CS1632, LECTURE 15: Security Testing

Bill Laboon

Writing Secure Software Is Difficult; So Is Testing It!

- **Heartbleed:** ~ 66% of servers connected to the Internet vulnerable; allowed for basically untraceable eavesdropping on data in memory
- **Shellshock**: A defect in bash (default shell for OS X and most Linux distributions) which allowed arbitrary code execution. Discovered in 2014; vulnerability was introduced in 1989.
- **June 2016**: Sixteen vulnerabilities found in Windows 7 font display subsystem!

Why Is It Difficult?

1. Adversaries are actively seeking to defeat security
2. Information about security vulnerabilities modifies behavior of adversaries
3. You need to protect all doors; they only need to find one they can open
4. Even minor vulnerabilities can have truly catastrophic consequences

Pittsburgh – A Great City To Learn About Security!

- Really!
- Many security researchers here at Pitt and CMU
  - LERSAIS – Laboratory for Education & Research on Security-Assured Information System
  - CyLab at CMU
  - People right here in the CS department
- Software Engineering Institute
- CERT
- Many security engineering positions (esp. at banks)

History

- Security was not a big deal in the early computing world
- Usually required physical access to a system to do anything
- Few people had necessary skills even if they did (“security through obscurity”)

But there were networked systems in the 60s and 70s…

Phone Phreaking

The 80s: Security Goes Mainstream

People Were Concerned This Would Happen

1988 – The Year It All Changed

Breaking Into Computers Went Mainstream

Sadly, skills used less and less often for curiosity… exploiting vulnerabilities is Big Business

The InfoSec (CIA) Triad

- A secure system needs to provide three qualities:
  - *Confidentiality*
  - *Integrity*
  - *Availability*

Confidentiality

No unauthorized users may read data.

Integrity

No unauthorized users may write data.

Availability

System is available for authorized parties to read from and write to.

Terminology: Kinds of Security Attacks

1. *Interruption* (attack on availability, e.g. pulling plug from network switch, DDoS)
2. *Interception* (attack on confidentiality; e.g. eavesdropping, keylogger)
3. *Modification* (attack on integrity; modifying or deleting data)
4. *Fabrication* (attack on integrity; making up or inserting data)

Terminology: Passive vs Active Attacks

- *Passive: Do not modify system in any way*
    - Eavesdropping
    - Monitoring
    - Traffic Analysis
- *Active: Modify the system in some way*
    - Log in as a different user
    - Fill up database with garbage data
    - Modify bank account information

Terminology: Vulnerability vs Exploit

- Vulnerability: identified weakness of a system
- Exploit: (aka "sploit") Technique or mechanism used to compromise a system using a vulnerability

Terminology: Kinds of Malicious Code

- **Malware** – General term for malicious code (includes all kinds below)
- **Bacteria** - program that consumes system resources (e.g. fork bomb)
- **Logic bomb** - code within a program which executes an unauthorized function
- **Trapdoor** - secret undocumented access to a system or app
- **Trojan horse** – program that pretends to be another program
- **Virus** - replicates itself WITH human intervention
- **Worm** - replicates itself WITHOUT human intervention
- **Zombie** – A computer or program being run by an unauthorized controller
- **Bot network** – collection of zombies controlled by master
- **Spyware** – surreptitiously monitors your actions
- **Adware** – Shows you more ads
- **DOS** (Denial of service) attacks (e.g. via LOIC)

