*These notes were made following the **TOTAL: CompTIA Security+ Certification (SY0-501) course from Mike Meyers and Total Seminars.***

- **Section 1: Risk Management**
  - CIA of Security
    - CIA Triad (Goals of Security)
      - Confidentiality
      - Integrity
      - Availability
    - Confidentiality: Keeping data secret from anyone who shouldn't be accessing it.
    - Integrity: Ensures data and systems is in an unaltered state when stored, transmitted, or received.
    - Availability: Ensures systems and data is available to authorized users when needed.
    - Also added:
      - Auditing & Accountability: Keeping track of what goes on (logs).
      - Non-Repudiation: Ties into accountability; making it to where users cannot deny an action.

  - Risk Management
    - Identification, assessment, and prioritization of risk.
    - Potential to harm organizations, people, systems.
      - Assets
        - Any part of our infrastructure that we protect.
          - Servers, routers, firewalls, systems.
          - People.
          - Server room doors, physical aspects.
      - Vulnerabilities
        - A weakness to an asset to be exploited.
          - Default passwords on equipment.
          - Server room that is unlocked.
      - Threats
        - A negative event or action that exploits a vulnerability.
          - An actual login attempt by hacker.
      - Threat agent
        - A person or entity that follows throw with the threat.
      - Likelihood
        - A level of certainty that a negative event will happen.
        - Often an annualized basis or percentage.
        - Two ways to measure likelihood:
          - Quantitative: A power supply for a Cisco device dying. (10%.)
          - Qualitative: Customer loyalty after a bad event. (Low, medium, high.)
      - Impact
        - Harm caused by a threat.
        - Preceded by a negative event happened.
          - Quantitative values: Cost, labor, time.
          - Qualitative values: Reputation, name recognition.
    - Threats -> vulnerabilities = risk
    - NIST SP 800-30 is a standard document of risks and vulnerabilities and is an industry standard.

  - Threat actors
    - Attributes:
      - Internal/external: Are these threat actors within the company or in a different country?
      - Level of sophistication: Threat actors can wreak havoc on basic levels or be very sophisticated and experiences.
      - Resources and funding: How much funding and willingness exists for threat actors to carry out their tasks?

        - Intent: What is the intention? Money? White hat, black hat.
        - Open-Source Intelligence (OSINT): Social media, public records.
    - Types of threat actors:
        - Script kiddies (skiddies)
            - Trivial attack knowledge
            - Use scripts and pre-made tools
            - Most cases are easily preventable.
        - Hacktivist
            - Intent is motivation of activism
        - Organized Crime
            - Smart groups of hackers to make money
        - Nation states/Advanced Persistent Threat (APT)
            - Motivation is intelligence and sensitive information
            - Sophisticated toolsets.
            - APTs gain access to a system and stay put, continuing to funnel information.
        - Insiders
            - Not always an employee - could be anyone within the infrastructure/organization.
            - Do they have access to information? (Usernames/passwords)
        - Competitors
            - Not as big of an issue in today's society due to private business laws.
    - Keep in mind, what are the attributes to be applied to each threat actor?

- Managing Risk
    - Risk Identification/Assessment
        - Catalog and define all assets/Vulnerability Assessment
            - What are the vulnerabilities of our assets?
            - NIST SP 800-37 summarizes vulnerabilities of assets, but very broad.
            - cve.mitre.org
                - Common Vulnerabilities and Exposure Database
                - Administered by the Mitre Corporation
                - Goes into detail about vulnerabilities
                    - Example: Mail application built-into Osx 8.0 or earlier vulnerable to sniffing.
            - Nessus, which is a program ran on the LAN that generates a report of vulnerabilities, is used quite often.
            - Penetration (pen) testing
                - Outside party of some sort looks for vulnerabilities and ways to exploit them, and reporting to the company.
        - Threat Assessment
            - Looking to define threats applicable to our infrastructure.
                - Adversarial threats:
                    - Hacker, malware, etc.
                - Accidental threats:
                    - User accidentally corrupts database.
                    - Administrator accidentally reformats HDD on a server.
                    - People who have permissions to cause damage, but done on accident.
                - Structural:
                    - Power supply dies, camera goes out, equipment failure, software failure.
                - Environmental:
                    - Fires, water, AC going out causing overheating.
        - Risk Response
            - Opportunities:
                - Mitigation: Applying a security control to a particular risk.

