Lecture 41 - OS Security

CprE 308

April 23, 2014

Intro

What have we learned about OS so far?

OS

- Goals
  - Resource Manager
  - User Interface
- Important things we have discussed
  - Multi-user, multi-process, multi-thread
  - Synchronization, Mutual Exclusion, Deadlock
  - Scheduling
  - Memory
  - I/O Devices
  - Files, and File Systems

What are the problems?

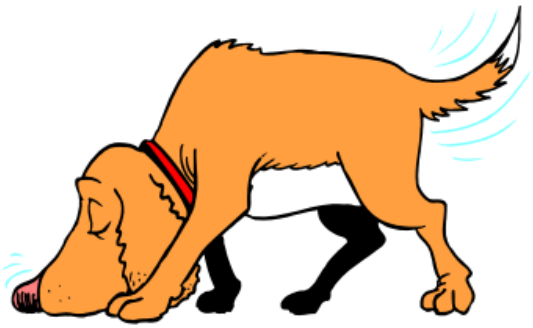
Top 25 Most Dangerous Software Errors

`http://www.sans.org/top25-software-errors/#cat1`

Version 3.0, June 2011

Problems and Fixes

Problem: Cleartext Transmit/Storage of Sensitive Info



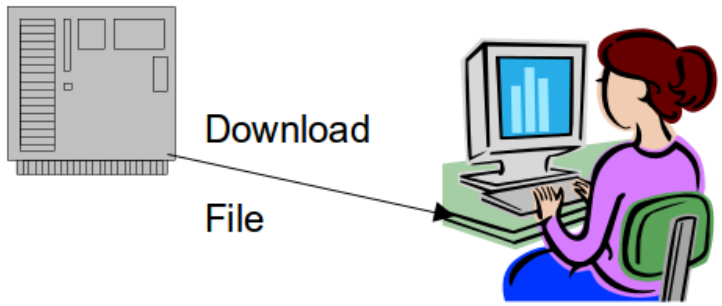
Fix:

- Encrypt data with standard, reliable encryption before transmission
- Whole-drive/File Encryption

Problem: Adopting Untrusted Software

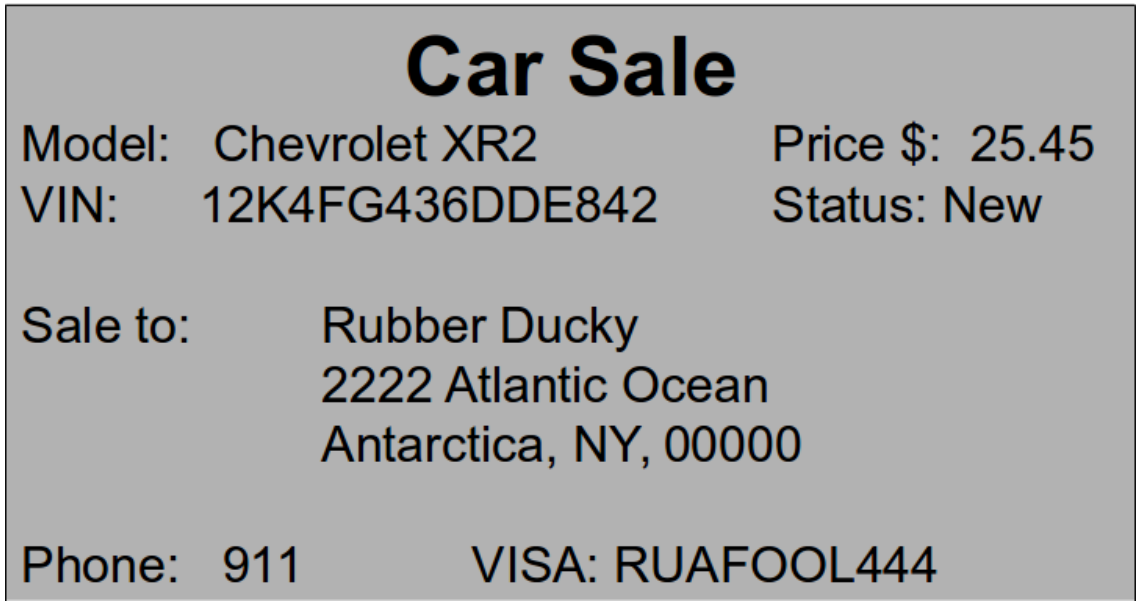
Fix:

