CSCI E-170 Lecture 09:
Attacker Motivations, Computer Crime and Secure Coding

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Today's Agenda

1. Administrivia
2. Missing Readings for L09, L10
3. Threat Models: Who is the attacker? What can the attacker do?
4. Secure Coding
5. Translucent Databases
6. RFID

Administrivia

1. Quizes - If you are a remote student and you want it back, please email `csci_e-170-staff@ex.com` with a fax number and we will fax it out.

2. Midterm Projects should be in.

Final Projects

This is a research project, not a book review.

You are expected to:

1. Create something and write about it.

2. Analyze something in detail.

You have until next Monday to form groups of 4 students.

Email group names and your proposed topic to `csci_e-170-staff@ex.com`.

Students who have not chosen groups will be assigned.

Why is building a *secure* system different than building a system that is:

1. Reliable
2. Safe
3. Easy-to-use

?

With security, there is an adversary.

N-UniversalSoldier.jpg
240 x 327 pixels - 25k
www.checkpoint-online.ch

adversary-1.gif
150 x 142 pixels - 16k
www.sonic-boom.com

20021011.gif
597 x 694 pixels - 81k
www.genecatlow.com

LexLuthor_RuthlessAdversa...
241 x 344 pixels - 50k
www.marveloverpower.com

309.jpg
500 x 500 pixels - 28k
www.habett.org

Bullfighting_1_2000_25
256 x 170 pixels - 14k
www.augusta.com

No reason to defend against an unbounded adversary. Why?

The nature of the adversary determines your defenses.

Possible adversaries include:

1. Employees (good and bad)
2. High school students
3. Foreign Governments (“Titan Rain?”)

Evaluate according to *who they are* and by *what they can accomplish.*

Remember RFC 602?

Public acknowledgment of hackers on the Internet:

1. Sites used physical security have not taken measures to secure machines accessible over the network.

2. “TIPs” allow anyone who knows a phone number access to the Internet.

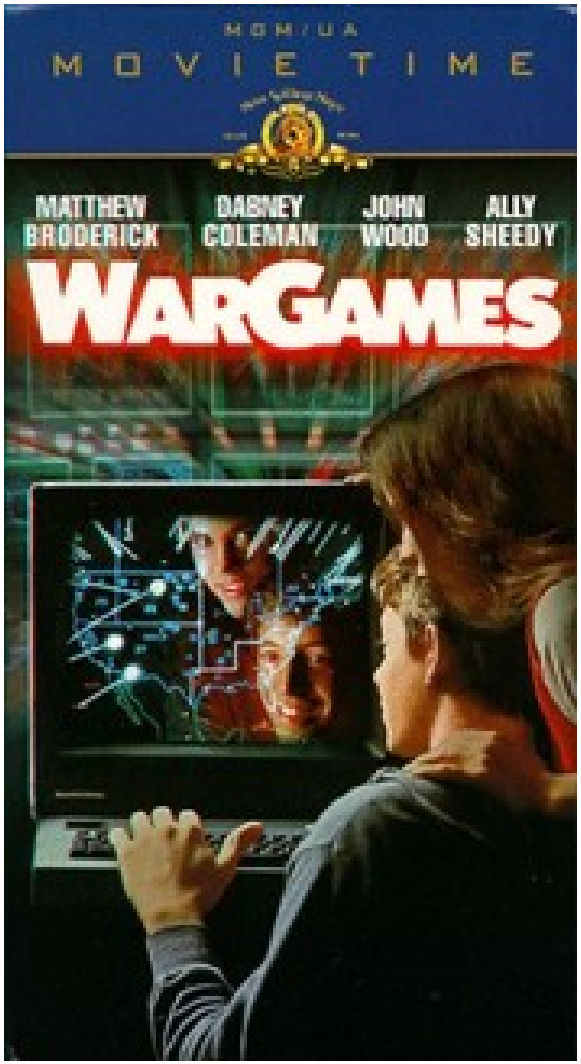
3. “There is lingering affection for the challenge of breaking someone’s system. This affection lingers despite the fact that everyone knows that it’s easy to break systems, even easier to crash them.”

`http://www.faqs.org/rfcs/rfc602.html`

1983: War Games

“How about a nice game of Chess?”

“Later. Let’s play Global Thermonuclear War.”



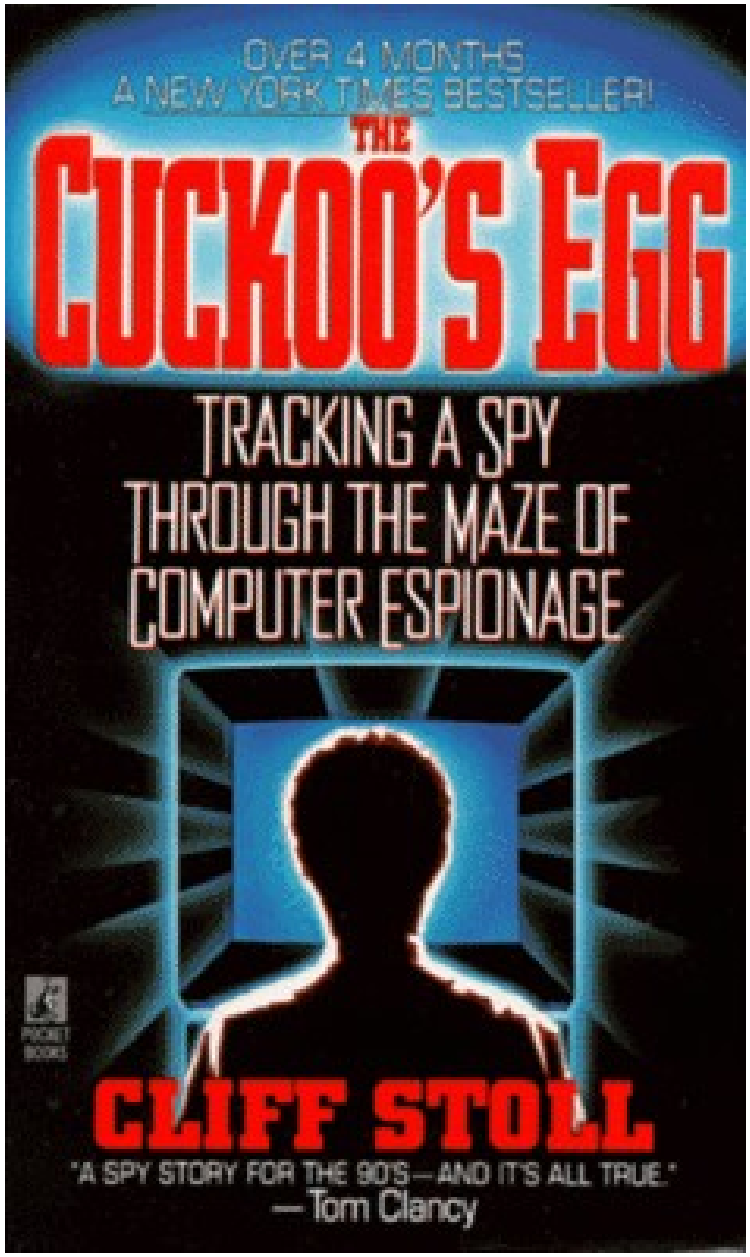
All of a sudden, hacking is cool.

1986: The Cuckoo's Egg

"75 cent accounting error"

Stoll sets up a honeypot filled with "SDINet" files.

Hacker gets traced back to Germany. Apparently sold secrets to KGB in exchange for cash and cocaine.



