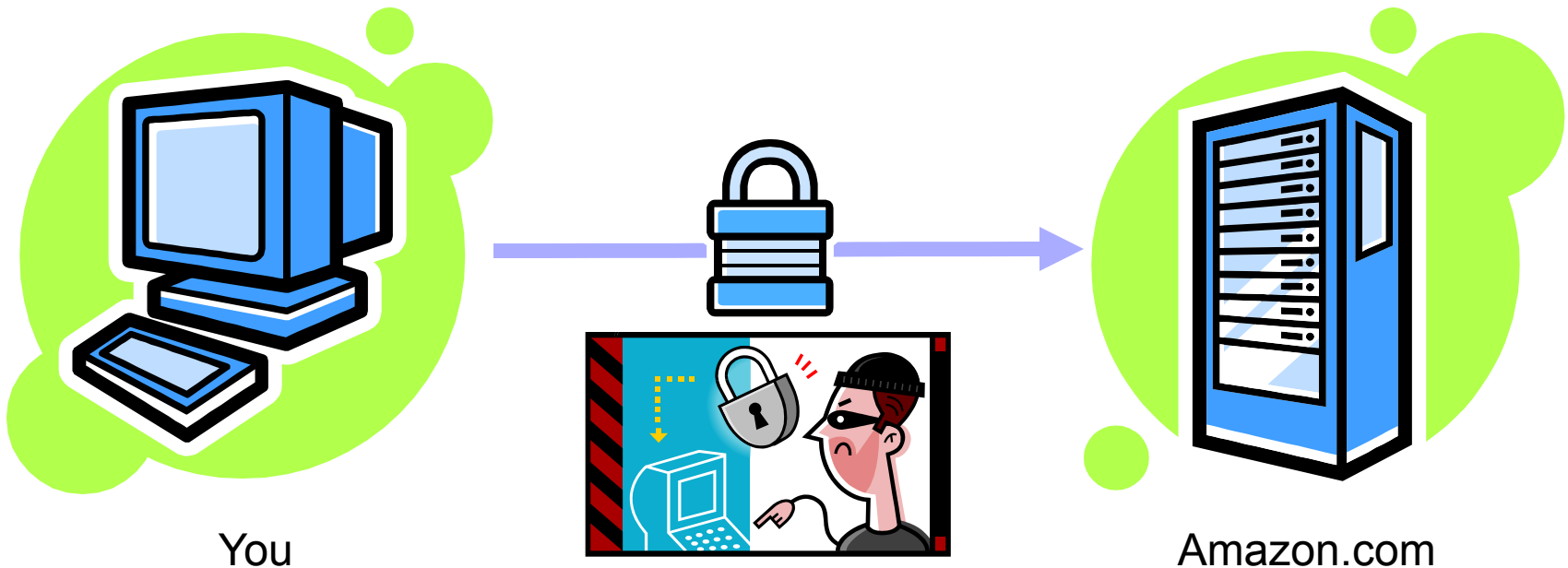


# Viruses, Worms, Zombies, and other Beasties

COS 116, Spring 2012  
Adam Finkelstein

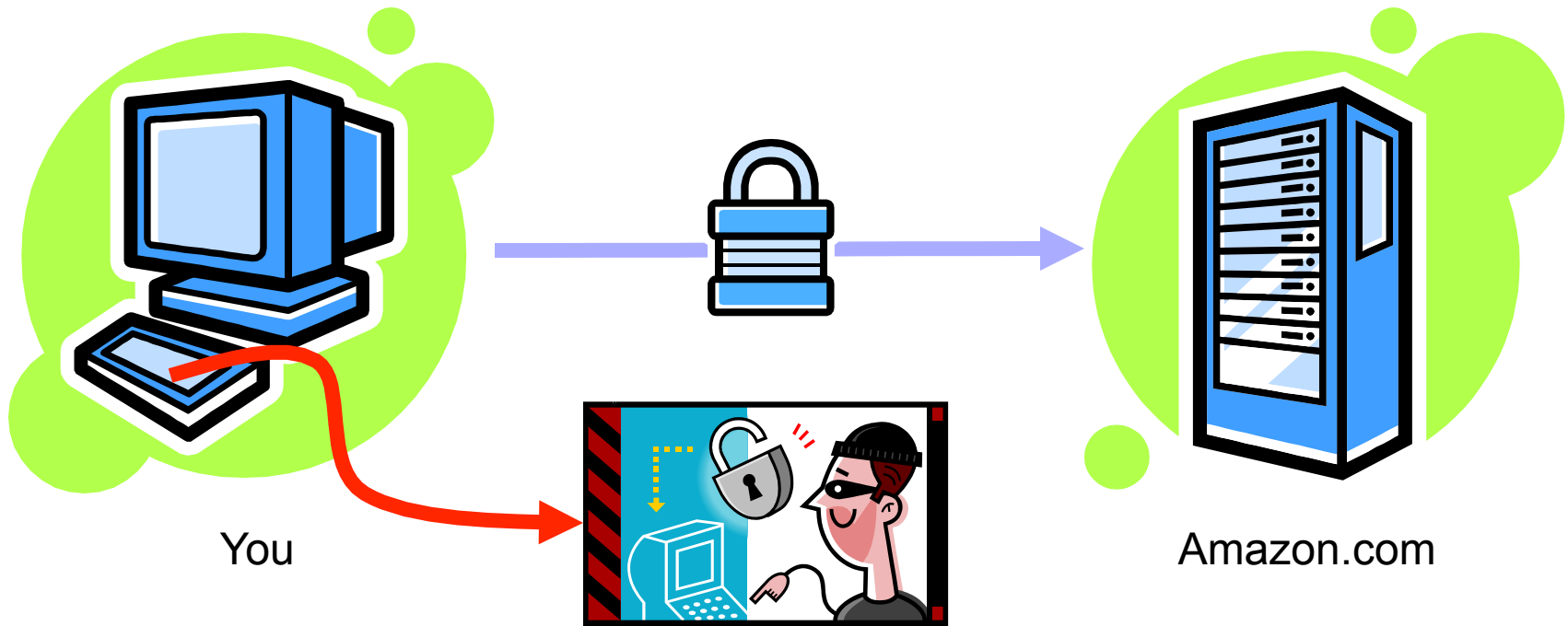
# Encryption (topic late in class)



Encryption strongly protects data en route

Today's story: Attacker can compromise your computer  
*without breaking encryption.*

# Encrypted $\neq$ Secure



Ex: break into your computer and “sniff” keystrokes as you type



# Breaking into a Computer

What does it mean?