- Use monitoring tools that examine processes as it interacts with the OS
  - Truss (Solaris)
  - Strace (Linux)
  - FileMon, RegMon, Process Monitor, Sysinternals (Windows)
  - Sniffers, Protocol analyzers



Free Software . . . Is it Safe?

Problem: Incorrect Input



Problem: Buffer Overflow

Name	Zzzzzzzzzz
Count	49, 425,222
State:	84
Return address	0x246625
Frame pointer	0x246625

Enter Name:
Zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

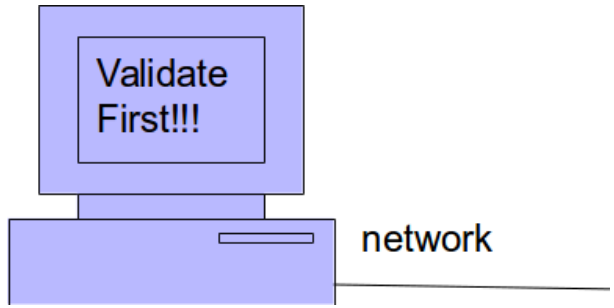
Fix: Input Validation

Assume all input is malicious!
Validate:

- Length
- Type
- Syntax
- Context: Business Rules

Or use:

- Special input checkers
- Whitelist: List of acceptable input
- Blacklist: Reject suspect input



Problem: Race Condition

Threads both using same variables.

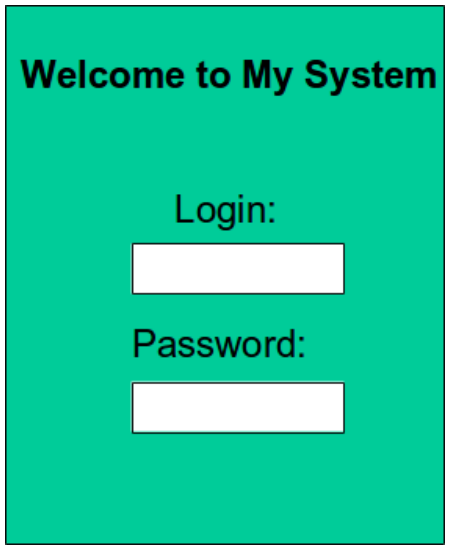
Fix:

- Use Synchronization Primitives around critical code
- Measure use of shared resources
- Test using artificial delays in race window
- Identify and trigger error conditions

Problem: OS Command Injection

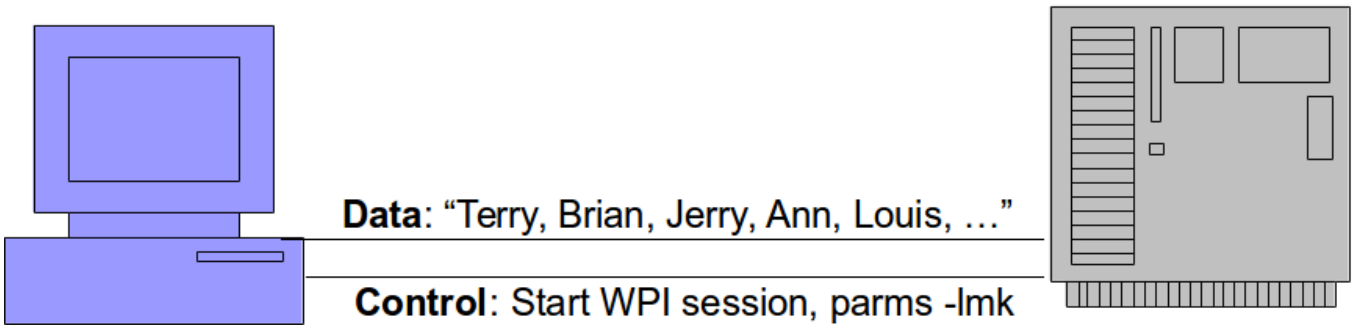
Problem: Command Injection into SQL
Inserts |`shell("cmd /c echo " & char(124) & "format c:")`|