            - Risk Transference: Offloading some likelihood, risk, and impact onto a third party. (Example: moving a server to the cloud.)
            - Risk Acceptance: Where the likelihood and impact of a risk is less than the cost of mitigating the risk.
            - Risk Avoidance: This particular combination of risk and likelihood is too high to even consider, so dropping the risk all together.
        - Frameworks
            - A workflow or methodology, or an idea of a process to deal with risk management.
            - Sources of two commonly used frameworks:
                - NIST Risk Management Framework Special Publication 800-37
                - ISACA Risk IT Framework
            - Boils down to: assessment, applying security controls, monitor the situation, respond to any risks; then the process continues in a circular motion.

- Using guides for Risk Assessment
    - CompTIA views this as "How do we secure stuff?" in a broad stroke.
    - Types of guides:
        - Benchmark: A company who sells a router should tell you what percentage of CPU usage at any time.
            - We can do our own benchmarks, such as running a benchmarking tool on a machine to check network throughput, etc.
            - Use threshold values to verify expected throughput or action.
        - Secure Configuration Guides:
            - Routes, operating systems, wireless access points - all of these devices have a "proper" or "recommended" configuration.
            - Platform and vendor guides.
            - Examples:
                - Apache Security Tips for their web server.
                - Windows guide for "Configure Web Server Security (IIS 7).
                - NIST provides guides for securing operating systems, such as "Guide to Securing Apple OS X 10.10 Systems for IT Professionals"
            - Network Infrastructure Devices:
                - Examples:
                    - Beginner's Guide to EdgeRouter (for Ubiquiti)
                    - NIST Guide SP 800-153 "Guidelines for Securing WLANs"
            - General Purpose Guides:
                - Lists of security controls, in a general sense, to apply.
                - Example:
                    - NIST SP 800-123 "Guide to General Server Security"
                    - Broad, less specific topics, such as: user accounts, password policies, intrusion protection, etc.

- Security Controls
    - A verb or action, a mechanism applied to our IT infrastructure to protect from security problems or remediate existing security problems.
    - Not just IT security - physical building security, phishing training for employees, etc.
    - Apply, monitor, and applying security controls to IT infrastructure.
    - Broken into categories:
        - Administrative Control (Management Control)
            - Controls actions people make towards IT security.
                - Laws
                - Policies
                - Guidelines
                - Best practices

                - What do people do?
        - Technical Control
            - Controls actions IT systems make towards IT security.
                - Computer stuff
                - Firewalls
                - Password links
                - Authentication
                - Encryption
        - Physical Control
            - Controls actions in the real world.
                - Gates
                - Guards
                - Keys
                - Man traps
    - Security Control Functions:
        - Deterrent
            - Deters the actor from attempting the threat
        - Preventative
            - Deters the actor from performing the threat
        - Detective
            - Recognizes an actor's threat, may or may not do anything about it.
        - Corrective
            - Mitigates the impact of a manifested threat
        - Compensating
            - Provides alternative or temporary fixes to any of the above functions.

- Interesting Security Controls
    - Mandatory Vacation
        - Requires individuals to take vacation - used to detect fraud and unauthorized activity.
    - Job Rotation
        - Periodically switching people around to different positions, also avoids contempt of position.
    - Multi-Person Control
        - More than one person is needed to accomplish a task or function, and also allows multiple people to make sure it is done correctly.
    - Separation of Duties
        - Administrative control. Single individuals should not perform all critical or privileged duties across the board.
    - Principle of Least Privilege
        - Users granted only the level of privilege that is needed for their job.

- Defense in Depth
    - AKA, Layered Security.
    - Diversity vs. Redundancy
        - Redundancy is the same type of security control implemented over and over again.
        - Diversity is varying controls implemented at once.
    - Defense in depth is typically discussed in regards to a variety of physical, administrative, and technical controls.
    - Vendor diversity is a method of defense in depth with technical controls.

- Security Governance
    - Governance is a set of overarching rules that defines how an organization and its personnel conduct themselves.

