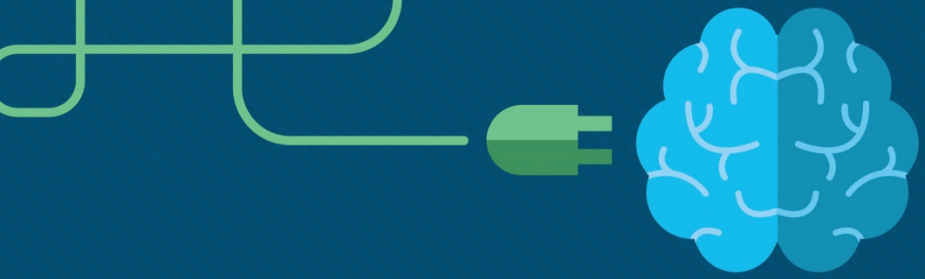

Introduction to Cybersecurity

Cisco Networking Academy

Adapted from: Cisco Introduction to Cybersecurity v2.1

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1.Why Cybersecurity?

1.1 Personal Data

Personal Data

Introduction to Personal Data

- What is Cybersecurity?
  - Protection of networked system and data from unauthorized use or harm
- Your Online and Offline Identity
  - Offline Identity
    - Your identity that interacts on a regular basis at home, school or work
  - Online Identity
    - Your identity while you are in cyberspace
    - Should only reveal a limited amount of information about you
    - Username or alias
      - Should not include any personal information
      - Should be appropriate and respectful
      - Should not attract unwanted attention

Personal Data

Introduction to Personal Data

- Your Data
  - Medical Records
    - electronic health records (EHR) – physical, mental, and other personal information
    - prescriptions
  - Education Records
    - Grades, test scores, courses taken, awards and degrees rewarded
    - Attendance
    - Disciplinary reports
  - Employment and Financial Records
    - Income and expenditures
    - Tax records – paycheck stubs, credit card statements, credit rating and banking statement
    - Past employment and performance

Personal Data

Introduction to Personal Data

- Where is Your Data?
  - Medical records: doctor's office, insurance company
  - Store loyalty cards
    - Stores compile your purchases
    - Marketing partner uses the profiles for target advertisement
  - Online pictures: friends, strangers may also have a copy
- Your Computer Devices
  - Data storage and your portal to your online data
  - List some example of your computing devices

Personal Data as a Target

- How do the criminals get your money?
  - Online credentials
    - Gives thieves access to your accounts
  - Creative schemes
    - Trick into wiring money to your friends or family
- Why do they want your identity?
  - Long-term profits
  - Medical benefits
  - File a fake tax return
  - Open credit card accounts
  - Obtain loans

1.2 Organizational Data

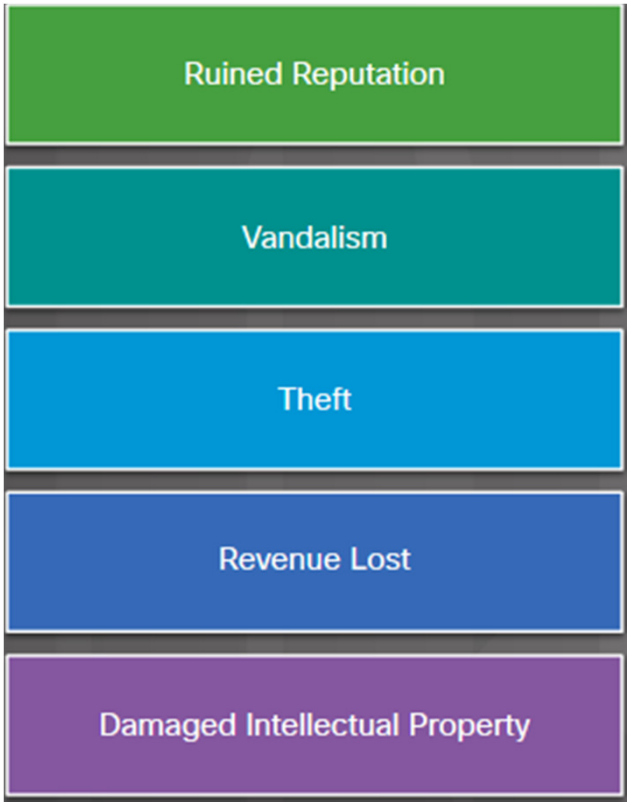
Introduction to Organizational Data

- Types of Organizational Data
  - Traditional Data
    - Personnel – application materials, payroll, offer letter, employee agreements
    - Intellectual – patents, trademarks, product plans, trade secrets
    - Financial – income statements, balance sheets, cash flow statements
  - Internet of Things and Big Data
    - IoT – large network of physical objects, such as sensors
    - Big Data – data from the IoT
- Confidentiality, Integrity and Availability
  - Confidentiality – privacy
  - Integrity – accuracy and trustworthiness of the information
  - Availability – information is accessible

Organizational Data

The Impact of a Security Breach

- The Consequences of a Security Breach
  - Not feasible to prevent every attack
  - Attackers will always find new ways
  - Ruined reputation, vandalism, theft, revenue lost, damaged intellectual property
- Security Breach Example - LastPass
  - An online password manager
  - Stolen email addresses, password reminders, and authentication hashes
  - Requires email verification or multi-factor authentication when logging in from an unknown device
  - Users should use complex master password, change master password periodically, and beware of phishing attacks



Organizational Data

The Impact of a Security Breach

- Security Breach Example - Vtech
  - Vtech is a high tech toy maker for children
  - exposed sensitive information including customer names, email addresses, passwords, pictures, and chat logs.
  - Vtech did not safeguard information properly
  - Hackers can create email accounts, apply for credits, and commit crimes using the children's information
  - Hackers can also take over the parents' online accounts
- Security Breach Example - Equifax
  - Equifax is a consumer credit reporting agency.
  - Attackers exploited a vulnerability in web application software.
  - Equifax established a dedicated web site with a new domain name that allowed nefarious parties to create unauthorized websites for phishing scheme

1.3 Attackers and Cybersecurity Professionals

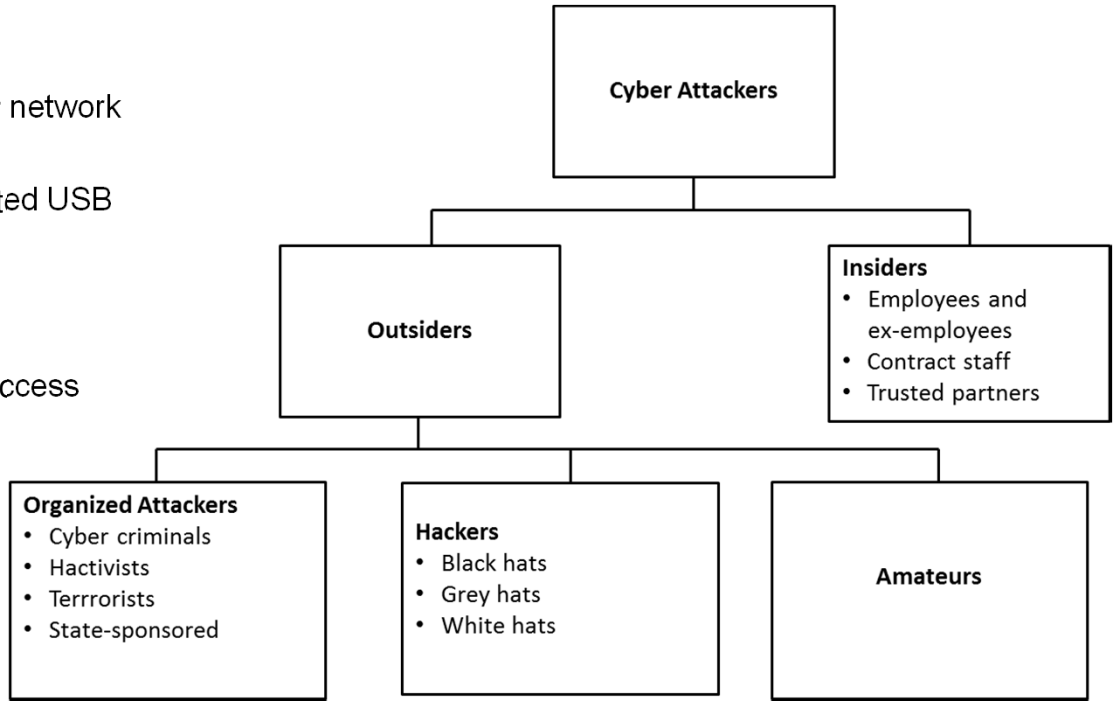
Types of Attackers

- Amateurs
  - Script kiddies with little or no skill
  - Using existing tools or instructions found online for attacks
- Hackers - break into computers or networks to gain access
  - White hats – break into system with permission to discover weaknesses so that the security of these systems can be improved
  - Gray hats – compromise systems without permission
  - Black hats - take advantage of any vulnerability for illegal personal, financial or political gain
- Organized Hackers - organizations of cyber criminals, hacktivists, terrorists, and state-sponsored hackers.