- Data and control can traverse same path



Fix: Avoid OS Command Injection

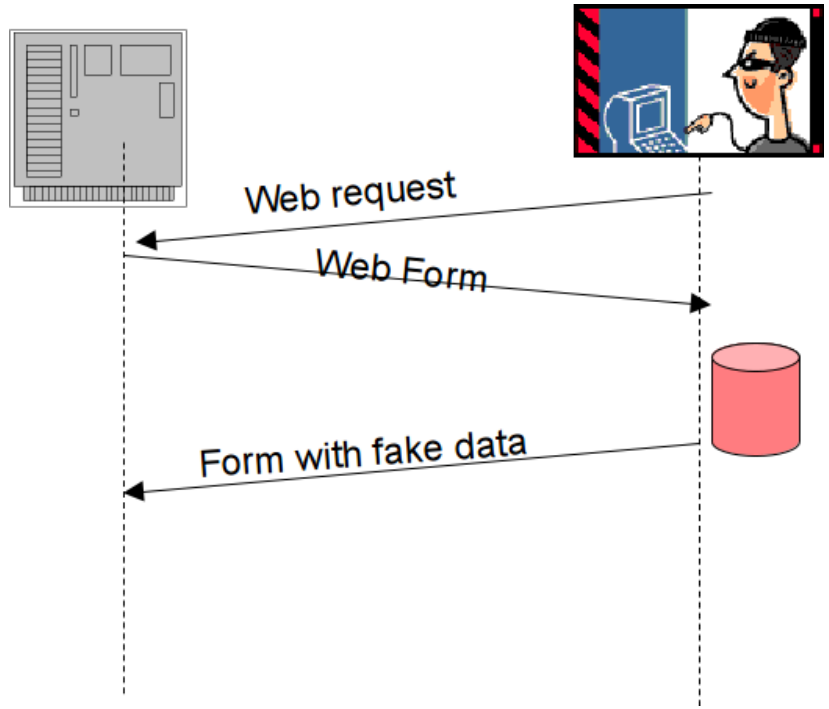
- Separate control information from data information.
  - E.G. where data -> database, control defines application
- Use library calls instead of external processes
- Avoid external control of command input
- Run code in "jail" or other sandbox environment
- Provide lowest possible permissions for executable