How is it done?

Can we prevent it?



# What's at Stake?

## Kinds of damage caused by break-ins

- Nuisance: spam, ...
- Data erased, corrupted, or held hostage
- Valuable information stolen  
(credit card numbers, trade secrets, etc.)
- Services made unavailable  
(email and web site outages, lost business)

**Other fears: cyber-crime, terrorism, etc.**



# Main themes of today's lecture

Self-reproducing programs: viruses, worms, zombies

Other threats to computer security

Internet = Today's Wild West

There is no silver bullet against cyber crime,  
but follow good security practices



# Breaking into a Computer

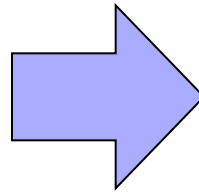
What?

- Run unauthorized software

How?

- Trick the user into running bad software (“social engineering”)
- Exploit software bugs to run bad software without the user's help

# Example of “social engineering”: Trojan Horse



CoolScreenSaver.exe



# Viruses and Worms

Automated ways of breaking in;

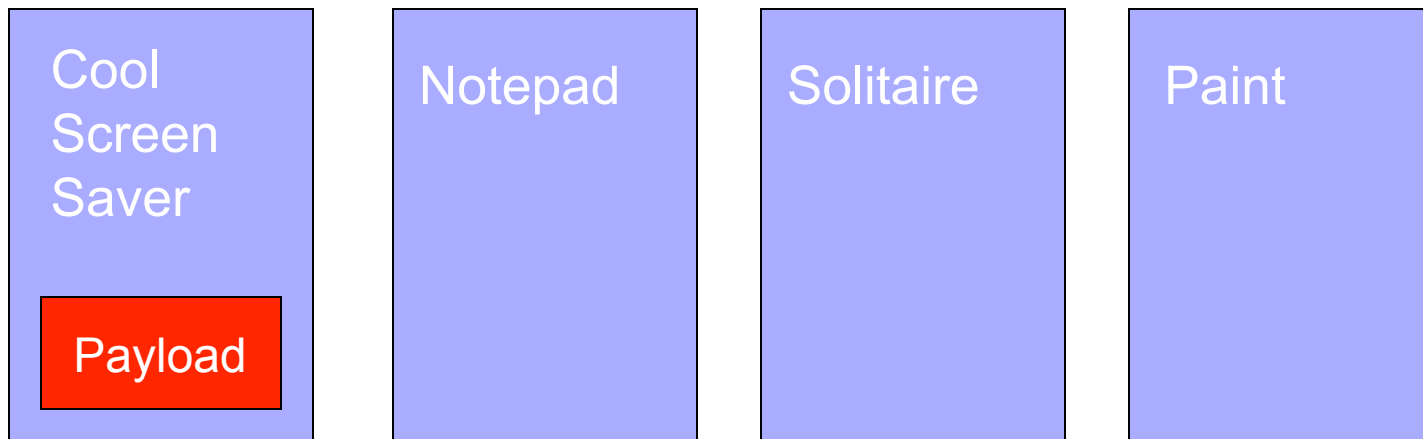
Use **self-replicating programs**

(Recall self-replicating programs:

*Print the following line twice, the second time in quotes. “Print the following line twice, the second time in quotes.” )*

# Computer Viruses

Self-replicating programs that spread by infecting other programs or data files



Must fool users into opening the infected file



# Email Viruses

- Infected program, screen saver, or Word document launches virus when opened
- Use **social engineering** to entice you to open the virus attachment
- **Self-spreading:** after you open it, automatically emails copies to everyone in your address book

# The Melissa Virus (1999)

- Social engineering: Email says attachment contains porn site passwords
- Self-spreading: Random 50 people from address book
- Traffic forced shutdown of many email servers
- \$80 million damage
- 20 months and \$5000 fine



David L. Smith  
Aberdeen, NJ



# Combating Viruses

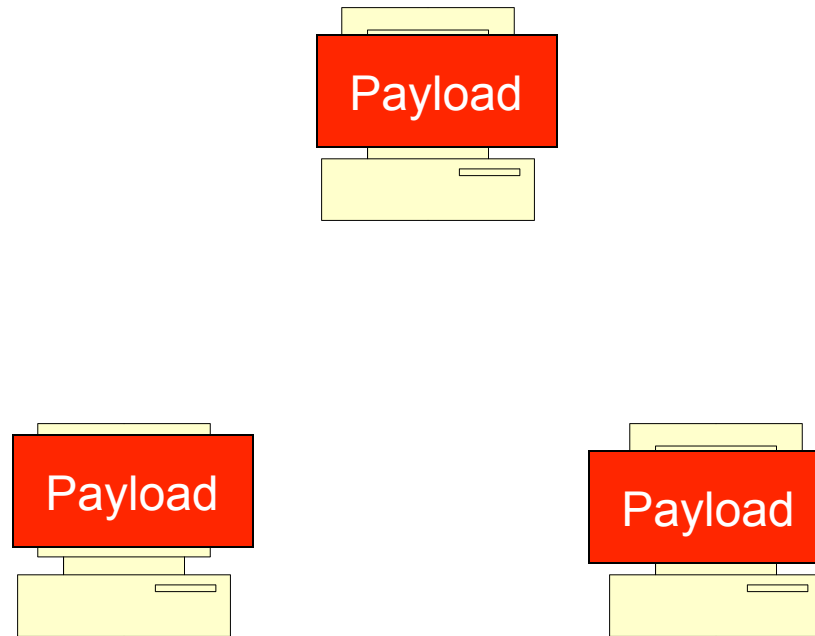
Constant battle between attackers and defenders

