computer Security

Security Concepts (cont)

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Slides adopted from Kirill Levchenko and Stefan Savage

Incentives and Deterrents

- Attacker’s equation:
  (expected gain) > (cost of attack)
- Defender’s equation:
  (cost of protection) < (expected loss)

Incentives and Deterrents

- Attacker’s equation:
  (expected gain) > (cost of attack) + (expected punishment)

- Defender’s equation:
  (cost of protection) < (expected loss)

Security Model

- Subjects: Individuals or processes acting on their behalf
- Objects: Protected information or function
    - Objects often also include subjects
- Subjects operate on objects
    - System mediates and facilitates subject-object interaction

Security Policy

- What action is subject allowed to do with object
- Is this enough?

Security Policy

- What action is subject allowed to do with object
- Is this enough?
  - And who can introduce new subjects and objects into system?

Access Control Matrix

	Objects				
Subjects					
		{allowed actions}			

Access Control Matrix

	Broccoli	Fruit from Tree of Life	Fruit from Tree of Knowledge
Adam	{see, eat}	{see, eat}	{see}
Eve	{see, eat}	{see, eat}	{see}

Access Control Lists (ACLs)

- What are ACLs?

  ➤

- How are ACLs enforced?

  ➤

- Real world examples?

  ➤

Access Control Lists (ACLs)

- An access control list of an object identifies which subjects can access the object and what they are allowed to do

- ACLs are object-centric: access control is associated with objects in the system

- Each access to object is checked against object's ACL

- Example: guest list at a night club

Capabilities

- What is a capability?
  -
- How are capabilities enforced?
  -
- Real world example of capabilities?

Capabilities

- A capability grants a subject permission to perform a certain action
  - Unforgeable
  - Usually transferrable
- Capabilities are subject-centric: access control is associated with subjects in the system
- Example: car key

Unix File System Security Model

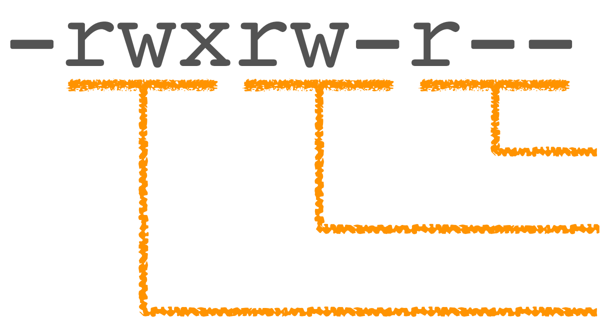
- Subjects:
- Objects:
- Actions:

Unix File System Sec. Model

- Subjects: Users
- Objects: Files and directories
- Actions: read, write, execute
  - Execute a file means can call `exec()` on file
  - Directory "execute" means user can traverse it
- Unix is a simplified ACL system
  - Arbitrary ACLs not possible in traditional Unix
  - Modern Unix operating systems allow arbitrary

Permissions

- Each file has an owner and a group
  - **Group:** named set of users
- File permissions specify what owner, group, and other (neither owner nor group) is allowed (read, write, exec)



```
-rwxrw-r--
```

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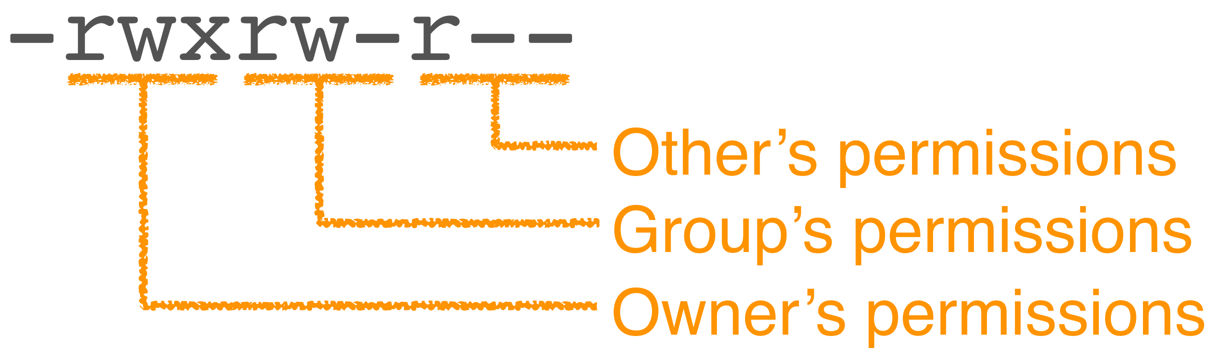

```
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```

Other’s permissions

Group’s permissions

Owner’s permissions

Permissions

- User’s allowed actions on file are:
  - Owner’s permissions if the user is the owner,
  - Group’s permissions if the user is in the group,
  - Other’s permissions otherwise

Permissions

- Users interact with system via processes acting on their behalf

- When you interact with system via terminal, command shell acts on your behalf

- Each process is associated with a user

Permissions

- Who can change permissions?
  - Only owner and superuser can change permissions
- Who can change owner?
  - Only superuser can change owner
- Who can change group?
  - Owner can only change to group she belongs to

Permissions

- Can you change group to arbitrary group?
    - A: yes, B: no

Permissions

- Only owner and superuser can change permissions
- Only superuser can change owner
- Only owner and superuser can change group
    - Owner can only change to group she belongs to
- User’s allowed actions on file are:
    - Owner’s permissions if the user is the owner,
    - Group’s permissions if the user is in the group,

Login

- When user connects to system via physical terminal, system runs `login` process as `root` to start session

- `sshd` performs similar actions

Login

- When user connects to system via physical terminal, system runs `login` process as `root` to start session
  - Authenticates user using username and password
  - Changes its user id and group id to that of user
  - Executes user’s shell
- `sshd` performs similar actions

Changing Privilege

- Superuser can drop privilege to become regular user

Changing Privilege

- Superuser can drop privilege to become regular user
- Want way to elevate privilege in controlled manner

Changing Privilege

- Superuser can drop privilege to become regular user
- Want way to elevate privilege in controlled manner
- How?

Elevating Privilege

- Executable files have a `setuid` and `setgid` bit
- If `setuid` is set, files is executed with privilege of owner
  - `ruid` is that of executing user, `euid` and `suid` that of owner
- The `setgid` bit does same for group
  - But supplementary groups remain that of executing user

Unix Security Model

- What do you like about the Unix security model?
- What do you dislike about it?
- Is it a good model?