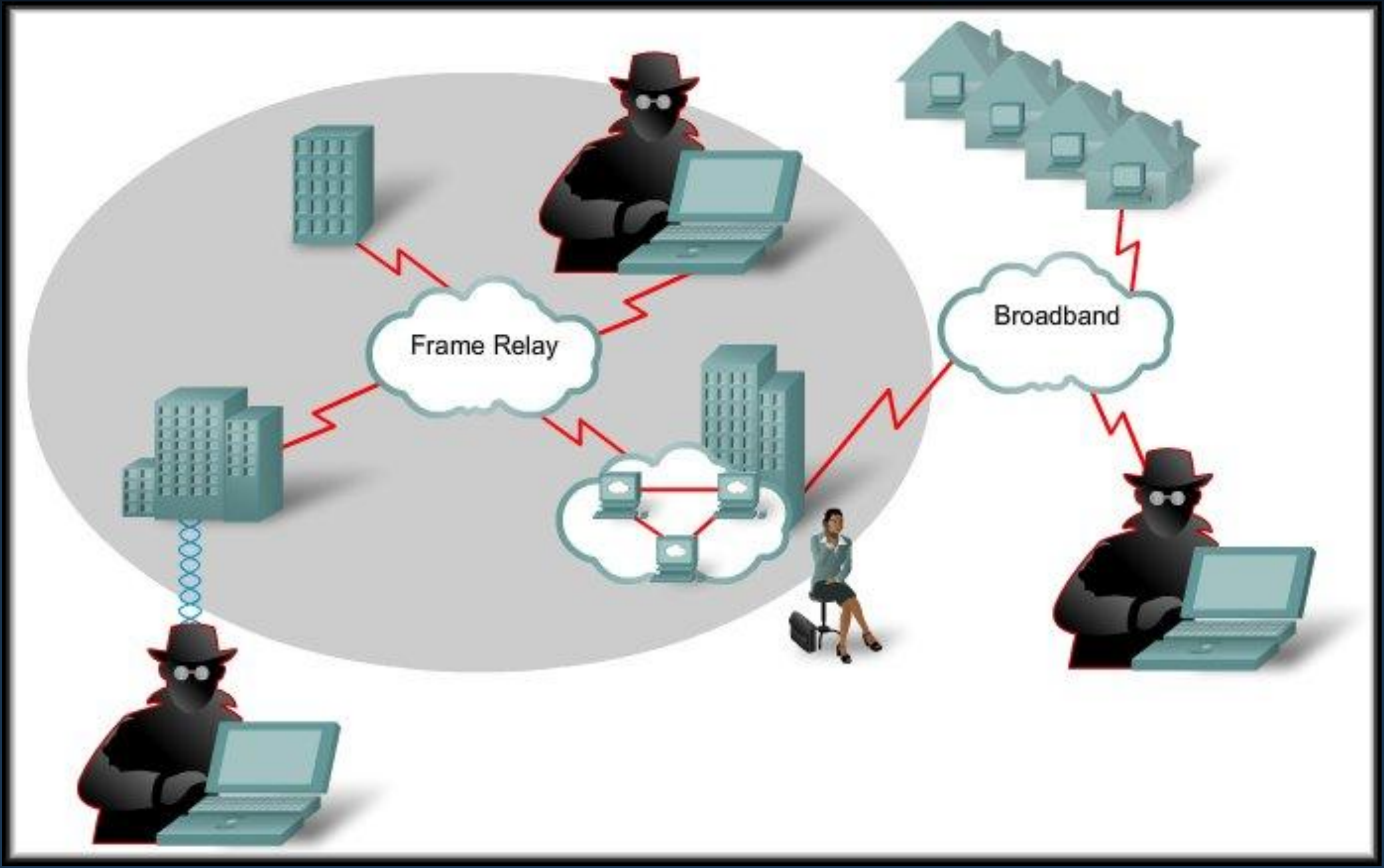
Chapter 4

Network Security

Part I

Introduction to Network Security



Introducing Network Security

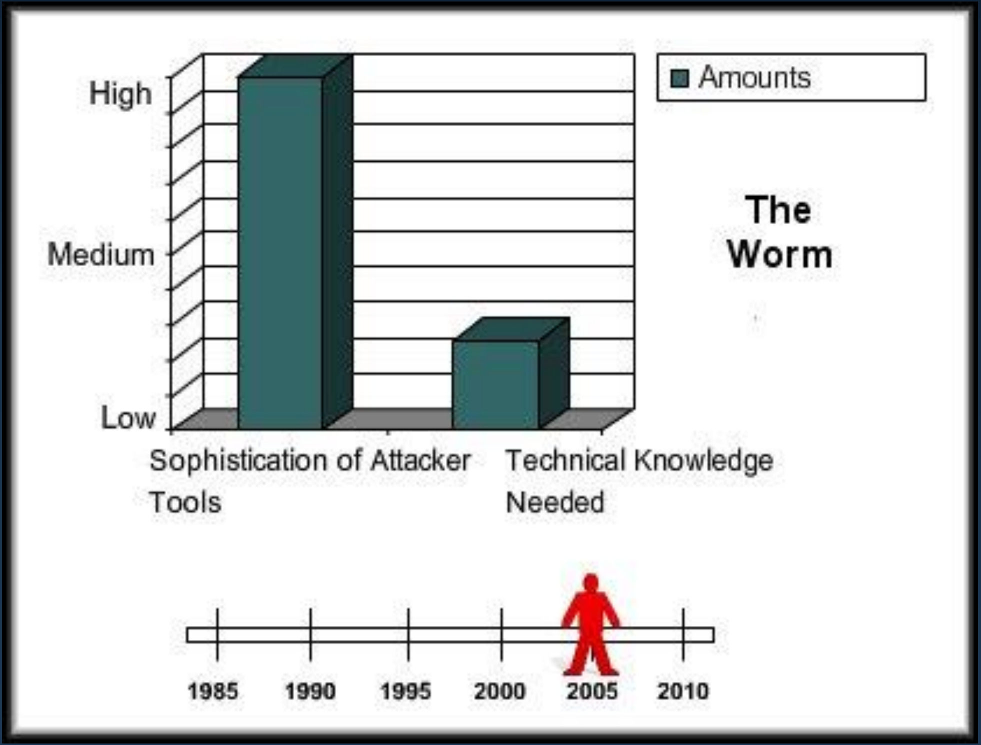
- Why is Network Security important?
  - Rapid growth in both size and importance.
  - Consequences of compromised security:
    - Loss of privacy.
    - Theft of information.
    - Legal liability.

Introducing Network Security

- Why is Network Security important?
  - We will discuss:
    - Different types of threats.
    - Development of organizational security policies, mitigation techniques,
    - Cisco software tools to help secure networks.
    - Managing Cisco IOS software images.
      - Cisco software images and configurations can be deleted. Devices compromised in this way pose security risks.

Introducing Network Security

- Increasing Threat to Security:
  - Over the years, attack tools have evolved.
  - Threats become more sophisticated as the technical expertise required to implement attacks diminishes.



Introducing Network Security

- Common Terms:
  - White Hat:
    - An individual who looks for vulnerabilities in systems and reports these so that they can be fixed.
  - Black Hat:
    - An individual who uses their knowledge to break into systems that they are not authorized to use.
  - Hacker:
    - A general term that has historically been used to describe a computer programming expert.

Introducing Network Security

- Common Terms:
  - Cracker:
    - Someone who tries to gain unauthorized access to network resources with malicious intent.
  - Phreaker:
    - Individual who manipulates phone network, through a payphone, to make free long distance calls.
  - Spammer:
    - An individual who sends large quantities of unsolicited e-mail messages.
  - Phisher:
    - Uses e-mail or other means to trick others into providing information.

Introducing Network Security

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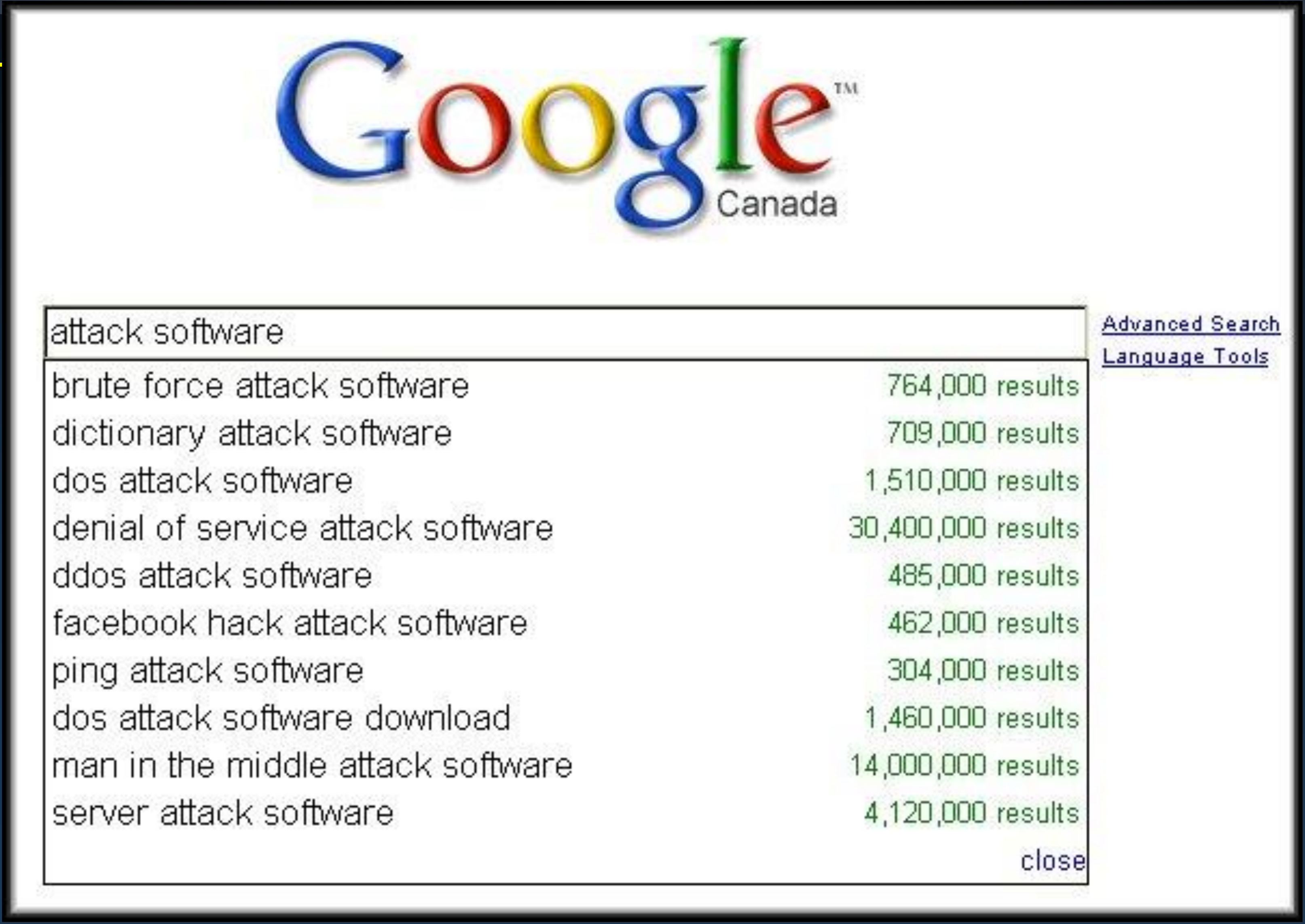


attack software

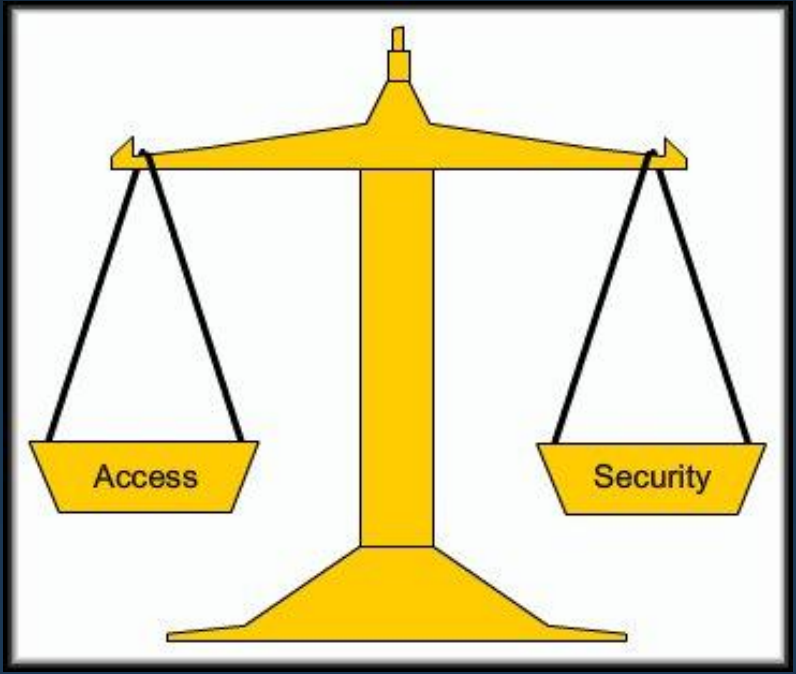
brute force attack software	764,000 results
dictionary attack software	709,000 results
dos attack software	1,510,000 results
denial of service attack software	30,400,000 results
ddos attack software	485,000 results
facebook hack attack software	462,000 results
ping attack software	304,000 results
dos attack software download	1,460,000 results
man in the middle attack software	14,000,000 results
server attack software	4,120,000 results

Introducing Network Security

- Types of computer crime:
  - Text and Curriculum lists the most commonly reported acts of computer crime that have network security implications.
  - They fall into four general categories, or a combination thereof, that effective and vigilant security management can address.
    - Insider Abuse
    - Denial of service
    - System Penetration
    - Password sniffing

Introducing Network Security

- Open versus Closed Networks:
  - The challenge is to find the correct balance.
    - Networks must be accessible to be of any use.
    - Networks must be secure to protect corporate and personal information.