Emergence of the Hacker Underground

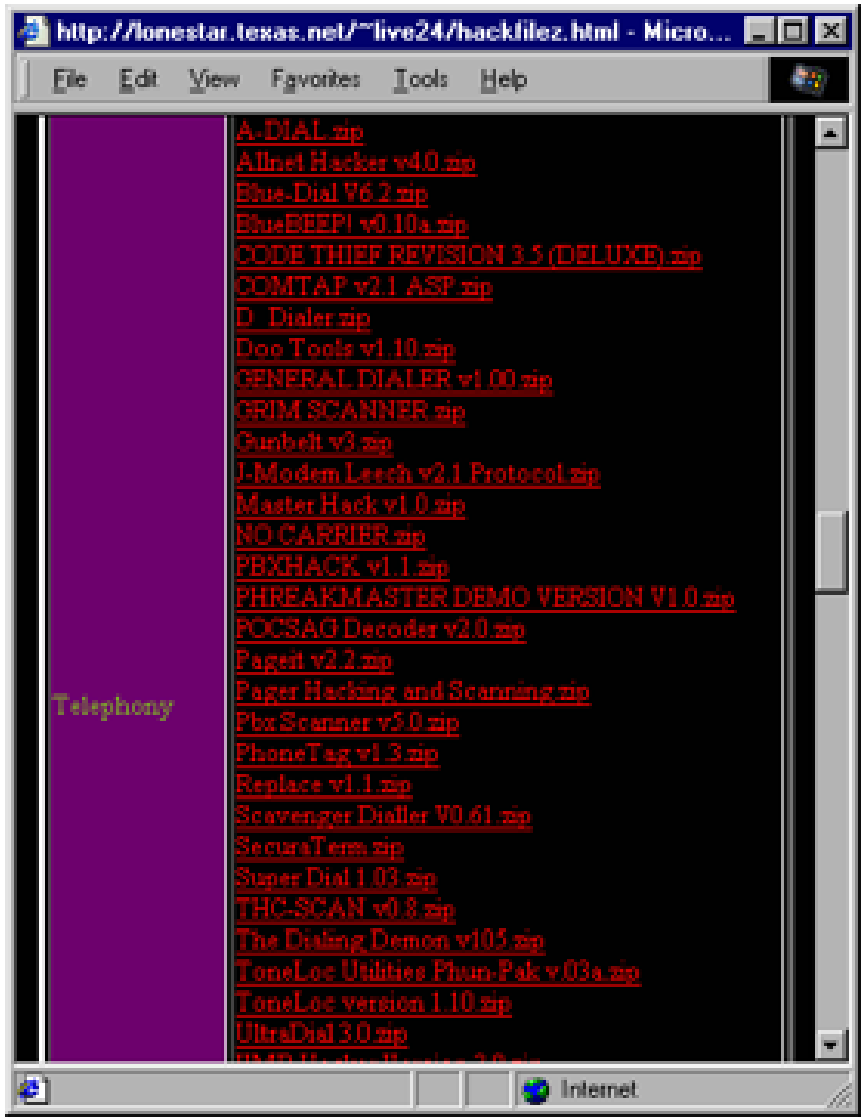
"Captain Crunch" (John Draper)

Based on the phone phreaks of the 1960s/1970s.

Magazines like "2600" and "Phrak"

Warez

Collections of attack tools (War dialers, root kits, etc.)

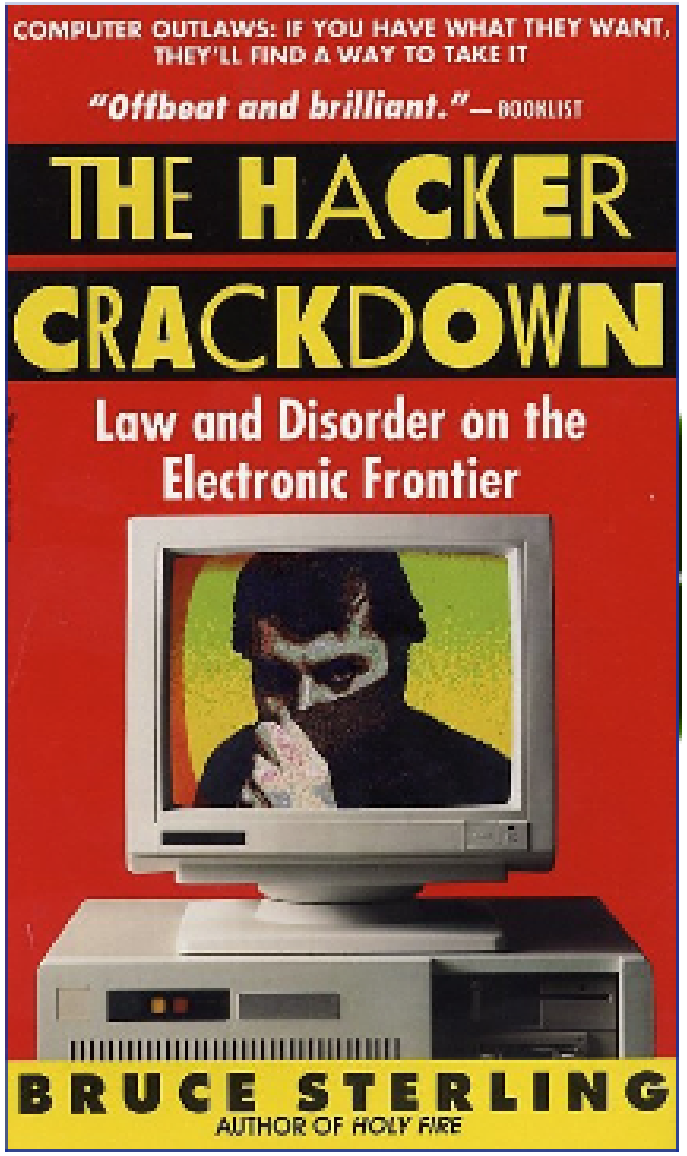


The FBI attacks the hackers: Project “Sun devil.”

January 15, 1990: AT&T’s long distance network crashes

FBI starts massive investigation into “hacker phenomena;” raids 100+ hacker homes and Steve Jackson Games.

Results: EFF; computer crime laws; lots of media attention



`http://www.mit.edu/hacker/hacker.html`

War Dialing is scanning the *telephone* network.

1. Determine phone numbers to call
2. Call each number.
3. Identify what answers:
   (a) Carrier
   (b) Fax
   (c) Voice
   (d) Busy (repeat if necessary)
4. Repeat
5. Analyze the Results

1998–2005: Evaluation of the hacker threat

1995–1999: Series of website defacements.

- Department of Justice (August 17, 1996)
- Central Intelligence Agency (September 18, 1996)
- Lost World Movie (May 23, 1997)
- New York Times (February 16, 2001)

1996–Spamming for porn and pharmaceuticals.

2004–”Phishing”

Threat evolution parallels but lags the commercialization of the Internet.

Understanding the adversary

The adversary needs:

- Skills
- Motive
- Access

Understanding the adversary: Skills

Readily available online.

Many opportunities for improvement.

Online training from some hacking groups.

Understanding the adversary: Motive

Originally: fun & reputation

Increasingly: profit

Access

Physical (need to secure perimeter & control access)

Software (AIDS virus disk)

Telephone (voice & modem)

Wireless

Internet

Software Exploitation: Terminology

Computer virus

- Modifies other programs on a system to replicate itself.
- Originally transmitted by floppy disks

Computer worm

- Copies itself onto your computer
- Stand-alone

Fred Cohen invented the computer virus.

Cohen created the first computer virus while studying for his PhD at University of Southern California

Presented research a computer security seminar on November 10, 1983

http://news.bbc.co.uk/2/hi/technology/3257165.stm

Early software exploits in the wild

1986 — BRAIN Virus

- Written by a pair of brothers in Pakistan. Given to tourists from the US who bought pirated programs.

1987 — Jerusalem Virus

- Discovered in Israel. Some thought written by the PLO as a way of punishing Israel. (Unlikely.)
- Rapidly “mutated.” (Used as a template for other viruses)

1989 — AIDS Trojan

- Sent out by “PC Cyborg” in Panama City to health care providers.

1992 - Michelangelo Virus

- Timed to go off on March 6, 1992. Massive public information campaign either prevented epidemic or overstated it.

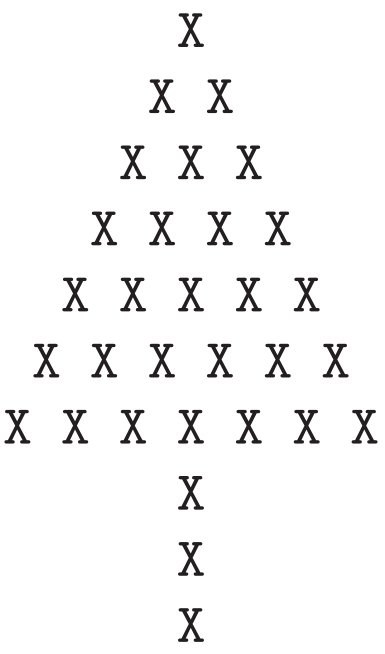
Second Generation: Word Macro Viruses

“Concept” written by a Microsoft employee to demonstrate the problem.

