Security

Portions courtesy Ellen Liu

Outline

- Introduction
- How security is compromised
- Security tips
- Security power tools
- Potpourri

Introduction

- Computer Security - protection of an automated information system in order to preserve the integrity, availability and confidentiality of information system resources, including hardware, software, firmware, information/data, and telecommunications
- CIA Triad
  - Confidentiality: Data confidentiality, privacy
  - Integrity: Data integrity, system integrity, authenticity: origin integrity, accountability/non repudiation: ability to trace a security breach to a responsible party
  - Availability

General Consensus

- No OS is secure. Security breaches are commonplace
- Need patience, vigilance, knowledge, persistence from all user, admin, management communities
- Security is an ongoing battle that can never really be won
- Security can make system more resistant to attacks
- Security often means less convenience and more constraints to users

How Security is Compromised

There are many vulnerabilities, threats, risks, and attacks. We will focus on just three aspects

- Social engineering
- Software vulnerability
- Configuration errors

Social Engineering

- Seemingly legitimate personnel or colleague ask for info
- Phishing: collect info via deceptive emails, instant msgs
- Often provide victim-specific info gleaned elsewhere to appear authentic and earn trust

- Need site policies on phone dos and don'ts, physical security, password selection, etc.
- Many organizations inform users that administrators will never request their passwords. Report immediately if such incidents occur

