Computer Security - Part 1

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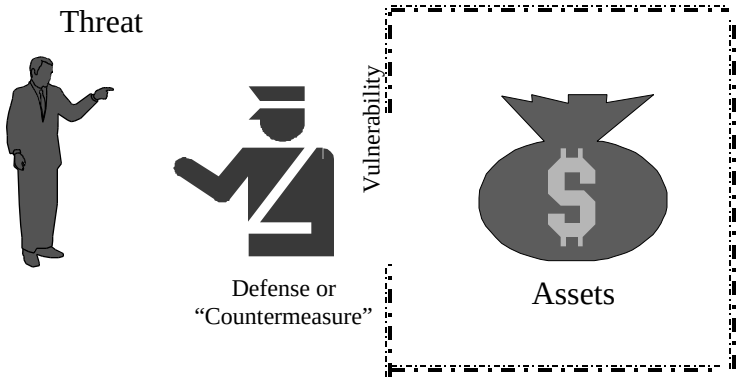
Outline

» Threats and Attacks
- Dealing with Attacks
- Preventative Measures

» Worked Examples
- Isolated Workstations
- Intranet Servers and Mainframes
- Encryption and VPNs
- Internet Browsing
- Public Key Cryptography
- Internet Servers

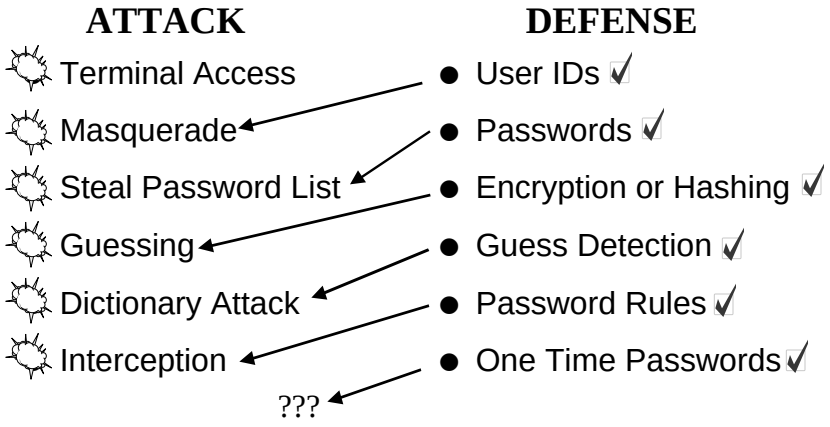
Threats and Attacks

Threats and Defenses



An attempt to steal or harm the assets is an **attack**

Attacks and Defenses Evolve



Dealing with Attacks

- Deterrence
- Detection Methods
- Responses
- Preventative Measures

Deterrence

- Accountability is the principal deterrent
  - » People are more likely to behave if their activities may be individually monitored
  - » Occasional monitoring is often enough
  - » Example: Web browser logs at schools, businesses
- Laws, regulations, and legal penalties
  - » Increases the risk to the perpetrator
  - » Example: Melissa virus writer was arrested

Detection Methods

- The first step in dealing with an attack
- Can be very difficult: 5% detection rates
  - » Example: Victims in military infowar games often assume it's just software "glitches"
- Keep records of attack-like behavior
  - » Invalid access attempt, login failures
  - » Remote probes: Internet port scans
- Be familiar with "normal" behavior
  - » Example: Aldrich Ames with shopping bags

Responses

- Limit immediate effects of attack
  - » Break attacker's connection
  - » Shut down subverted processes
- Post-attack procedures
  - » Monitors and logs for future attacks
  - » Restore lost data, restart systems
  - » Reports to managers, outside agencies
  - » Investigations

Attack Responses in Practice

- Internet Worm (1988)
  - » Disconnect from network, abort and delete offending software, patch known holes
  - » FBI tracked down the perpetrator
- Melissa (1999)
  - » Same, with "patching" of anti-virus software
- Sniffer incidents (mid 1990s)
  - » Monitor repeated attacks, forensic analysis