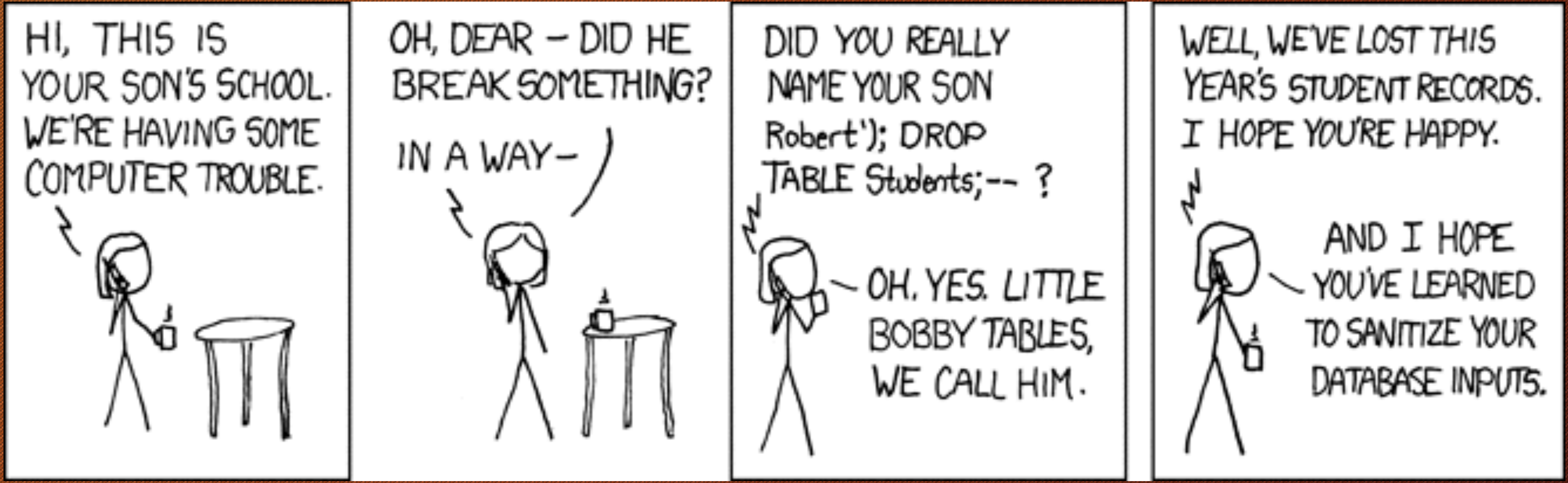
Protections

- Firewalls
- Operating System Permissions
- CDNs
- Well-written code
- Proper security measures
- Cryptography
- User training

Common Attacks

- Injection Attacks
- Broken Authentication
- Cross-Site Scripting (XSS)
- Insecure Object References
- Security Misconfiguration
- Insecure Storage
- Buffer overruns
- Social Engineering

Injection Attacks


HI, THIS IS YOUR SON'S SCHOOL. WE'RE HAVING SOME COMPUTER TROUBLE.
OH, DEAR – DID HE BREAK SOMETHING?
IN A WAY–
DID YOU REALLY NAME YOUR SON Robert'); DROP TABLE Students;-- ?
OH. YES. LITTLE BOBBY TABLES, WE CALL HIM.
WELL, WE'VE LOST THIS YEAR'S STUDENT RECORDS. I HOPE YOU'RE HAPPY.
AND I HOPE YOU'VE LEARNED TO SANITIZE YOUR DATABASE INPUTS.

Broken Authentication

- One user pretends to be another
- How?
  - Guess or crack passwords
  - “Password reset”
  - Unencrypted session IDs
- Apple iCloud leak was suspected of being this
- Sarah Palin email hack was definitely this
  - All the impersonator needed to know, he learned from Wikipedia
  - Answered security questions, reset password

Cross-Site Scripting

- Get a third party to execute code on their system
- Similar to an injection attack, but with an intermediary
- <html>I love Nickelback! They're so dreamy!<script>eval("evil code!!!!")</script></html>

Insecure Object References

- Someone can access something by knowing where it is, despite not having proper security credentials
  - http://bank.com/?account=9844
  - http://bank.com/?account=9845

Security Misconfiguration

- You have proper security, it’s just not set up correctly!
- Default passwords
- IPS, packet filtering, etc. not running
- Insecure machine on secure network