Introducing Network Security

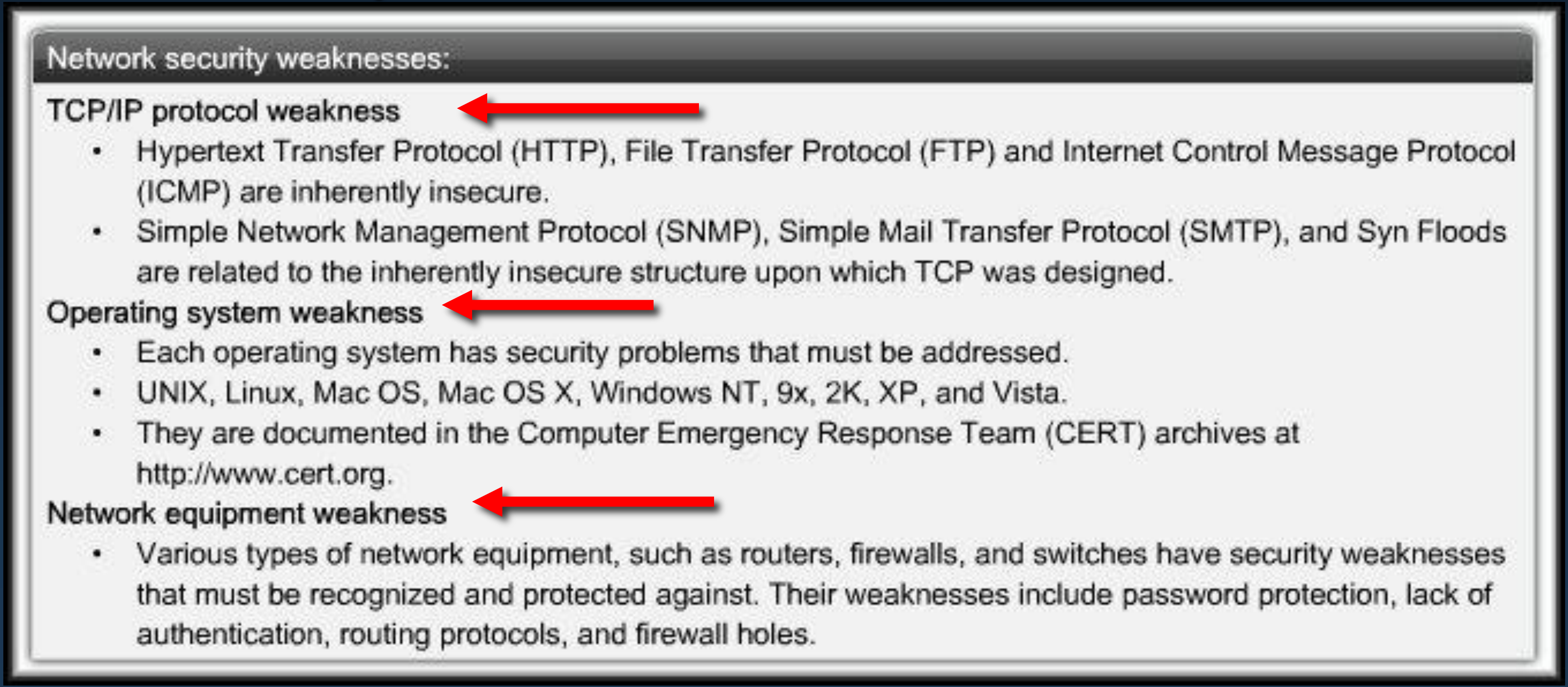
- Developing a Security Policy:
  - First step an organization should take to protect its data and a liability challenge.
  - A security policy meets these goals:
    - Informs users, staff, and managers of their requirements for protecting information assets.
      - Acceptable and unacceptable use.
    - Specifies the mechanisms through which these requirements can be met.
      - Managing security violations.
    - Provides a baseline from which to acquire, configure, and audit computer systems for compliance.
      - Basis for legal action.

Common Security Threats

- Three common factors - Network Security:
  - Vulnerability:
    - It is the degree of weakness which is inherent in every network and device.
      - Routers, switches, desktops, and servers.
  - Threats:
    - They are the people interested in taking advantage of each security weakness.
  - Attack:
    - The threats use a variety of tools, and programs to launch attacks against networks.

Vulnerabilities

- Three primary Vulnerabilities or Weaknesses:
  - Technological weaknesses.
    - Computer and network technologies have intrinsic security weaknesses.



Network security weaknesses:

TCP/IP protocol weakness

- Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP) and Internet Control Message Protocol (ICMP) are inherently insecure.
- Simple Network Management Protocol (SNMP), Simple Mail Transfer Protocol (SMTP), and Syn Floods are related to the inherently insecure structure upon which TCP was designed.

Operating system weakness

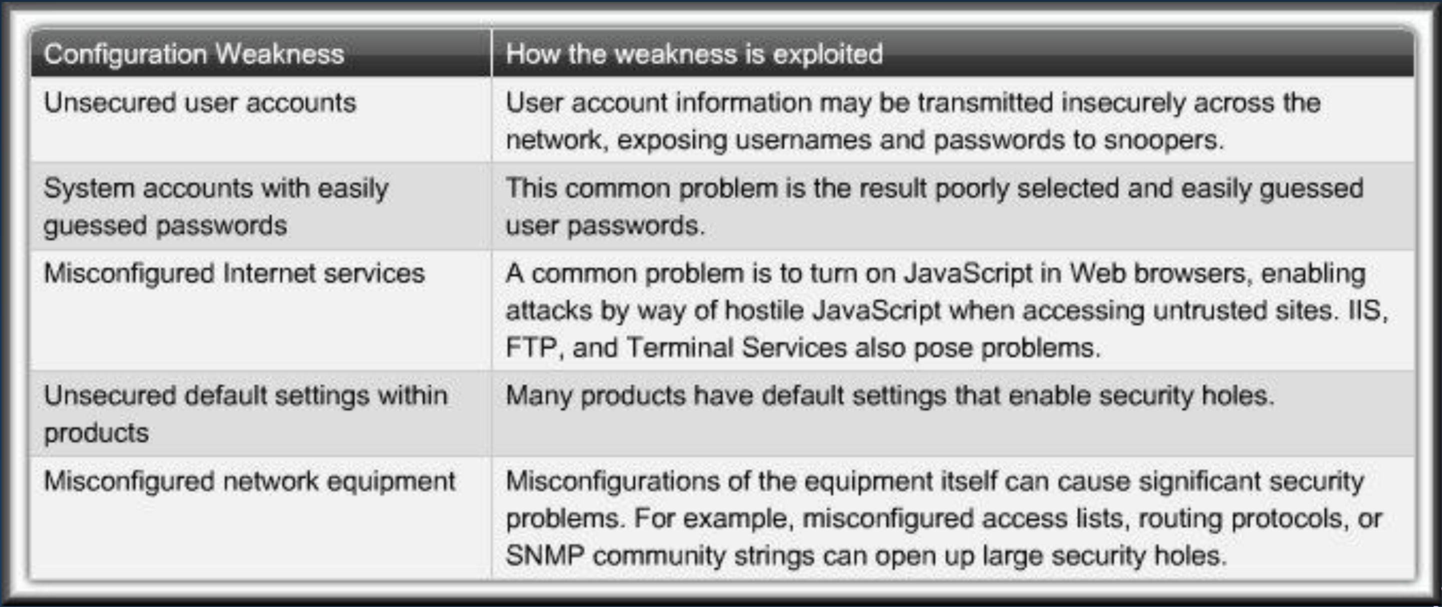
- Each operating system has security problems that must be addressed.
- UNIX, Linux, Mac OS, Mac OS X, Windows NT, 9x, 2K, XP, and Vista.
- They are documented in the Computer Emergency Response Team (CERT) archives at http://www.cert.org.

Network equipment weakness

- Various types of network equipment, such as routers, firewalls, and switches have security weaknesses that must be recognized and protected against. Their weaknesses include password protection, lack of authentication, routing protocols, and firewall holes.

Vulnerabilities

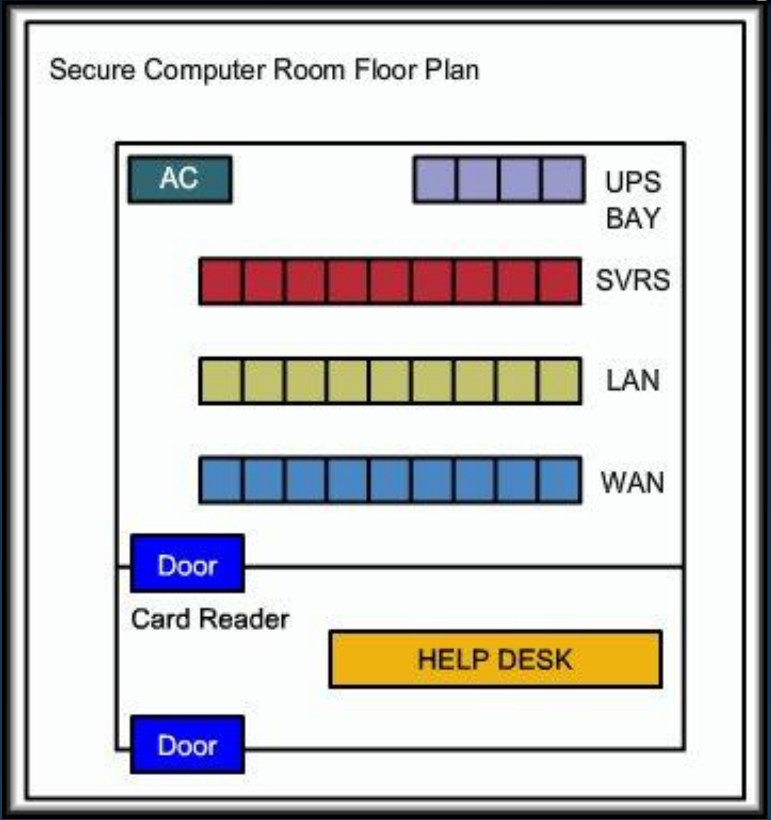
- Three primary Vulnerabilities or Weaknesses:
  - Configuration weaknesses.
    - Network administrators or network engineers need to learn what the configuration weaknesses are and correctly configure their computing and network devices to compensate.



Configuration Weakness	How the weakness is exploited
Unsecured user accounts	User account information may be transmitted insecurely across the network, exposing usernames and passwords to snoopers.
System accounts with easily guessed passwords	This common problem is the result poorly selected and easily guessed user passwords.
Misconfigured Internet services	A common problem is to turn on JavaScript in Web browsers, enabling attacks by way of hostile JavaScript when accessing untrusted sites. IIS, FTP, and Terminal Services also pose problems.
Unsecured default settings within products	Many products have default settings that enable security holes.
Misconfigured network equipment	Misconfigurations of the equipment itself can cause significant security problems. For example, misconfigured access lists, routing protocols, or SNMP community strings can open up large security holes.

Threats to Physical Infrastructure

- Four classes of Physical Threats:
  - Hardware Threat:
    - Physical damage to servers, routers, switches, cabling plant, and workstations.
  - Security Measures:
    - Lock up equipment and prevent unauthorized access.
    - Monitor wiring closet access – electronic logs.
    - Security cameras


Secure Computer Room Floor Plan

Threats to Physical Infrastructure

- Four classes of Physical Threats:
  - Environmental Threat:
    - Temperature or humidity extremes.
  - Security Measures:
    - Temperature control.
    - Humidity control.
    - Positive air flow.
    - Remote environment alarms.

Threats to Physical Infrastructure

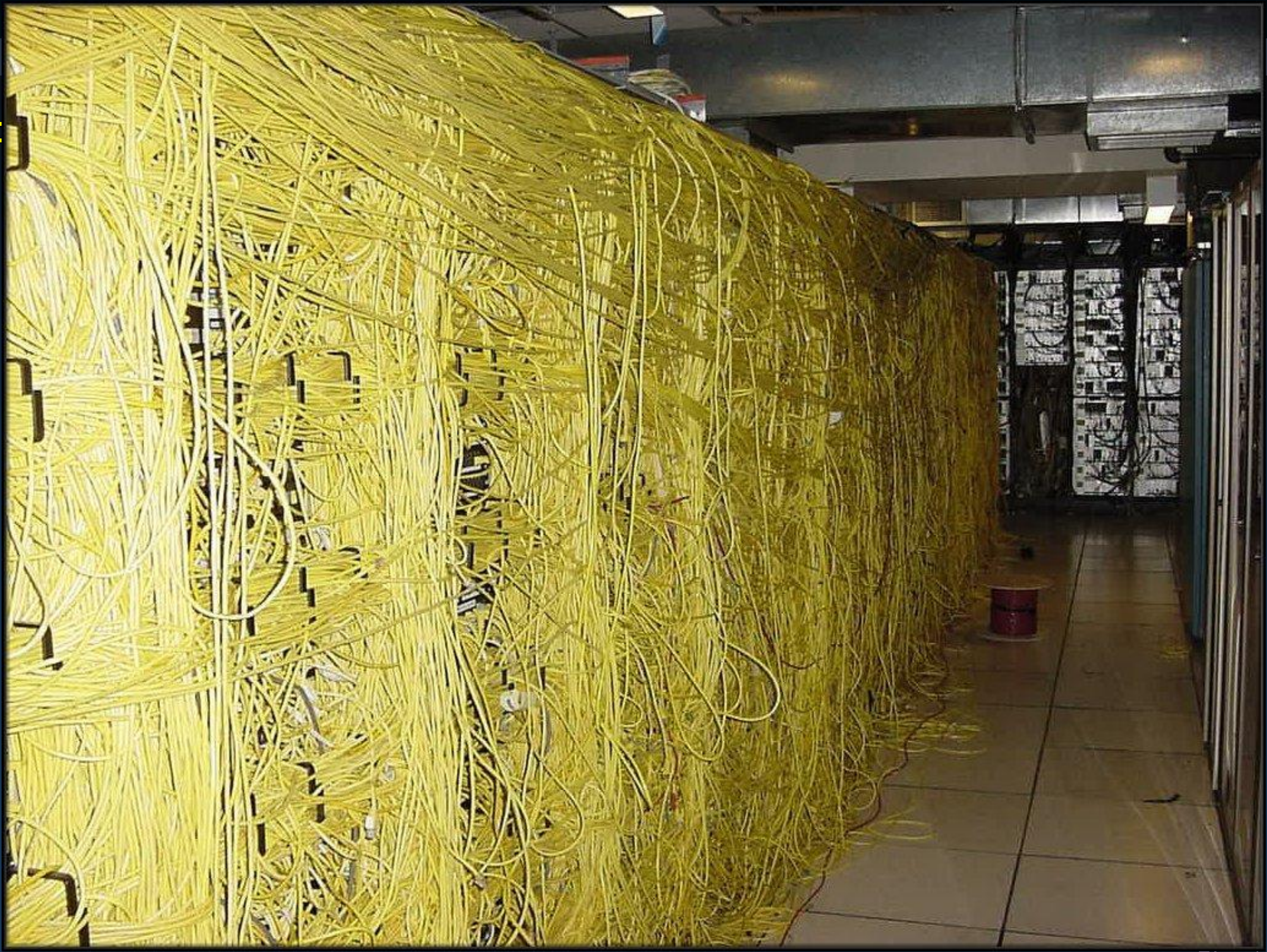
- Four classes of Physical Threats:
  - Electrical Threat:
    - Voltage spikes, insufficient voltage (brownouts), unconditioned power (noise), and total power loss.
  - Security Measures:
    - UPS systems.
    - Generators.
    - Preventive maintenance.
    - Redundant power supply.
    - Remote alarms.