The Profile of a Cyber Attacker

Internal and External Threats

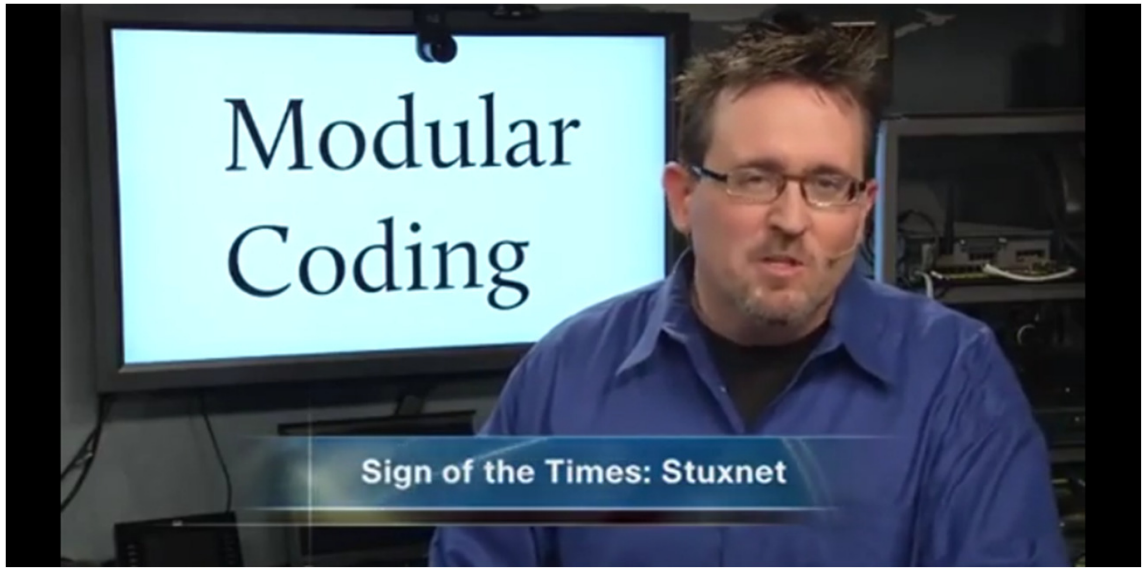
- Internal Security Threats
  - Can be an employee or contract partner
    - Mishandle confidential data
    - Threaten the operations of internal servers or network infrastructure devices
    - Facilitate outside attacks by connecting infected USB media into the corporate computer system
    - Accidentally invite malware onto the network through malicious email or websites
    - Can cause great damage because of direct access
- External Security Threats
  - exploit vulnerabilities in network or computing devices
  - use social engineering to gain access



1.4 Cyberwarfare

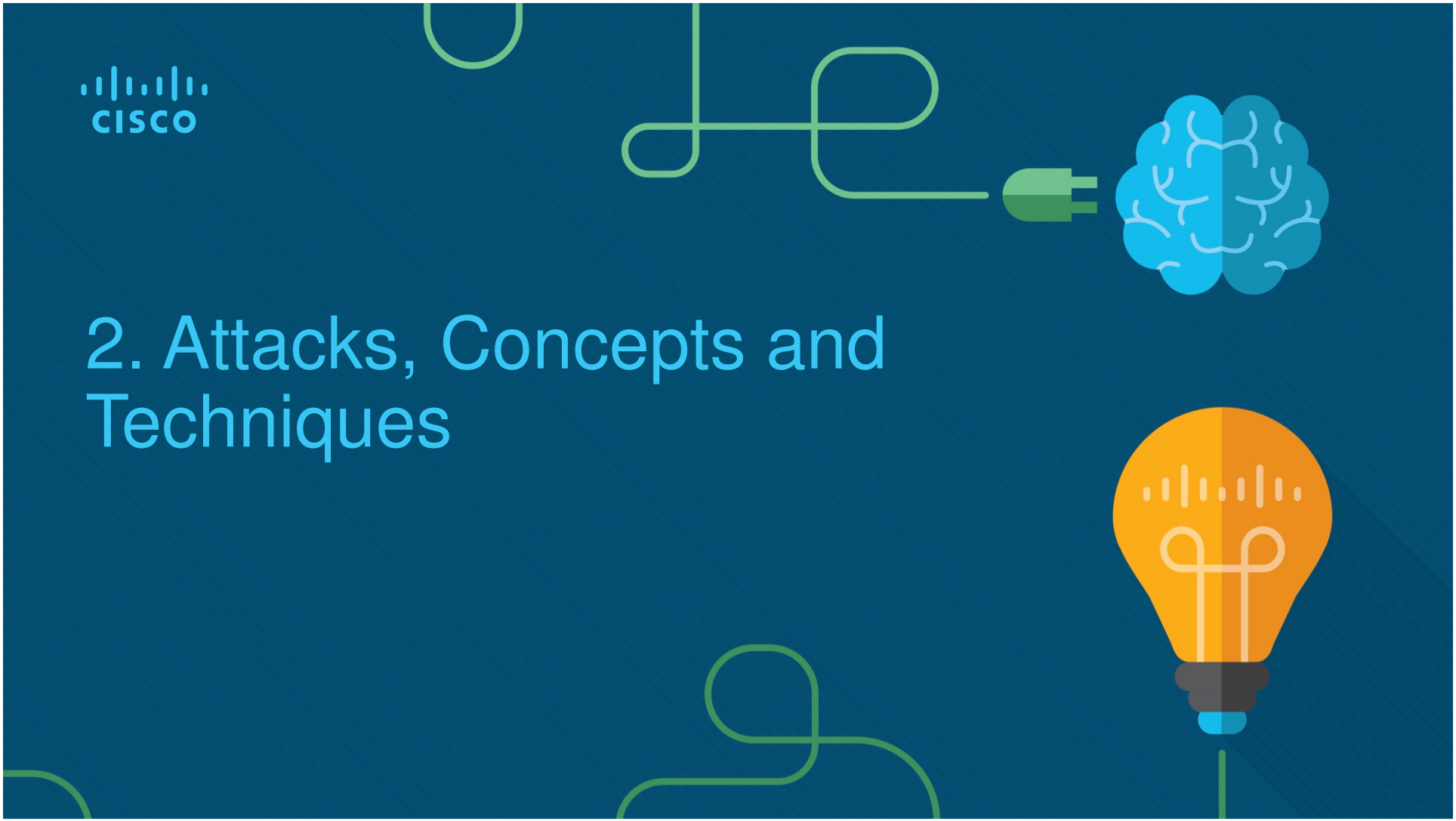
What is Cyberwarfare

- What is Cyberwarfare?
  - Conflict using cyberspace
  - Stuxnet malware
    - Designed to damage Iran's nuclear enrichment plant
    - Used modular coding
    - Used stolen digital certificates



The Purpose of Cyberwarfare

- Use to gain advantage over adversaries, nations or competitors
  - Can sabotage the infrastructure of other nations
  - Give the attackers the ability to blackmail governmental personnel
  - Citizens may lose confidence in the government's ability to protect them.
  - Affect the citizens' faith in their government without ever physically invading the targeted nation.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2. Attacks, Concepts and Techniques

2.1 Analyzing a Cyberattack

Finding Security Vulnerabilities

- An *exploit* is the term used to describe a program written to take advantage of a known vulnerability.
- An *attack* is the act of using an exploit against a vulnerability.
- Software vulnerability
  - Errors in OS or application code
  - SYNful Knock – Vulnerability in Cisco IOS
    - allows attackers to gain control of the routers
    - monitor network communication
    - infect other network devices.
  - Project Zero – Google formed a permanent team dedicated to finding software vulnerabilities.

