PURDUE UNIVERSITY

CS52600: Information Security

Malicious Code

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What is Malicious Code?

- Set of instructions designed to violate security policy
  - Is an unintentional mistake that violates policy malicious code?
  - What about "unwanted" code that doesn't cause a security breach?
- Generally relies on "legal" operations
  - Authorized user *could* perform operations without violating policy
  - Malicious code "mimics" authorized user

Types of Malicious Code

- Trojan Horse
  - Trick user into executing malicious code
- Virus
  - Replicates into fixed set of files
- Worm
  - Copies itself from computer to computer
- *And then there is the payload*

Trojan Horse

- Program with an overt (expected) and covert effect
  - Appears normal/expected
  - Covert effect violates security policy
- User tricked into executing Trojan horse
  - Expects (and sees) overt behavior
  - Covert effect performed with user's authorization

- *Perpetrator:*

```
cat >/homes/victim/ls <<eof
cp /bin/sh /tmp/.xxsh
chmod u+s,o+x /tmp/.xxsh
rm ./ls
ls $*
eof
```

- *Victim*

```
ls
```

Propagation

- Trojan horse may replicate
  - Create copy on execution
  - Spread to other users/systems
- How (and why) would you make the "ls" Trojan horse self-propagate?

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Virus

- Self-replicating code
  - Like replicating Trojan horse
  - Alters normal code with "infected" version
- No *overt* action
  - Generally tries to remain undetected
- Operates when infected code executed

If *spread condition* then
  For *target files*
    if *not infected* then *alter to include virus*
Perform malicious action
Execute normal program

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Virus Types

- Boot Sector
  - Problem: How to ensure virus "carrier" executed?
  - Solution: Place in boot sector of disk
    - Run on any boot
  - Propagate by altering boot disk creation
    - *Less common with few boots off floppies*
- Executable
  - Malicious code placed at beginning of legitimate program
  - Runs when application run
  - Application then runs normally

Virus Types/Properties

- Terminate and Stay Resident
  - Stays active in memory after application complete
  - Allows infection of previously unknown files
    - Trap calls that execute a program
- Stealth
  - Conceal Infection
    - Trap read and disinfect
    - Let execute call infected file
  - Encrypt virus
    - Prevents "signature" to detect virus
  - Polymorphism
    - Change virus code to prevent signature

Macro Virus

- Infected “executable” isn’t machine code
  - Relies on something “executed” inside application data
  - Common example: Macros
- Otherwise similar properties to other viruses
  - Architecture-independent
  - Application-dependent

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Worms

- Replicates from one computer to another
  - Self-replicating: No user action required
  - Virus: User performs “normal” action
  - Trojan horse: User tricked into performing action
- Communicates/spreads using standard protocols

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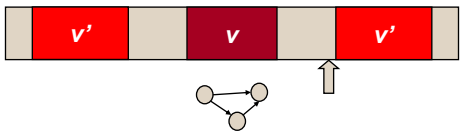
Payload

- We've discussed how they propagate
  - But what do they do?
- Rabbits/Bacteria
  - Exhaust system resources
  - Denial of service
- Logic Bomb
  - Triggers on external event
    - Date, action
  - Performs system-damaging action
    - Often related to event
- Others?

What do we Do?



- Turing machine definition of a virus
  - Makes copies on parts of tape not including *v*
- Is it decidable if an arbitrary program does this?
  - ***No!***

Proof:

- Reduce to halting problem
  - *T* reproduces *v* iff *T'* halts on *v'*
- Idea:
  - *T'* copies *v*
  - *T'* simulates *T*, but doesn't allow access to copy of *v*
  - If *T'* halts, *V* is a virus
- See book for details
- Generalized to state it is undecidable if a program contains malicious logic

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We can't detect it: Now what? Detection

- Signature-based antivirus
  - Look for known patterns in malicious code
  - Always a battle with the attacker
  - *Great business model!*
- Checksum
  - Maintain record of "good" version of file
  - Check to see if changed
- Validate action against specification
  - Including intermediate results/actions
  - *N*-version programming: independent programs
  - *see the problem for virus detection?*

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Detection

- Proof-carrying code
  - Code includes proof of correctness
  - At execution, verify proof against code
    - *If code modified, proof will fail*
- Statistical Methods
  - High/low number of files read/written
  - Unusual amount of data transferred
  - Abnormal usage of CPU time
  - *Only works after the damage is done*

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Defense

- Clear distinction between data and executable
  - Virus must write to program
    - Write only allowed to data
  - Must execute to spread/act
    - Data not allowed to execute
  - Auditable action required to change data to executable

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Defense

- Information Flow
  - Malicious code usurps authority of user
  - Limit information flow between users
    - If *A* talks to *B*, *B* can no longer talk to *C*
  - Limits spread of virus
  - Problem: Tracking information flow
- Least Privilege
  - Programs run with minimal needed privilege
  - Example: Limit file types accessible by a program

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Defense

- Sandbox / Virtual Machine
  - Run in protected area
  - Libraries / system calls replaced with limited privilege set
- Use Multi-Level Security Mechanisms
  - Place programs at lowest level
  - Don't allow users to operate at that level
  - *Prevents writes by malicious code*

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