Example:

- Anti-virus software finds “signature” of known virus
- Attacker response: *Polymorphic virus* – to thwart detection, change code when reproduced
- Anti-virus software adapts to find some kinds of polymorphism
- But an infinite number of ways to permute viruses available to attackers

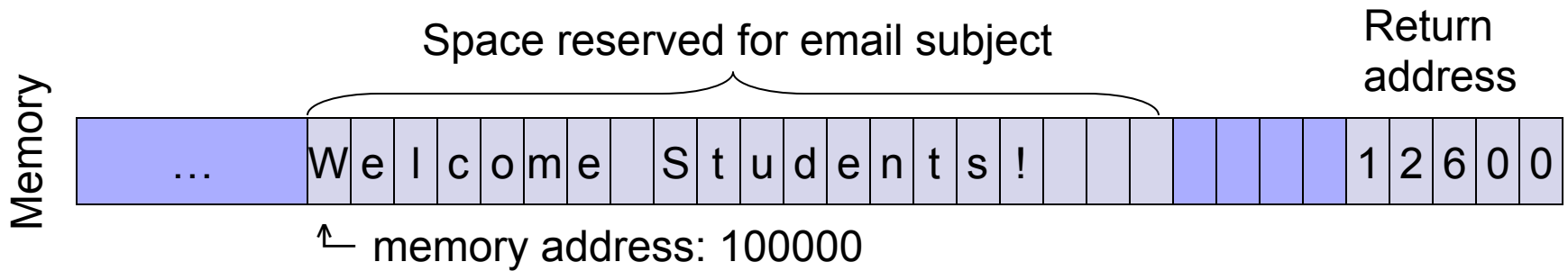
# Computer Worms

Self-replicating programs like viruses, except exploit security holes to spread on their own without human intervention



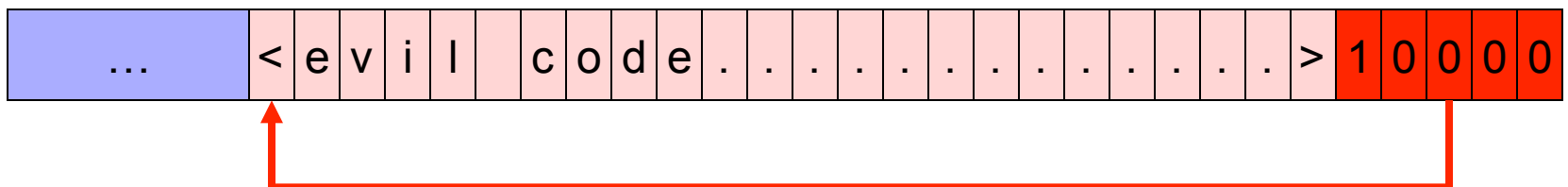
# Frequent source of vulnerability: Buffer Overflow bug

From: COS 116 Staff  
Subject: Welcome Students!



Buffer overflow bug: Programmer forgot to insert check for whether email subject is too big to fit in memory “buffer”

From: Bad Guy  
Subject: <evil code . . . . . >100000



# The Morris Worm (1988)

- First Internet worm
- Created by student at Cornell
- Exploited holes in email servers, other programs
- Infected ~10% of the net
- Spawned multiple copies, crippling infected servers
- Sentenced to 3 years probation, \$10,000 fine, 400 hours community service



Robert Tappan Morris



CAPT. VIC



25 AD

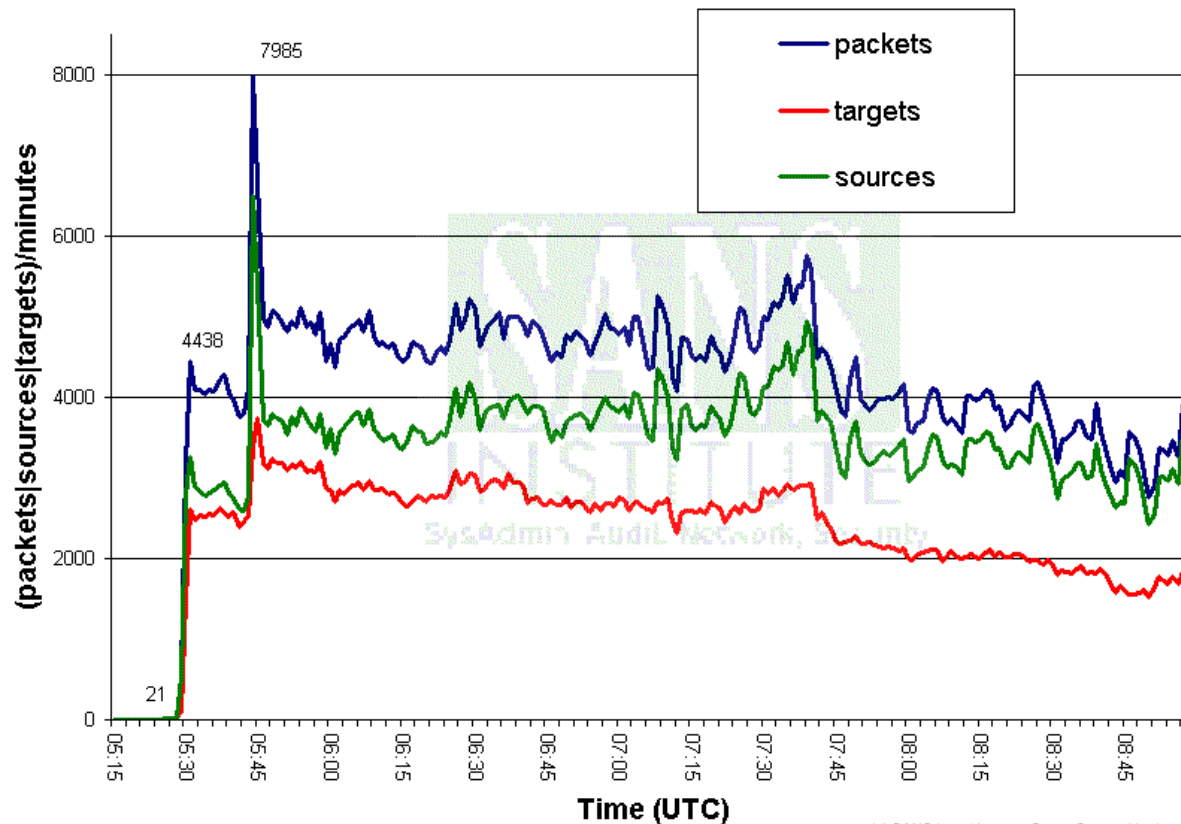
# The Slammer Worm (2003)