- Hardware vulnerability
  - Hardware design flaws
  - Rowhammer - RAM memory exploit allows data to be retrieved from nearby address memory cells.

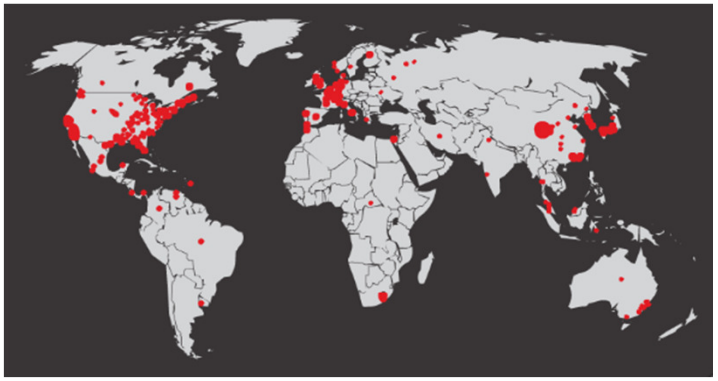
Types of Security Vulnerabilities

Categorizing Security Vulnerabilities

- Buffer Overflow
  - Data is written beyond the limits of a buffer
- Non-validated Input
  - Force programs to behave in an unintended way
- Race Conditions
  - Improperly ordered or timed events
- Weaknesses in Security Practices
  - Protect sensitive data through authentication, authorization, and encryption
- Access-control Problems
  - Access control to physical equipment and resources
  - Security practices

Types of Malware

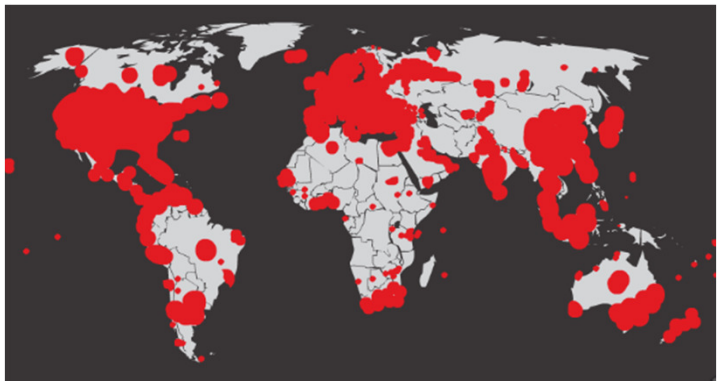
- Malware is used to steal data, bypass access controls, cause harm to, or compromise a system.
- Types of Malware
  - **Spyware** - track and spy on the user
  - **Adware** - deliver advertisements, usually comes with spyware
  - **Bot** - automatically perform action
  - **Ransomware** - hold a computer system or the data captive until a payment is made
  - **Scareware** - persuade the user to take a specific action based on fear.



Initial Code Red Worm Infection

Types of Malware (Cont.)

- Types of Malware (Cont.)
  - **Rootkit** - modify the operating system to create a backdoor
  - **Virus** - malicious executable code that is attached to other executable files
  - **Trojan horse** - carries out malicious operations under the guise of a desired operation
  - **Worm** - replicate themselves by independently exploiting vulnerabilities in networks
  - **Man-in-The-Middle** or **Man-in-The-Mobile** – take control over a device without the user's knowledge



Code Red Worm Infection 19 Hours Later

Symptoms of Malware

- There is an increase in CPU usage.
- There is a decrease in computer speed.
- The computer freezes or crashes often.
- There is a decrease in Web browsing speed.
- There are unexplainable problems with network connections.
- Files are modified.
- Files are deleted.
- There is a presence of unknown files, programs, or desktop icons.
- There are unknown processes running.
- Programs are turning off or reconfiguring themselves.
- Email is being sent without the user's knowledge or consent.

Methods of Infiltration

Social Engineering

- Social Engineering – manipulation of individual into performing actions or divulging confidential information
  - **Pretexting** - an attacker calls an individual and lies to them in an attempt to gain access to privileged data.
  - **Tailgating** - an attacker quickly follows an authorized person into a secure location.
  - **Something for something (Quid pro quo)** - an attacker requests personal information from a party in exchange for something

Methods of Infiltration

Wi-Fi Password Cracking

- Wi-Fi Password Cracking – Password discovery
  - **Social engineering** - The attacker manipulates a person who knows the password into providing it.
  - **Brute-force attacks** - The attacker tries several possible passwords in an attempt to guess the password.
  - **Network sniffing** - The password maybe discovered by listening and capturing packets send on the network.

Methods of Infiltration

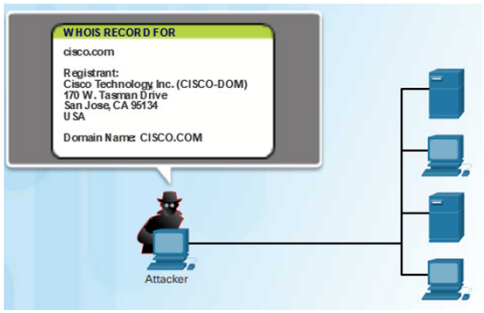
Phishing

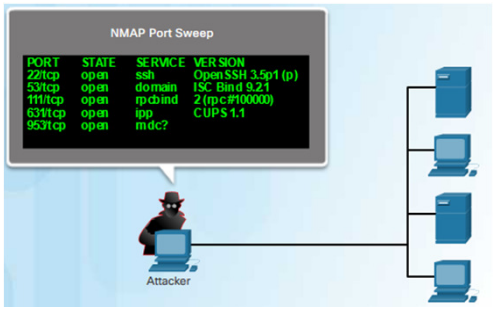
- Phishing
  - malicious party sends a fraudulent email disguised as being from a legitimate, trusted source
  - trick the recipient into installing malware on their device or sharing personal or financial information
- Spear phishing
  - a highly targeted phishing attack

Methods of Infiltration

Vulnerability Exploitation

- Vulnerability Exploitation – scan to find vulnerability to exploit
  - **Step 1** - Gather information about the target system using port scanner or social engineering
  - **Step 2** - Determine learned information from step 1
  - **Step 3** - Look for vulnerability
  - **Step 4** - Use a known exploit or write a new exploit
- Advanced Persistent Threats – a multi-phase, long term, stealthy and advanced operation against a specific target
  - usually well-funded
  - deploy customized malware