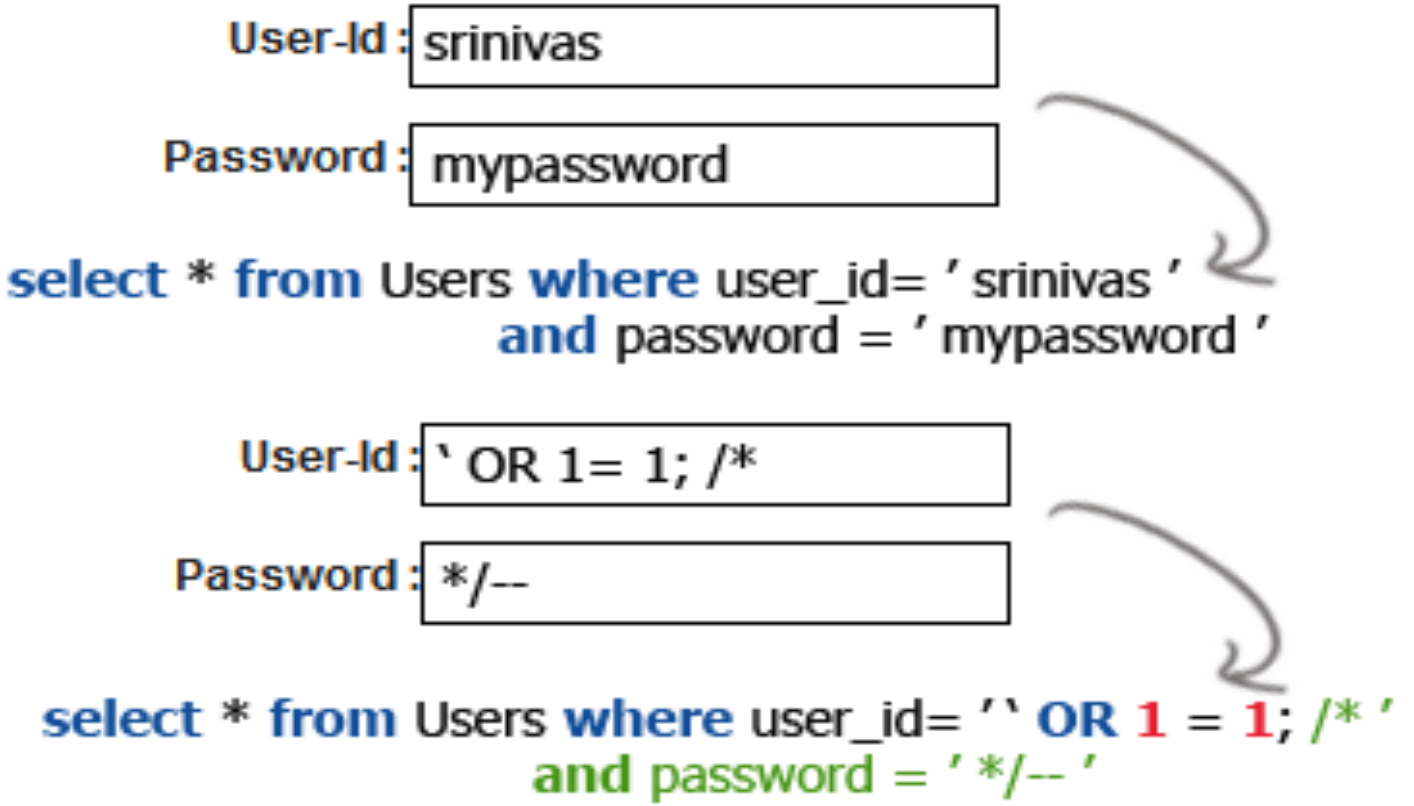
Software Vulnerabilities

- Program errors or context dependencies
- Buffer overflow: allocate a fixed-size buffer to store data, without checking the actual size of data to be stored. If larger than buffer size, it overflows /overwrites adjacent memory space, may crash the program or execute arbitrary code
  - Some programming systems include automatic checks
- Input validation vulnerabilities

```
#!/usr/bin/perl
open(htmlfile, "/var/www/html/$argv[0]") or die "fail\n";
while(<htmlfile>) { print; }
close htmlfile;
```

`$argv[0]` is a user input. What if sb enters `../../../etc/passwd`

SQL Injection.



Evaluation of 1=1 will always be true

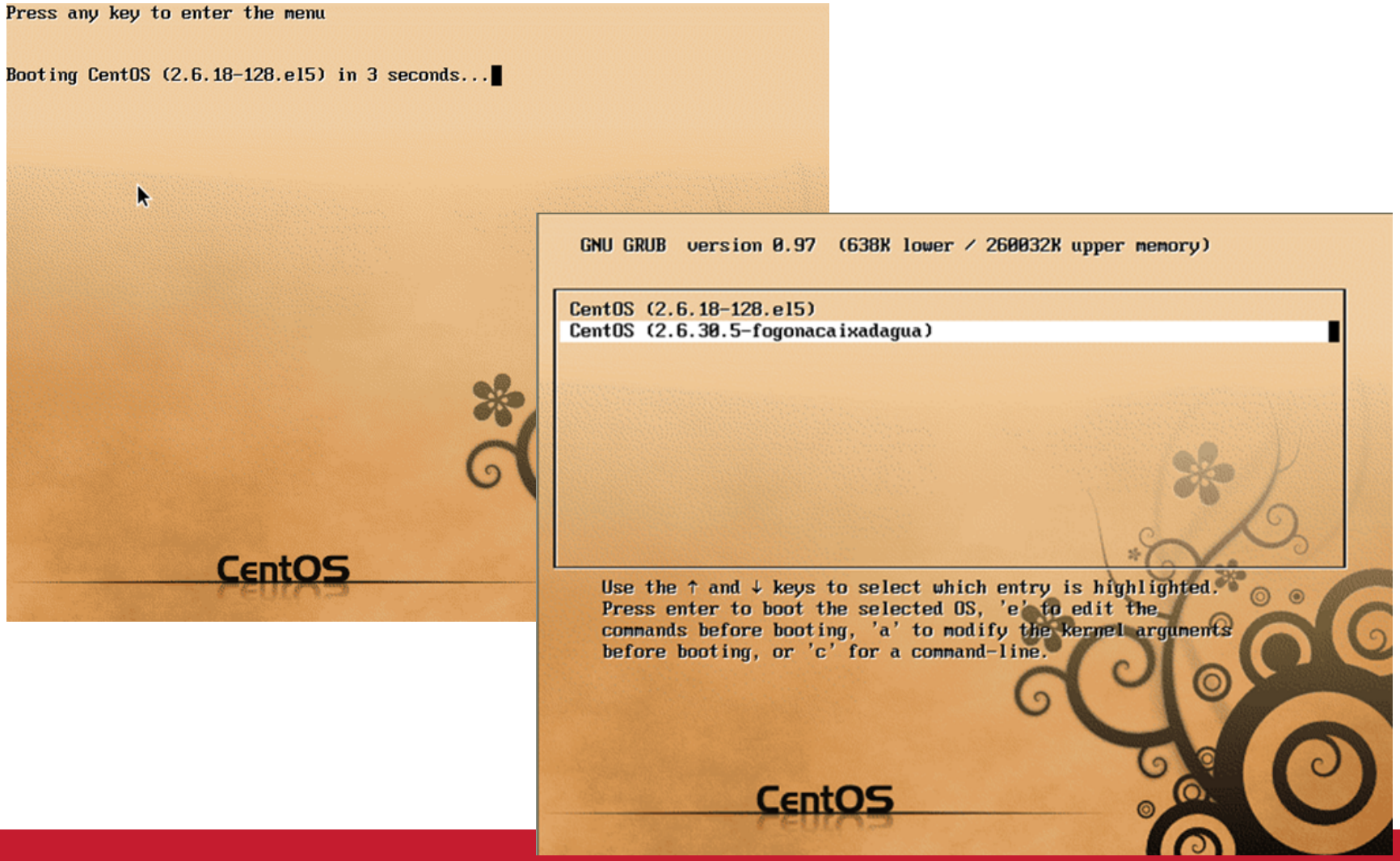
/* */ enclose comments

-- precedes a comment within a single line

Configuration Errors

- Security vs. convenience
  - E.g., accounts without passwords, disks shared with the world, unprotected databases
- Boot loader password example
  - GRUB can be configured at install time to require a password, admins almost always decline the option
  - This leaves the system open to physical attack
  - With a password means if the system is rebooted, say, after a power outage, an admin has to drive to work to get the machine up and running again
- Do not leave ports open

