

# Network Security Concepts

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These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse571-07/>



1. Security Components and Threats
2. Security Policy and Issues
3. Types of Malware and Attacks
4. Security Mechanisms
5. Network Security Audit
6. The Orange Book
7. Legal Issues

## Security Components

- ❑ **Confidentiality**: Need access control, Cryptography, Existence of data
- ❑ **Integrity**: No change, content, source, prevention mechanisms, detection mechanisms
- ❑ **Availability**: Denial of service attacks,
- ❑ Confidentiality, Integrity and Availability (**CIA**)



## Threats

- ❑ Disclosure, alteration, and denial (**DAD**)
- ❑ **Disclosure or unauthorized access**: snooping, passive wiretapping,
- ❑ **Deception or acceptance of false data**: active wiretapping (data modified), man-in-the-middle attack, Masquerading or spoofing (impersonation), repudiation of origin (denying sending), denial of receipt
- ❑ **Disruption or prevention of correct operation**
- ❑ **Usurpation or unauthorized control of some part of a system**: Delay, Infinite delay  $\Rightarrow$  Denial of service

## Security Policy



- ❑ Statement of what is and what is not allowed
- ❑ Security Mechanism: Method, tool or procedure for enforcing a security policy

## Elements of Network Security Policy

1. **Purchasing guidelines:** Required security features
2. **Privacy Policy:** files, emails, keystrokes
3. **Access Policy:** Connecting to external systems, installing new software
4. **Accountability Policy:** Responsibilities of users/staff/management. Audit capability.
5. **Authentication Policy:** password policy
6. **Availability statement:** redundancy and recovery issues
7. **Maintenance Policy:** Remote maintenance? How?
8. **Violations Reporting Policy:** What and to whom?
9. **Supporting Information:** Contact information, handling outside queries, laws,...

Ref: RFC 2196

## Security Issues

- ❑ **Goals:** Prevention, Detection, Recovery
- ❑ **Assurance:** Assurance requires detailed specs of desired/undesired behavior, analysis of design of hardware/software, and arguments or proofs that the implementation, operating procedures, and maintenance procedures work.
- ❑ **Operational Issues:** Benefits of protection vs. cost of designing/implementing/using the mechanisms
- ❑ **Risk Analysis:** Likelihood of potential threats
- ❑ **Laws:** No export of cryptography from USA until 2000. Sys Admins can't read user's file without permission.
- ❑ **Customs:** DNA samples for authentication, SSN as passwords
- ❑ **Organizational Priorities:** Security not important until an incident
- ❑ **People Problems:** Insider attacks

## Steps in Cracking a Network

- ❑ **Information Gathering:** Public sources/tools.
- ❑ **Port Scanning:** Find open TCP ports.
- ❑ **Network Enumeration:** Map the network. Servers and workstations. Routers, switches, firewalls.
- ❑ **Gaining Access:** Keeping root/administrator access
- ❑ **Modifying:** Using access and modifying information
- ❑ **Leaving a backdoor:** To return at a later date.
- ❑ **Covering** tracks

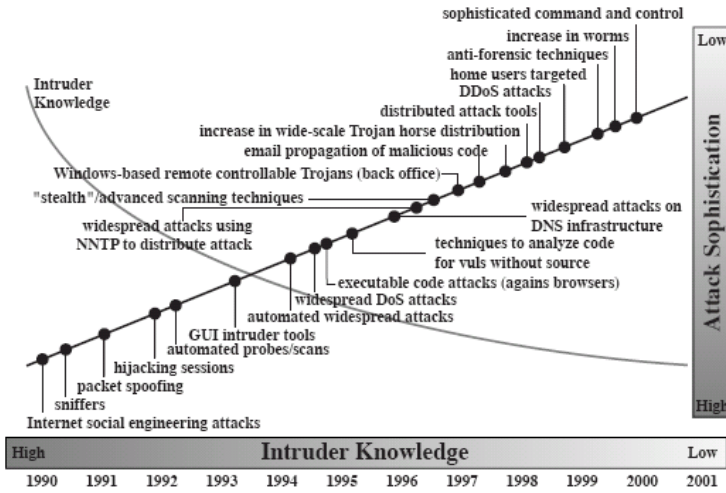
## Hacker Categories

- ❑ **Hacker** - Clever programmer
- ❑ **Cracker** - Illegal hacker
- ❑ **Script Kiddies** - Starting hacker. May not target a specific system. Rely on tools written by others.
- ❑ **White Hat Hackers** - Good guys. Very knowledgeable. Hired to find a vulnerability in a network. Write own software.
- ❑ **Black Hat Hackers** - Bad guys. Desire to cause harm to a specific system. Write own software.
- ❑ **Cyber terrorists** - Motivated by political, religious, or philosophical agenda.