- Fastest spreading worm to date
- Only 376 bytes—Exploited buffer overflow in Microsoft database server products
- Spread by sending infection packets to random servers as fast as possible, hundreds per second
- Infected 90% of vulnerable systems within 10 minutes!  
200,000 servers
- No destructive payload, but packet volume shut down large portions of the Internet for hours
- 911 systems, airlines, ATMs — \$1 billion damage!
- Patch already available months previously, but not widely installed

# Why is it so hard to stop Worms?

contact: SANS Inst., <http://isc.sans.org>, [jullrich@sans.org](mailto:jullrich@sans.org)

Port 1434 traffic 5:15 am - 9 am January 25th 2003



(c) SANS Inst. / Internet Storm Center. Unaltered distribution permitted.


Spread of the Slammer worm



“Can we just develop software  
to detect a virus/worm?”

[Adleman'88] This task is undecidable.  
(so no software can work with 100% guarantee)

How about Norton?!? No real guarantee



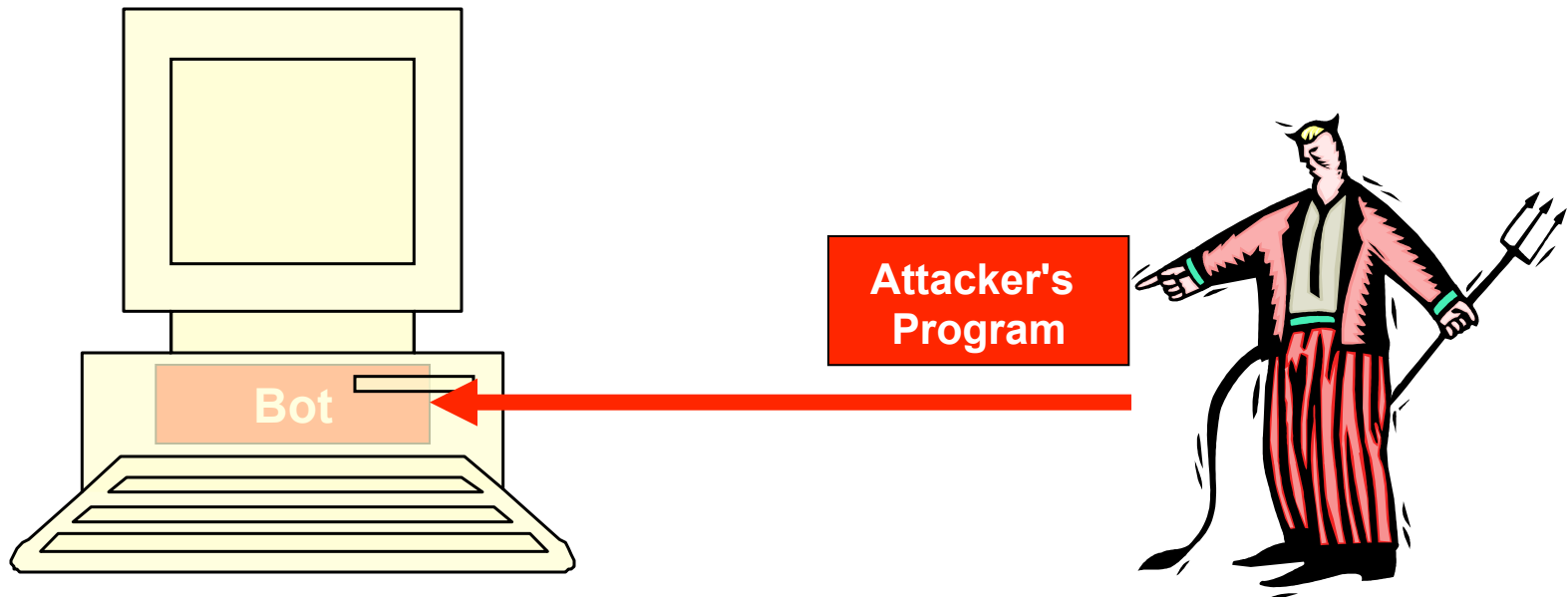
# Why do people write worms and viruses?

Sometimes because they are  
curious / misfits / anarchists / bored...