CentOS Entering GRUB



Security Tips

- Patches
- Unnecessary services
- Remote event logging
- Backups
- Malware (viruses, worms, Trojans, rootkits)
- Packet filtering, passwords, vigilance

Patches

- Keeping the system updated with the latest patches is chore of the highest security value
- A recommended patching approach includes:
  - A regular schedule to install routine patches
  - A change plan to document impact, post-installation testing steps, and steps to back out the changes if needed
  - Understand what patches are relevant
    - Keep an inventory of apps and OS in use
    - Subscribe to vendor-specific lists/blogs, also general ones such as Bugtraq

Unnecessary Services

- Find out which services are running
  - Use the netstat command to find all listening sockets
- Find and identify services that use unknown ports
  - Use the fuser, lsof, and then ps commands
- If not needed, stop it, and do not start it at boot time
- Disable known vulnerable network protocols
  - FTP, Telnet
  - BSD “r” programs: rcp, rlogin, rsh

Disable root ssh login

- Sudo is good enough
- A high-value target for brute-force guessing
- In /etc/ssh/sshd_config:

```
PermitRootLogin no
```

Remote Event Logging

- Syslog forwards log info to files, lists of users, or other hosts on network
- Set up a secure host as a central logging machine
  - Parse forwarded events and take proper action such as alerting admins when certain events occur
- Remote logging also prevents hackers from covering their tracks by rewriting or erasing log files on compromised systems

Backups

- Regular backups of all partitions and store some backups off-site

- When storing tapes off-site, use a fireproof safe to deter theft, also use encryption
  - If using contract storage facility, take a physical tour

Viruses and Worms

- Viruses: Rogue software program that attaches itself to other software programs or data files in order to be executed
- Worms: Independent programs that copy themselves from one computer to other computers over a network
- Linux/UNIX have been mostly immune from viruses
  - Less market share in desktop market, thus not a target
  - Access control in Unix may limit self-propagating worm or virus; need root privilege to alter system executables

Don't neglect email and file servers!

- A Linux server can inadvertently distribute viruses to Windows machines on the network
- Run antivirus software on UNIX servers to protect site's Windows systems from Windows viruses
  - E.g., mail server scans inboxes, file server scans shared files
  - Supplement with desktop antivirus such as ClamAV: a popular, free antivirus product with signatures of thousands of viruses

Trojan Horses

- Trojan horses: programs that aren't what they seem to be. E.g., claims to draw a picture, but deletes files instead
- Packages affected in the past
  - sendmail, tcpdump, OpenSSH, InterBase
  - Typically embed code that allows attackers to access the victim's systems at will
  - Fixed in a week or two, notified in mailing list
- Obvious security problems are discovered quickly and widely discussed on the net
  - Google a software package before installing it

Rootkits

- Rootkits: programs and patches that enable continued privileged access to a computer while hiding important system information such as process, disk, or network activity
  - Cover tracks and avoid detection
  - So the attacker can continue using the system to distribute software illegally, probe other networks, or launch attacks against other systems
  - Range from hacked *ls* and *ps,* to hacked kernel modules
- Tools to detect: host-based IDS e.g., OSSEC, special scripts e.g., chkrootkit
- Compromised machine is better reformatted than cleaned

Packet Filtering, Passwords, Vigilance

- Packet filtering: always filter network packets entering the system
  - Use packet-filtering routers, firewall, or filter software
- Passwords
  - every account must have a hard-to-guess password
  - Never send plaintext reusable passwords across the net
  - Always use secure remote access software such as ssh
- Vigilance
  - Monitor system health, network connections, process table, status report regularly (daily)
  - Perform regular self-assessment

Security Power Tools

Warning: Do not run these tools on someone else's system or network without permission! Instead use them for self-assessment/debugging.