Problem: External Control of Critical State Data

User - side data can be modified

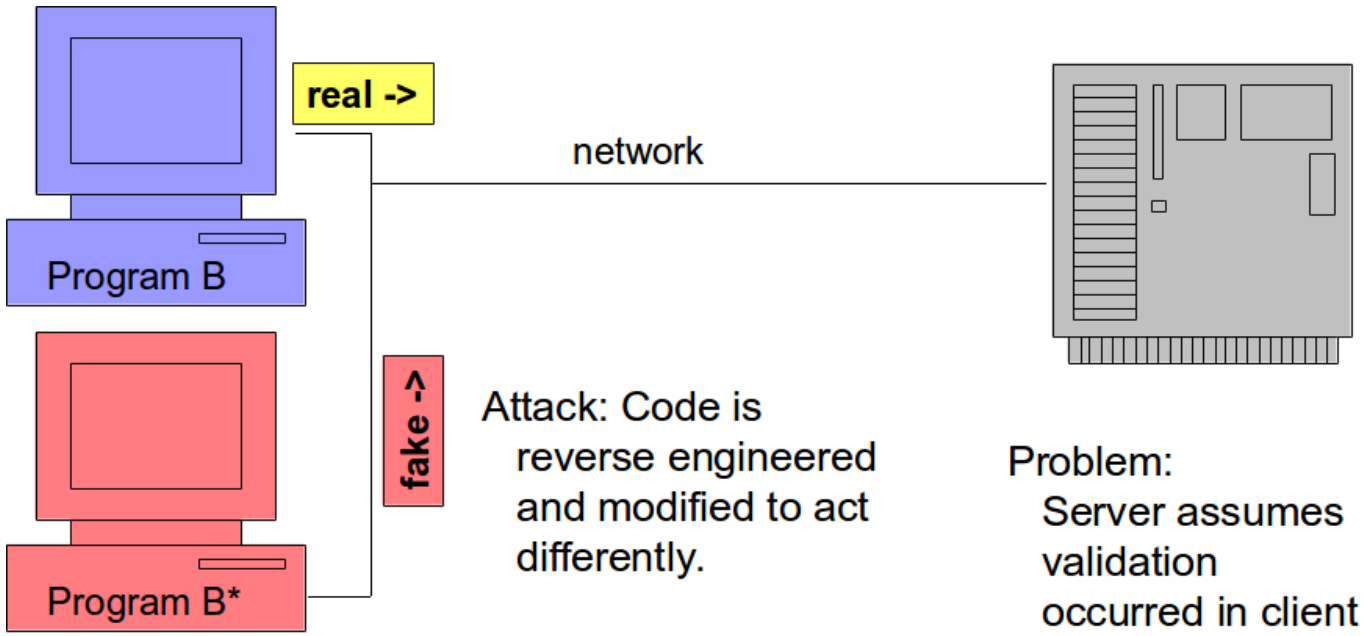
- Cookies
- Configuration files
- Profiles
- Hidden form fields
- Environmental variables
- Registry keys



Fix: Control Critical State Data

- Understand all locations that are accessible to attackers
- Do not keep state info on client without using encryption and integrity checking (e.g. HMAC)
- Store state info on server side only: ASP.NET View State, OWASP ESAPI Session Mgmt

Problem: Insecure Interaction Between Components

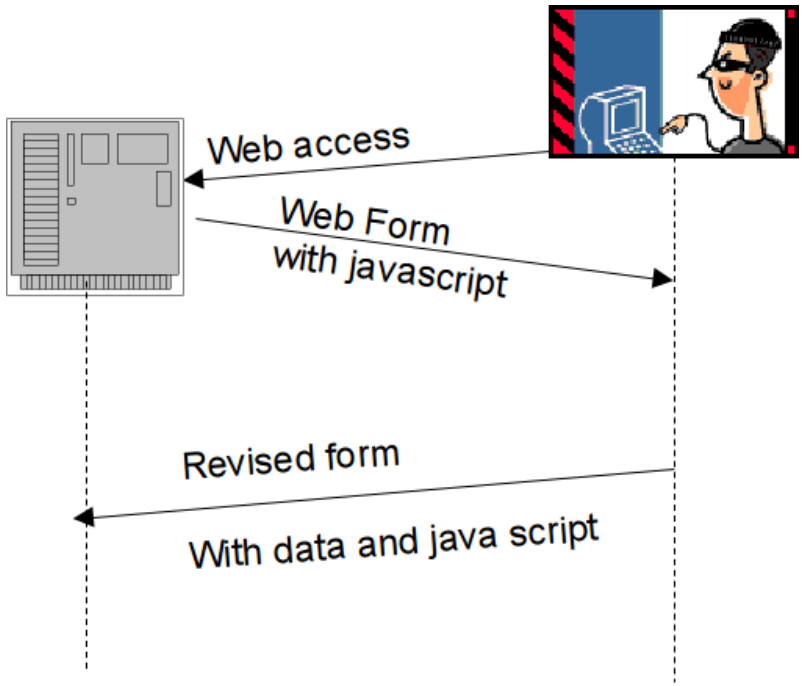


Attack: Code is reverse engineered and modified to act differently.