## Types of Malware

- ❑ **Viruses**: Code that *attaches* itself to programs, disks, or memory to propagate itself.
- ❑ **Worms**: Installs copies of itself on other machines on a network, e.g., by finding user names and passwords
- ❑ **Trojan horses**: Pretend to be a utility. Convince users to install on PC.
- ❑ **Spyware**: Collect personal information
- ❑ **Hoax**: Use emotion to propagate, e.g., child's last wish.
- ❑ **Trap Door**: Undocumented entry point for debugging purposes
- ❑ **Logic Bomb**: Instructions that trigger on some event in the future
- ❑ **Zombie**: Malicious instructions that can be triggered remotely. The attacks seem to come from other victims.

## History of Security Attacks



Source: CERT

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## Brief History of Malware

1981	Elk Cloner	Propagated on Apple II floppy disks and displayed a poem.
1983		Demod by Fred Cohen at a security seminar. Term virus was coined.
1988	Morris Worm	First Internet worm written by Robert Morris.
1995	Concept	First word macro virus
1998	Strange Brew	First Java virus
	Back orifice	First trojan horse allowing remote administration of the victim
1999	Melissa	First word macro virus to use outlook address book
2000	ILOVEYOU	Email attachment worm. Executed when clicked.

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## Types of Virus

- ❑ Boot sector virus
- ❑ Macro virus
- ❑ Email malware
- ❑ Web site malware (JavaScripts)

## Types of Attacks

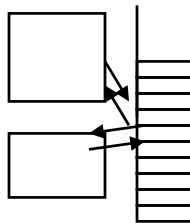
- ❑ **Denial of Service (DoS):** Flooding with traffic/requests
- ❑ **Buffer Overflows:** Error in system programs. Allows hacker to insert his code in to a program.
- ❑ **Malware**
- ❑ **Brute Force:** Try all passwords.
- ❑ **Port Scanning:**
  - ⇒ Disable unnecessary services and close ports
- ❑ **Network Mapping**

## Root Kits

- ❑ Hide by placing themselves between calls to system routines and lower layers of operating system.
- ❑ When a program makes a system call, the root kit intercepts the call and either passes it to the system, handles the call itself, or drops the call.
- ❑ Allow hacker to enter a system at any time
- ❑ See [rootkit.com](http://rootkit.com)

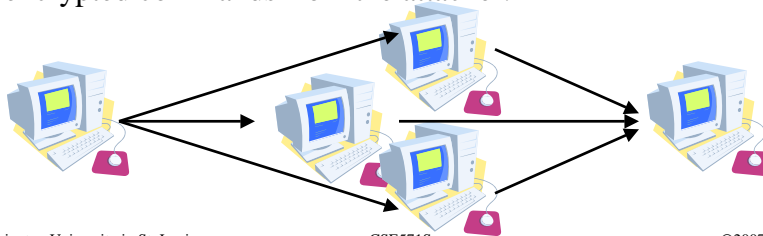
## Buffer Overflows

- ❑ Return address are saved on the top of stack.
- ❑ Parameters are then saved on the stack.
- ❑ Writing data on stack causes stack overflow.
- ❑ Return the program control to a code segment written by the hacker.



## Distributed DoS Attacks

- ❑ **Tribe Flood Network** (TFN) clients are installed on compromised hosts.
- ❑ All clients start a simultaneous DoS attack on a victim on a trigger from the attacker.
- ❑ **Trinoo** attack works similarly. Use UDP packets. Trinoo client report to Trinoo master when the system comes up.
- ❑ **Stacheldraht** uses handlers on compromised hosts to receive encrypted commands from the attacker.



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2-17

## Social Engineering

- ❑ **Reverse social engineering:** User is persuaded to ask Hacker for help.
- ❑ **Phone calls:**
  - Call from tech support to update the system.
  - High-level VP calling in emergency.
  - Requires employee training.
- ❑ Electronic Social Engineering (**Phishing**):
  - EBay transactions, PayPal Accounts, Bank Account, Nigerian 419 scams (Section 419 of Nigerian criminal code), Lottery.
  - Anti-phishing workgroup (antiphishing.org) found that 5% of the recipients respond compared to 1% for spam.



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2-18

## Security Mechanisms

- Encipherment
- Digital Signature
- Access Control
- Data Integrity
- Authentication Exchange
- Traffic Padding
- Routing Control
- Notarization

## Honey Pots

- Trap set for a potential system cracker
- All the services are simulated
- Honey pot raises alert allowing administrator to investigate
- See [www.specter.com](http://www.specter.com)



## Network Security Audit

1. **Pre-Audit Contact:** Study security policy
2. **Initial Meeting:** Discuss scopes and objectives of audit
3. **Risk Assessment:** Find vulnerabilities.
4. **Physical security Audit:** locked doors, etc.
5. **Network Configuration Audit:** What devices are on the network?
6. **Penetration testing:** attempts to crack the security
7. **Backup recovery audit:** Simulates a disaster to check recovery procedures
8. **Employee audit:** Passive monitoring of employee activities to verify policy enforcement
9. **Reporting:** Preparation of Audit Report and presentation to the management.