Threats to Physical Infrastructure

- Four classes of Physical Threats:
  - Maintenance:
    - Poor handling of key electrical components, lack of critical spare parts, poor cabling, and poor labeling.
  - Security Measures:
    - Neat cable runs.
    - Label the cables.
    - Electrostatic discharge procedures.
    - Stock critical spares.
    - Control console port access.

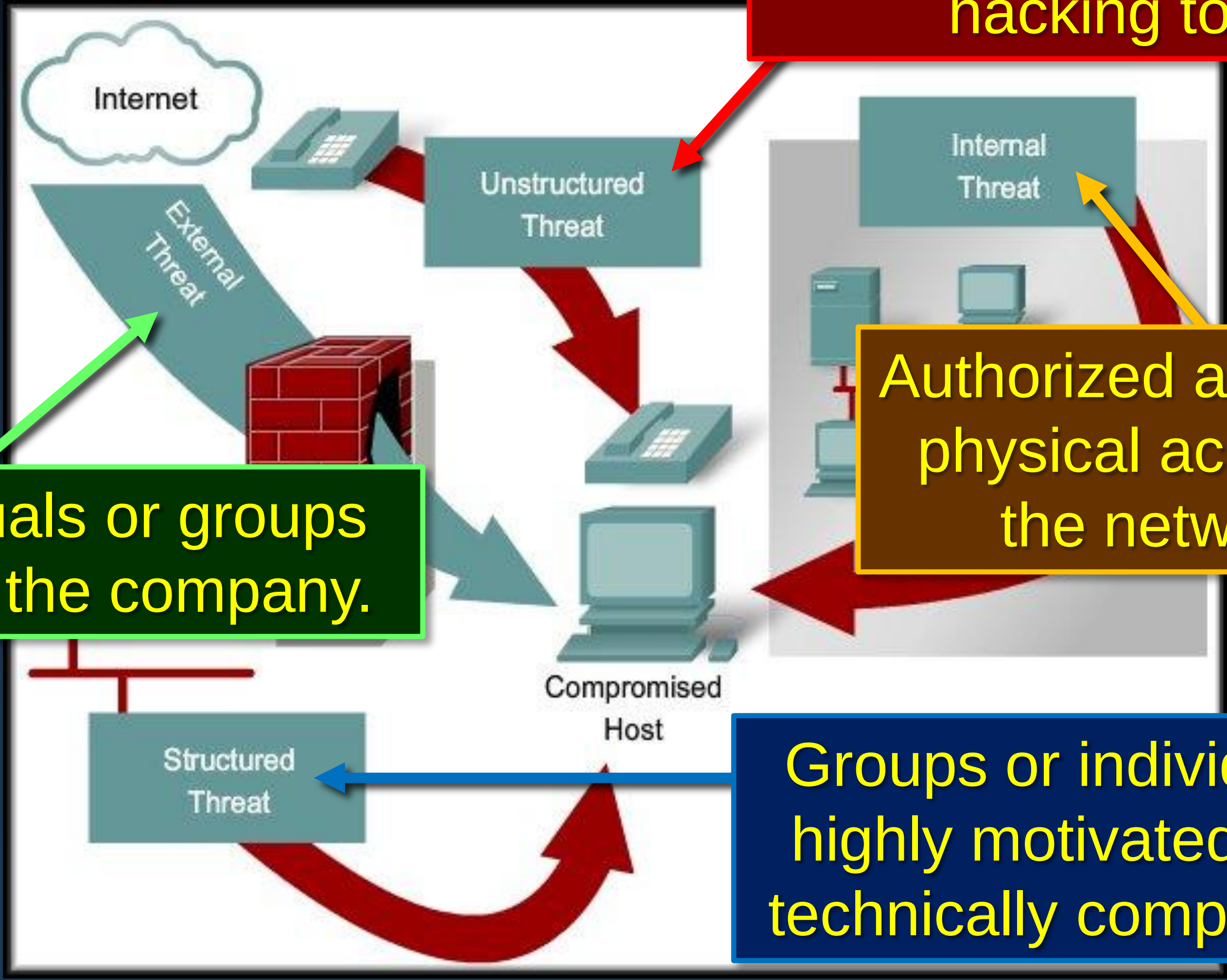
Threats to Physical Infrastructure

- F



Threats to Networks

- Network Threats:



Inexperienced individuals with easily available hacking tools.

Authorized access or physical access to the network.

Individuals or groups outside the company.

Groups or individuals highly motivated and technically competent.

Social Engineering

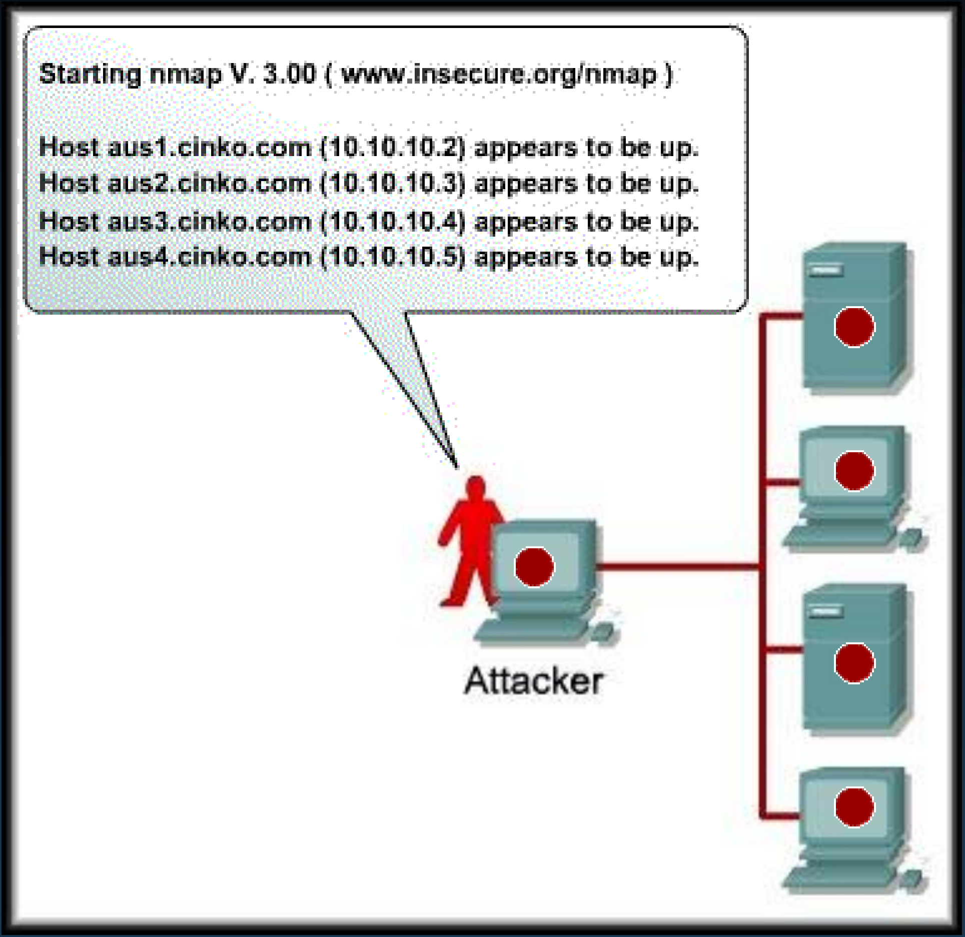
- The easiest hack involves no computer skill.
  - If an intruder can trick a member of an organization into giving over information, such as the location of files or passwords, the process of hacking is made much easier.
- Phishing:
  - A type of social engineering attack that involves using e-mail in an attempt to trick others into providing sensitive information, such as credit card numbers or passwords.
  - Phishing attacks can be prevented by educating users and implementing reporting guidelines when they receive suspicious e-mail.

Types of Network Attacks

- There are four primary classes of attacks:
  - Reconnaissance
  - Access
  - Denial of Service
  - Malicious Code

Types of Network Attacks

- Reconnaissance:
  - Reconnaissance is the unauthorized discovery and mapping of systems, services, or vulnerabilities.
  - In most cases, it precedes another type of attack.

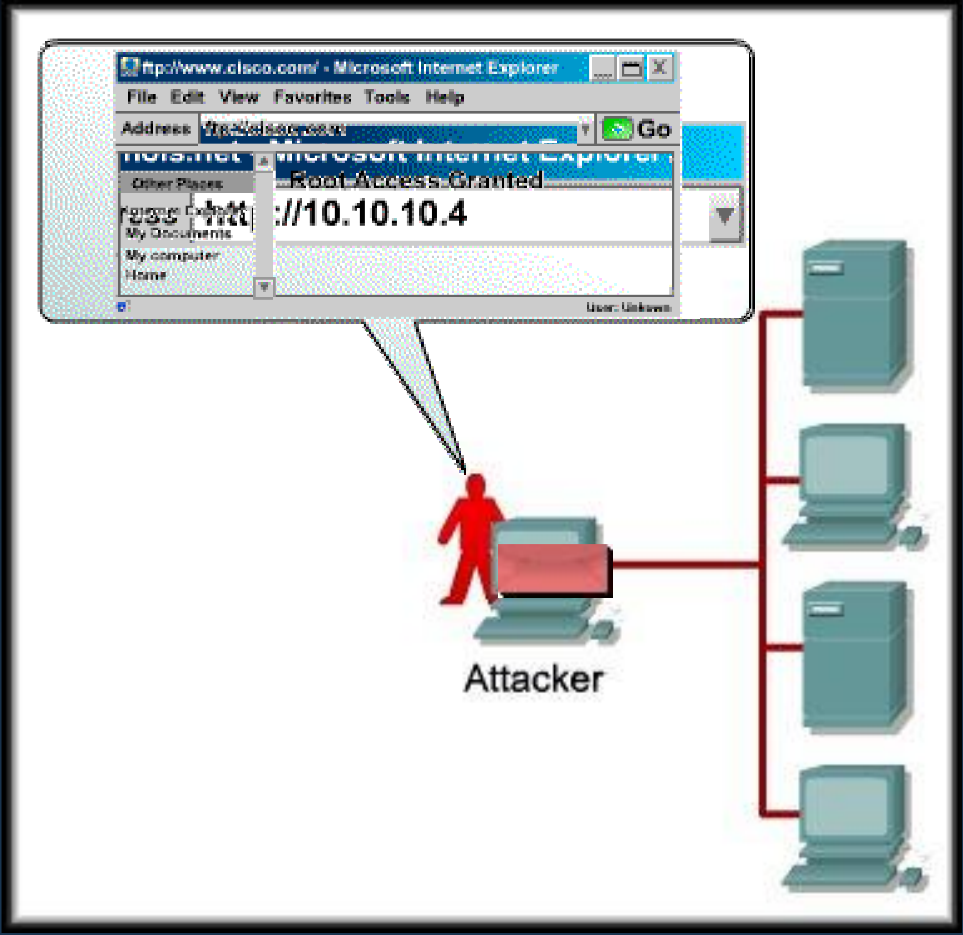


```
Starting nmap V. 3.00 ( www.insecure.org/nmap )

Host aus1.cinko.com (10.10.10.2) appears to be up.
Host aus2.cinko.com (10.10.10.3) appears to be up.
Host aus3.cinko.com (10.10.10.4) appears to be up.
Host aus4.cinko.com (10.10.10.5) appears to be up.
```

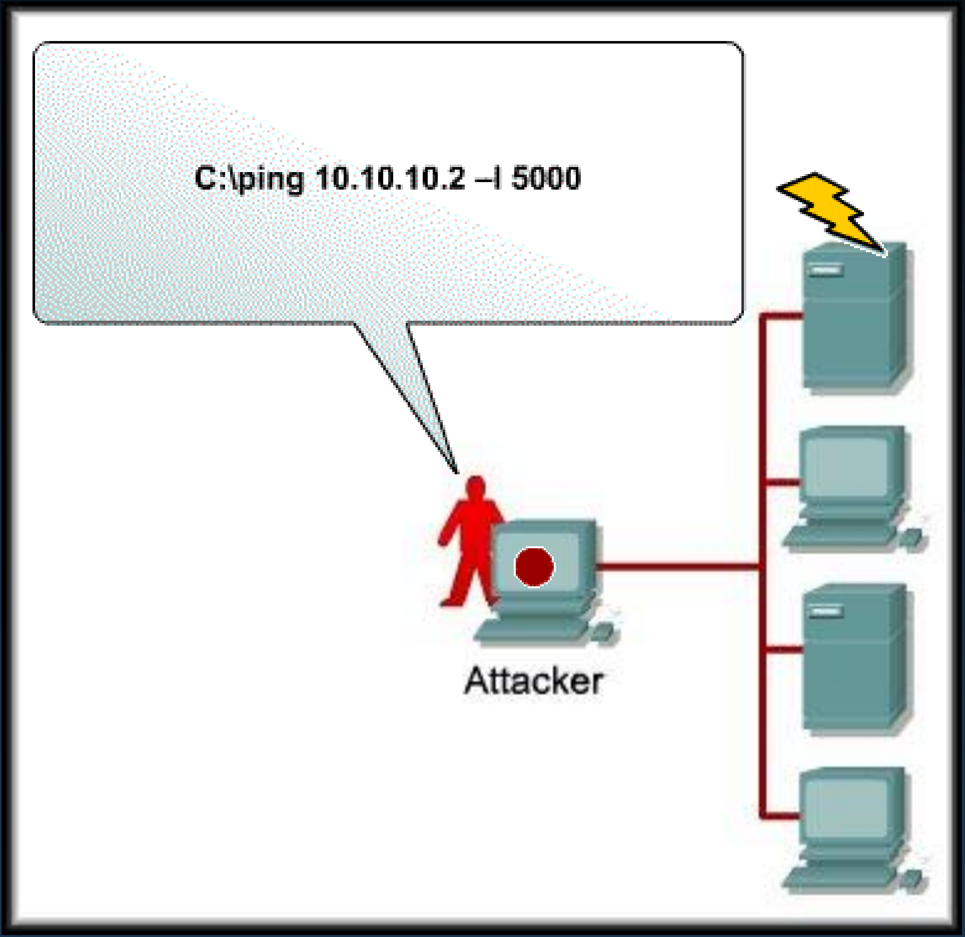
Types of Network Attacks

- System Access:
  - System access is the ability for an intruder to gain access to a device for which the intruder does not have an account or a password.
  - Usually involves running a hack, script, or tool that exploits a known vulnerability of the system or application being attacked.