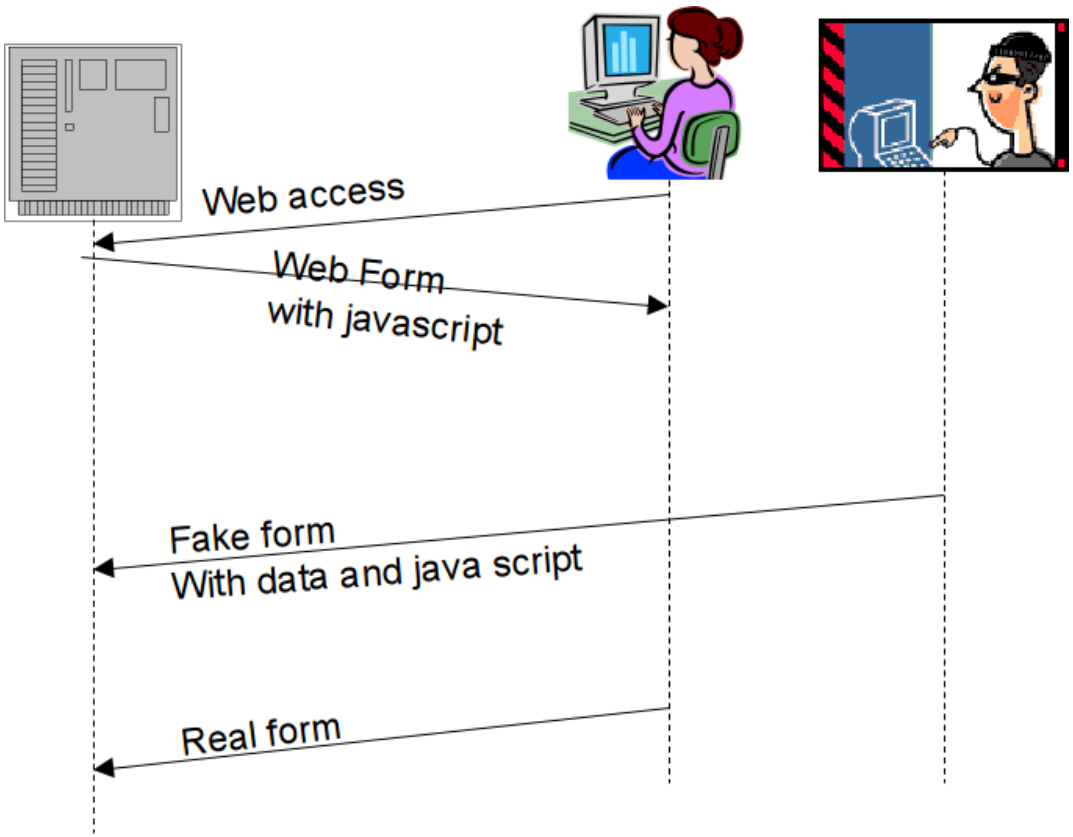
Problem:
Server assumes validation occurred in client
Does not recheck

Problem: Insecure Interaction Between Components

- Web servers are memoryless
- Do not remember sending a form to a client - what type, info
- Client side can remove checks, insert other code, return unexpected data, etc.