# Main reason: Botnets

- Virus/worm payload:  
Install *bot* program on target computer
- Bot makes target a *zombie*,  
remotely controlled by attacker
- Many zombies harnessed into armies  
called *botnets* – often 100,000s of PCs

# Zombies



Bot program runs silently in the background,  
awaiting instructions from the attacker

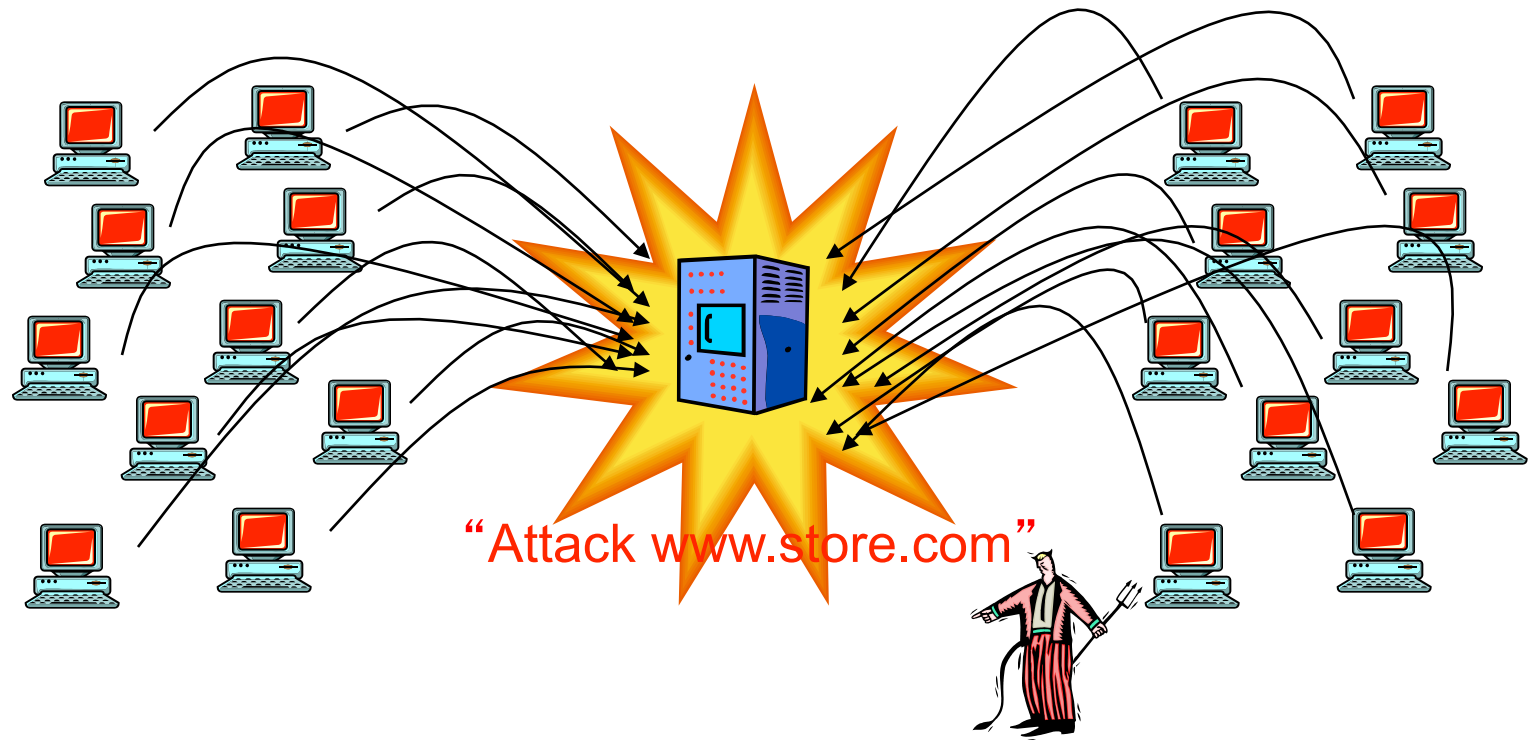


Why go to the trouble of  
creating a botnet?



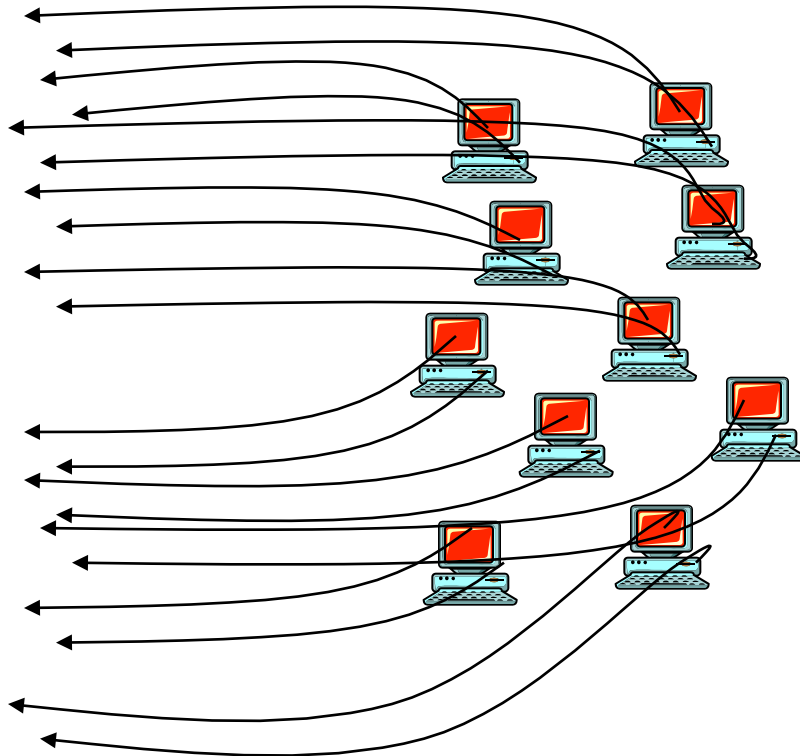
# Reason 1: DDOS Attacks

“Distributed Denial of Service”



Objective: Overwhelm target site with traffic

# Reason 2: Sending Spam



“Forward this message:  
Subject: Viagra!  
...”