## The Orange Book

- National Computer Security Center defines computer systems ratings
- D - Minimal protection
- C1 - Discretionary security Protection (prevent unprivileged programs from overwriting critical memory, authenticate users)
- C2 - Controlled Access Protection (per user access control, clearing of allocated memory, auditing)
- B1 - Labeled Security Protection (Sensitivity labels for all users, processes, files)
- B2 - Structured protection (trusted path to users, security kernel)
- B3 - Security Domains (ACLs, active audit, secure crashing)
- A1 - Verified Design

## The Orange Book (Cont)

- ❑ Originally published in 1983.
- ❑ Single non-US standard called ITSEC in 1990.
- ❑ Single worldwide Common Criteria in 1994.
- ❑ Version 2.1 of Common Criteria in 1999.

## Legal Issues

- ❑ **Children's Online privacy protection act of 1998:**
  - Can ask only first name and age if under 13.
  - Need parents permission for last name, home address, email address, telephone number, social security number, ...
- ❑ **Gramm-Leach-Bliley Financial Modernization Act of 1999 (GLB):** Financial institutions can share nonpublic personal information unless you "opt-out."
  - ⇒ Need to safeguard all such information on the network.
- ❑ **Health Insurance Portability and Accountability Act of 1996 (HIPAA):** Requires consent of a patient's legal representative before confidential information can be released.

## Summary



- ❑ CIA: Confidentiality, Integrity, and Availability  
DAD: Disclosure, Acceptance, Disruption
- ❑ Security Policy: Complete, clear, and enforced
- ❑ Malware: Virus, Worm, Spyware, Hoax, Root kits, ...
- ❑ Attacks: DoS, DDoS, Buffer overflows, ...
- ❑ Protection: Audit, Laws, Honey pots

## References

1. Jan L. Harrington, "Network Security," Morgan Kaufmann, 2005, ISBN:0123116333
2. Gert De Laet and Gert Schauwers, "Network Security Fundamentals," Cisco Press, 2005, ISBN:1587051672
3. Eric Maiwald, "Fundamentals of Network Security," McGraw-Hill, 2004, ISBN:0072230932
4. William Stallings, "Cryptography and Network Security: Principles and Practices," 4<sup>th</sup> edition, Prentice Hall, 2006, ISBN:0131873164
5. Charlie Kaufman, et al, "Network Security: Private Communication in a public world," 2<sup>nd</sup> edition, Prentice Hall, 2002, ISBN:0130460192

## Security URLs

- ❑ Center for Education and Research in Information Assurance and Security,  
<http://www.cerias.purdue.edu/about/history/coast/archive/>
- ❑ IETF Security area, [sec.ietf.org](http://sec.ietf.org)
- ❑ Computer and Network Security Reference Index,  
<http://www.vtcif.telstra.com.au/info/security.html>
- ❑ The Cryptography FAQ,  
<http://www.faqs.org/faqs/cryptography-faq/>
- ❑ Tom Dunigan's Security page,  
<http://www.csm.ornl.gov/%7edunigan/security.html>
- ❑ IEEE Technical Committee on Security and Privacy,  
<http://www.ieee-security.org/index.html>
- ❑ Computer Security Resource Center, <http://csrc.nist.gov/>

## Security URLs (Cont)

- ❑ Security Focus, <http://www.securityfocus.com/>
- ❑ SANS Institute, <http://sans.org/>
- ❑ Data Protection resource Directory,  
<http://www.dataprotectionhq.com/cryptographyanddatasecurity/>
- ❑ Helger Lipmaa's Cryptology Pointers,  
<http://www.adastral.ucl.ac.uk/%7ehelger/crypto/>
- ❑ Network Security Directory,  
<http://www.networksecuritysite.info/>

## Security Related Usenet Groups

- sci.crypt.research
- sci.crypt
- sci.crypt.random-numbers
- alt.security
- comp.security.misc
- comp.security.firewalls
- comp.security.announce
- comp.risks
- comp.virus

## Lab Homework 2

1. Read about the following tools
  - a. **Ethereal**, network protocol analyzer, [www.ethereal.com](http://www.ethereal.com)
  - b. **Superscan4**, network port scanner (like nmap), <http://www.lock-mypc.com/SuperScan4.html>
  - c. **Network Surveyor**, network mapping, <http://www.solarwindssoftware.com/lansurveyor.aspx>
2. Use superscan4 to scan one to three hosts on your local net (or 128.252.166.77, 128.252.160.213, 128.252.160.222) to find their open ports. Select scan type “connect” in the Host and Service discovery panel.
3. Use network surveyor to show the map of all hosts on your local net (or between 128.252.166.77 through 128.252.166.85)
4. Start Ethereal to capture all traffic. Open [www.google.com](http://www.google.com) in a web browser. Stop Ethereal. List all packets seen and interpret them.