Types of Network Attacks

- Denial of Service:
  - Denial of service (DoS) is when an attacker disables or corrupts networks, systems, or services with the intent to deny services to intended users.
  - DoS attacks involve either crashing the system or slowing it down to the point that it is unusable.

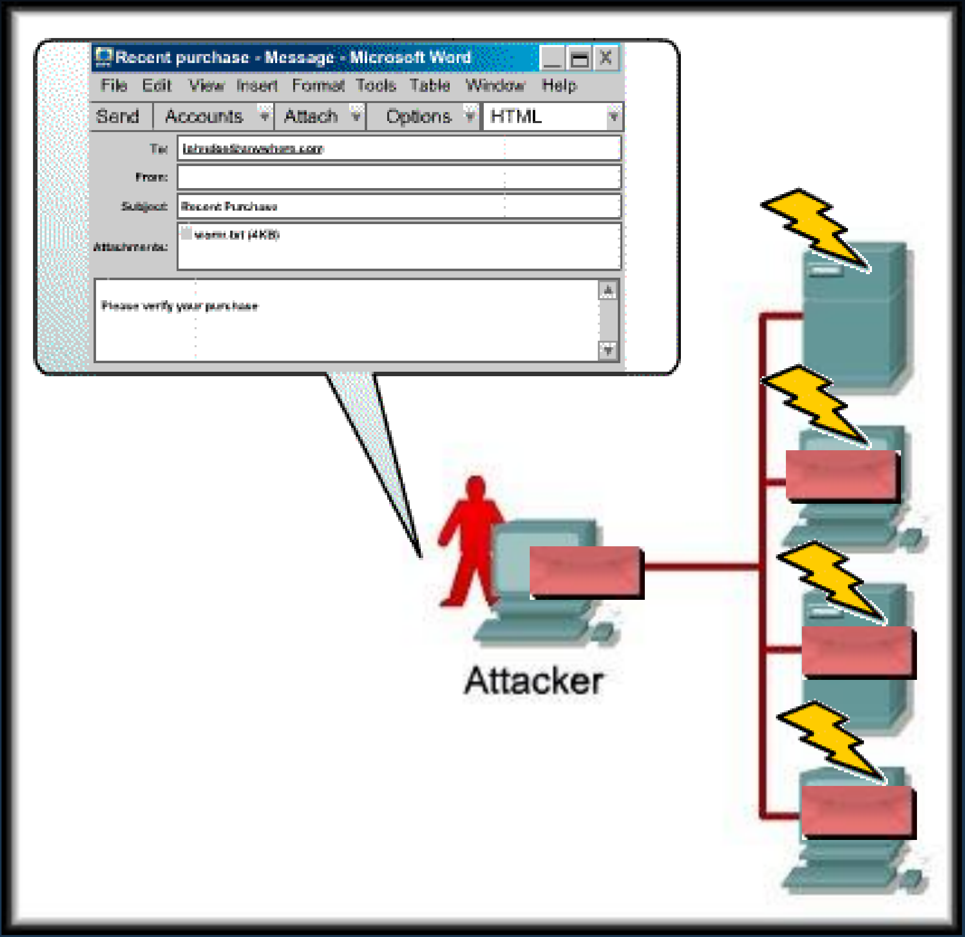


```
C:\ping 10.10.10.2 –l 5000
```

DoS MOST FEARED!

Types of Network Attacks

- Worms, Viruses and Trojan Horses:
  - Malicious software can be inserted onto a host to damage or corrupt a system, replicate itself, or deny access to networks, systems, or services.


Recent purchase - Message - Microsoft Word
File Edit View Insert Format Tools Table Window Help
Send
Accounts
Attach
Options
HTML
Attacker

To: [illegible]

From:

Subject: Recent Purchase

Attachments: worm.txt (4KB)

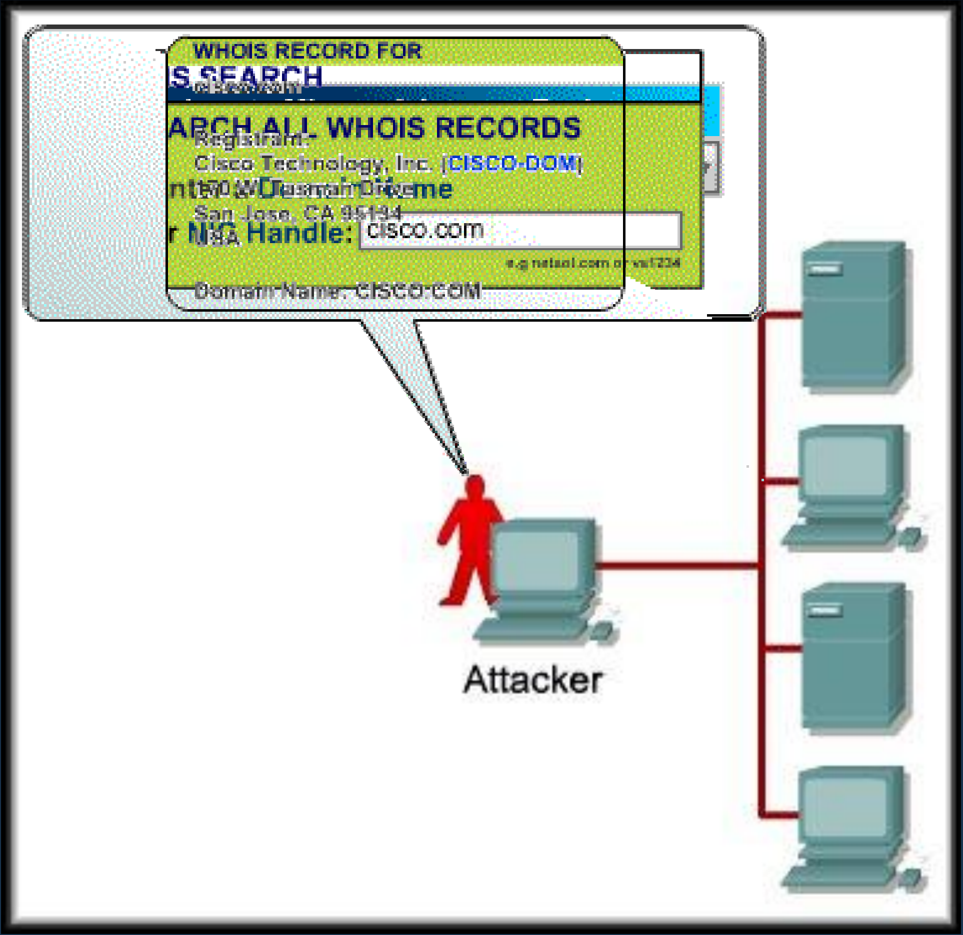
Please verify your purchase

Types of Network Attacks

- Reconnaissance Attacks:
  - Reconnaissance is the unauthorized discovery or mapping of systems, services or vulnerabilities.
  - It usually precedes another type of attack.
  - Can consist of:
    - Internet Information Queries
    - Ping Sweeps
    - Port Scans
    - Packet Sniffers

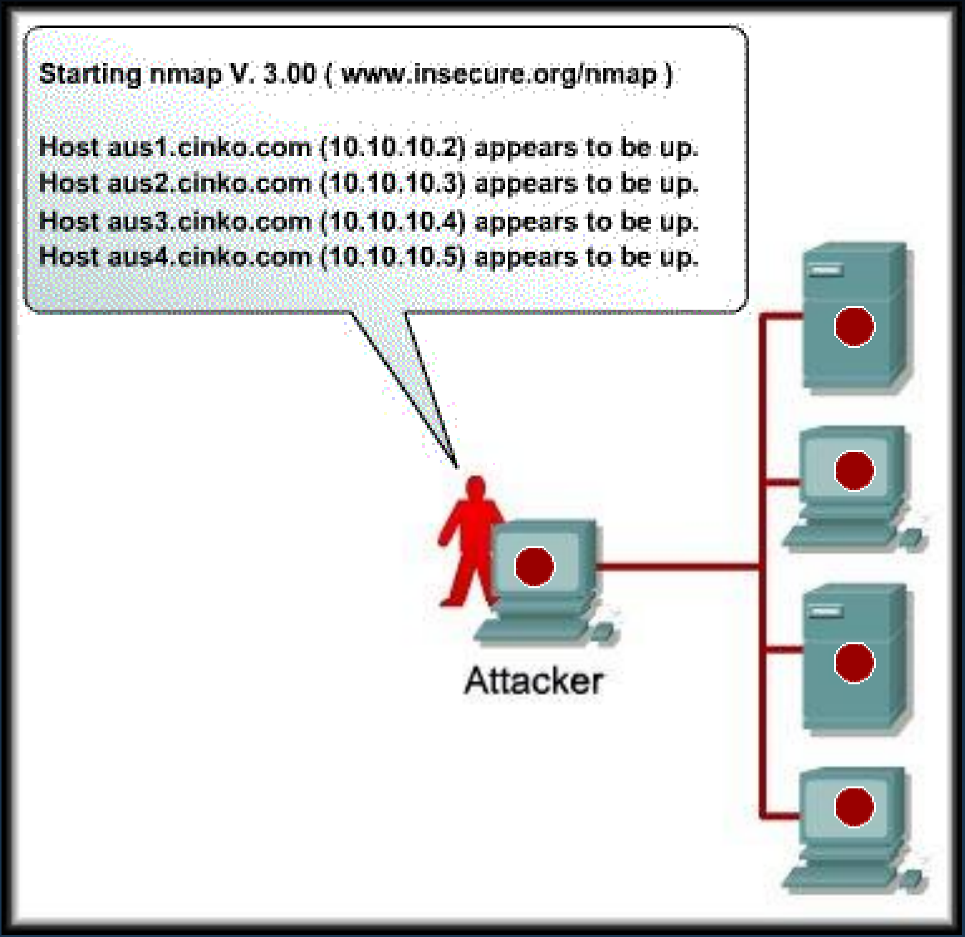
Types of Network Attacks

- Internet Queries:
  - External attackers can use Internet tools, such as the nslookup and whois utilities, to easily determine the IP address space assigned to a given corporation or entity.



Types of Network Attacks

- Ping Sweeps:
  - After the IP address space is determined, an attacker can then ping the publicly available IP addresses to identify the addresses that are active.
  - To help automate this step, an attacker may use a ping sweep tool, such as fping or gping.