Messages are hard to filter because there are thousands of senders





# Other reasons

- Click fraud.
- Commit other cybercrime that is hard to trace

# Storm Botnet

- Created via email scam in 2007
  - spread to a million computers
- Owners unknown (believed to be Russian)
- Used for DoS and Email spams, available for “rent”
- Fiendishly clever design
  - distributed control, similar to Kazaa, Gnutella
  - rapidly morphing code; morphs every hour or so
  - seems to detect attempts to track/contain it and “punishes” its pursuers



And if you weren't scared  
enough already...

# Princeton prof hacks e-vote machine

Students uploaded viruses able to spread to other machines

**AP** Associated Press

updated 9:48 p.m. ET, Wed., Sept. 13, 2006

TRENTON, N.J. - A Princeton University computer science professor added new fuel Wednesday to claims that electronic voting machines used across much of the country are vulnerable to hacking that could alter vote totals or disable machines.

In a paper posted on the university's Web site, Edward Felten and two graduate students described how they had tested a Diebold AccuVote-TS machine they obtained, found ways to quickly upload malicious programs and even developed a computer virus able to spread such programs between machines.

## MSN TECH AND GADGETS

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Part of complete coverage on  
**Election Center**

AMERICA'S CHOICE 2012 **ELECTION CENTER**

## Analysis: Professor exposes more voting system flaws

By **Dave Schechter**, CNN Senior National Editor  
October 27, 2010 9:14 a.m. EDT

<http://www.cnn.com/2010/POLITICS/10/25/voting.system.flaws/index.html>

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**J. Alex Halderman**  
UNIVERSITY OF MICHIGAN



**Electronic voting not hard to hack**

Source: CNN

### STORY HIGHLIGHTS

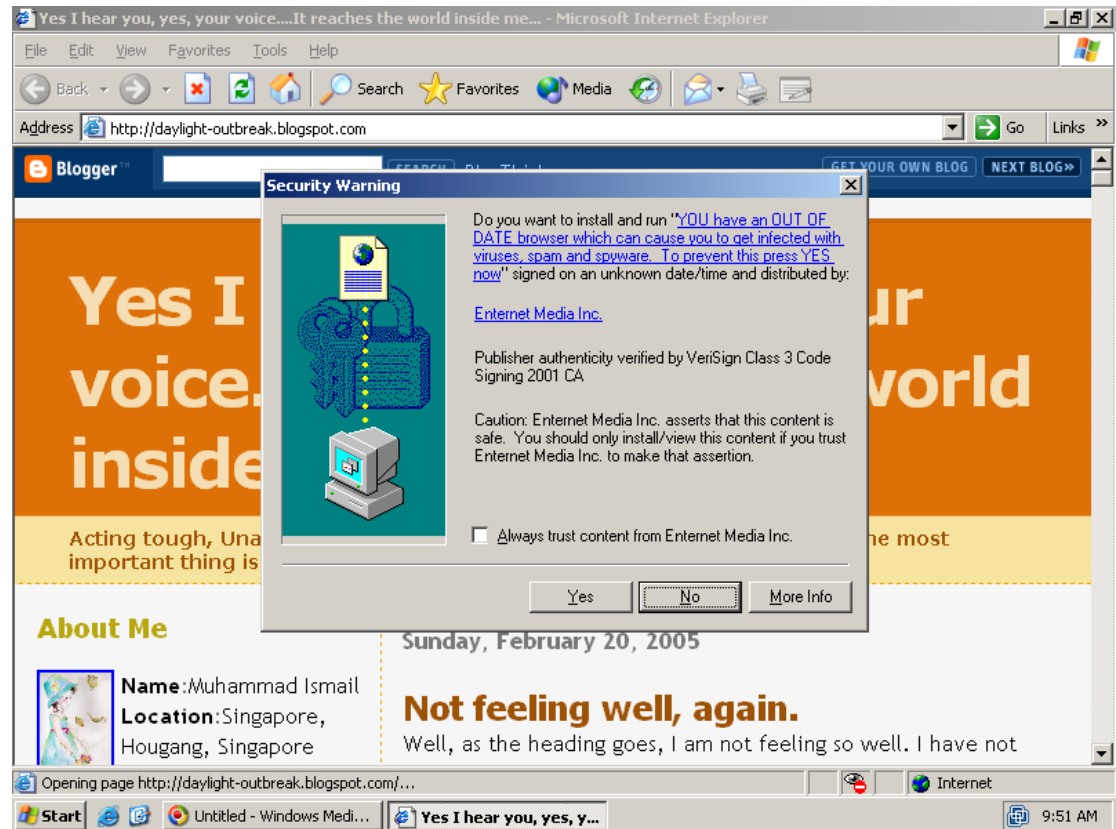
- Professor, students expose vulnerabilities in internet-based voting system
- Halderman's team modified online ballots; had page play University of Michigan fight song

*As the 2010 midterm elections approach, Dave Schechter has been following voting systems and voter irregularity issues for CNN.*

**(CNN)** -- In a previous posting about voting issues, I mentioned J. Alex Halderman, an assistant professor of engineering and computer science at the University of Michigan, whose "resume" includes hacking into voting machines in the name of exposing