- Port Scanner: Nmap, Nessus
- Password Cracker: John the ripper
- Network IDS – Bro, Snort
- HIDS: OSSEC

Nmap

- A network port scanner
- Check a set of target hosts to see which TCP and UDP ports have servers listening on them
- A port is a numbered communication channel
  - An IP address identifies an entire machine
  - An IP address + a port # identifies a server, an application, or a conversation on that machine
  - Most network services are associated with "well known" port numbers. See /etc/services

Nmap Output

```
[root@darkstar ~]#
[root@darkstar ~]# nmap -PN -sS  -O Scanme.Nmap.Org

Starting Nmap 5.21 ( http://nmap.org ) at 2010-04-01 11:19 IDT
Nmap scan report for Scanme.Nmap.Org (64.13.134.52)
Host is up (0.18s latency).
rDNS record for 64.13.134.52: scanme.nmap.org
Not shown: 993 filtered ports
PORT      STATE  SERVICE
25/tcp    closed smtp
53/tcp    open   domain
70/tcp    closed gopher
80/tcp    open   http
113/tcp   closed auth
8009/tcp  open   ajp13
31337/tcp closed Elite
Device type: general purpose
Running: Linux 2.6.X
OS details: Linux 2.6.15 - 2.6.26

OS detection performed. Please report any incorrect results at http://nmap.org/submit/
Nmap done: 1 IP address (1 host up) scanned in 16.99 seconds
[root@darkstar ~]#
```

Interpreting Nmap Output

- The host Scanme.Nmap.Org is running three services: 53, 80, and 8009. Under "STATE"
  - open: ports that have servers listening
  - closed: ports with no server
  - unfiltered: ports in an unknown state
  - filtered: cannot be probed due to intervening packet filters
- May guess what OS is used based on implementation of TCP/IP
- May guess what software is behind a running open port

Nessus

- Nessus: The most widely accepted and complete vulnerability scanner available
  - Scans for network servers running on any port and checks for known vulnerabilities instead of relying on version numbers
- Closed source, proprietary, but freely available
- New vulnerability checks (called plugins) daily, freely available to non-commercial users

John the Ripper

- A finder of insecure passwords from Solar Designer
- Implements several password-cracking algorithms
- It replaces an earlier tool called crack
- Can scan encrypted password files e.g., /etc/shadow

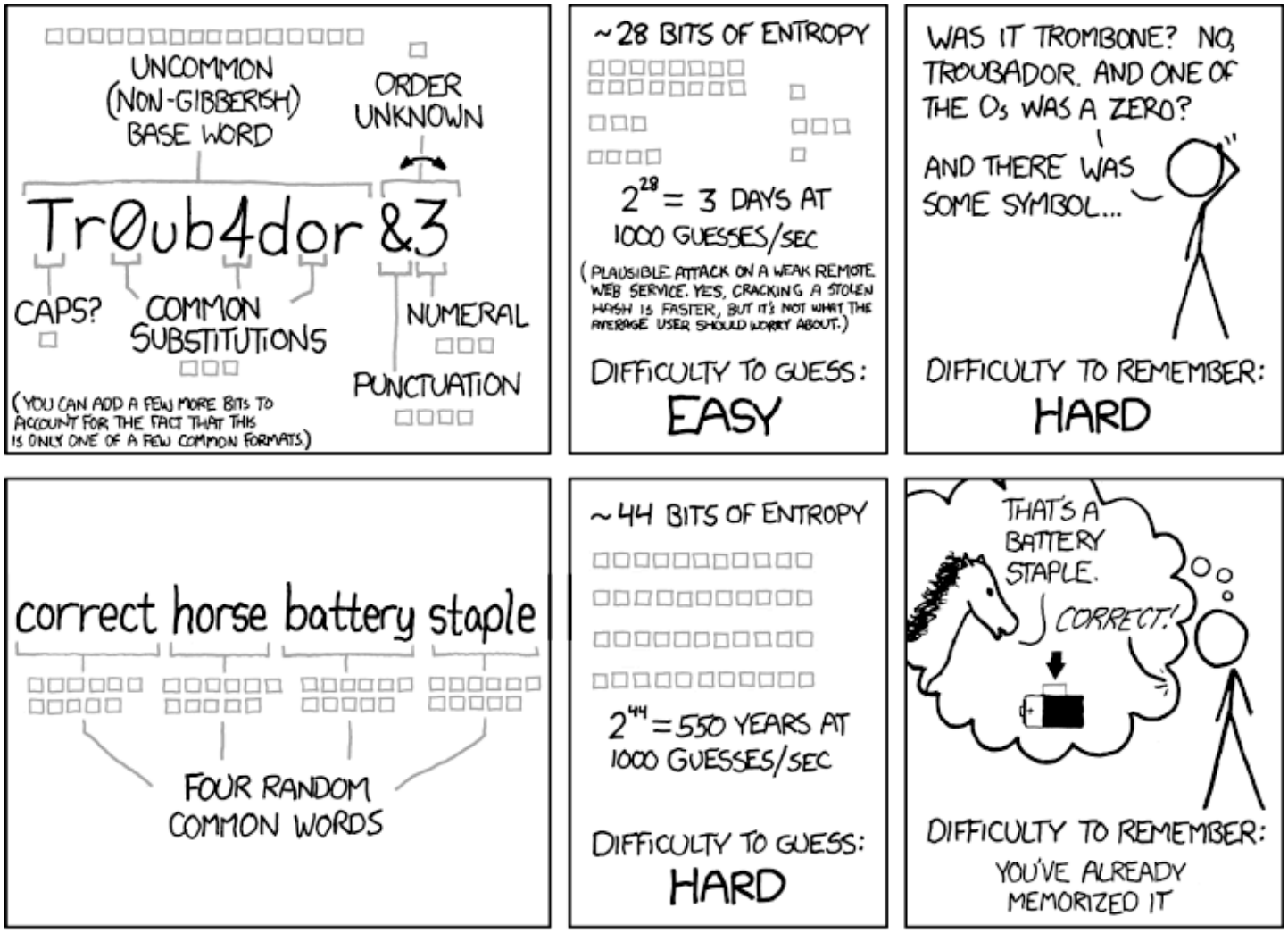
```
root@undecided:# john /etc/shadow
Loaded 3 password hashes with 3 different salts (FreeBSD MD5 [32/32])
badpass                  (tjones)
test             (test)
```