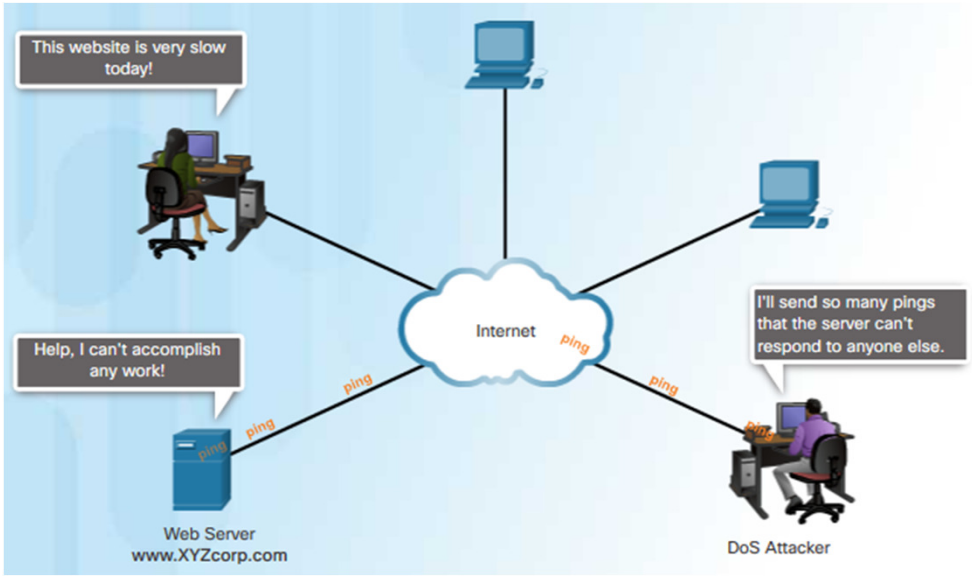




Denial of Service

DoS

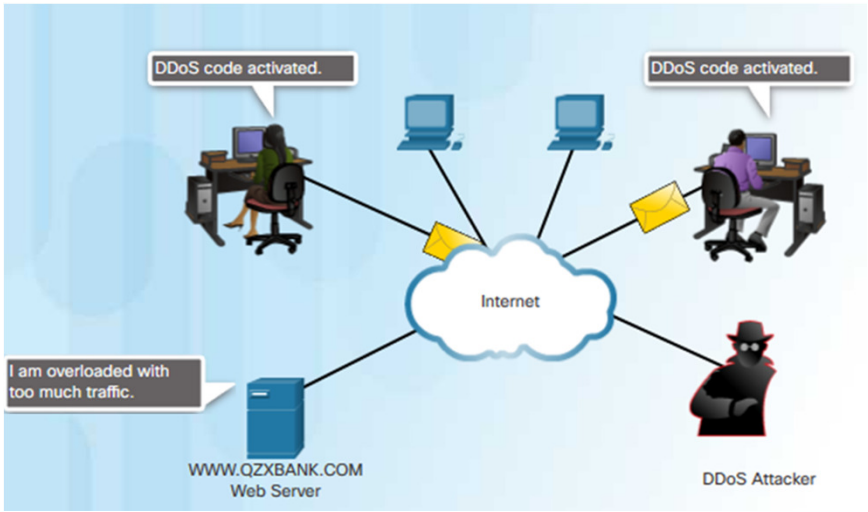
- DoS is a disruption of network services
  - **Overwhelming quantity of traffic** - a network, host, or application is sent an enormous quantity of data at a rate which it cannot handle
  - **Maliciously formatted packets** - maliciously formatted packet is sent to a host or application and the receiver is unable to handle it



Denial of Service

DDoS

- Similar to DoS, from multiple, coordinated sources
- Botnet - a network of infected hosts
- Zombie - infected hosts
- The zombies are controlled by handler systems.
- The zombies continues to infect more hosts, creating more zombies.



Denial of Service

SEO Poisoning

- SEO
  - Search Engine Optimization
  - Techniques to improve a website's ranking by a search engine
- SEO Poisoning
  - Increase traffic to malicious websites
  - Force malicious sites to rank higher

2.2 The Cybersecurity Landscape

Blended Attack

What is a Blended Attack?

- Uses multiple techniques to compromise a target
- Uses a hybrid of worms, Trojan horses, spyware, keyloggers, spam and phishing schemes
- Common blended attack example
  - spam email messages, instant messages or legitimate websites to distribute links
  - DDoS combined with phishing emails
- Examples: Nimbda, CodeRed, BugBear, Klez, Slammer, Zeus/LICAT, and Conficker

Impact Reduction

What is Impact Reduction?

- Communicate the issue
- Be sincere and accountable
- Provide details
- Understand the cause of the breach
- Take steps to avoid another similar breach in the future
- Ensure all systems are clean
- Educate employees, partners and customers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3. Protecting Your Data and Privacy

3.1 Protecting Your Data

Protecting Your Computing Devices

- Keep the Firewall On
  - Prevent unauthorized access to your data or computing devices
  - Keep the firewall up to date
- Use Antivirus and Antispyware
  - Prevent unauthorized access to your data or computing devices
  - Only download software from trusted websites
  - Keep the software up to date
- Manage Your Operating System and Browser
  - Set the security settings at medium or higher
  - Update your computer's operating system and browser
  - Download and install the latest software patches and security updates
- Protect All Your Devices
  - Password protect
  - Encrypt the data
  - Only store necessary information
  - IoT devices

Use Wireless Networks Safely

- Home Wireless Network
  - Change the pre-set SSID and default administrative password on your Wi-Fi router.
  - Disable SSID broadcast
  - Use WPA2 encryption feature
  - Be aware of WPA2 protocol security flaw – KRACK
    - Allows intruder to break the encryption between wireless router and clients
- Use caution when using public Wi-Fi hotspots
  - Avoid accessing or sending sensitive information
  - Use of VPN tunnel can prevent eavesdropping
- Turn off Bluetooth when not in use

Use Unique Passwords for Each Online Account

- Prevents criminals from accessing all your online accounts using one stolen credentials
- Use password managers to help with remembering passwords
- Tips for choosing a good password:
  - Do not use dictionary words or names in any languages
  - Do not use common misspellings of dictionary words
  - Do not use computer names or account names
  - If possible use special characters, such as ! @ # $ % ^ & * ( )
  - Use a password with ten or more characters

OK	Good	Better
allwhitecat	a11whitecat	A11whi7ec@t
Fblogin	1FBLogin	1.FB.L0gin$
amazonpass	AmazonPa55	Am@z0nPa55
ilikemyschool	ILikeMySchool	!Lik3MySch00l
Hightidenow	HighTideNow	H1gh7id3Now

Use Passphrase Rather Than a Password

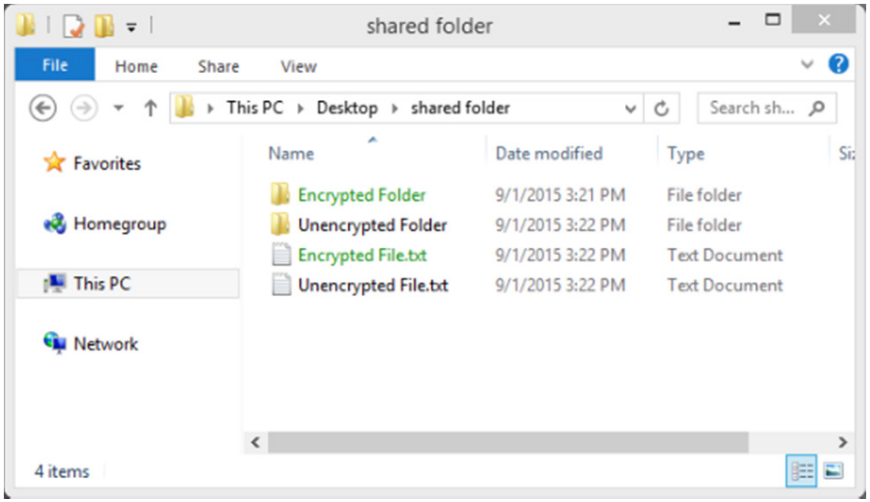
- Tips in choosing a good passphrase:
  - Choose a meaningful statement to you
  - Add special characters, such as ! @ # $ % ^ & * ( )
  - The longer the better
  - Avoid common or famous statements, for example, lyrics from a popular song
- Summary of the new NIST guidelines:
  - 8 characters minimum in length, but no more than 64 characters
  - No common, easily guessed passwords, such as password, abc123
  - No composition rules, such as having to include lowercase and uppercase letters and numbers
  - No knowledge-based authentication, such as information from shared secret questions, marketing data, transaction history
  - Improve typing accuracy by allowing the user to see the password while typing
  - All printing characters and spaces are allowed
  - No password hints
  - No periodical or arbitrary password expiration

OK	Thisismypassphrase.
Good	Acatthatlovesdogs.
Better	Acat th@tlov3sd0gs.