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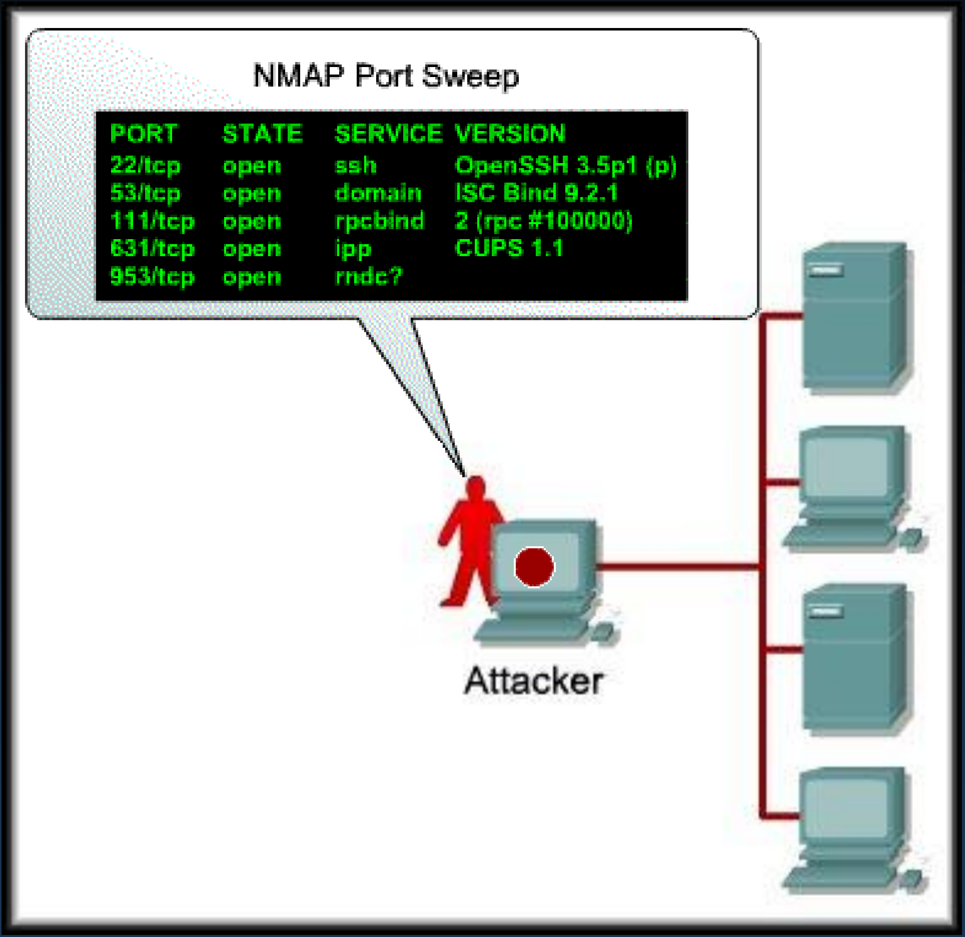
Host aus4.cinko.com (10.10.10.5) appears to be up.
```

Types of Network Attacks

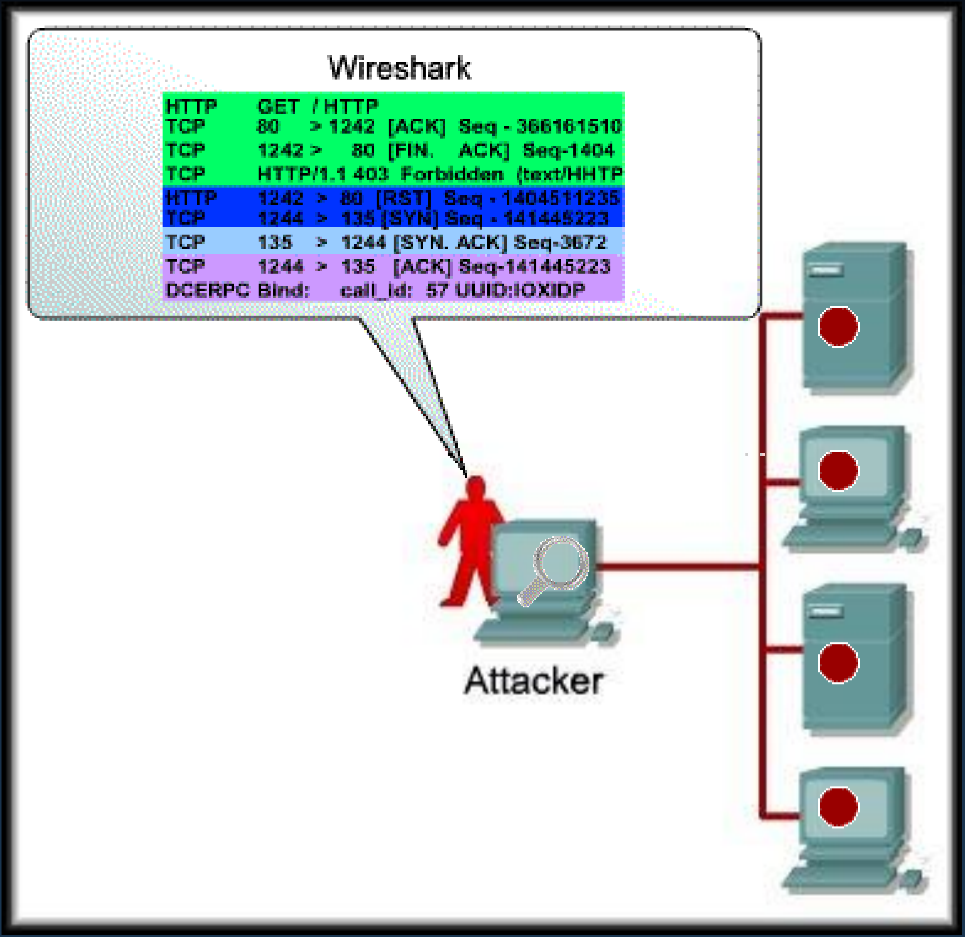
- Port Scans:
  - When the active IP addresses are identified, the intruder uses a port scanner to determine which network services or ports are active on the live IP addresses.
  - A port scanner is software, such as Nmap or Superscan, that is designed to search a network host for open ports.



```
PORT     STATE   SERVICE  VERSION
22/tcp   open    ssh      OpenSSH 3.5p1 (p)
53/tcp   open    domain   ISC Bind 9.2.1
111/tcp  open    rpcbind  2 (rpc #100000)
631/tcp  open    ipp      CUPS 1.1
953/tcp  open    rndc?
```

Types of Network Attacks

- Packet Sniffers:
  - Internal attackers may attempt to "eavesdrop“ on network traffic.
  - Wire Shark
  - Two common uses of eavesdropping are Information Gathering and/or Information Theft.