- Again, do not try it against others' passwords without approval

What makes a secure password?

- Hard to guess
- If I were an attacker, what would I guess first?
  - User name
  - Dictionary words
  - Oh, and I'd do obvious special character substitutions
    - 5 for an s, @ for an a, etc.
- What is the best password?
  - A truly random string
- How do I construct randomness?

Truth from xkcd



True randomness

- Humans can't produce random passwords. Let a program do it:
  - Diceware aggregates common words for important passwords
  - Lastpass generates un-rememberable passwords, has browser plugins
- Also, note that having published requirements, like "must have exactly one number" or "six to eight characters" can actually *limit* the search space of the attacker
  - If possible, best to keep private to your users

Requiring strong passwords

- We've discussed PAM previously
- It has a nice module pam-cracklib that can reject weak passwords
- Add to /etc/pam.d/common-password:

```
password requisite pam_cracklib.so retry=3 minlen=8 difok=3
```

Aging passwords?

- "You must change your password every 3 months"
- Good idea?
  - Pros: Mitigate risk of a very slow brute-force attack
  - Cons: Users dislike having to come up with new passwords, more likely to reuse a password

Bro

- Bro: An open source network intrusion detection system (NIDS), monitors network traffic and looks for suspicious activities
- Inspects all traffic into and out of a network
  - Passive mode: report on suspicious activity
  - Active mode: injects traffic to disrupt malicious activity
- Sophisticate: correlate inbound and outbound traffic
- Configuration is complex and require good coding experience
- Capable: can supplement or replace a commercial NIDS

Snort

- An open source NIDS and network IPS (intrusion prevention system). Basis for many commercial NIDS implementations
- Free base, subscription fee to access the most recent detection rules
  - Third-party extensions. E.g., Aanval
- Signature (i.e., a set of rules extracted for known attacks) based
- Less powerful than Bro, but much simpler to configure
  - A good "starter" NIDS

OSSEC

- Host-based intrusion detection (HIDS). Free software
  - Rootkit detection
  - Filesystem integrity checks
  - Log file analysis
  - Time-based alerting and active responses
- Monitors host activity, takes action according to a set of rules configured
- Two components
  - The manager (server): one per network. It stores file-integrity check databases, logs, rules, configurations, events, auditing entries
  - Agents (clients): on each host and reports to the manager