Preventative Measures

- Mechanisms to block attacks
  - » Physical Protection
    - – always the starting point for security
  - » Procedural Measures
    - – Roles, responsibilities, operating rules
  - » Technical Measures
    - – User authentication - who is trying to use it
    - – Access control - give different people different capabilities

Physical Security

- Computer based security measures rely on physical protection
- Given enough time and the right hardware, attackers will succeed
- Distinguish between people **with** physical access and those **without**
- Difficult to provide security when untrusted people have physical access

Insiders versus Outsiders

» Outsiders

- Not members of your organization, not specially committed to its success.
- Members of the general public, customers, competitors.
- Outsiders must “intrude” to access your resources

» Insiders

- Members of your organization that are generally committed to its success.
- Have physical access to enterprise resources and assets
- Insider attacks: abuse or expand legitimately granted permissions

Users and Administrators

» Users

- People who use computing resources to get jobs done
- Access granted to do their job: no more, no less
- Physical and technical security restricts their capabilities

» Administrators

- People charged with maintaining the integrity of your computing systems
- In theory they can make any change to a computer within their realm of responsibility and completely cover their tracks.

The Insider Threat

- Most computer intrusions and most fraud is perpetrated by insiders
- Preventative mechanisms work best against outsiders, not insiders
- Computer systems can keep records that may deter fraud
  - » Example: bank reconciles accounts weekly; embezzler caught by deadline

Recommendations

- » Insiders have work to do - balance security measures against real threat of loss
  - – Strongest measures that don't' interfere
- » Put heavy restrictions on systems with a high risk of attack or embezzlement
  - – Make insiders into outsiders
  - – Keep logs of transactions, and audit them
- » Don't mix system administrator duties with other business responsibilities

For Further Information

» Dorothy Denning, ***Information Warfare and Security***, Addison Wesley

» National Research Council, ***Trust in Cyberspace***, National Academy Press

» Dorothy Denning and Peter Denning, ***Internet Besieged***, Addison Wesley

» Donn Parker, ***Fighting Computer Crime***, Wiley

Worked Examples

- Isolated Workstations
- Intranet Servers and Mainframes
- Encryption and VPNs
- Internet Browsing
- Public Key Cryptography
- Internet Servers

Isolated Workstations

Workstation Access Control

- Protection is Based Mostly on Physical Access
- "Lock screens" and authentication devices
  - » Resists unsophisticated attacks
  - » Prevent some crimes of opportunity- if the attacker doesn't steal or penetrate the physical machine
- File and Disk Encryption

File and Disk Encryption

» Can resist refined and even innovative attacks, if built correctly
  – Transforms your data into unreadable text
  – Snooper can't read, and probably can't reliably change
» Double Edged Sword
  – If encryption is weak, then a trained attacker can easily breach it
  – If encryption is strong and you lose your password or key, then the data is lost forever

Computer Viruses

» Computer Virus Behavior
  – Most viruses are merely nuisances and cause no intentional damage
  – Some viruses intentionally cause damage, but this is rare because it reduces the likelihood that the virus will continue to spread and thrive
» Virus Countermeasures
  – Careful behavior isn't practical in most environments
  – Anti-virus software finds and repairs damage
    - Updates by subscription for latest viruses

Virus Examples

- Application viruses (games),
  - » Michaelangelo “time bomb” virus
- Operating system viruses
  - » Mac window frame, boot sector
- MS Word macro viruses
  - » Melissa - word macro distributed by e-mail
- Network virus: Internet “Worm”
  - » Others: e-mail Trojan programs

Workstation Summary

- Physical Protection is essential
  - » Anti-Virus Measures are essential in most situations
  - » Systematic procedures for workstation data backup
- Other security measures
  - » “Lock” screens with password protection

For Further Information

- Russell and Gangemi, ***Computer Security Basics***, O'Reilly
  - A classic introductory work
- Davis and Lewis, ***Computer Security for Dummies***, IDG Books
  - Practical introduction and reams of basic advice
- Cohen, A ***Short Course on Computer Viruses***, John Wiley
  - Technical background on viruses