```
HTTP    GET  / HTTP
TCP     80     > 1242  [ACK]  Seq - 366161510
TCP     1242 >    80  [FIN.   ACK]  Seq-1404
TCP     HTTP/1.1 403  Forbidden  (text/HHTP
HTTP    1242  >  80  [RST]  Seq - 1404511235
TCP     1244  >  135 [SYN] Seq - 141445223
TCP     135    >  1244 [SYN. ACK] Seq-3672
TCP     1244  >  135   [ACK] Seq-141445223
DCERPC Bind:     call_id:  57 UUID:IOXIDP
```

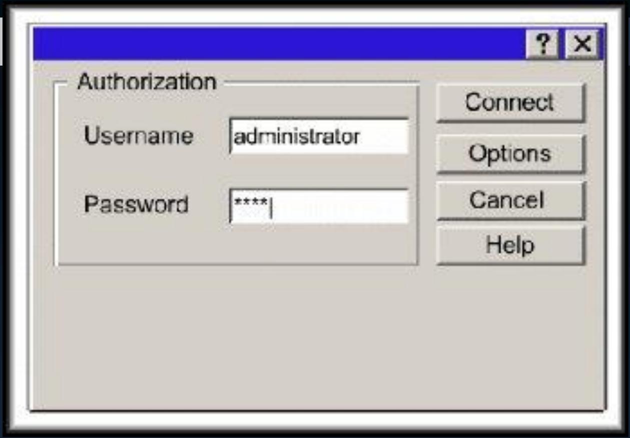
Types of Network Attacks

- Packet Sniffers:
  - A common method for eavesdropping is to capture TCP/IP or other protocol packets and decode the contents.
  - Three of the most effective methods for counteracting eavesdropping are as follows:
    - Using switched networks instead of hubs so that traffic is not broadcast to all endpoints or network hosts.
    - Using encryption that meets the data security needs without imposing an excessive burden on system resources or users.
    - Forbid the use of protocols with known susceptibilities to eavesdropping. (e.g. SNMP vs SNMP v3)

Types of Network Attacks

- Access Attacks:
  - Access attacks exploit vulnerabilities in authentication, FTP, and web to gain entry to accounts, confidential, and sensitive information.
  - The more common are:
    - Password Attacks
    - Trust Exploitation
    - Port Redirection
    - Man-in-the-Middle

Types of Network Attacks



Authorization

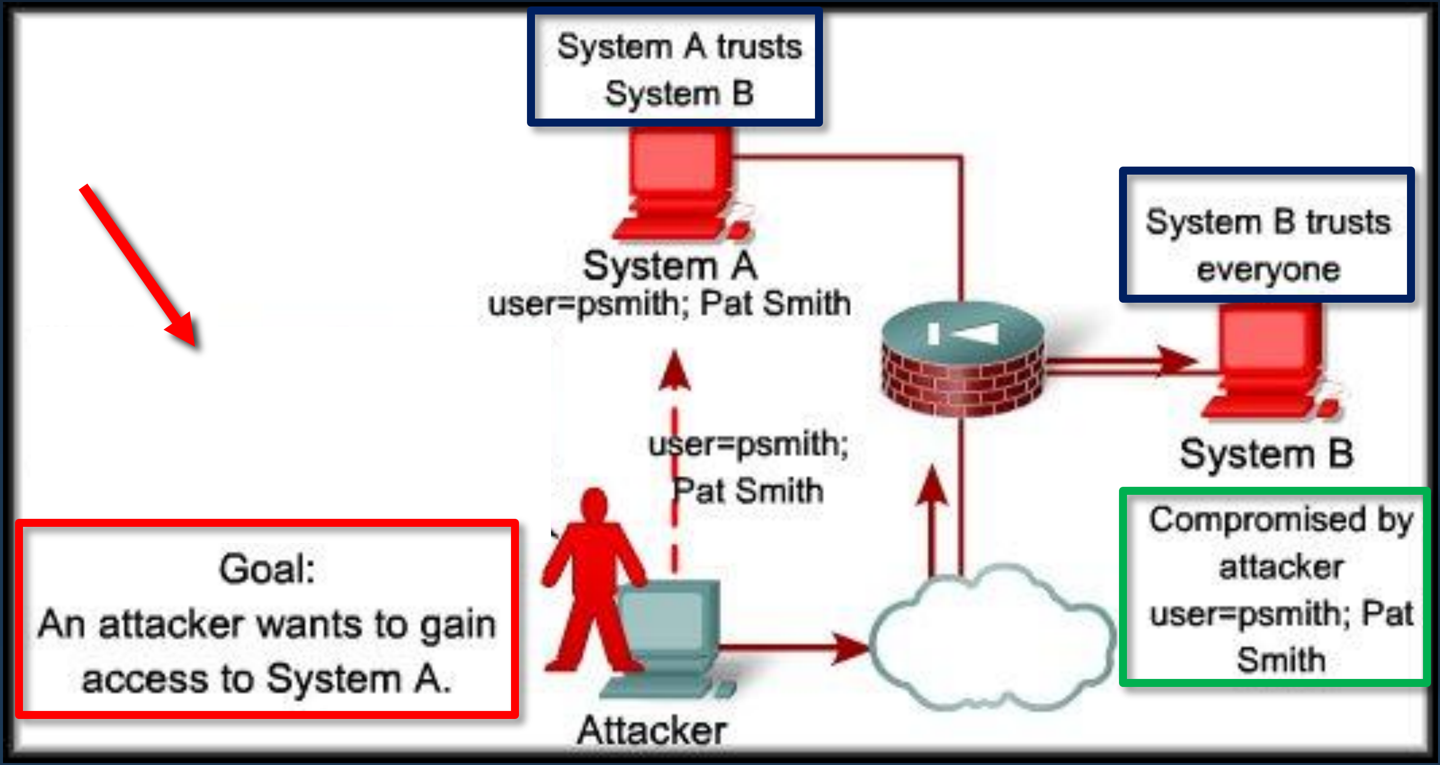
Username: administrator

Password: ****

- Password Attacks:
  - Packet sniffer to yield user accounts and passwords that are transmitted as clear text.
  - Dictionary Attacks or Brute-Force Attacks:
    - Repeated attempts to log in to a shared resource.
    - Tools such as L0phtCrack or Cain.
    - Rainbow Tables:
      - A rainbow table is pre-computed series of passwords which is constructed by building chains of possible plaintext passwords.
    - Password attacks can be mitigated by educating users to use long, complex passwords.

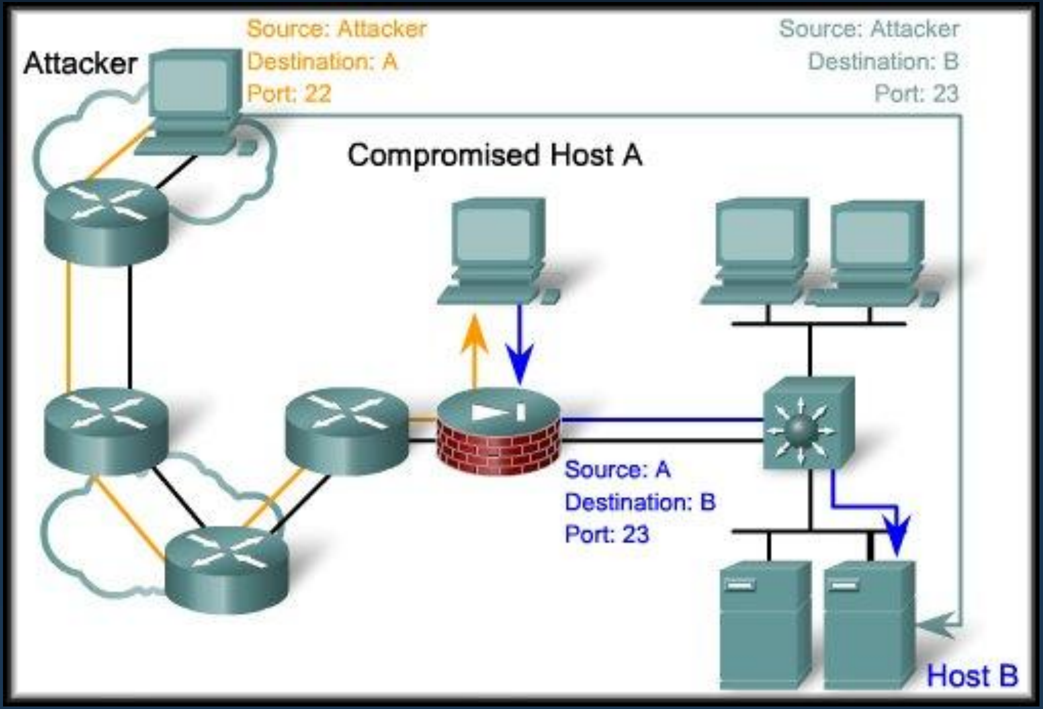
Types of Network Attacks

- Trust Exploitation:
  - The goal of a trust exploitation attack is to compromise a trusted host, using it to stage attacks on other hosts in a network.



Types of Network Attacks

- Port Redirection:
  - Port redirection is a type of trust exploitation attack that uses a compromised host to pass traffic through a firewall. Traffic that would normally be stopped.
  - Utility - netcat
  - Port redirection can be mitigated through the use a host-based Intrusion Detection System (IDS).
    (e.g. Snort)



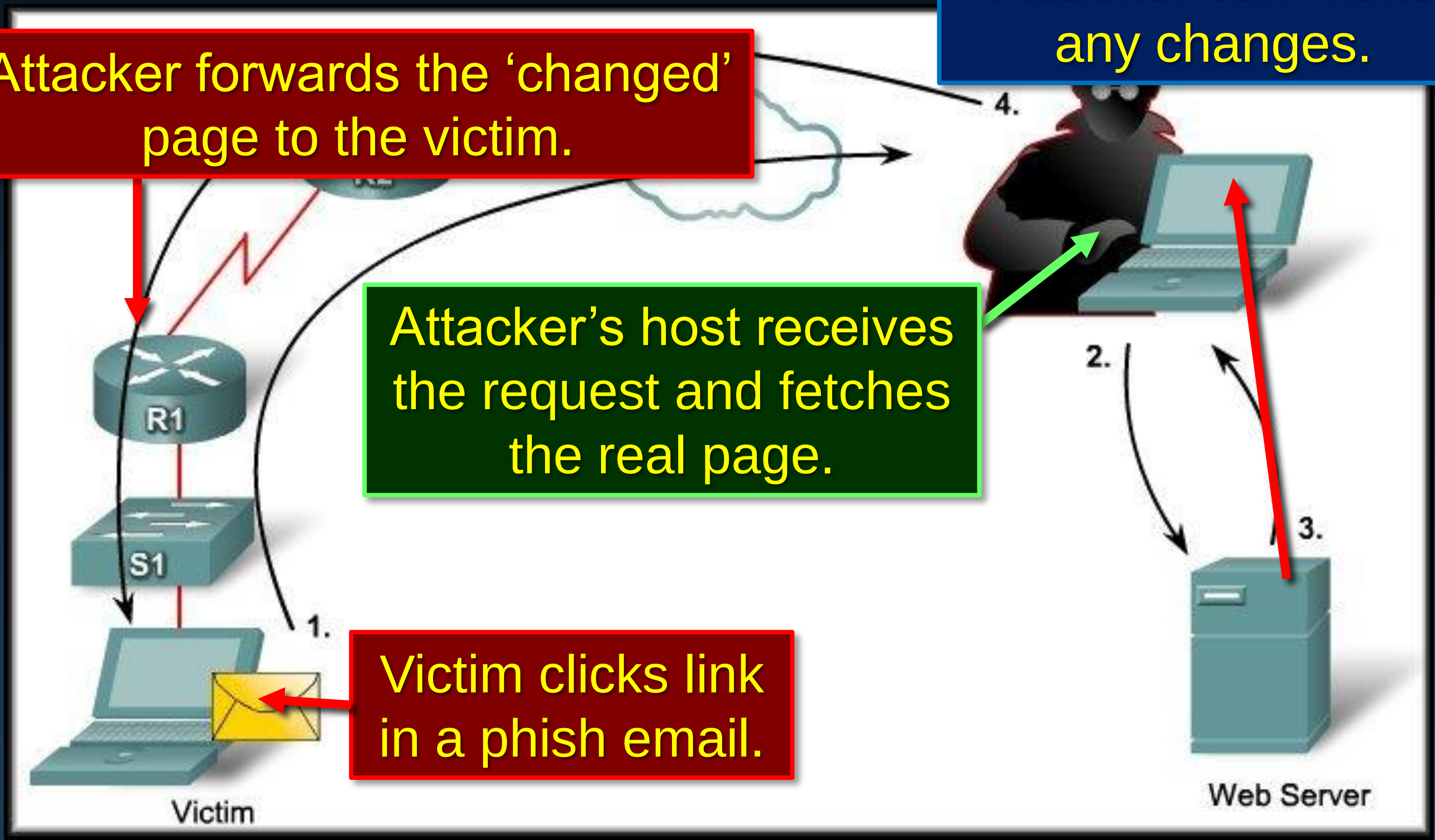
Types of Network Attacks

- Man-in-the-Middle:
  - A man-in-the-middle (MITM) attack is carried out by attackers that manage to position themselves between two legitimate hosts.
  - There are many ways that an attacker gets positioned between two hosts.
  - One popular method, the transparent proxy:
    - In a transparent proxy attack, an attacker may catch a victim with a phishing e-mail or by defacing a website.
    - Then the URL of a legitimate website has the attacker's URL prepended.

*http:www.attacker.com/*http://www.legitimate.com

Types of Network Attacks

- Man-in-the-Middle:



Attacker can make any changes.

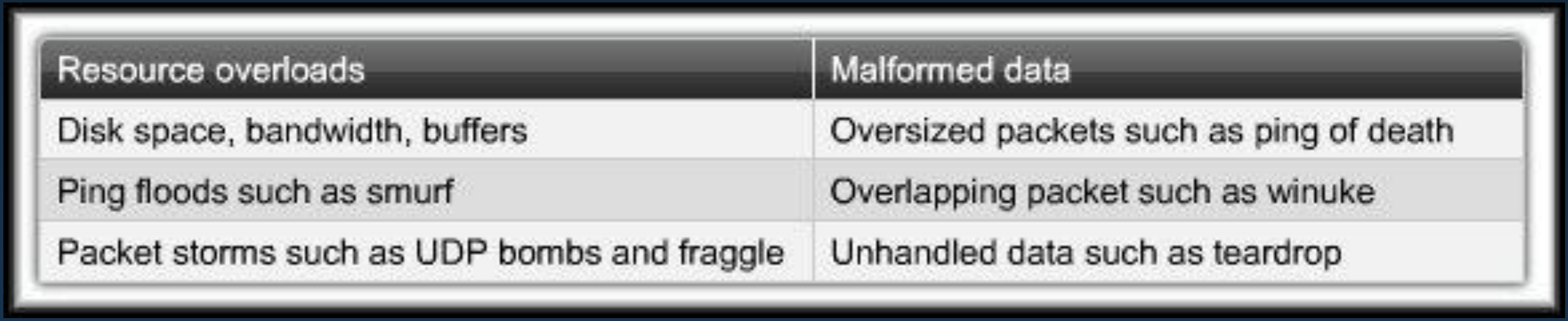
Attacker forwards the 'changed' page to the victim.