Data Maintenance

Encrypt Your Data

- Encrypted data can only be read with the secret key or password
- Prevent unauthorized users from reading the content
- What is Encryption?
  - process of converting the information into a form where an unauthorized party cannot read it



Data Maintenance

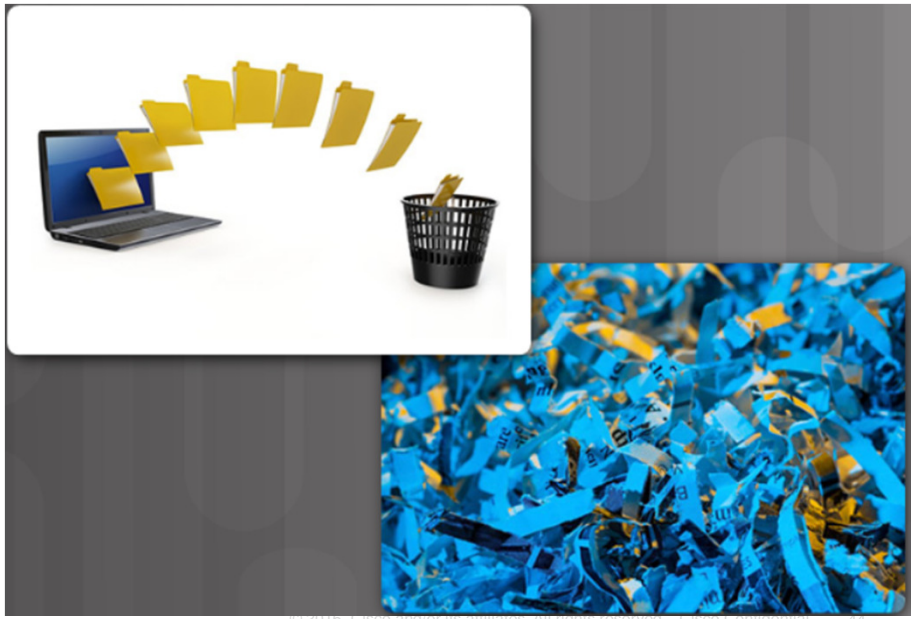
Back up Your Data

- Prevent the loss of irreplaceable data
- Need additional storage location for the data
- Copy the data to the backup location regularly and automatically
- Local Backup
  - NAS, external hard drive, CDs/DVDs, thumb drives, or tapes
  - Total control and responsible for the cost and maintenance
- Cloud Storage Service, such as AWS
  - Access to backup as long as you have access to your account
  - may need to be more selective about the data being backed up

Data Maintenance

Deleting Your Data Permanently

- Use available tools to delete permanently: SDelete and Secure Empty Trash, for example
- Destroy the storage device to ensure that the data is unrecoverable
- Delete the online versions



3.2 Safeguarding Your Online Privacy

Strong Authentication

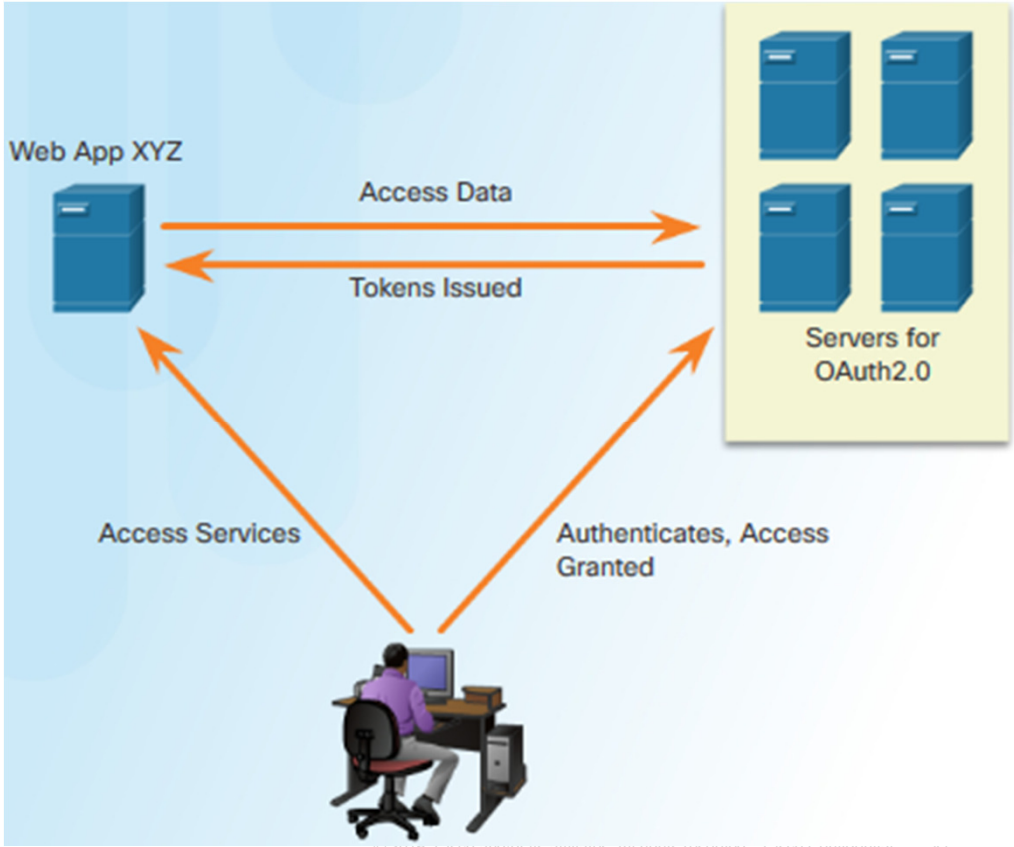
Two Factor Authentication

- Popular online services use two factor authentication
- Need Username / password or PIN and a second token for access:
  - **Physical object** - credit card, ATM card, phone, or fob
  - **Biometric scan** - fingerprint, palm print, as well as facial or voice recognition

Strong Authentication

OAuth 2.0

- An open standard protocol that allows an end user's credentials to access third party applications without exposing the user's password
- Act as the middle man to decide whether to allow end users access to third party applications.



Sharing Too Much Information?