- IT Security Governance is a set of overarching rules that defines how an organization and its personnel conduct IT security.
- Sources of Security Controls:
- Laws and Regulations
    - Example: HIPAA
- Standards
    - Government Standards: NIST or ISO
    - Industry Standards: PCI-DSS (Credit card standards)
- Best Practices
    - Microsoft Best Practices
- Common Sense & Experience
    - What has worked in the past? What do I think is the best way to do something?
- Creating policies:
    - Broad in nature
    - Used as directives
    - Define roles and responsibilities
- Organization standards define the acceptable level of performance of policy.
- Security controls come from the policies and standards.
- A procedure is a step-by-step process of how we do a task.
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- Guidelines
    - A guideline is considered optional.
    - Not clearly defined.
    - Just an idea of how we should tend to do something.

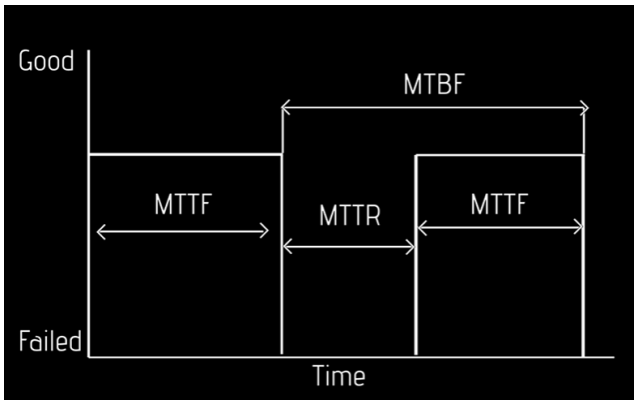
- Security Policies
    - Acceptable Use Policy
        - Most well-known.
        - Defines what a person can or can not do when using company assets.
        - Uses very broad strokes.
    - Data Sensitivity and Classification Policies
        - Defines importance or nature of data.
        - Applying labels to types of data (top secret, secret, confidential, etc.)
    - Access Control Policies
        - Defines how someone gets access to data or resources.
        - Can cover passwords, fobs, smart cards, etc. Defines what type of data users have access to.
        - Addresses data access and classification restrictions.
        - Can be incorporated into Acceptable Use Policy, Data Classification Policy, etc.
    - Password Policy
        - Defines how we deal with passwords.
        - Typically incorporated into other documents.
        - Covers password recovery/loss.
        - Bad login attempts.
        - Password retention and reuse policies.
    - Care and Use of Equipment

        - Often under Acceptable Use Policy.
        - Covers maintenance of equipment, how to borrow/check out equipment, responsibility matrixes.
    - Privacy Policies
        - Applied to customers and in-house.
        - Common among social media for customers of that media.
    - Personnel Policies
        - Deals with the people dealing with our data.
        - Background checks, security clearances, etc.
        - "We will use job rotation and mandatory vacations."
        - If it has to do with a person, and a person dealing with data, it goes in a personnel policies.

- Frameworks
    - Nothing more than a process idea. Provides organization for good IT security infrastructure.
    - Types of Frameworks:
        - Regulatory
        - Non-Regulatory
        - National standards
        - International standards
        - Industry-specific frameworks
    - Examples of Frameworks:
        - NIST SP800-37 - National standard and US federal regulatory.
        - ISACA IT Infrastructure - Non-regulatory.
        - ISO 27000 - International standard
    - NIST Risk Management Framework

        - Categorize workflows, processes, vendors, organizational inputs/outputs.
        - Select security controls - look at what is taking place, and based on regulations/laws/best practices, etc. - choose what to implement.
        - Implement security controls.
        - Assess security controls once implemented. Verify that everything works the way it is supposed to. Often done in a sandbox.
        - Authorize information systems. Creates lessons learned, and establishes hierarchy of responsibility.
        - Monitor security controls. Watch the controls and making sure it is mitigating/eliminating risk, not impacting users' lives too severely, etc.

- Quantitative Risk Calculations
    - Asset value
        - Not just the cost of an item. For example:
            - A router costs $2500. Factor in cost of a technician to replace it, and how much money/productivity is lost during the downtime. (Router = $2500, plus $500/day for a technician, plus the $2000 lost per day makes the asset value $5000.)
    - Exposure Factor

        - Percentage of an asset that's lost as a result of an incident.
        - A router that, if shorted, would be a full loss; would be an EF of 1.
        - A server room that, if flooded, would only have some items damaged, could be an EF of .75.
    - Asset Value x Exposure Factor = Single Loss Expectancy
        - The $5000 asset value of the router example, at an exposure factor of 1 (5000 x 1 = 5000).
    - Annualized Rate of Occurrence = in a given year, what are the chances of this particular instance taking place.
        - If it floods once every twenty years, that would be .05.
    - SLE x ARO = Annualized Loss Expectancy
    - 

    - MTTF - Mean Time To Failure - Usually applied to an item that cannot be repaired.
    - MTTR - Mean Time To Repair
    - MTBF - Mean Time Between Failures - Usually applied to an item that can be repaired.