Potpourri

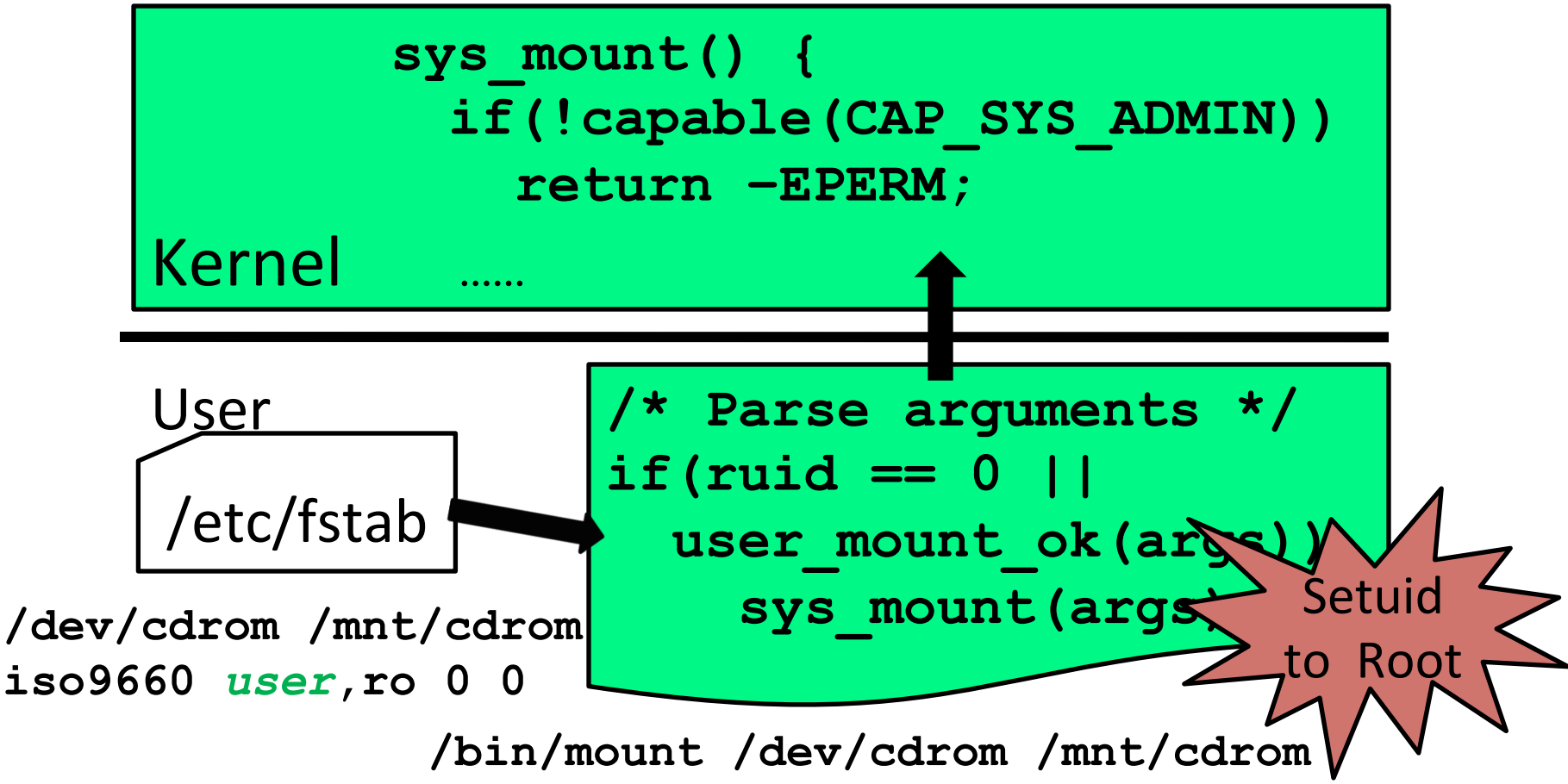
- Setuid
- Chroot
- Mandatory Access Control and SELinux
- SSH tunneling
- What to do if you are attacked?