Microsoft released this by accident at a developer’s conference

Third Generation: Network Worms

December 1987



```
A very happy Christmas and my best wishes for the next year.
             Let this run and enjoy yourself.
Browsing this file is no fun at all.  Just type Christmas.
```

Self-propagating worms

“The Internet Worm” (November 1988) Written by Robert T. Morris

- Now a professor at MIT; father was famous security expert at NSA

Infected 2000 Unix systems

- 5 different attack vectors
- Attacked both DEC and Sun computers
- Anatomy was worrisome: included “DES” implementation.

Shut down the Internet

- First time the word “Internet” appears on front page of the New York Times.

Other examples include NIMDA, Code Red, Slammer

User-assisted worms

Melissa (March 1999)

ILOVEYOU (2000)

HAPPY99

Numerous screen savers

Understanding software exploitation

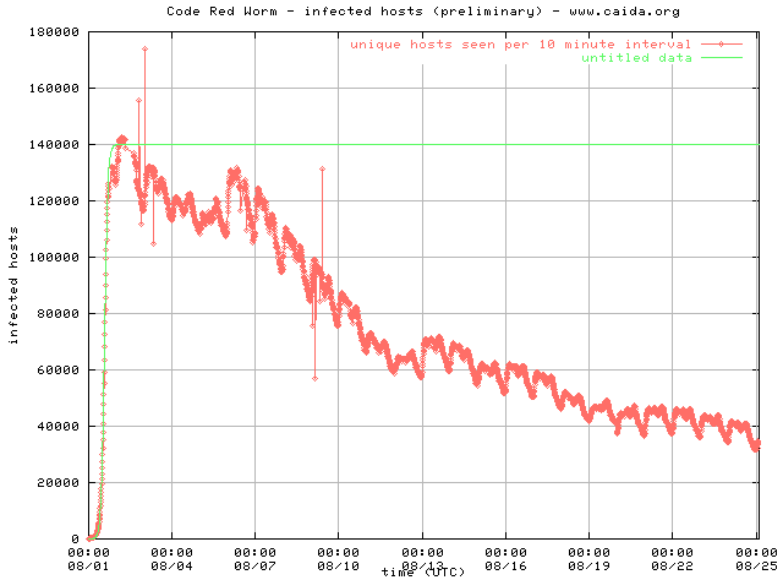
Three phases:

1. Identify vulnerable systems
2. Infect
3. Payload

How fast can a virus propagate?

Code Red propagation statistics

- Most hosts infected within 12 hours
- Source: CAIDA (Cooperative Association for Internet Data Analysis)



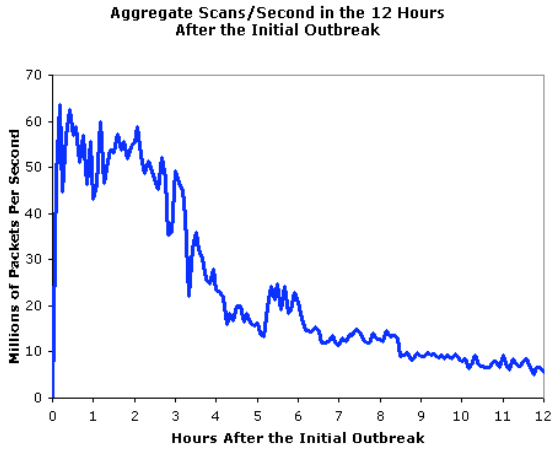
Sapphire / Slammer

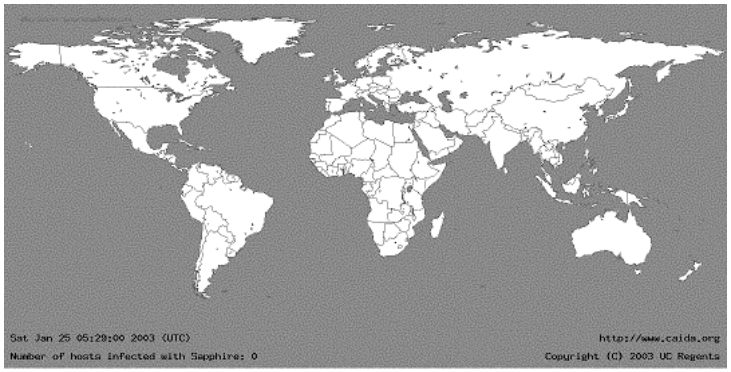
Doubled every 8.5 seconds

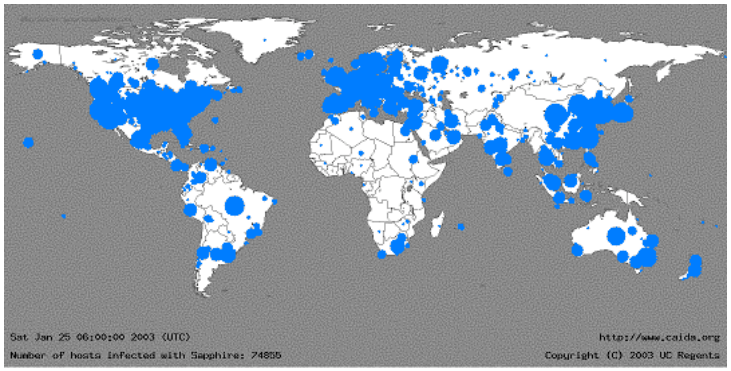
Infected 90% of vulnerable hosts in 30 minutes.

- 74,855 hosts
- Reasons:

  1 packet infection







Theoretical Minimum: 30 seconds?

Flash Worm Paper

- "Flash Worms: Thirty Seconds to Infect the Internet"
- Stuart Staniford, Gary Grim, Roelof Jonkman
- http://www.silicondefense.com/flash/
- August 16, 2001

Warhol Worms

- "How to Own the Internet in your Spare Time"
- Stuart Staniford, Vern Paxson, Nicholas Weaver
- http://www.cs.berkeley.edu/~nweaver/cdc.web/
- August 2002

Typical payloads

None

SPAM proxy

Hardware Destruction

CHI/Chernobyl Virus

April 26, 1999: One million computers destroyed

Cost: Korea $300M; China $291M

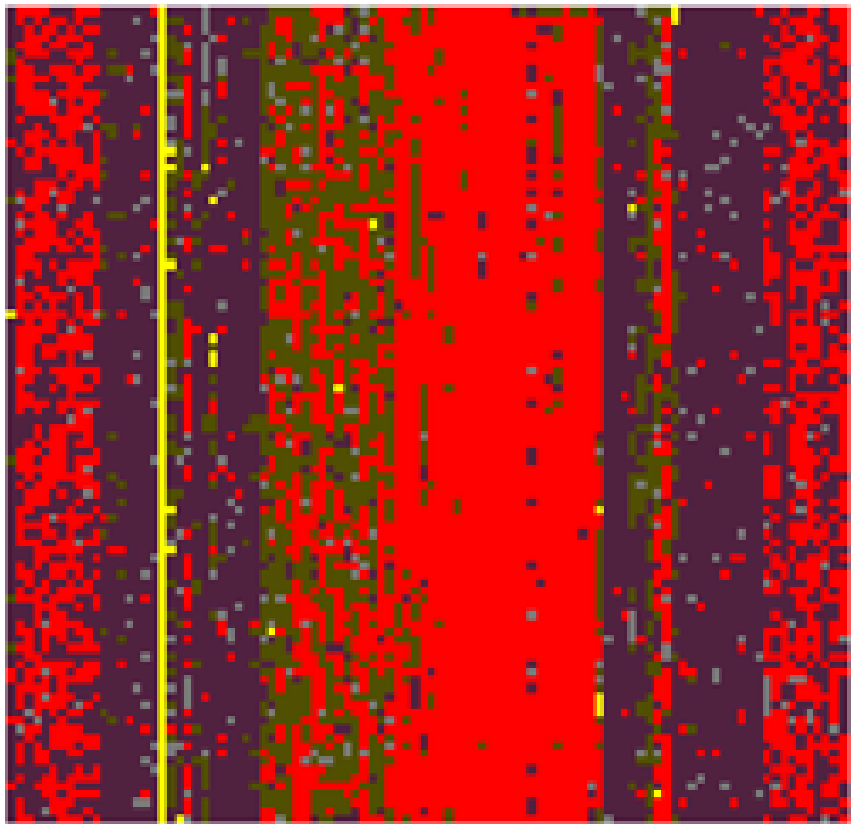
Access through telephones:
SF Bay War Dialing Survey [Garfinkel & Shipley, '01]