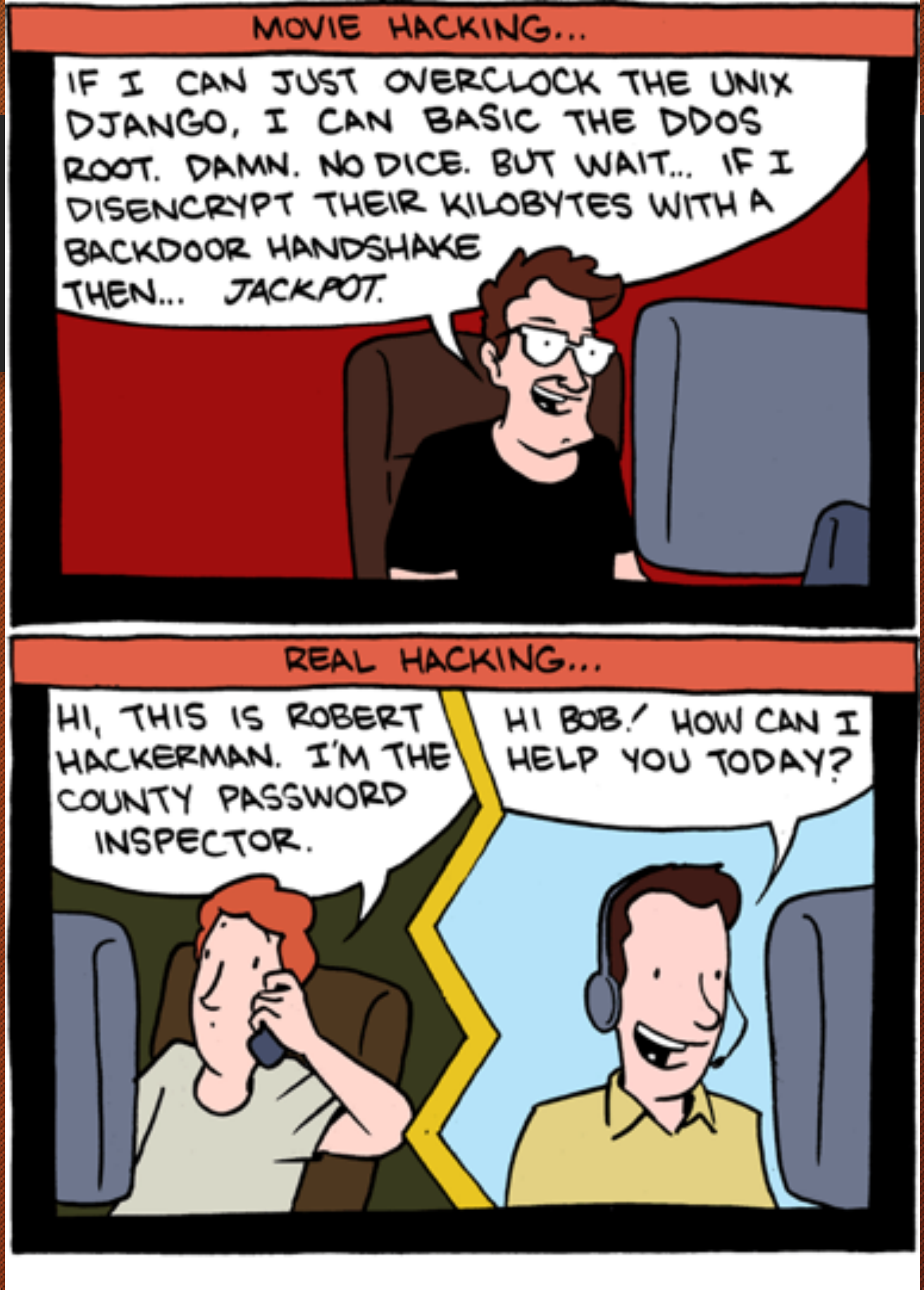
Insecure Storage

- Secure data is stored in an unsafe way
- Example: credit card numbers being stored in a /tmp or logging directory as part of logging all transactions

Buffer Overrun

- Trying to read or write more data than a buffer supposedly has access to – reading or writing past the end of a buffer
- This is what heartbleed was – see heartbleed.c in sample_code directory

Social Engineering


MOVIE HACKING...
IF I CAN JUST OVERCLOCK THE UNIX DJANGO, I CAN BASIC THE DDOS ROOT. DAMN. NO DICE. BUT WAIT... IF I DISENCRYPT THEIR KILOBYTES WITH A BACKDOOR HANDSHAKE THEN... JACKPOT.
REAL HACKING...
HI, THIS IS ROBERT HACKERMAN. I'M THE COUNTY PASSWORD INSPECTOR.
HI BOB! HOW CAN I HELP YOU TODAY?