Setuid-to-Root Binary

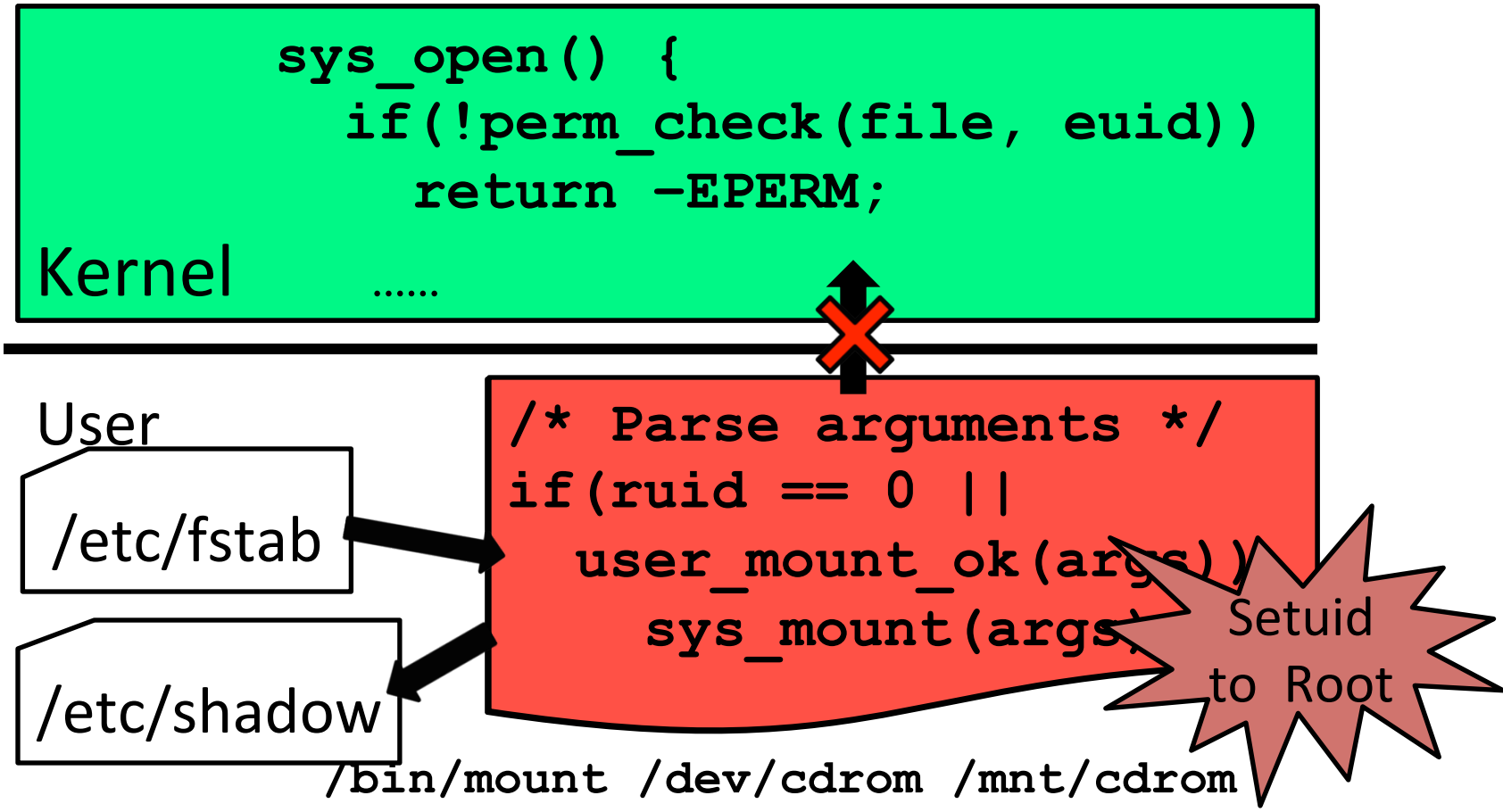
```
$ stat -c 'Access:(%a/%A) Uid:(%u/%U) Gid:(%g/%G)' /bin/bash
Access:(0755/-rwxr-xr-x) Uid:(0/root) Gid:(0/root)

$ stat -c 'Access:(%a/%A) Uid:(%u/%U) Gid:(%g/%G)' /bin/mount
Access:(4755/-rwsr-xr-x) Uid:(0/root) Gid:(0/root)
```

- Setuid causes a binary to run as the file owner, rather than the user that issued the command
- Trusted setuid binaries export safe functionalities.
  - E.g., ping, mount, passwd, etc.
  - Administrator configures policies on safe subsets

Linux mount


sys_mount() {
if(!capable(CAP_SYS_ADMIN))
return -EPERM;
Kernel
.....
User
/etc/fstab
/* Parse arguments */
if(ruid == 0 ||
user_mount_ok(args))
sys_mount(args);
Setuid
to Root
/dev/cdrom /mnt/cdrom
iso9660 user,ro 0 0
/bin/mount /dev/cdrom /mnt/cdrom

Vulnerable `mount`



Principle of Least Privilege

- Least authority necessary to perform duties
- Setuid-root violates least privilege principle
  - Empowers binaries to issue privileged system calls
- Kernel policy conflicts with the system policy
  - Kernel : only `root` can mount
  - System : any `user` can mount at safe locations
- Setuid binary `mount` bridges the gap

Advice

- Think twice before installing setuid-root programs
  - Some are required, but I would minimize this
- Mount non-root file systems with nosuid
  - Avoid someone adding a setuid binary from a cdrom or flash drive

chroot

- Confine a process to a given directory
- Useful for sandboxing (or jailing) a program
  - Although you do have to create a complete environment
- Other useful tools to sandbox an application:
  - Chromium sandbox, plash, etc.

Mandatory Access Control

- Mandatory Access Control (MAC)
  - have the control of all permissions in the hands of a security administrator
  - Do not allow users to modify any permissions, even on their own objects. Contrast traditional Unix access control
- Users are assigned a security level from a structured hierarchy. Users can read/write items at the same level or lower, but not any higher level
  - User with "secret" access cannot read "top secret" objects
- Least privilege - allowing access only when necessary
  - Limit scope of breach to specific resources required by SW

SELinux

- MAC is available to UNIX and Linux
  - Solaris trusted extension, HP-UX security containment, etc.
- Security-enhanced Linux (SELinux)
  - Implements MAC for Linux. Default component in Red Hat 4+
  - Adopted in environment with strict security requirements. E.g., government agencies
  - Policy is critical. E.g., to protect a daemon, a policy must enumerate all files, directories, and other objects to which the process needs access.
  - /etc/selinux/config controls SELinux configuration. Check /var/log/messages for SELinux errors, if problems with newly installed software