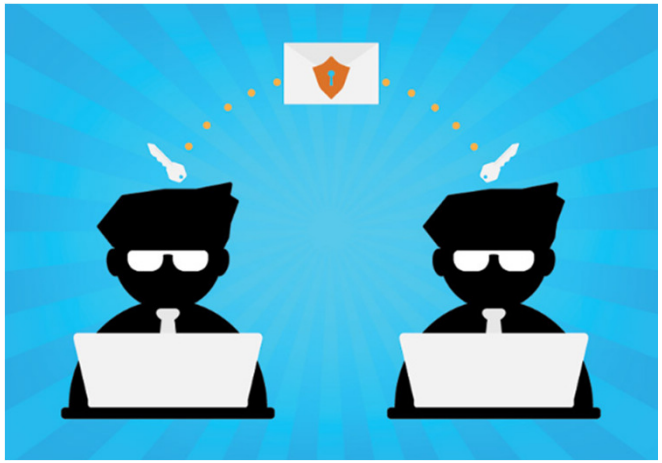
Do Not Share Too Much on Social Media

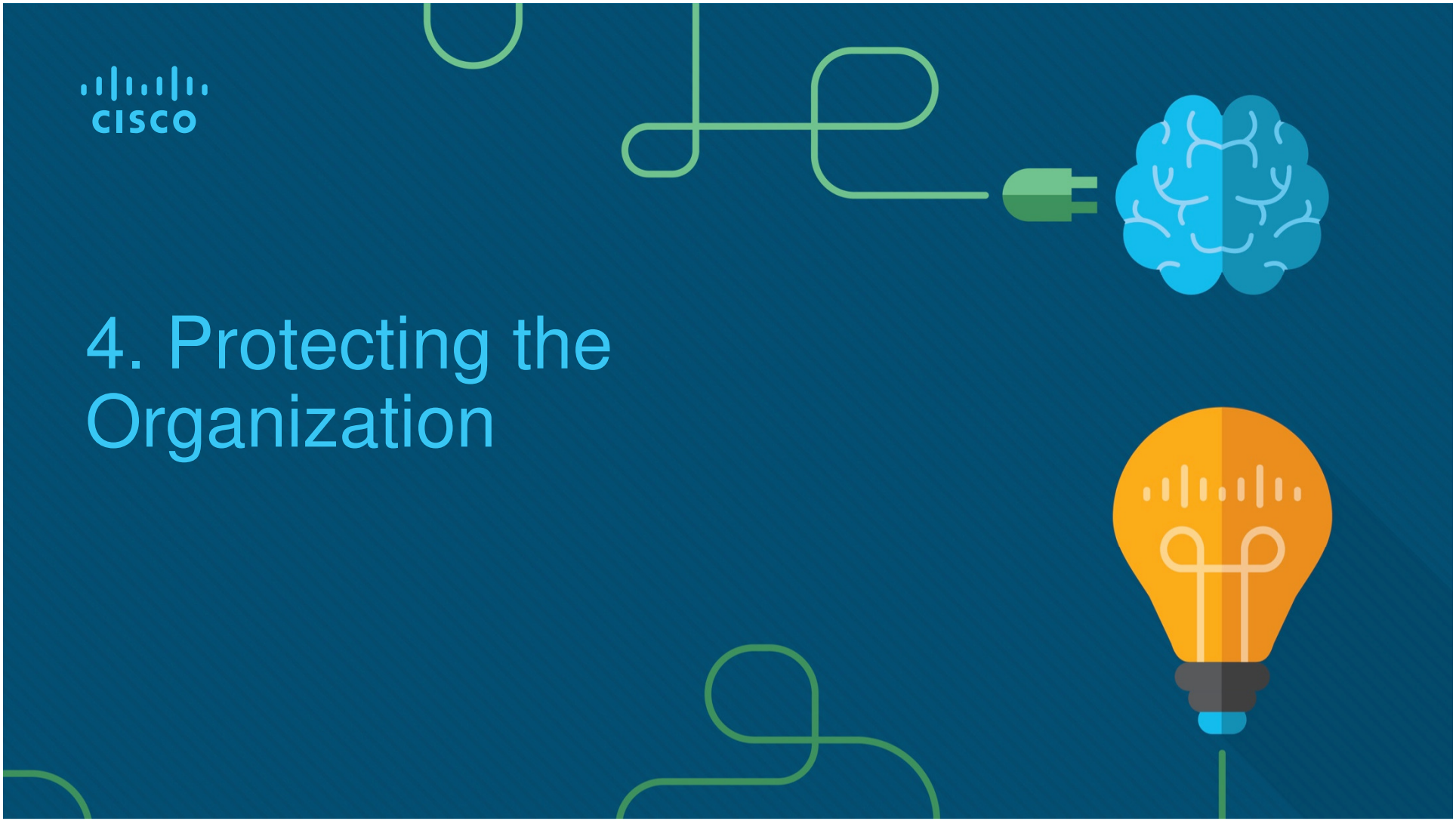
- Share as little information as possible on social media
- Do not share information such as:
  - Birth date
  - Email address
  - Phone number
- Check your social media settings

Sharing Too Much Information

Email and Web Browser Privacy

- Email is like sending a postcard.
- Copies of the email can be read by anyone with access.
- The email is passed among different servers
- Use the private browsing mode can prevent other from gathering information about your online activities.
- Private mode on popular browser
  - **Microsoft Internet Explorer**: InPrivate
  - **Google Chrome**: Incognito
  - **Mozilla Firefox**: Private tab / private window
  - **Safari**: Private: Private browsing

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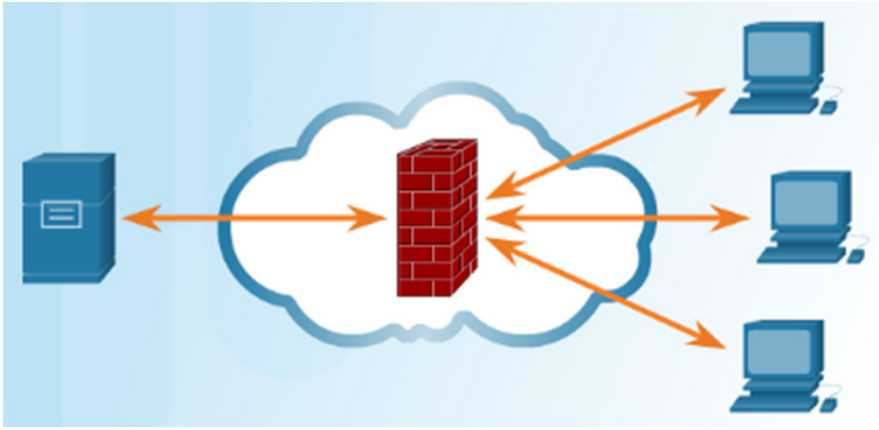
4. Protecting the Organization

4.1 Firewalls

Firewall Types

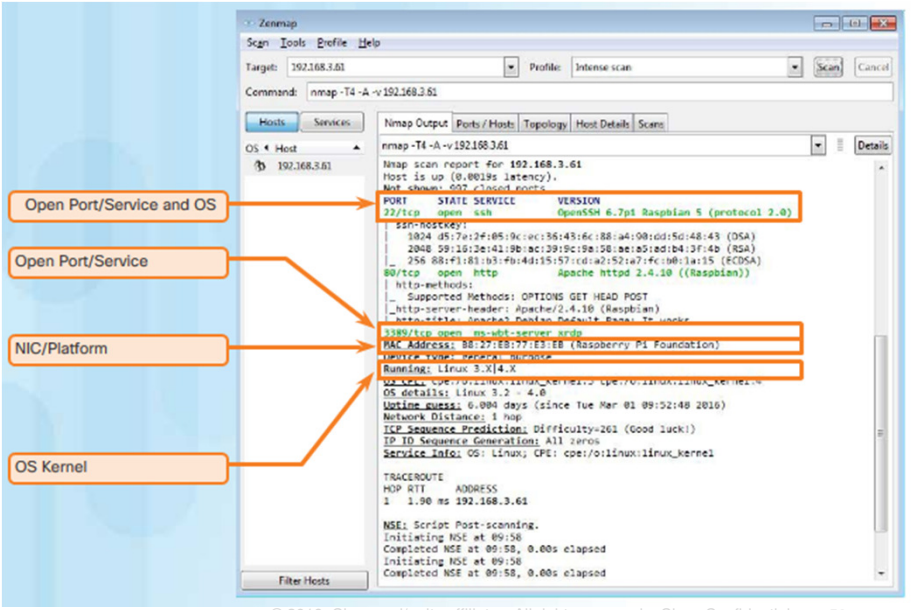
- Control or filter incoming or outgoing communications on a network or device
- Common firewall types
  - **Network Layer Firewall** – source and destination IP addresses
  - **Transport Layer Firewall** – source and destination data ports, connection states
  - **Application Layer Firewall** – application, program or service
  - **Context Aware Application Firewall** – user, device, role, application type, and threat profile
  - **Proxy Server** –web content requests
  - **Reverse Proxy Server** – protect, hide, offload, and distribute access to web servers
  - **Network Address Translation (NAT) Firewall** – hides or masquerades the private addresses of network hosts
  - **Host-based Firewall** – filtering of ports and system service calls on a single computer operating system



Firewall Types

Port Scanning

- Process of probing a computer, server or other network host for open ports
- Port numbers are assigned to each running application on a device.
- Reconnaissance tool to identify running OS and services
  - Nmap – A port scanning tool
- Common responses:
  - **Open or Accepted** - a service is listening on the port.
  - **Closed, Denied, or Not Listening** – connections will be denied to the port.
  - **Filtered, Dropped, or Blocked** – no reply from the host.