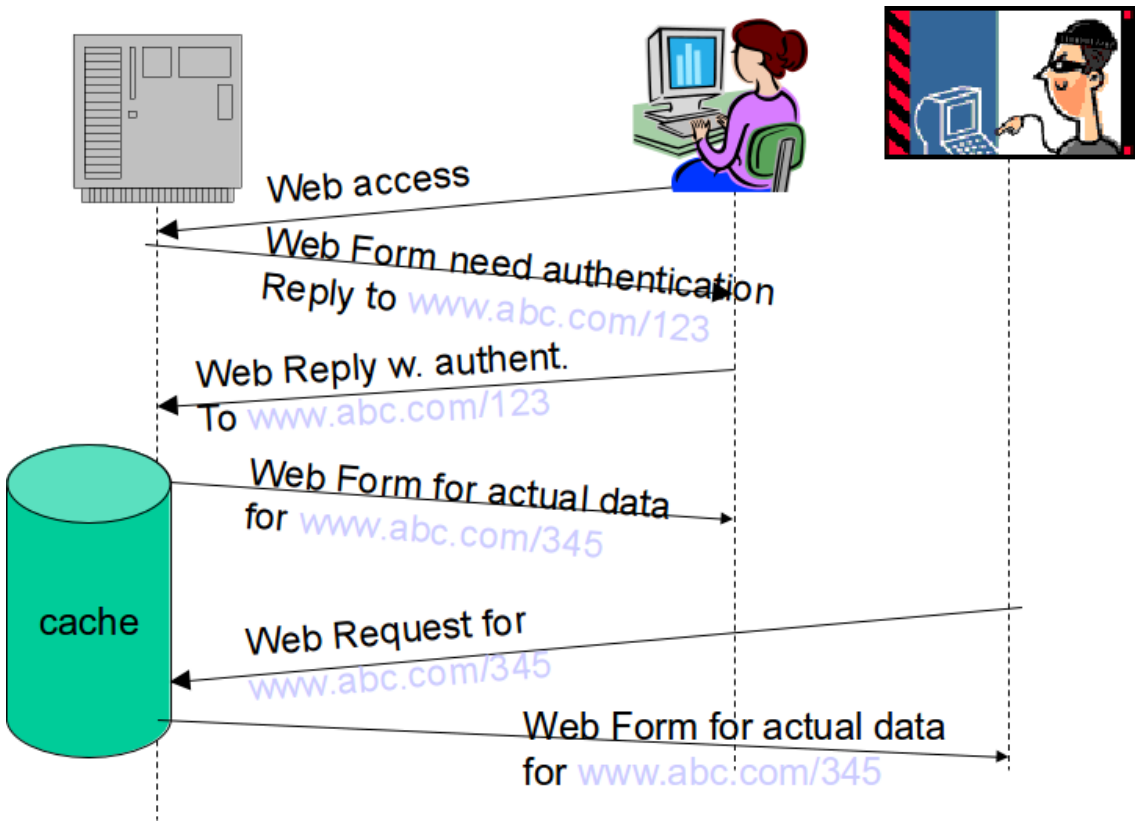
Problem: Forgery



Fix: Prevent Forgery

- Use a nonce for each form
- Not predictable
- If dangerous operation, send a separate confirmation request

Problem: Improper Access Control



Fix: Access Permissions

- Use Role-Based Access
  - At least permissions: anonymous, normal, privileged, administrative
- Verify access control at server side
- Sensitive pages are never cached and must have active authorization token
- Only provide higher level access when you need it; always run with the minimum possible authorization level
- Check that files read have the required access level permissions; administrators may not set them properly.
- Use a good random number generator when generating random session keys – if not random, attackers will figure out next key sequence

Problem: External Control of Path

- If you download an external file or navigate to a URL - and execute
- If you provide access to a file on your system
- Attacker can insert `../../` and access files outside privilege.

Fix:

- Run as low-privilege user
- Provide fixed input values
- Run code in 'jail': Unix chroot jail and AppArmor

Examples

Problem: Some Security Errors

Find the errors:

```
Security() {
    String contents, environment;
    String spath = "security.dat"
    File security = new File;
    if (security.open("spath") >0)
        contents = security.read();
        environment = security.read();
    else
        print("Error: Security.dat not found");
}
```

Problem: Some Security Errors

1. Variables contents & Environment not initialized
   - Can cause problems if executed in certain ways
   - Attacker can initialize or read variables from previous session
2. "security.dat" is not full pathname
   - File can be replaced if run from another location
3. File 'security' not closed
   - Leaves file open to attack
   - Keeps unnecessary resources busy
4. Error message indicates file name
   - Can give attacker important info

Problem: More Security Errors

Find the errors:

```
purchaseProduct() {
    password = "N23m**2d3";
    count = form.quantity;
    total = count * product.cost();
    Message m = new Message(
        name,product,total);
    m.myEncrypt();
    server.send(m);
}
```

Problem: More Security Errors

1. Password is hardcoded
   - If attacker find it, every system can be broken into before software is changed on all computers
   - Passwords may only be stored in encrypted file
2. Total may overflow, producing very small number
   - Input is not checked (could be zero or invalid)
3. Encryption should be standard algorithm
   - Home-written variety can be broken into easily