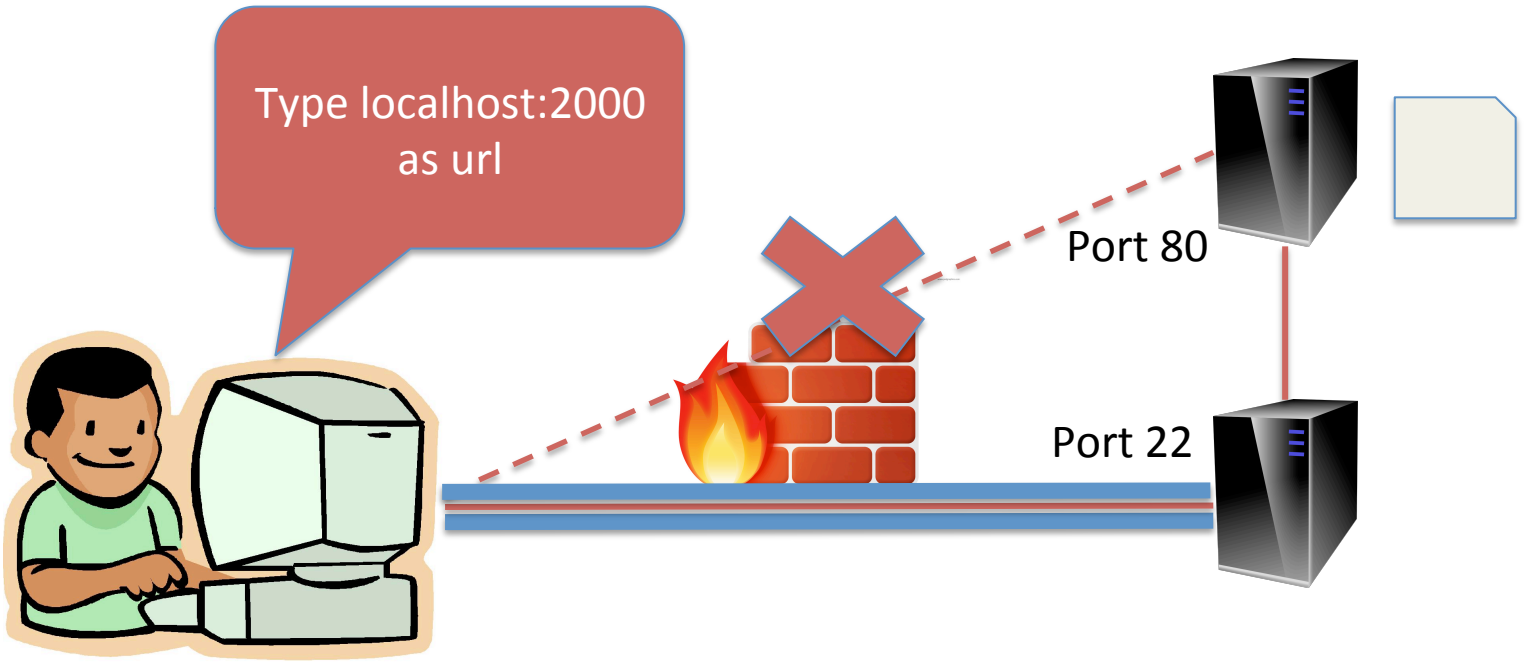
SELinux Administration

- SELinux is used by Fedora,
  - Users tolerate it mostly because they have good defaults
- Make no mistake: writing SELinux policies is **hard**
  - If you have a one-off piece of software, you will probably pay RedHat consultants to write a policy for you
- Still not a bad idea…

SSH tunneling

- A common firewall setting: Only let ssh in
- What if I want to access a web server behind a firewall?
- SSH to the rescue!

An SSH Tunnel



Why SSH tunnels are ok

- Still only expose ssh to outside world
- An authorized user can connect to services inside a firewall from a computer inside the firewall
- No risk beyond allowing ssh in the first place
- Fairly easy to configure (previous example):

```
ssh -f user@example.com
    -L 2000:internal-webserver.example.com:80 -N
```

Final advice

- Subscribe to mailing lists for software you administer
- They announce important security patches you may want to push out more aggressively
  - E.g., “This specially crafted packet to ssh drops you to a root shell”

What to do when your site is attacked

9-step plan

- Don't panic
- Decide on an appropriate level of response
- Collect away all available tracking information
- Assess degree of exposure
- Pull the plug
- Devise a recovery plan
- Communicate the recovery plan
- Implement the recovery plan
- Report the incident to authorities