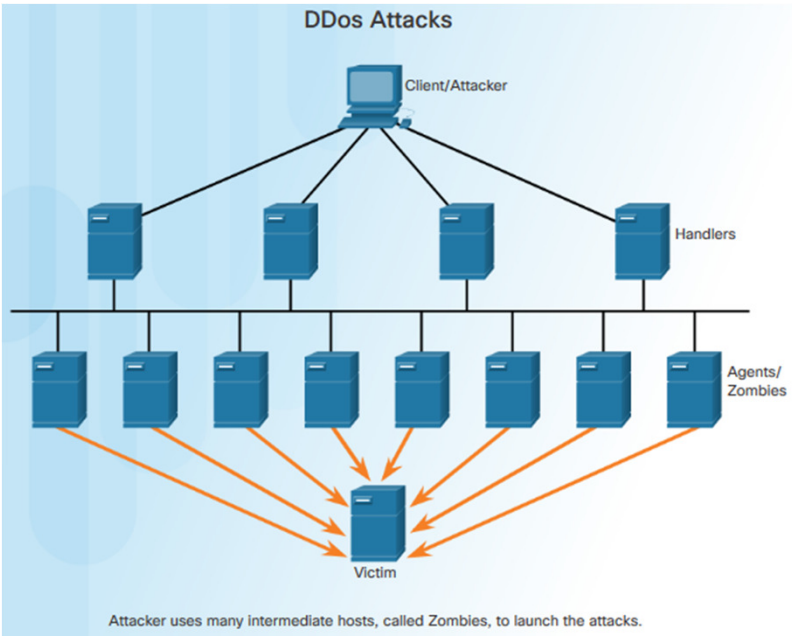


Security Appliances

- Security appliances fall into these general categories:
  - **Routers** - can have many firewall capabilities: traffic filtering, IPS, encryption, and VPN.
  - **Firewalls** – may also have router capability, advanced network management and analytics.
  - **IPS** - dedicated to intrusion prevention.
  - **VPN** - designed for secure encrypted tunneling.
  - **Malware/Antivirus** - Cisco Advanced Malware Protection (AMP) comes in next generation Cisco routers, firewalls, IPS devices, Web and Email Security Appliances and can also be installed as software in host computers.
  - **Other Security Devices** – includes web and email security appliances, decryption devices, client access control servers, and security management systems.

Detecting Attacks in Real Time

- Zero-day attack
  - A hacker exploits a flaw in a piece of software before the creator can fix it.
- **Real Time Scanning from Edge to Endpoint**
  - Actively scanning for attacks using firewall and IDS/IPS network device
  - detection with connections to online global threat centers
  - detect network anomalies using context-based analysis and behavior detection
- **DDoS Attacks and Real Time Response**
  - DDoS, one of the biggest attack threats, can cripple Internet servers and network availability.
  - DDoS originates from hundreds, or thousands of zombie hosts, and the attacks appear as legitimate traffic.



Detecting Malware

Protecting Against Malware

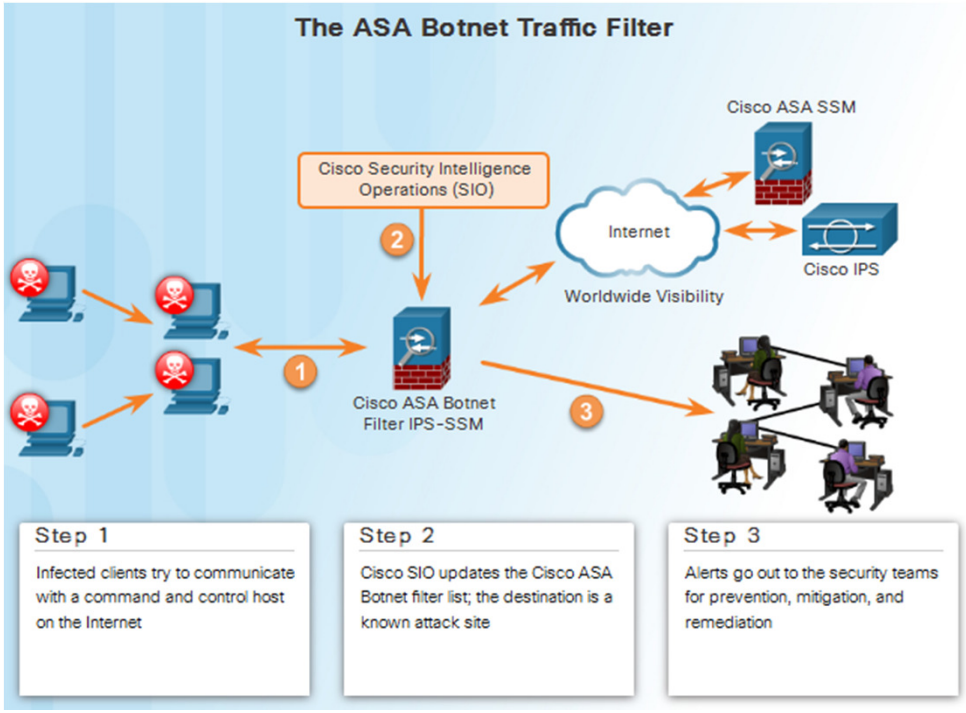
Security Best Practices

- **Some published Security Best Practices:**
  - **Perform Risk Assessment** – Knowing the value of what you are protecting will help in justifying security expenditures.
  - **Create a Security Policy** – Create a policy that clearly outlines company rules, job duties, and expectations.
  - **Physical Security Measures** – Restrict access to networking closets, server locations, as well as fire suppression.
  - **Human Resource Security Measures** – Employees should be properly researched with background checks.
  - **Perform and Test Backups** – Perform regular backups and test data recovery from backups.
  - **Maintain Security Patches and Updates** – Regularly update server, client, and network device operating systems and programs.
  - **Employ Access Controls** – Configure user roles and privilege levels as well as strong user authentication.
  - **Regularly Test Incident Response** – Employ an incident response team and test emergency response scenarios.
  - **Implement a Network Monitoring, Analytics and Management Tool** - Choose a security monitoring solution that integrates with other technologies.
  - **Implement Network Security Devices** – Use next generation routers, firewalls, and other security appliances.
  - **Implement a Comprehensive Endpoint Security Solution** – Use enterprise level antimalware and antivirus software.
  - **Educate Users** – Educate users and employees in secure procedures.
  - **Encrypt data** – Encrypt all sensitive company data including email.

4.2 Behavior Approach to Cybersecurity

Botnet

- Botnet
  - A group of bots connect through the Internet
  - Controlled by malicious individuals or groups
- Bot
  - Typically infected by visiting a website, opening an email attachment, or opening an infected media file

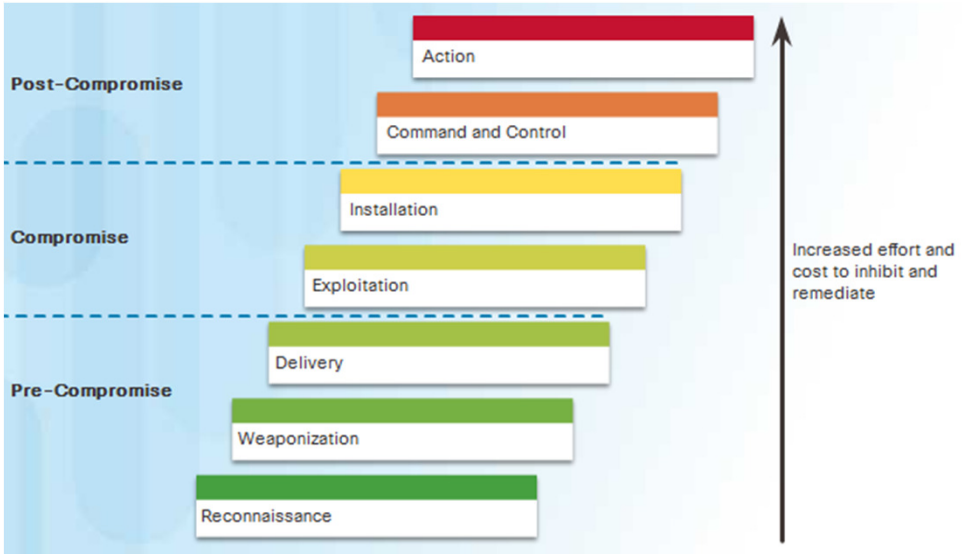


Kill Chain

The Kill Chain in Cyberdefense

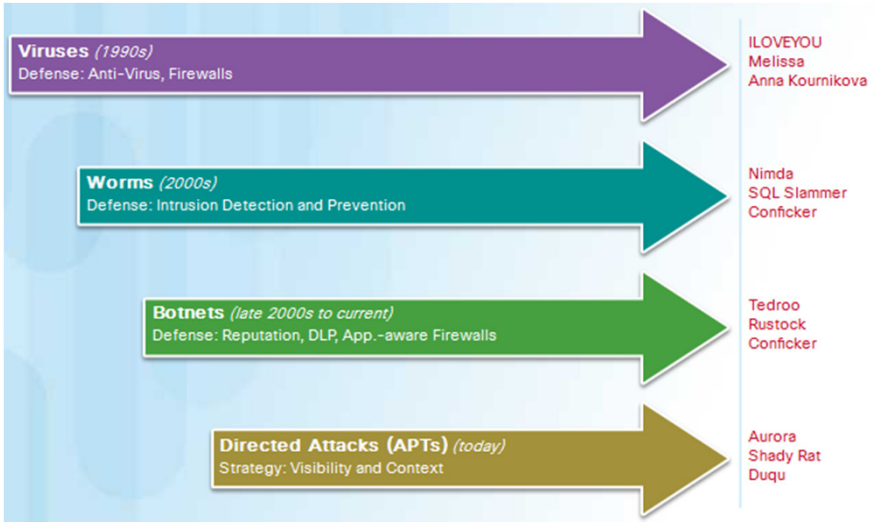
Kill Chain is the stages of an information systems attack.