Time period:	April 1997 — January 2000
Dialed Phone Numbers:	5.7 million
Area codes:	408, 415, 510, 650
Carriers Found:	46,192

http://www.dis.org/filez/Wardial_ShipleyGarfinkel.pdf

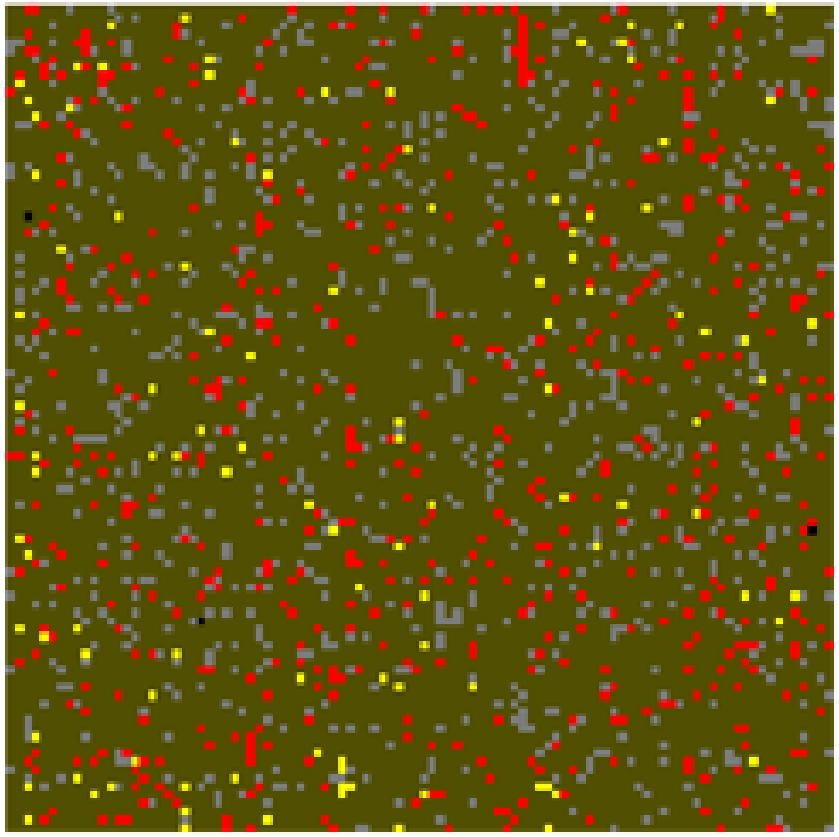
Phone Survey Finding 1:
Business & Residential exchanges look different.

Business



Lots of structure

Residential



Random distribution

Finding 2: Modems are friendly

94 modems per exchange, on average

- $\simeq 1\%$
- $\simeq 4.0\% - 6.1\%$ in the "top 10" exchanges (U.C. Berkeley and others)

87% of modems responded with a banner

- 335,412 lines of banners!
- Microsoft RAS gives no banner.
- Less than 2% had warning banners.

Friendly banners make it easier for an attacker to compromise the system.

Finding 3: Many modems are vulnerable

3% of all Shiva LAN Rover had no password on “root” account

- Shiva had documented “admin” account but not “root account.”

30% of Ascend concentrators gave “`ascend%`” prompt

Majority of Cisco routers gave command prompt.

- 25% were in “enable” mode!

Finding 4: Some significant systems were vulnerable

Oakland Fire Dispatch:

```
                        - - - FIRE DISPATCH HELP SCREEN - - -
AHC - Display adjacent hazs cautns      TSP - Test station printer
CN  - Display caution notes for loc     UP  - Menu of user-written programs
CQ  - Display coverages and quarters    US  - Display Unit Status
CYC - Cycle Through Moveup Maps         UT  - Display unit times
DA  - Display CJ days activity          @   - Log off
EC  - Emergency contact information     #   - Telephone / pager directory
F   - Display fire actives              #T  - Truck status screen (1-9)
H   - Hazardous materials research      ?   - Display this help screen
INF - General info. file inquiry
M   - Display recommended moveups
MED - Display medical notes for addr
MO  - Memo system access
PC  - Display prior calls
PI  - Display prior incidents at loc
RUN - Display unit times and notes
SOP - Standard operating procedures
SR  - Display shift roster/schedule
T   - Display truck status screen #1
TIM - Display and reset timers
```

Other notable vulnerables:

Leased line control system

- Similar dialup shut down Worcester, MA airport in March 1997

Cody's Bookstore order system

- Customer names & credit card numbers

Berkeley Pediatrics

- Concurrent DOS prompt

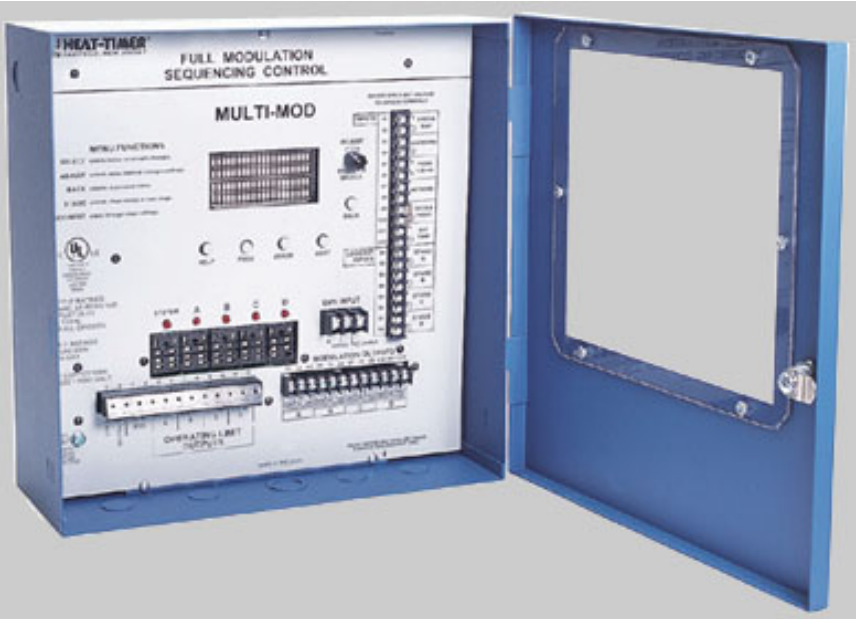
Numerous LAN Rovers at financial institutions

- Behind firewalls

Dialup for a high-voltage transmission line system

Unauthorized and unsecured modems are *still* a problem today.

- Legacy modems (frequently unknown)
- HVAC systems
- Elevators



VISUAL GOLD - Remote Communication Packages

VISUAL GOLD Complete Packages	Catalog #
Multi-Mod (0-135 Ohm) Complete and VISUAL GOLD with Modem	926650-135-RIM
Multi-Mod (0-135 Ohm) Complete and VISUAL GOLD without Modem	926650-135-RI

`http://www.heat-timer.com/?page=products`

War dialing: Conclusions

War dialing is a *technique.*

The Shipley/Garfinkel study established that there is a vulnerability.

Dial-up modems continue to represent a vulnerability for many organizations.

Telephone scanning large areas finds more than scanning known blocks.

The most vulnerable dialups were not part of PBX exchanges.

But who would exploit this?

Road Island Teenager shuts down airport in Worcester, MA (March 10, 1997)

Airport operations disrupted.

600 homes left without telephone services.

Teenager discovered fiber-optic controller with a war dialer; types “shutdown” command.

(Courtesy WHDH)

http://www.cnn.com/TECH/computing/9803/18/juvenile.hacker/

Former employee disrupts Caterpillar LAN (September 1998)

Two weeks of unfettered acces, through unsecured dialup.

Apparently a former employee

War Dialing Conclusions

Dial-up modems continue to represent a vulnerability for many organizations.

Many organizations are not even aware that they have these modems operating.

Telephone scanning large areas finds more than scanning known blocks.