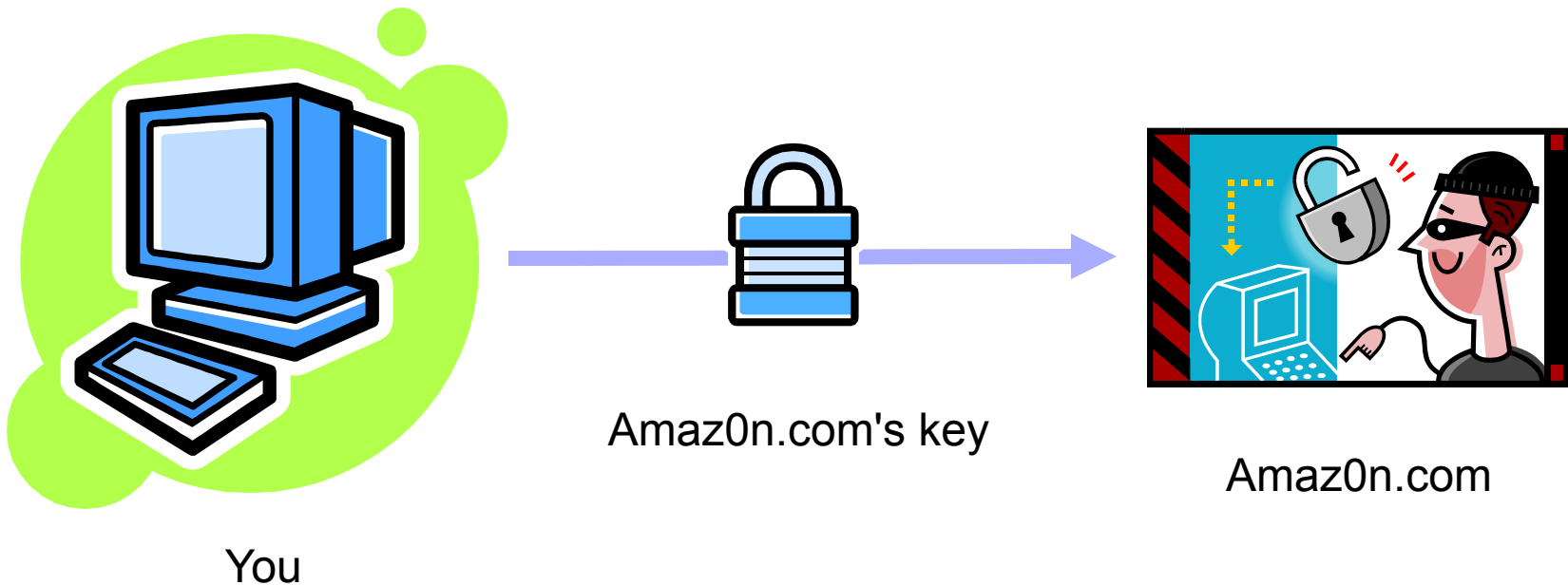
# Spyware/Adware

- Hidden but not self-replicating
- Tracks web activity for marketing, shows popup ads, etc.
- Usually written by businesses: Legal gray area





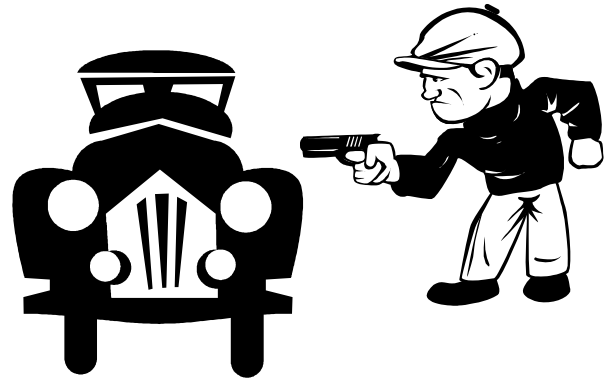
# Spoofting Attacks



Attacker impersonates the merchant (“spoofing”)  
Your data is encrypted...

...all the way to the bad guy!

# Attackers are Adaptive



Defenders must continually adapt to keep up



# Can we stop computer crime?

Probably not!

- Wild West nature of the Internet
- Software will always have bugs
- Rapid exponential spread of attacks

But we can take steps to reduce risks...