Intranet Servers and Mainframes

Server Security Defenses

- » Physical Access Control
  - – Server machines reside in a physically secure machine room
  - – Risk of unauthorized administration (mingled machine room)
  - – Terminals reside in physically safe environments
- » Identification and Authentication “I&A”
- » Computer Based Access Control
- » Auditing

Identification / Authentication

- Who are you? Can you give me evidence?
- Computer Based I&A Relies on 1 or more of these “factors”:
  - » Something You Know (a password or PIN)
  - » Something You Have (a card or token)
  - » Something You Are (a physical feature, voice, fingerprint)

I&A in Practice

- Often tied to records of what you do
  - Audit records tagged with user names
- Authentication is essential for remote access
  - War Dialer Attacks, 1980s
    - ("WarGames" movie)
- Users Generally Hate It
  - Requires something Lost, Forgotten, or Injured.

Attacks on Passwords

» Interactive Password Guessing
- Passwords should be easy to remember but hard to guess
- Server should detect bad password attempts and raise an alarm

» Password "Sniffing"
- Shoulder Surfing, Wiretapping, Bugs,etc.
- Example: Pennsylvania Students in 1987

More Attacks

- Stealing the Password File
  - "Ancient" trick dating back to CTSS
  - Solved by storing encrypted or "hashed" passwords
    - » 1. Collect the plaintext password
    - » 2. Encrypt or hash it in an irreversible fashion
    - » 3. Compare against hashed version in the password database
- Dictionary Attack on Encrypted Passwords
  - Computer based guessing of encrypted passwords -- extremely fast, undetectable.
  - Easy to remember passwords become easy to attack

One Time Password Systems

- » Ideal for remote access - uses a secret to generate a new password for each login
  - Eliminate the risk of password sniffing
- » Software OTP implementations
  - Examples: Windows NT, 2000
- » Hardware OTP implementation: Tokens
  - Examples: Safeword, SecurID, WatchWord
  - Eliminates intentional sharing
  - Only authorized users are issued tokens
    - Citibank example: international embezzling

Generating OTPs

- Event or Clock Driven
  - Token generates a password for each login attempt
  - Client increments the time or a counter
  - Client encrypts it with the secret
  - Server repeats the process with same secret
- Challenge-Response Passwords
  - Server sends a random number “challenge”
  - Client encrypts it with secret value
  - Server repeats the process

Using Multiple Factors

- Single Factor Authentication with Passwords
  - Vastly popular, but vulnerable to Common attacks
- Two Factor Authentication
  - usually Smart Cards or Tokens with PINs
  - used in Sophisticated environments
- Three Factor is rarely used
  - Biometric activated Cards with PINs, or other combinations

Session Authentication

- Traditionally, I&A is applied at the beginning of an interactive session
  - » Can subvert authentication by subverting the session
- Attacks on Sessions
  - » Wiring attacks are possible but rare
  - » Attacks on dial-up connection
    - – Mitnick,1980s

Computer Based Access Control

- » Controlling what people can do on the server
  - – Controlled access to computer's resources: files, printers, other Services
  - – Often left fairly loose for convenience
- » Access Control is Hard to Manage
  - – Sophisticated settings get "stale" as programs evolve and staff changes
  - – Requires systematic maintenance to remain effective

Attacks on Access Controls

» Access Control in Commercial Computers Rarely Stops a Trained Attacker
  – Convenience sells better -- even potentially strong computers are sold with protections disabled
» Modern systems are very complex
» it's extremely costly to "lock down" a sophisticated operating system completely
  – 10-15 hours of work

Activity Audit Records

» A "Log" of security relevant events
  – Seeks to deter abuse by increasing Accountability
  – Consequences of Enforcement
    ● Educational measures, Penalties, Policy changes
» The log is often too big for casual use
  – Thousands of records for days of activity
  – Usually reviewed as a last resort
» Intrusion Detection Systems: detect attacks by watching audit records in real time

Server Security Summary

- Essentials
  - » Rigidly restrict all outside access
  - » Authenticate all outside users
- Other measures
  - » Use stronger measures if a lot is at risk
  - » Save your audit records if trouble occurs
- For Further Information
  - » Check local computer bookstore and Internet news groups about your server