1. **Reconnaissance** – Gathers information
2. **Weaponization** - Creates targeted exploit and malicious payload
3. **Delivery** - Sends the exploit and malicious payload to the target
4. **Exploitation** – Executes the exploit
5. **Installation** - Installs malware and backdoors
6. **Command and Control** - Remote control from a command and control channel or server.
7. **Action** – Performs malicious actions or additional attacks on other devices



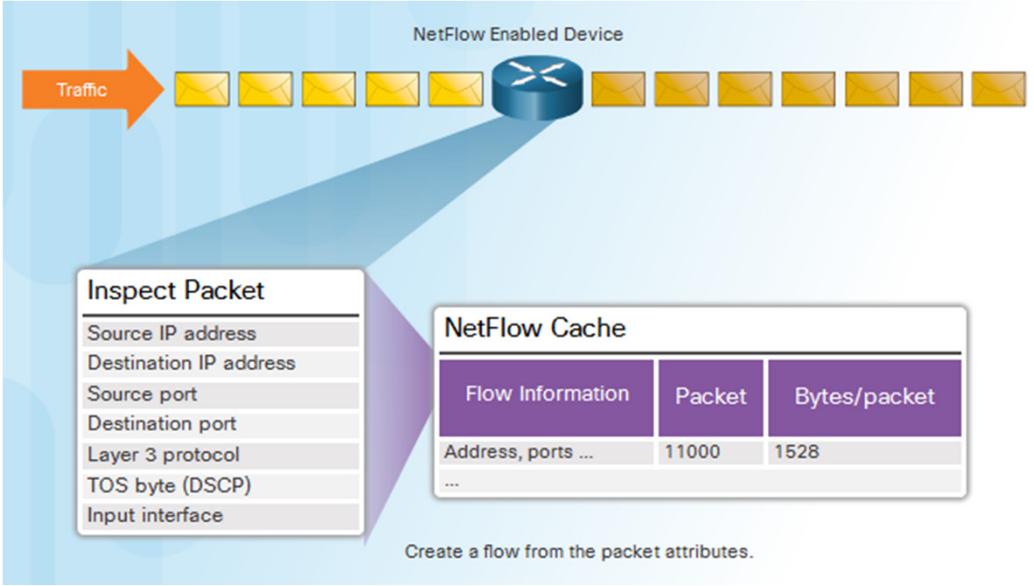
Behavior-Based Security

- Honeypots
  - Lures the attacker by appealing to the attackers' predictable behavior
  - Captures, logs and analyze the attackers' behavior
  - Administrator can gain more knowledge and build better defense
- Cisco's Cyber Threat Defense Solution Architecture
  - Uses behavior-based detection and indicators
  - Provide greater visibility, context and control



Netflow

- Gather information about data flowing through a network
- Important components in behavior-based detection and analysis
- Establish baseline behaviors



4.3 Cisco's Approach to Cybersecurity

CSIRT

- Computer Security Incident Response Team
  - help ensure company, system, and data preservation by performing comprehensive investigations into computer security incidents
  - provides proactive threat assessment, mitigation planning, incident trend analysis, and security architecture review

US-CERT
UNITED STATES COMPUTER EMERGENCY READINESS TEAM

APCERT

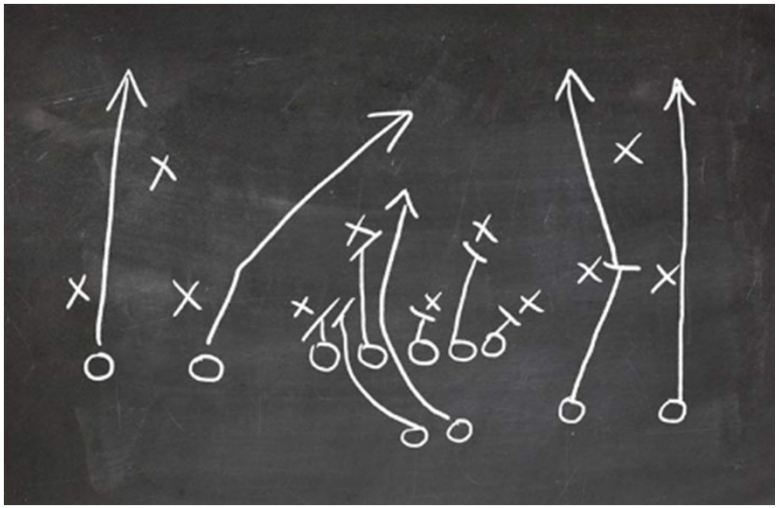
FIRST
Improving Security Together

computer emergency response team CERT-EU
for the EU institutions, bodies and agencies

Software Engineering Institute | Carnegie Mellon University

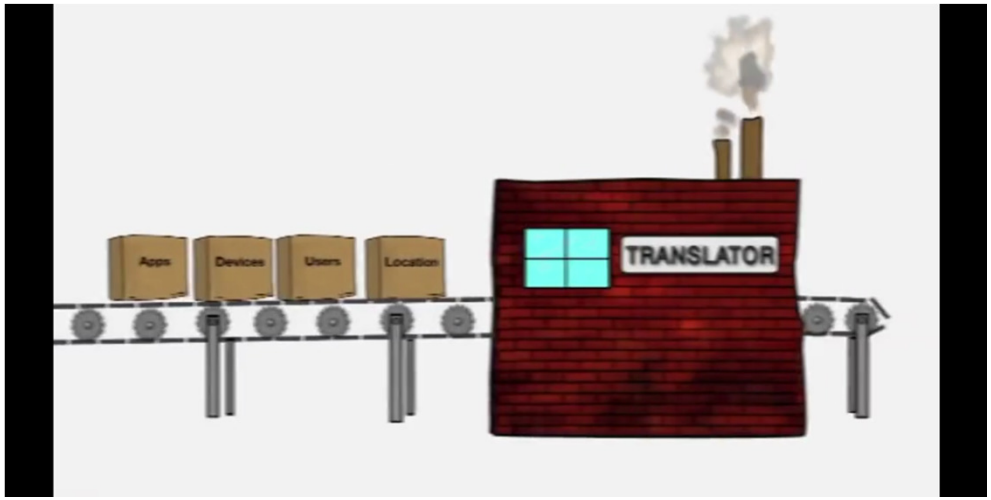
Security Playbook

- Collection of repeatable queries against security event data sources that lead to incident detection and response
- What does it need to accomplish?
  - Detect malware infected machines.
  - Detect suspicious network activity.
  - Detect irregular authentication attempts.
  - Describe and understand inbound and outbound traffic.
  - Provide summary information including trends, statistics, and counts.
  - Provide usable and quick access to statistics and metrics.
  - Correlate events across all relevant data sources.



Tools for Incident Prevention and Detection

- SIEM – Security Information and Event Management
  - Software that collects and analyzes security alerts, logs and other real time and historical data from security devices on the network
- DLP – Data Loss Prevention
  - Stops sensitive data from being stolen or escaped from the network
  - Designs to monitor and protect data in three different states
- Cisco Identity Services Engine (Cisco ISE) and TrustSec
  - Uses role-based access control policies



IDS and IPS

- IDS – Intrusion Detection System
  - Usually placed offline
  - Does not prevent attacks
  - Detect, log, and report
- IPS – Intrusion Prevention System
  - Ability to block or deny traffic based on a positive rule or signature match
- IDS/IPS system
  - Snort
  - Sourcefire (Cisco)


CISCO