Attacker's host receives the request and fetches the real page.

Victim clicks link in a phish email.

Types of Network Attacks

- Denial-of-Service Attacks:
  - An attacker disables or corrupts networks, systems or services with the intent to deny service to intended users.
  - DoS attacks are the most publicized form of attack and also among the most difficult to eliminate.



Resource overloads	Malformed data
Disk space, bandwidth, buffers	Oversized packets such as ping of death
Ping floods such as smurf	Overlapping packet such as winuke
Packet storms such as UDP bombs and fraggle	Unhandled data such as teardrop

  - Ping of Death
  - SYN Flood
  - DDos
  - Smurf

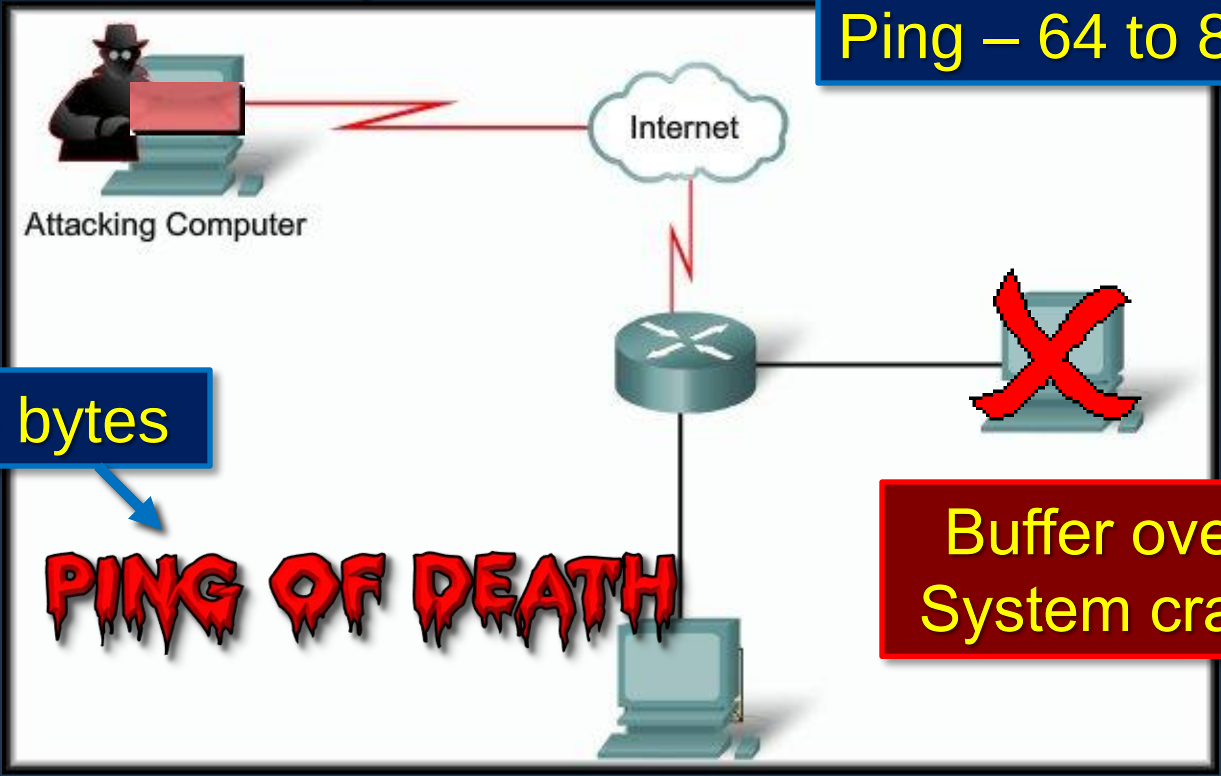
Types of Network Attacks

Older OS – most networks no longer susceptible.

- Denial-of-Service Attacks:
  - This attack modified the IP portion of a ping packet header to indicate that there is more data in the packet than there actually was.

Ping – 64 to 84 bytes

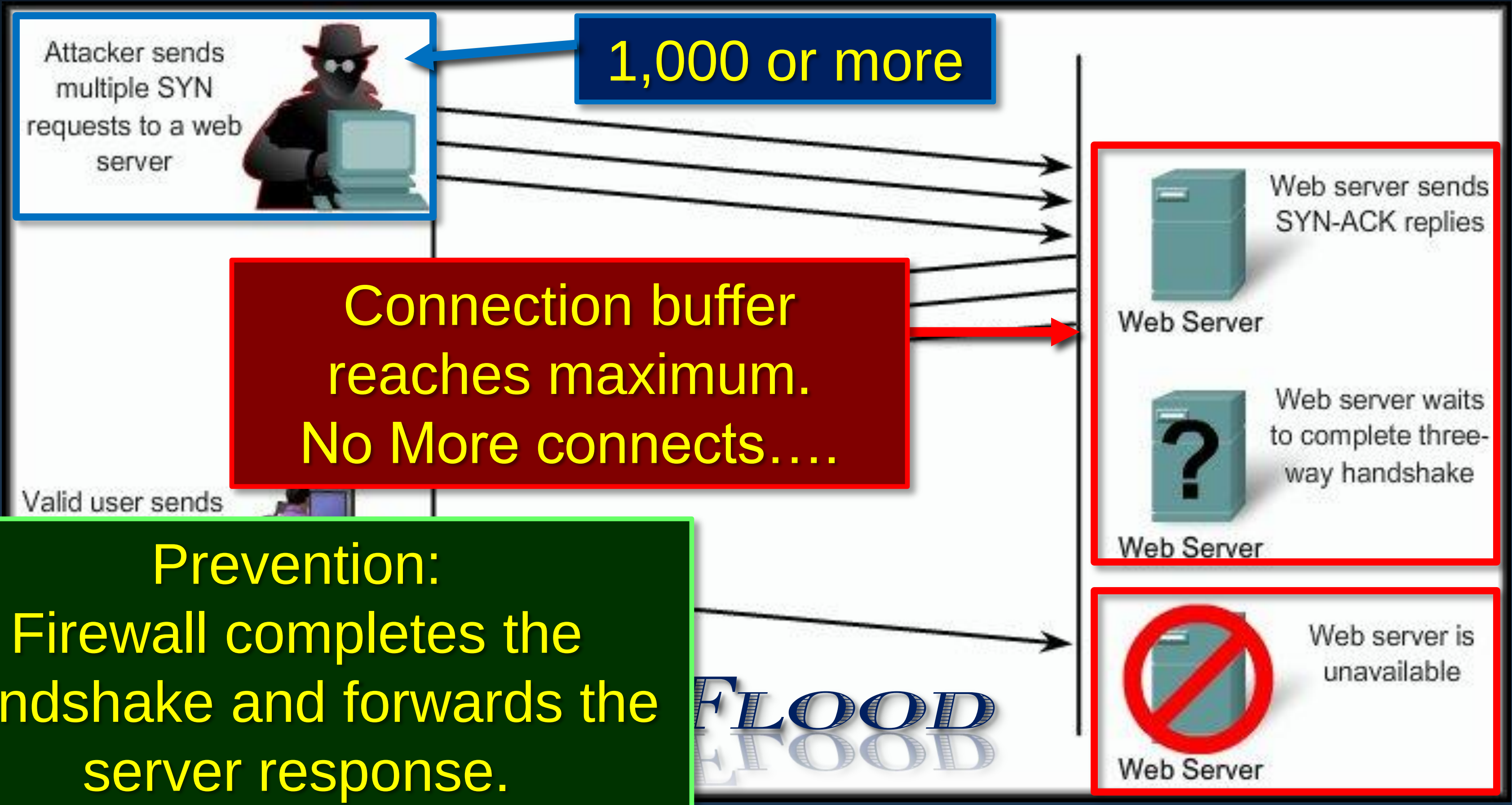
65,536 bytes



Buffer overrun…
System crashes…

Types of Network Attacks

- Denial-of-Service Attacks:
  - This attack exploits the TCP three-way handshake.


Attacker sends multiple SYN requests to a web server
Web server sends SYN-ACK replies
Web Server
Web server waits to complete three-way handshake
Web Server
Valid user sends
FLOOD
Web server is unavailable
Web Server

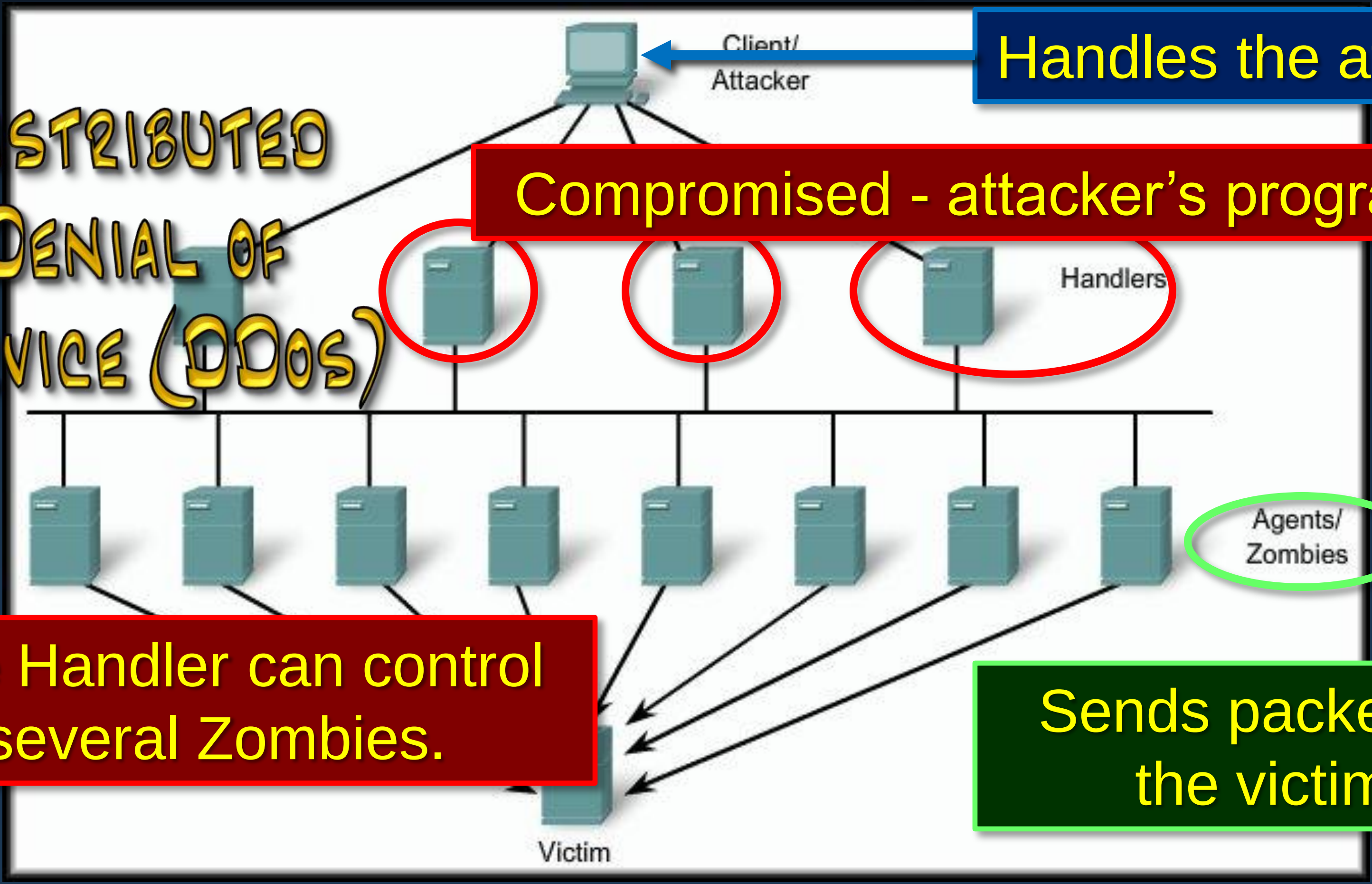
1,000 or more

Connection buffer reaches maximum.
No More connects….

Prevention:
Firewall completes the handshake and forwards the server response.

Types of Network Attacks

- Denial-of-Service Attacks:
  - Overwhelm network links with illegitimate data.



Handles the attack.

Distributed Denial of Service (DDos)

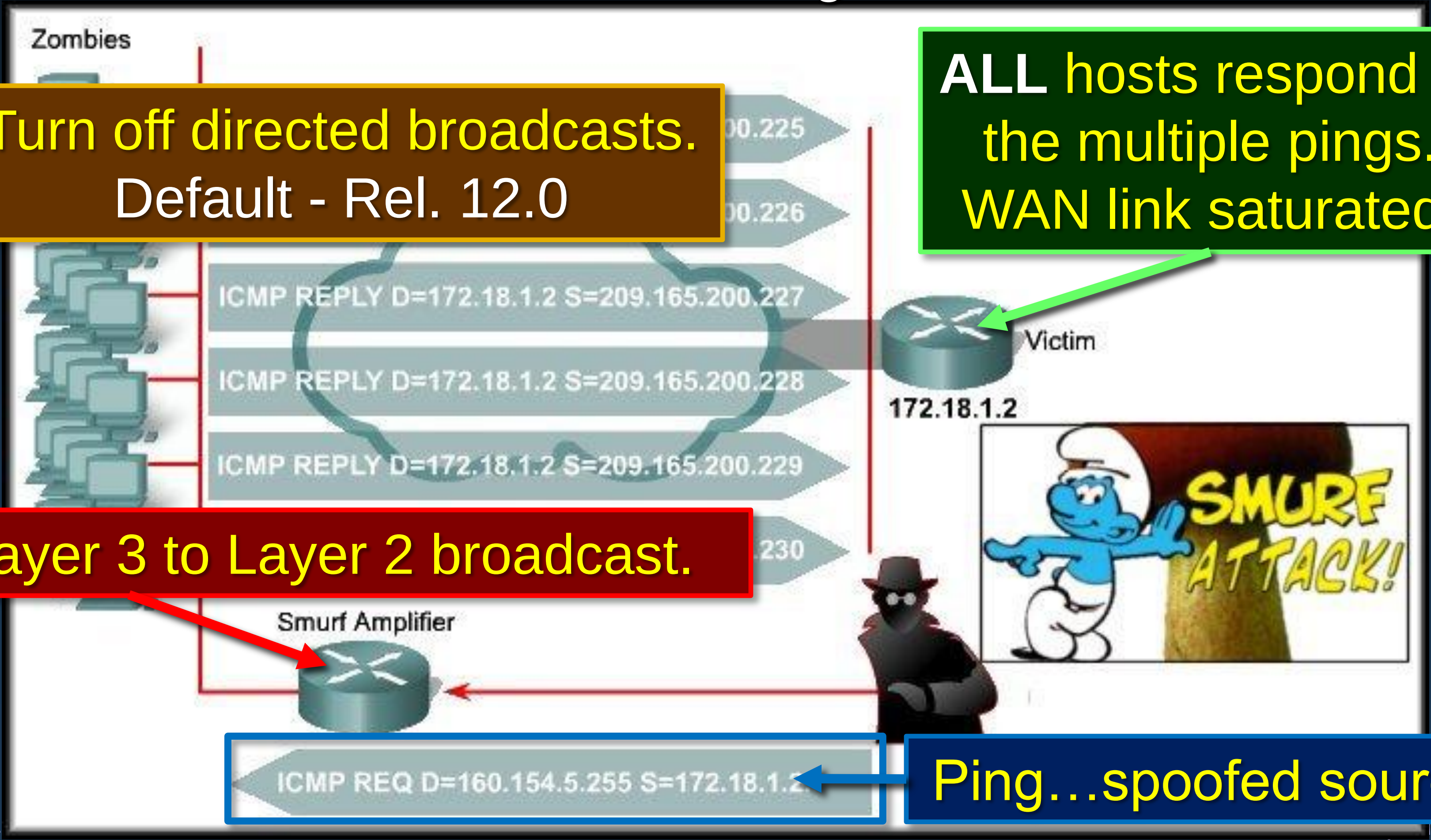
Compromised - attacker's program

One Handler can control several Zombies.

Sends packets to the victim.

Types of Network Attacks

- Denial-of-Service Attacks:
  - Overwhelm WAN links with illegitimate data.


Zombies
...00.225
...00.226
ICMP REPLY D=172.18.1.2 S=209.165.200.227
ICMP REPLY D=172.18.1.2 S=209.165.200.228
ICMP REPLY D=172.18.1.2 S=209.165.200.229
...230
Victim
172.18.1.2
SMURF ATTACK!
Smurf Amplifier
ICMP REQ D=160.154.5.255 S=172.18.1.2

Turn off directed broadcasts.
Default - Rel. 12.0

ALL hosts respond to the multiple pings.
WAN link saturated.

Layer 3 to Layer 2 broadcast.

Ping…spoofed source

Types of Network Attacks

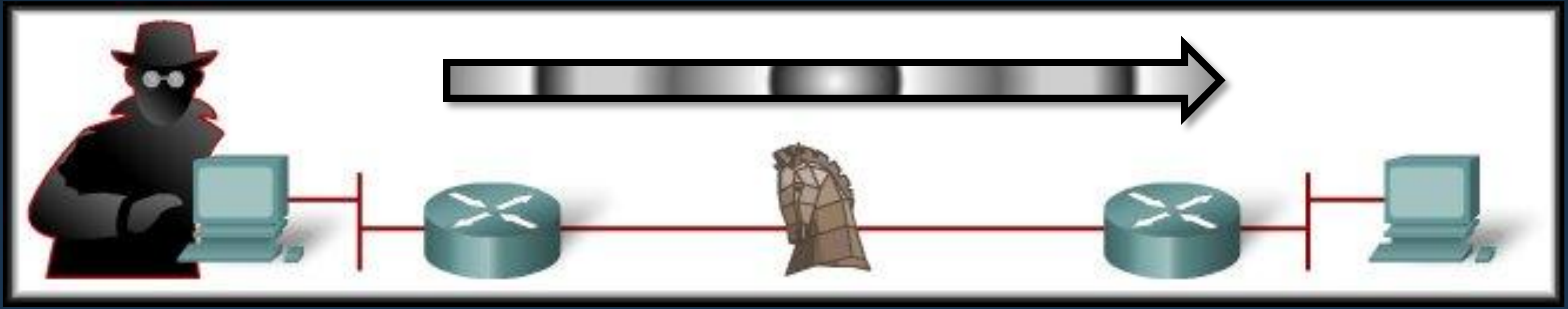
- Malicious Code Attacks:
  - Worm:
    - Executes code and installs copies of itself in the memory of the infected computer, which can, in turn, infect other hosts.

Types of Network Attacks

- Malicious Code Attacks:
  - Virus:
    - Malicious software that is attached to another program for the purpose of executing a particular unwanted function on a workstation.

Types of Network Attacks

- Malicious Code Attacks:
  - Trojan Horse:
    - Different from a worm or virus only in that the entire application was written to look like something else, when in fact it is an attack tool.



General Mitigation Techniques

- Device Hardening:
  - Default usernames and passwords should be changed.
  - Access to system resources should be restricted to only the individuals that are authorized.
  - Any unnecessary services should be turned off.