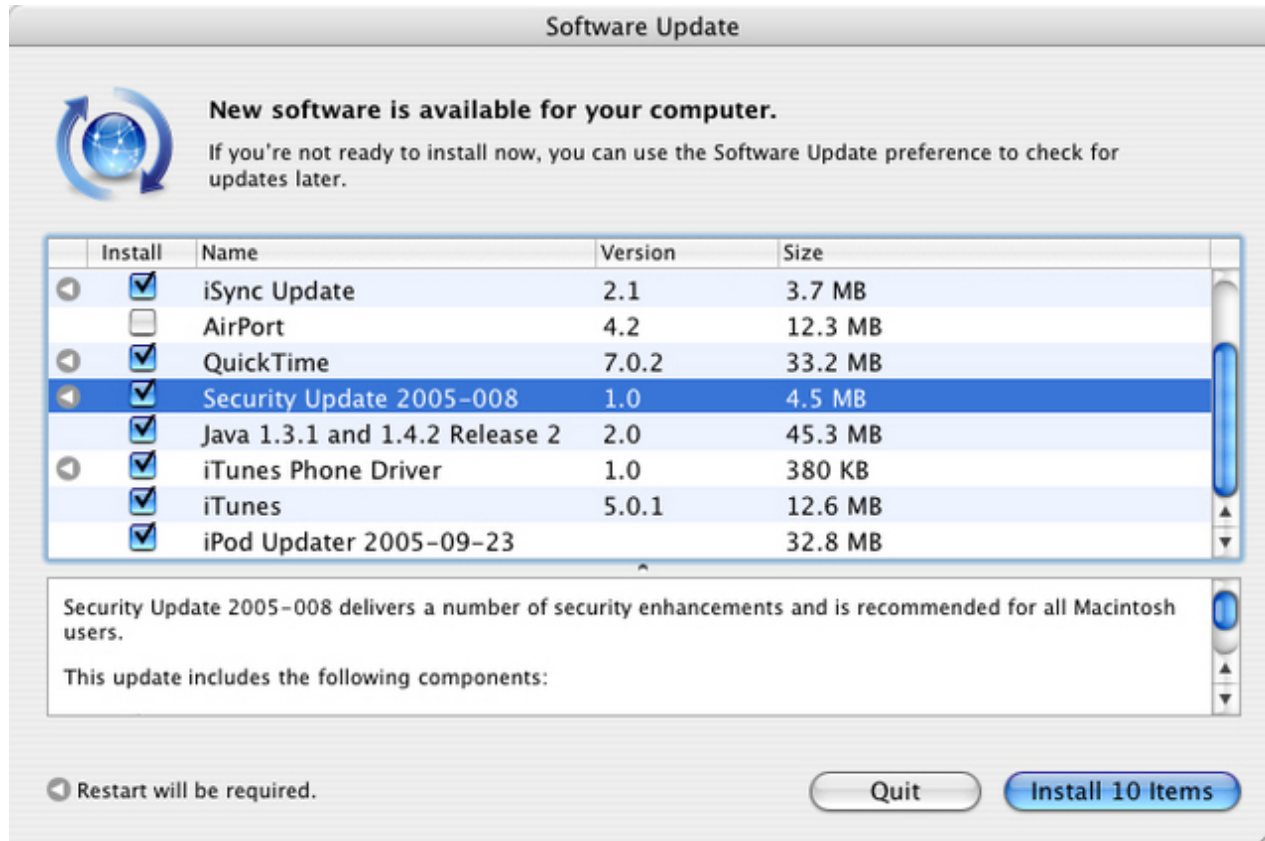


# Protecting Your Computer

Six easy things you can do...

- Keep your software up-to-date
- Use safe programs to surf the 'net
- Run anti-virus and anti-spyware regularly
- Add an external firewall
- Back up your data
- Learn to be “street smart” online

# Keep Software Up-to-Date



# Use Safe Software to Go Online

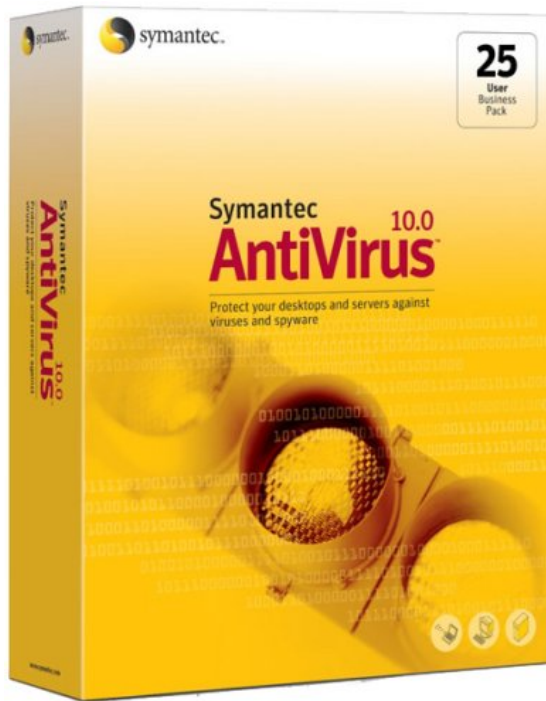


Firefox  
(web browser)



Thunderbird  
(email)

# Anti-virus / Anti-spyware Scans

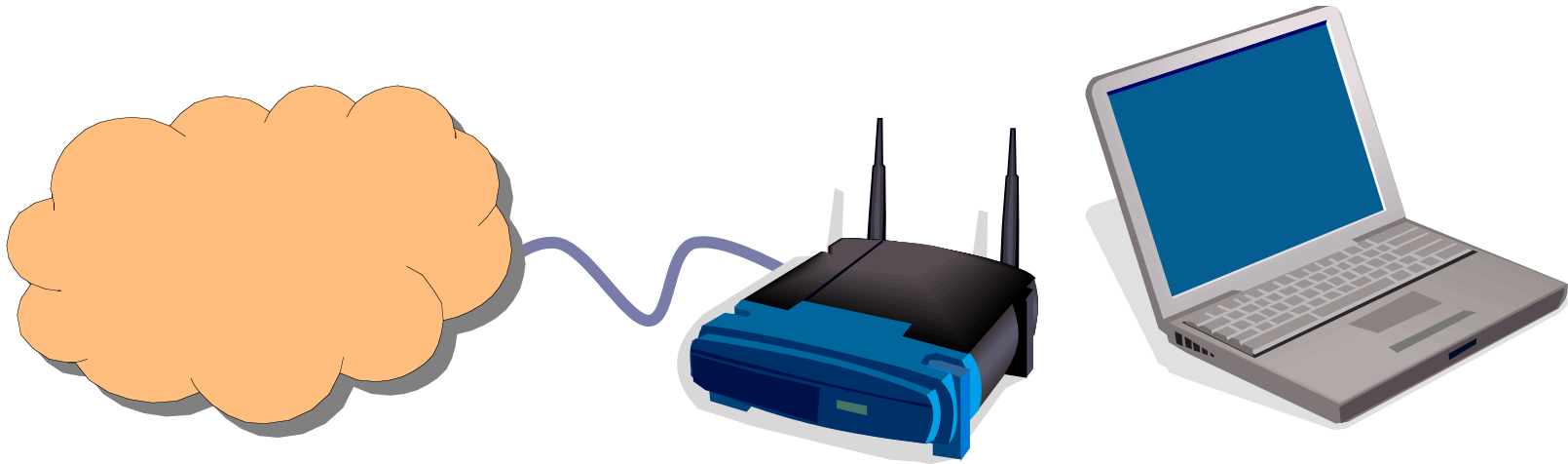


Symantec Antivirus  
(Free from OIT)



Spybot Search & Destroy  
(Free download)

# Add an External Firewall



Provides **layered security**  
(think: castle walls, moat)

(Recent operating systems have built-in firewall features)



# Back Up Your Data



Tivoli Storage Manager  
(Free from OIT)



CrashPlan  
(Free for friends)



# Learn Online “Street Smarts”

- Be aware of your surroundings
  - Is the web site being spoofed?
- Don't accept candy from strangers
  - How do you know an attachment or download isn't a virus, Trojan, or spyware?
- Don't believe everything you read
  - Email may contain viruses or phishing attack – remember, bad guys can forge email from your friends