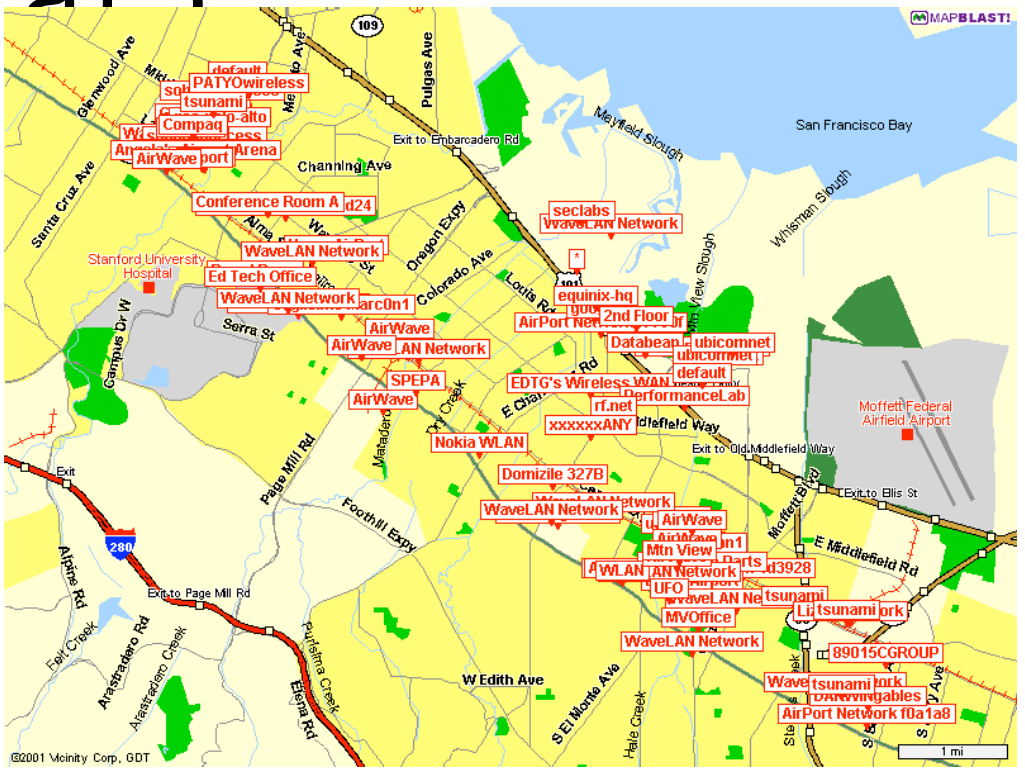
- Many vulnerable dialups were not part of PBX exchanges.

“War Driving” (Shipley et. al.)

Materials:

- 802.11(b) card
- 8db antenna
- GPS
- Acquisition Software

Started by Shipley in 2000; now a popular geek pastime.



802.11(b) Security

2.4Ghz transmission; 11 Mbps

Access Points (APs) provide wireless connectivity.

SSID – Service Set Identifier --- Like an "SNMP" community

- A password transmitted in the clear
- 802.11 vendors initially claimed that SSID provided security.
- In 2000, WaveLAN drivers allowed "Any" SSID to associate with any observed AP

WEP – Wired Equivalent Privacy encryption algorithm.

- Poor encryption algorithm
- Poor key setup
- Nevertheless, provides limited security against people who follow the rules.

Latest Berkeley Findings (as of 6/21/2002)

Totals: 173 APs

SSIDs:

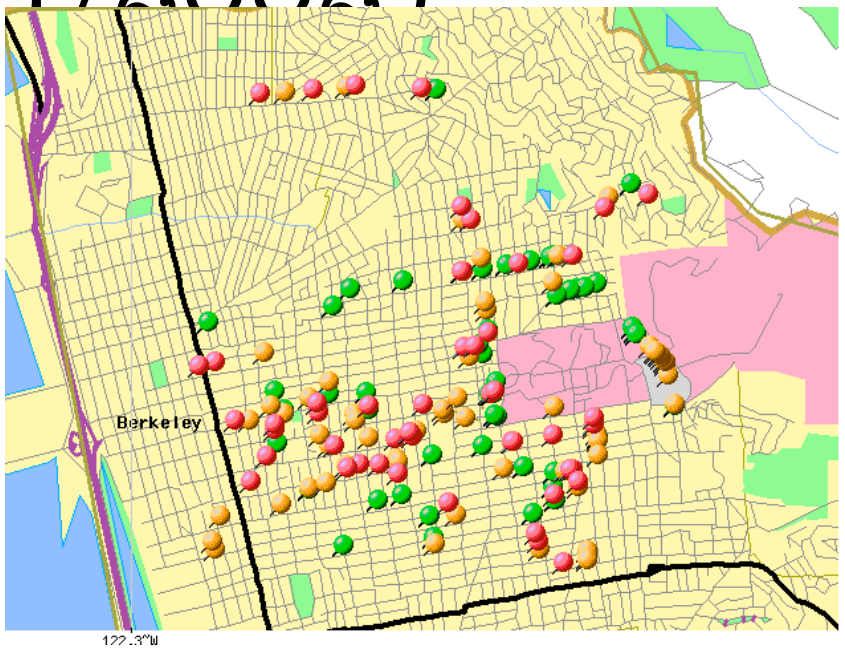
- 53 default SSIDs,
- 105 unique SSIDs
- 30.6% default SSIDs

WEP:

- 60 with WEP
- 113 without WEP (34.7%)

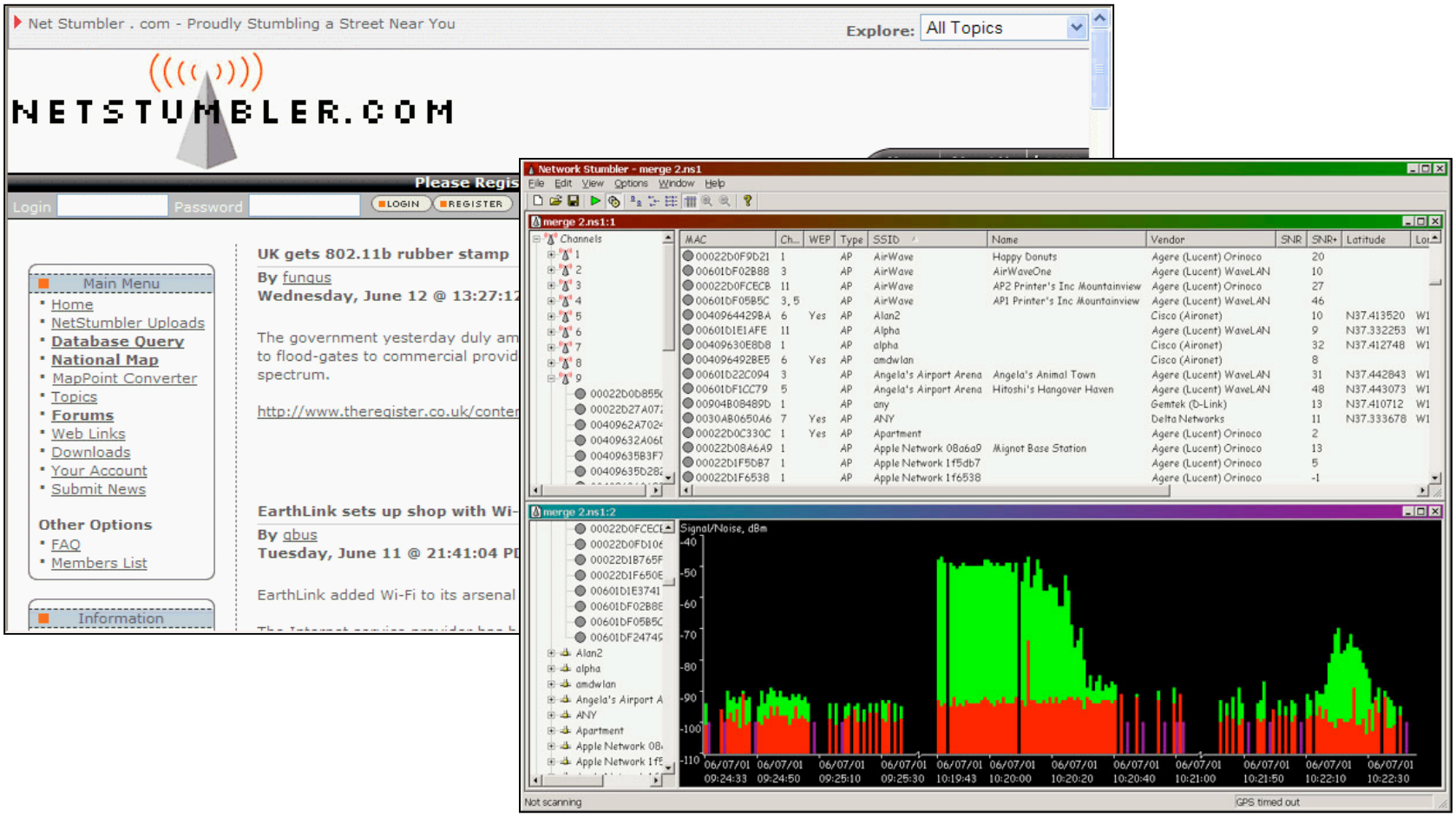
SSIDs:

- 45 Default without WEP (26%)
- 8 Default with WEP (4.6)

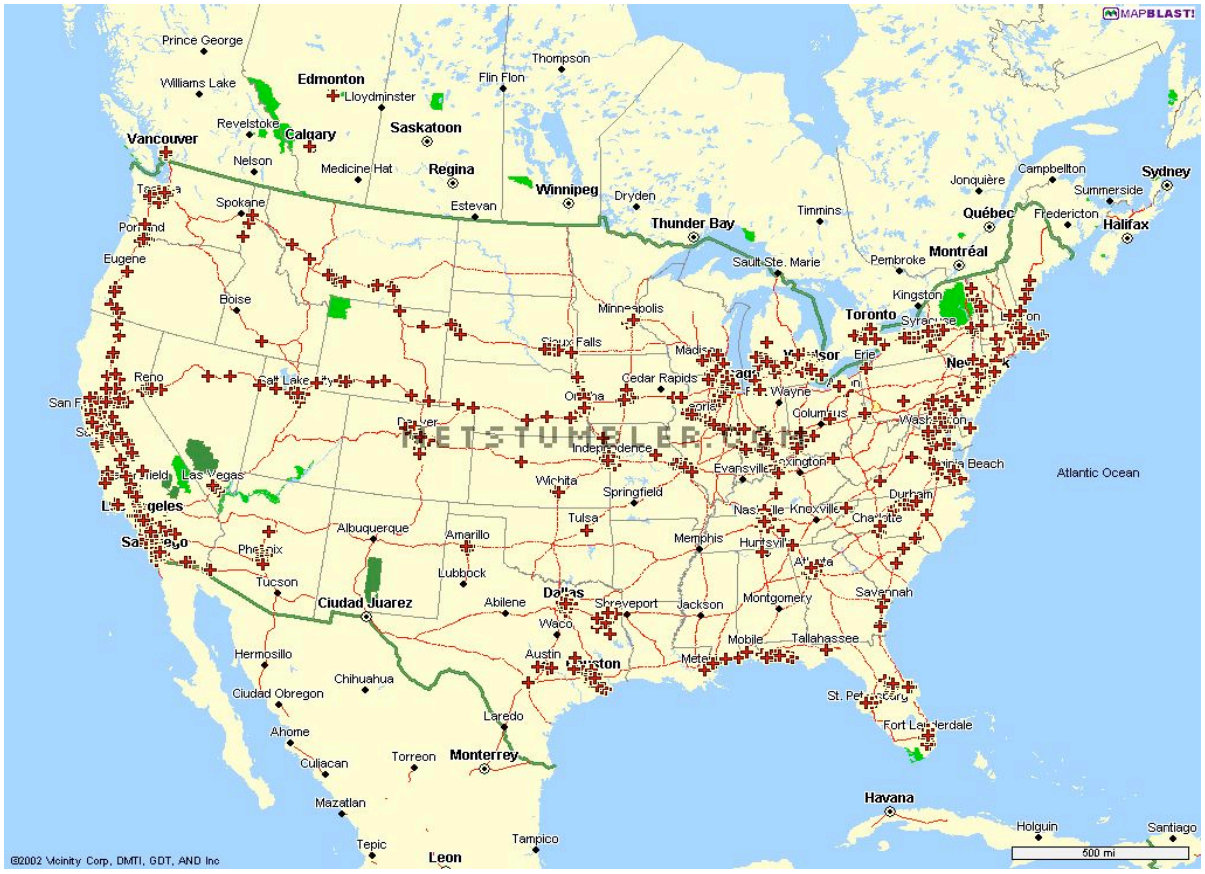


RED = NoWep & default SSID
Orange = NoWep
Green = Wep

Netstumbler:
War driving for the masses



Stumbler Nation



Long Distance ?

Some security officers feel that if AP is distanced from the street or on a high floor of a building they will be safe from network trespassers.

Shipley's experiments show that it is possible to successfully make a network connection twenty-five (25) miles away from hilltops and high-rise buildings.

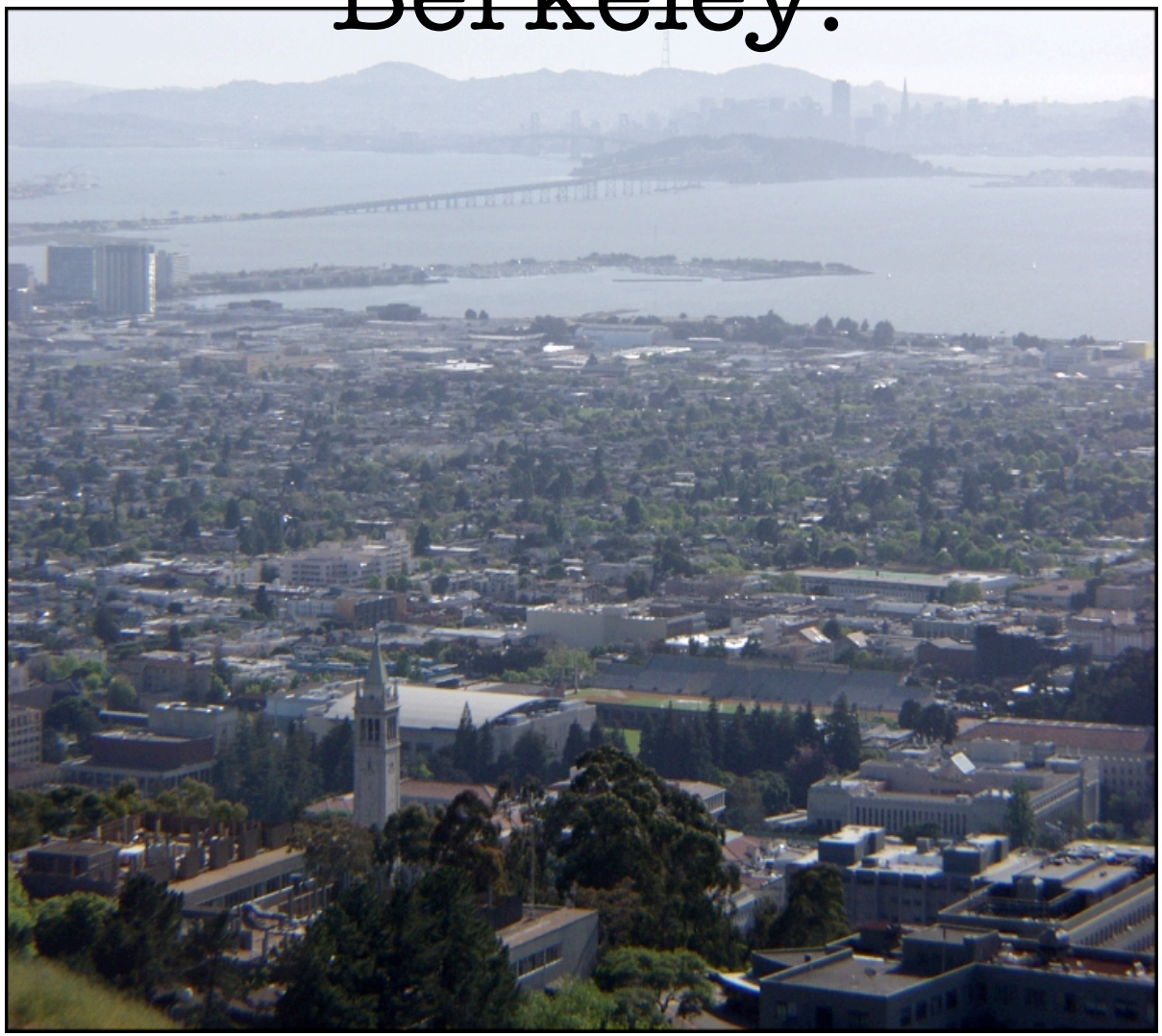
Hardware

Connecting to WLANs networks from across the bay.

24db dish

500mw amplifier

The view from a hilltop in ~~Berkeley.~~



Why does 802.11 security matter?

Home Network

- Primary threats are unauthorized, anonymous access:
  - Spamming
  - Hacking
  - Anonymous threats
- Violations can result in loss of service

Corporate Networks

- Primary threat is theft of corporate information

Accidental Trespass

- Individuals may think they are associating with café, but actually be associating with nearby business

Typical Case (Mass)

MA business: attacker sat on a park bench and stole username & password of CEO and senior management using 802.11(b) sniffer.