- Antivirus Software.
- Personal Firewalls.
- OS Patches.

General Mitigation Techniques

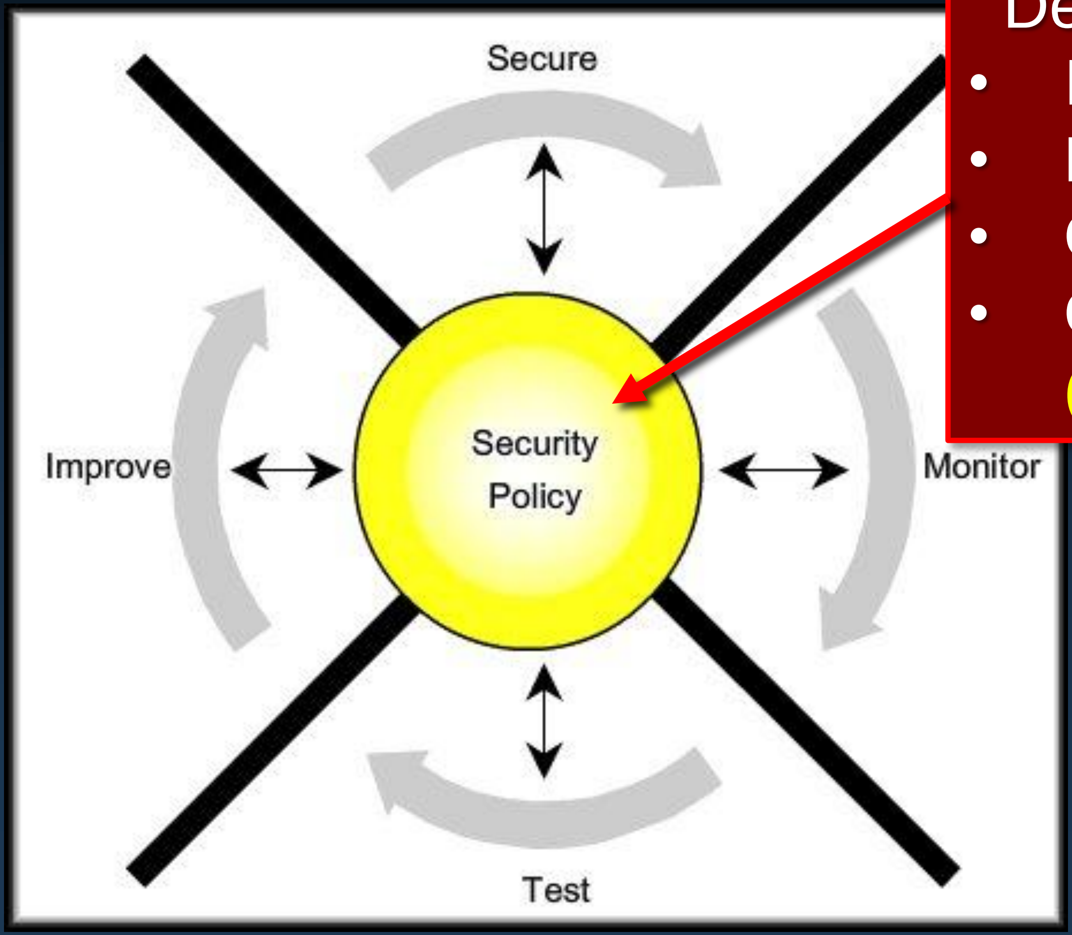
- Intrusion Detection and Prevention:
  - Intrusion Detection Systems (IDS):
    - Detect attacks against a network and send logs to a management console.
  - Intrusion Prevention Systems (IPS):
    - Prevent attacks against the network and should provide the following active defense mechanisms in addition to detection:
      - Prevention….Stops the detected attack from executing.
      - Reaction…..Immunizes the system from future attacks from a malicious source.

General Mitigation Techniques

- Common Security Appliances and Applications:
  - A firewall by itself is no longer adequate for securing a network.
  - Integrated approach with a firewall, intrusion prevention, and VPN.
  - Follows these building blocks:
    - Threat Control: Regulates network access, prevents intrusions, by counteracting malicious traffic.
    - Secure Communications: Secures network endpoints with a VPN.
    - Network Admission Control (NAC): Provides a roles-based method of preventing unauthorized access.

The Network Security Wheel

- A continuous process and an effective approach.

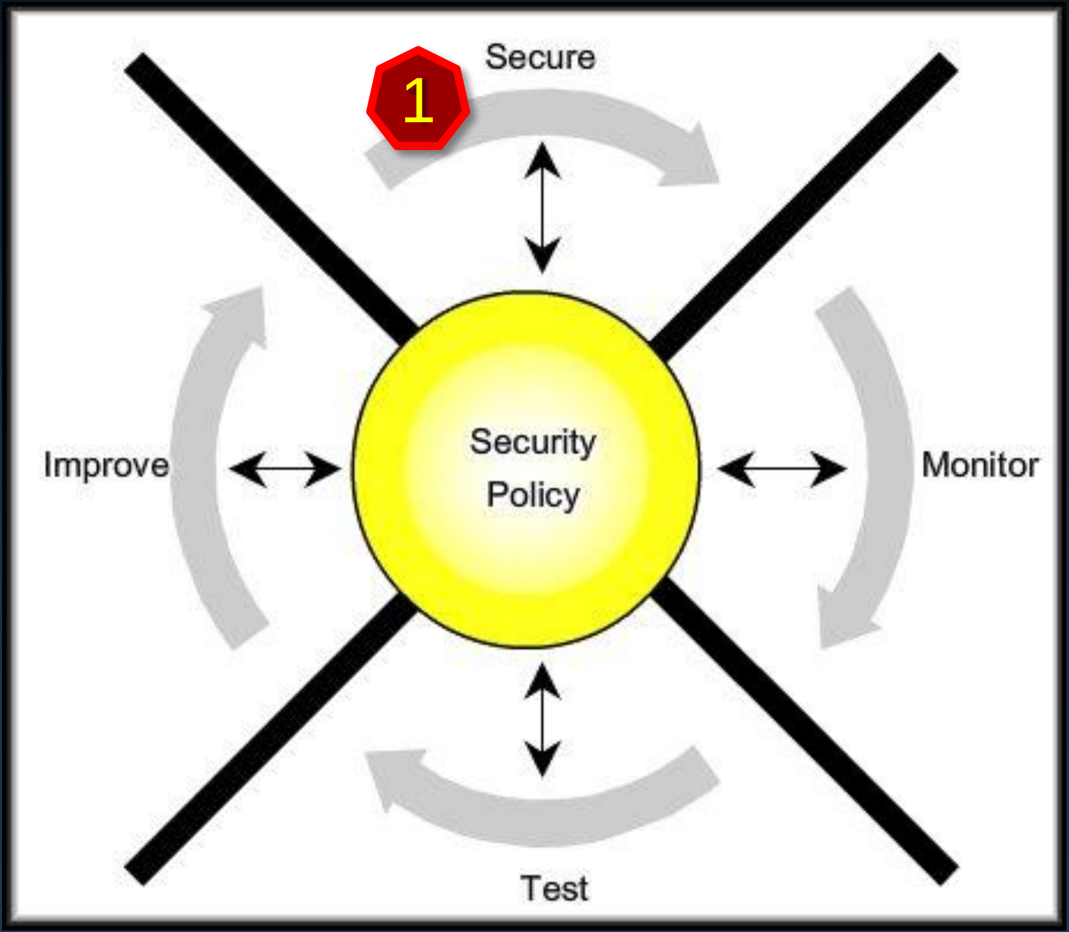


Develop a Security Policy.

- Identify objectives.
- Document resources.
- Current infrastructure.
- Critical resources (Risk Assessment).

The Network Security Wheel

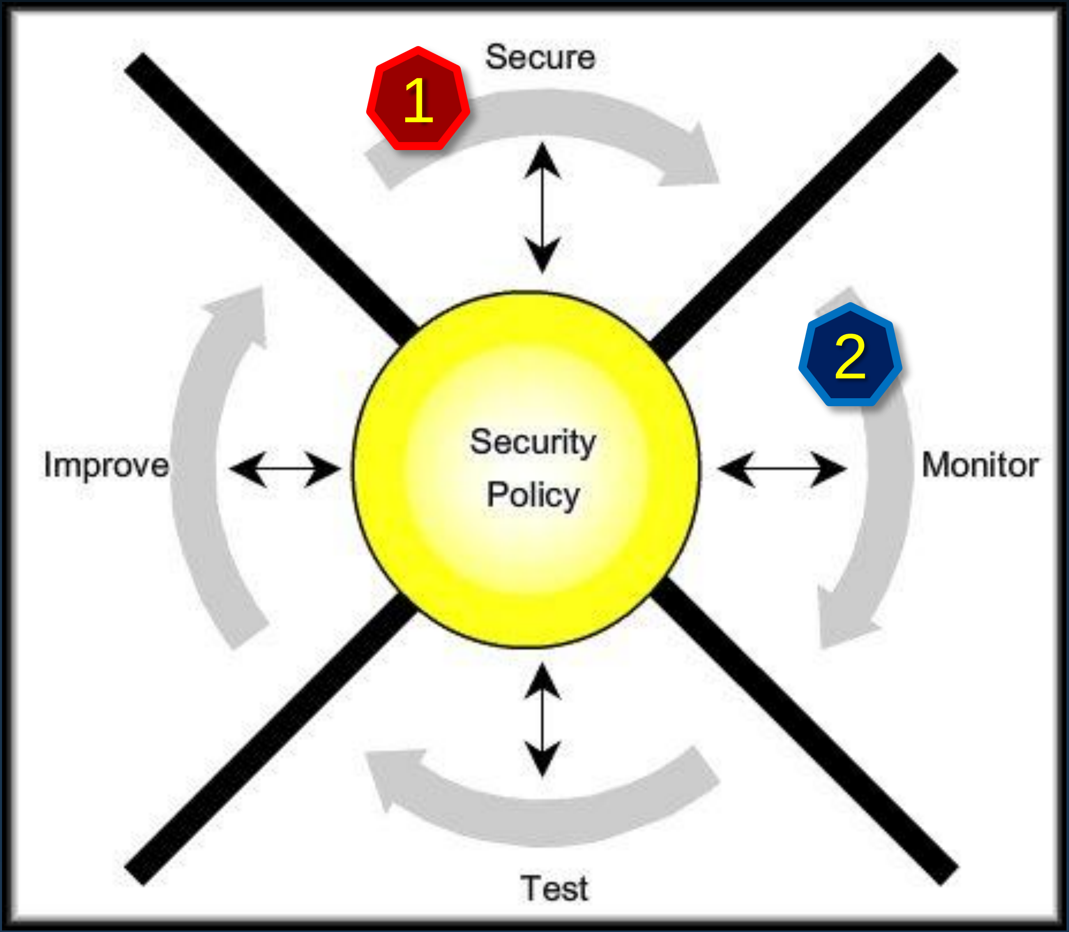
- A continuous process and an effective approach.



- Threat Defense
- IPS
- OS Patches
- Disable unnecessary services.
- Filter traffic
- VPNs (encrypted)
- Trusts
- User Authentication
- Policy Enforcement

The Network Security Wheel

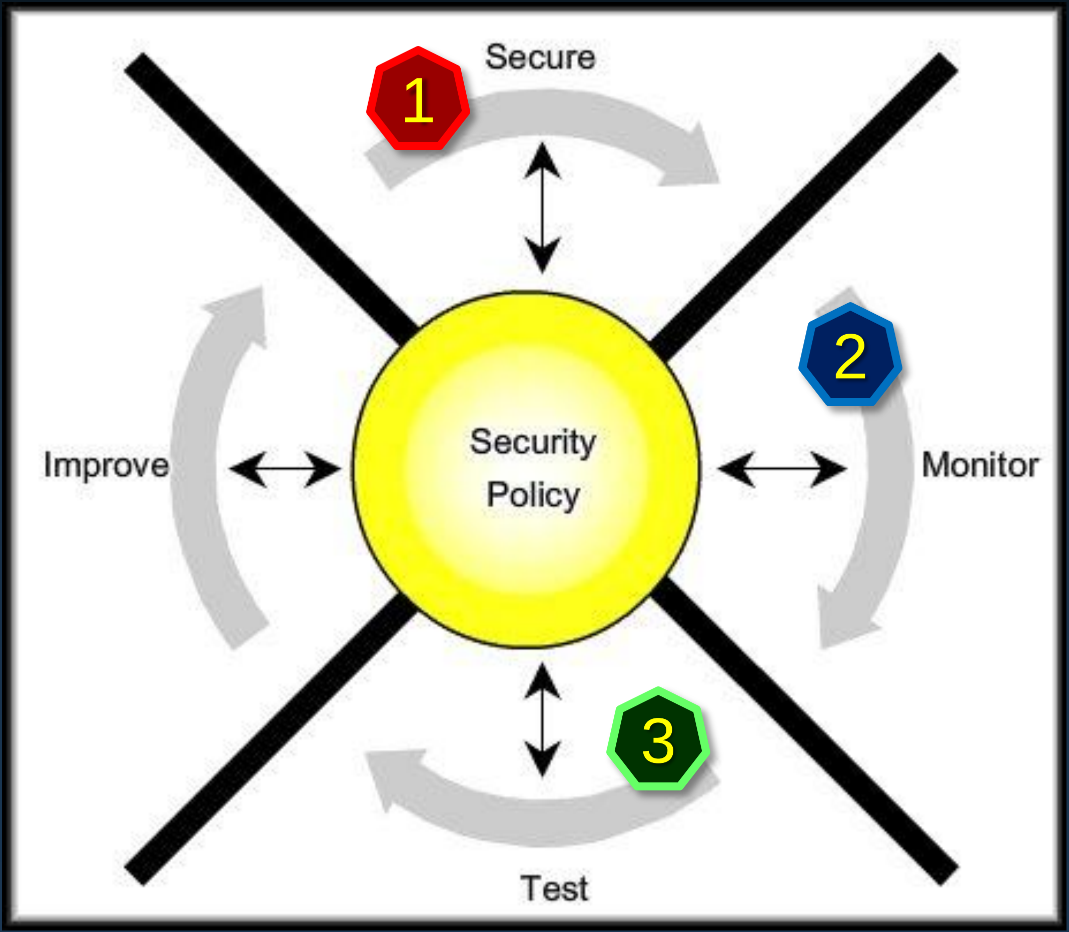
- A continuous process and an effective approach.



- Active and passive methods.
- Active:
  - Audit host logs
- Passive:
  - IDS

The Network Security Wheel

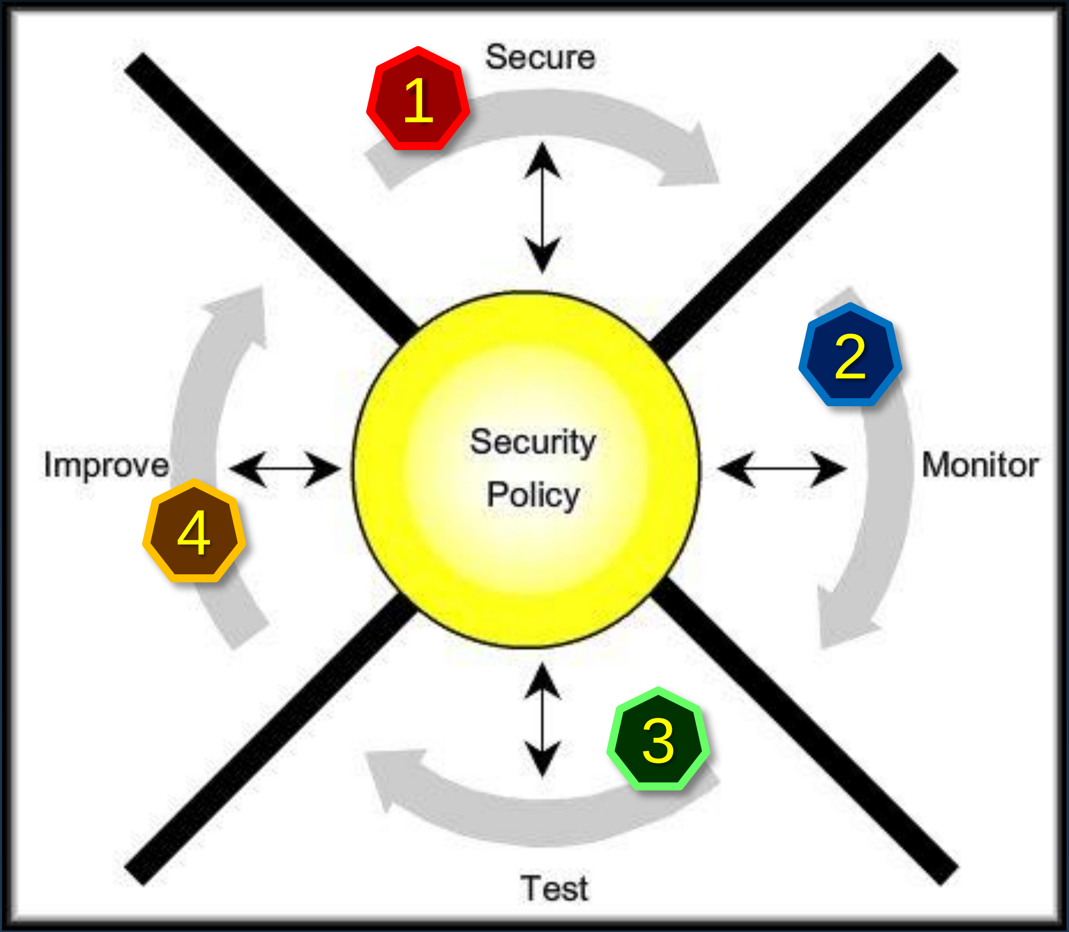
- A continuous process and an effective approach.



- Verify the methods implemented in Steps 1 and 2.
- Vulnerability assessment tools:
  - SATAN
  - Nessus
  - Nmap

The Network Security Wheel

- A continuous process and an effective approach.



- Using the information from steps 2 and 3, implement improvements.

The Enterprise Security Policy

- A living document:
  - The document is never finished and is continuously updated as technology and employee requirements change.
- Essential Functions:
  - Protects people and information.
  - Sets the rules for expected behavior by users, system administrators, management, and security personnel.
  - Authorizes security personnel to monitor, probe, and investigate.
  - Defines and authorizes the consequences of violations.

The Enterprise Security Policy

- Attributes:
  - Provides a means to audit existing network security and compare the requirements to what is in place.
  - Plan security improvements, including equipment, software, and procedures.
  - Defines the roles and responsibilities of the company executives, administrators, and users.
  - Defines which behavior is and is not allowed.
  - Defines a process for handling network security incidents.
  - Enables global security implementation and enforcement by acting as a standard between sites.
  - Creates a basis for legal action if necessary.