Attacker then logged into Exchange server and downloaded corporate email archives.

Email was published on a website, resulting in $10M in damage to the company (lost contracts, renegotiated contracts, etc.)

802.11 solutions

Place APs

- Outside corporate LANs
- in DMZs
- On separate Internet connections

“arpwatch” to detect unknown/unauthorized users.

IPsec

802.1x (support is not uniform)

Enterprise solutions from Cisco, Newberry Networks

Today

Hackers have grown up

Most hacking seems to be criminal-related. (Make money fast.)

International scope.

Cyberwar and Cyberterrorism

“first cyberwar.”

CNBC & The Wall Street Journal. Business

WSJ.COM HIGHLIGHTS Sponsored by Microsoft

Unsolicited e-mail hits targets in America in first cyberwar

By Ellen Joan Pollock
and Andrea Petersen
THE WALL STREET JOURNAL

April 8 — Think of it as the first cyberwar. While missiles explode over Belgrade, refugees from Kosovo pour into Albania and politics play themselves out on a global scale, some Serbs are fighting for American support, using laptops as their weapon.

IN RECENT DAYS, electronic mail attacking the NATO bombing campaign has been lobbed by at least 25 computers in Yugoslavia, clogging the in-boxes of well more than 10,000 Internet users, mostly in the U.S. Many people on the receiving end are annoyed by this unwanted Serbian “spam,” which at the very least is a pain to delete.

BOOMERANG EFFECT

For many recipients, there’s an added, irksome twist. Hundreds have sent reply e-mail messages demanding to be taken off the Yugoslav mailing lists. In many cases, copies of the requests are then circulated to everyone who received the message in the first place and that engenders new messages from new sources. That’s a lot of e-mail. There are, for instance, 6,500 names on the mailing list of the Belgrade Academic Association for Equal Rights in the World, an organization whose mail is boomeranging all over the world.

This is was not cyberwar

Wired Magazine: "The Great Cyberwar of 2002"

10 July 2002
PFW Announcement appears on websites
- CNN
- USA Today
- The Guardian
- DISNEY.COM

http://www.wired.com/wired/archive/6.02/cyberwar.html

Wired Magazine...

14 July

- Western US States Suffer Blackout
- 500KV Transmission line shut down by hackers
- 35 deaths

15 July

- Second Ultimatum Issued

Wired Magazine...

16 July

- Midair collision of 2 jets
- 463 dead
- All US commercial aviation grounded

Wired Magazine

21 July

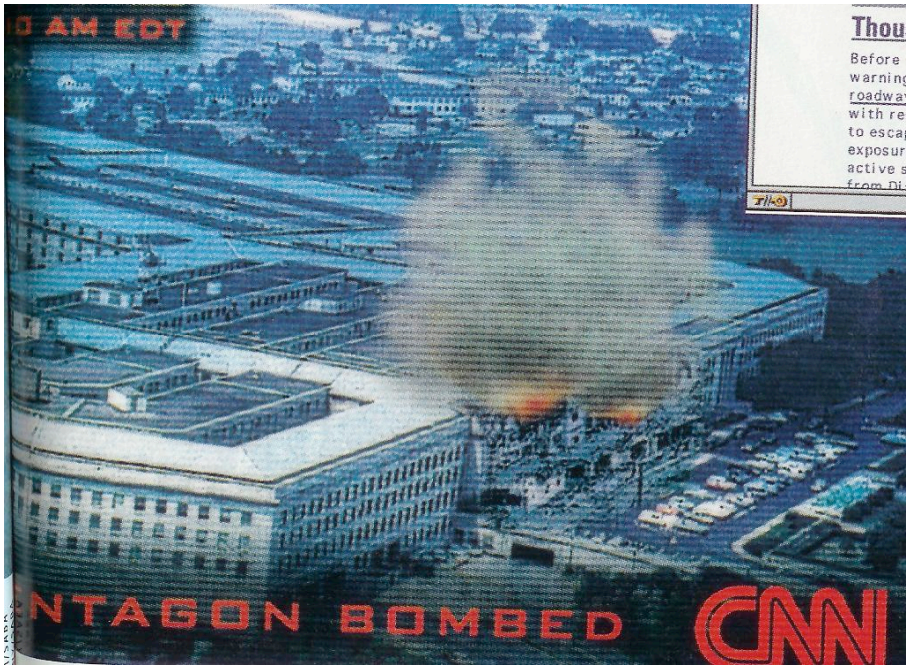
- Computer-controlled Chemical factory blows up in Detroit, taking 1/2 the city with it

22 July

- Trans Alaska pipeline burst near Valdez

2 August

- Microwave bomb attack on Pentagon



National Strategy to Secure Cyberspace

Mostly a bust

- http://www.whitehouse.gov/pcipb/
- Largely recommended antivirus and firewalls

FBI's InfraGard

Started in 2001 by FBI; now incorprated as a non-profit
Local chapters.
24x7 system to communicate cyberthreats.
Off-the-record discussions of cybersecurity issues.
High-level meetings between governmet and industry
Key interest is leveraging of cyber structure by "terrorists."

Phyllis Schneck, InfraGard's National Chair
Members must pass FBI background check

Small and medium business to
Fortune 500

Interview in SC Magazine, March 2004

US Department of Homeland Security's National Cyber Security Division (NCSD)

- US Computer Emergency Readiness Team (US-CERT)
- Chief Information Security Officers Forum (for federal CISOs)
- Forum of Incident Response and Security Teams (FIRST; exchanges information about incidents)
- Cyber Interagency Incident Management Group
- Critical Infrastructure Warning Information Network (a private, secure, and survivable network for use in the event of an information outage)

What the government isn't doing for private industry:

No tax credits

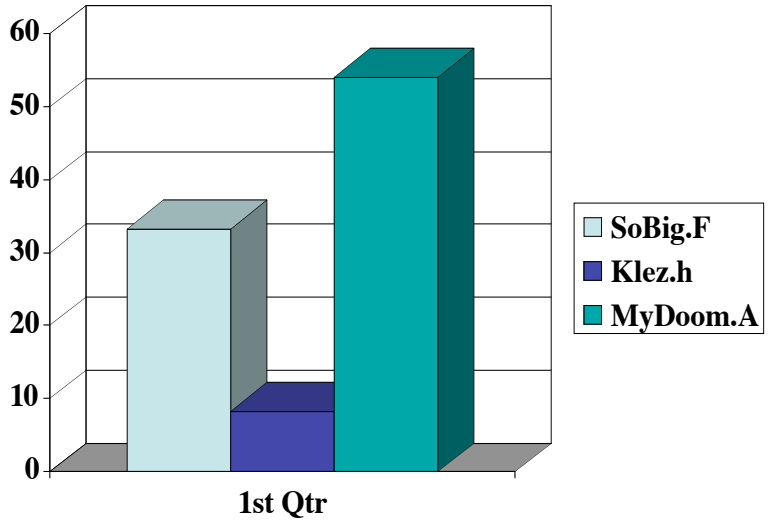
No cost sharing

No real regulations

Do these worms actually cause problems?

Number of infected messages blocked by MessageLabs over 12 months

- SoBig.F: 33.3m
- Klez.h: 8.3m
- MyDoom.A: 54.1 m



Regulatory approaches:

Health Insurance Portability and Accountability Act (HIPAA)

- Businesses must secure health care information.

Sarbanese-Oxley Act (SEC Rule 17a)

- Financial reporting regulation; businesses must document their risks

References:

"Who's Driving the Security Train," Investigative report, pp. 6, 7, 8, 22, *Computerworld*, March 8, 2004

Cyber Report Cards

Based on the Federal Information Security Management Act, assigned by the Inspector General (2002 -> 2003)

2003 A grades:

- Nuclear Regulatory Commission C->A
- National Science Foundation: D- -> A-

2003 B grades:

- Social Security Administration: B- -> B+
- Department of Labor: C+ -> B

2003 C grades:

- Department of Education: D -> C+
- Department of Veteran's affairs: F -> C
- Environmental Protection Agency: D- -> C
- Small Business Administration: F -> C-
- Agency for International Devt.: F -> C-

2003 D grades:

- Department of Defense: F -> D
- General Services Administration: D -> D
- Department of the Treasury: F -> D
- Office of Personnel Mgt: F -> D-
- NASA: D+ -> D-
- Department of Health and Human Services: F -> D-

2003 F grades:

- Department of Energy: F-> F
- Department of Justice: F -> F
- Department of the Interior: F -> F
- Department of Agriculture: F -> F
- Department of Housing and Urban Development: F -> F
- Department of State: F -> F
- Department of Homeland Security: F

Secure Coding

Saltzer & Schroeder
Seven Design Principles

Least Privilege

Economy of Mechanism

Complete Mediation

Open design

Separation of privilege

Least Common Mechanism

Psychological acceptability

1988: Morris Internet Worm

fingerd.c:

```
char line[512];
…
line[0] = '\0';
gets(line);
```

Results in 6,000 computers being infected.

Fingerd bug fix

```
line[0] = '\0';
gets(line);
```

Becomes

```
memset(line,0,sizeof(line));
fgets(line,sizeof(line),stdin);
```

Miller, Fredrickson & So

1990, “An Empirical Study of the Reliability of Unix Utilities”

1995, “Fuzz Revisited”

2000, “Windows NT Fuzz Report”

1990 Fuzz Findings

Between 25% and 33% of Unix utilities crashed or hung by supplying them with unexpected inputs

- End-of-file in the middle of an input line
- Extra-long input
- Letters for numbers, etc.

In one case, the entire computer crashed.

1995: Fuzz Revisited

Vendors not overly concerned about bugs in their programs

"Many of the bugs discovered (approximately 40%) and reported in 1990 are still present in their exact form in 1995.

- Code was made freely available via anonymous FTP
- Exact random data streams used in testing were made available
- 2000 copies of the tools were downloaded from FTP

"It is difficult to understand why a vendor would not partake of a free and easy source of reliability improvements"

1995 Fuzz Revisited, cont.

Lowest failure rates wee for the Free Software Foundation's GNU utilities (7%)

- FSF had strict coding rules that forbid the use of fixed-length buffers.

Many X clients would readily crash when fed random streams of data

2000 Fuzz against NT

45% of all programs expecting user input could be crashed

100% of Win32 programs could be crashed with Win32 messages

```
LRESULT CALLBACK
w32_wnd_proc (hwnd, msg, wParam, lParam)
{
   . . .
   POINT *pos;
   pos = (POINT *)lParam;
   . . .
   if (TrackPopupMenu((HMENU)wParam,
   flags, pos->x, pos->y, 0, hwnd,
   NULL))
   . . .
}
```

Fuzz Today

eEye Digital Security does net[illegible]
fuzz testing

- http://www.eeye.com/

Most remote crashes can be turned into remote exploits

Retina Vulnerability Scanner

Morris Worm II

Exploited Sendmail's WIZ and DEBUG commands

Cracked passwords

Caused havoc by hyper-replication (common problem)

Avoiding Security-Related Bugs

Avoid bugs in general

Test with non-standard input

Look for back doors

- (theoretically impossible to do perfectly)

Design Principles

Carefully design the program before you start.

- Remember: you will either design it before you start writing it, or *while you are writing it*. But you will design it.

Document your program before writing the code.

Make critical portions of the program as small as possible.

Resist adding new features. The less code you write, the less likely you are to introduce new bugs.

Design Principles 2

Resist rewriting standard functions. (Even when standard libraries have bugs.)

Be aware of race conditions:

- Deadlock conditions: More than one copy of your program may be running at the same time!
- Sequence conditions: Your code does not execute automatically!

  Do not stat() then open()

  Do not use access()

Write for clarity and correctness before optimizing.

Coding Standards

Check all input arguments. Always.

Check arguments you pass to system calls

Return Codes

Check *all system call returns.*

- fd = open(*filename*,O_RDONLY) *can fail!*
- read(fd,buf,sizeof(buf)) *can fail*
- close(fd) *can fail!*

Use perror("open") or err(1,"open failed:") to tell the user *why something failed.*

Log important failures with syslog()

File Names

Always use full pathnames

Check all user-supplied input (filenames) for shell metacharacters

If you are expecting to create a new file, open with O_EXCL|O_CREAT to fail if the file exists.

If you are expecting an old file, open with O_EXCL to fail if it does not exist.

Temporary Files

Use tmpfile() or mkstemp() to create temporary files

```
FILE *f=tmpfile(void);
int fd = mkstemps(char *template, int suffixlen);
```

*Never use **mktemp()** or **tmpnam()***

Functions to avoid

Avoid	**Use instead**
`gets()`	`fgets()`
`strcpy()`	`strncpy()`
`strcat()`	`strncat()`
`sprintf()`	`snprintf()`
`vsprintf()`	`vsnprintf()`

Coding Standards 2

Check arguments passed to program via environment variables

- e.g., HOME, PAGER, etc.

Do bounds checking on every variable.

- If a variable should be 0..5, make sure it is not -5 or 32767
- Check lengths *before you copy*.

Coding Standards...

Use assert() within your program.

```
j = index(buf,';');
assert(j>0);
```

Coding Standards

Avoid C functions that use statically-allocated buffers

- These are the rules for multi-threaded coding as well!

don't use:

```
struct tm *
    localtime(const time_t *clock);
```

Use:

```
struct tm *
    localtime_r(const time_t *clock,
    struct tm *result);
```

Logging

Design your logs to be parsed by a computer

Using syslog() if possible.

Include a heartbeat log

RFC 1750: Randomness Recommendations

Keep seeds for RNGs secret!

Don't seed with:

- Time of day
- Serial number
- Ethernet address

Beware using:

- Network timing
- "Random selections" from databases

Use:

- Analog input devices (/dev/audio)

Never use rand()

Passwords

Store the hash of passwords and a salt, not the passwords themselves

Also store:

- Date password was changed
- # of invalid password attempts
- Location of invalid password attempt

Don’t restrict password character set

Try flipping password case (just to be nice)

Limit Privilege

Limit access to the file system

- chroot() and jail() under Unix
- Restrict use of C compiler

Programs that need privilege (SUID/SGID/Admin)

"Don't do it. Most of the time, it's not necessary" (Wood & Kochan, *Unix System Security*, 1985)

Don't use **root** or **Administrator** privs when you can create a specialty group.

Use permissions as early as possible to open files, etc., then *give up the privs.*

Avoid embedding general-purpose command languages, interfaces, etc., in programs that require privilege

Erase execution environment (PATH, etc.) and build from scratch

Use full path names

Tips for Network Programs

Do reverse lookups on all connections

Include load shedding or load limiting

Include reasonable timeouts

Make no assumptions about content of input data

Make no assumption about the amount of input

Call *authd* if possible — but don't trust the results

More Network Tips

Use SSL if at all possible.

Include support for using a proxy

Build in graceful shutdown:

- From signals
- From closed network pipes

Include “self recognition” so that more than one copy of the server doesn’t run at the same time.

Try not to create a new network protocol

Don’t hard-code port numbers

Don’t trust “privileged” ports, IP source addresses

Don’t send passwords in clear text.

Web-based Applications

Validate all information from the client

- Don't trust the content of HIDDEN fields
- Verify Cookies
- Digitally sign or MAC all information

Use prepared SQL statements

- Never: sprintf(%s,"select * where username='%s'",username)
- Always: "select * where username=?"

Programming Languages

Avoid C, C++ if possible

Use perl's tainting feature (-T)

Be careful with Java's class loader

Be careful with eval():

- perl
- python
- shell `

Things to avoid

- Don't provide shell escapes in interactive programs
- Be very careful with system() and popen() calls
- Do not create files in world-writable directories
- Use setrlimit() to avoid dumping core

Before you Finish

Read though your code

- How would you attack your own code?
- What happens if it gets unexpected inputs?
- What happens if you place a delay between system calls?

Test your assumptions:

- Run by *root*. Run by *nobody*
- Run in a different directory
- What is /tmp or /tmp/root doesn't exist?

Testing

Test with a testing tool:

- tcov (SVR4)
- gcov (GNU)

Commercial Testing tools:

- CodeCenter
- PurifyPlus

More testing

Stress Test:

- Low memory
- Filled disk

Test Missing DLLs

- Internet Explorer fails open if msrating.dll is not installed

Monitor all reads & writes

- Holodeck (Windows)
- dtrace (Solaris)

Code Review

Walk through your code with another competent programmer

Simply putting your code on the Internet is not the same as having it reviewed!

Famous Open-Source Problems

Kerberos random number generator

Sendmail – DEBUG and WIZ

fingerd

Less famous, but affecting me personally:

- Hylafax program
- NNTPcache