- Business Impact Analysis
    - The study and analysis of the impact on the organization when a disruption occurs.
    - BIA Basics:
        - Determine mission process. What are the things that we do within our IT infrastructure to perform our jobs?
        - Identify critical systems. If our modem is not working, we cannot do our jobs.
        - Single point-of-failure. Set up redundancy to minimize this.
        - Identify resource requirements. In order to access payroll files, we need the servers that store them to be available.
        - Identify recovery priorities. If everything goes down, what are the priorities to make the business recover best?
    - Impact examples:
        - Monetary loss
        - Property loss
        - People
            - Safety
            - Life
        - Finance
            - Ability to create revenue. Cash flow. Credit. Payroll.
        - Reputation
    - Privacy Impact Assessment (PIA)
        - What will the impact be to us if the private data we control were breached?
        - PII (Personally Identifiable Information)
        - PHI (Personal Health Information)
    - Privacy Threshold Assessment (PTA)
        - What is this data? Where is this data? How are we storing this data?
    - A PIA and PTA are both done in order to understand what the impact what the loss of personal information can do to a business.
    - Recovery Time Objective (RTO)
        - The minimum time necessary to restore a critical system operation. The maximum time a critical system can be down without substantial impact.

        - Recovery Point Objective (RPO)
            - Maximum amount data that can be lost without substantial impact.

- Organizing Data
    - Data Labeling allows recipients of the data to know if or how the data can be shared.
    - Data types:
        - Public data is data that has no restriction, within the public domain.
        - Confidential data is data that one party offers to a second party, but only to that party. Limited to authorized viewing.
        - Private information is information that is limited to only the individual to whom the information is shared. Personally Identifiable Information (PII).
        - Proprietary is private information at a corporate level.
        - Protected Health Information (PHI) is any information pertaining to the health of a particular person. Health Insurance Portability and Accountability Act (HIPAA).
    - Data roles:
        - Owner of the data. Person/entity who has the legal responsibility for the data.
        - Steward/custodian, who is meant to maintain the accuracy and integrity of data.
        - Privacy Officer is the person who is in charge of ensuring data adheres to privacy policies and procedures.
    - Data users:
        - Users. Assigned standard permissions to complete task.
        - Privileged users. Increased access and control relative to a user.
        - Executive users. The user who makes strategic decisions, sets policies on data and incident response actions.
        - System administrators. Has access to delete entire databases, set permissions on all others, etc.
        - Data owner/system owner. People or organizations who have legal ownership of particular dataset or system.

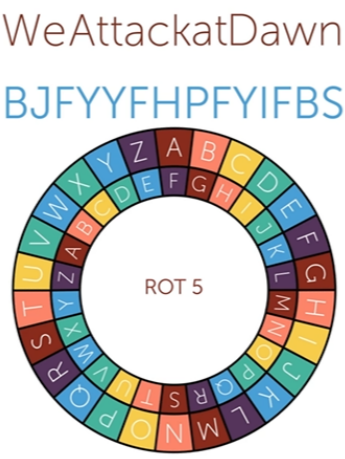
- Security Training
    - Onboarding is the process that takes an entity outside of your infrastructure that brings that entity into your infrastructure.
        - Requires background check.
        - Non-disclosure agreement (NDA)
        - Standard operating procedures.
        - Specialized issues. (Requirement of clean desk, etc.)
        - Rules of behavior (Good acceptable use policy)
        - General security policies. (Social media use, etc.)
    - Offboarding is the process in which someone leaves your infrastructure.
        - Disable accounts
            - Never delete.
        - Return credentials
        - Exit interview
        - Knowledge transfer
    - PII is a huge part of training for legality's sake, stolen information, etc.
    - NIST 800-122 goes into great detail on the concept of PII.
        - Information to watch out for:
            - Full name
            - Home address
            - Email address
            - National Identification number (social security)
            - Passport number
            - Vehicle registration plate number
            - Driver's license number

            - Face, fingerprints, or handwriting
            - Credit card numbers
            - Digital Identity
            - Date of birth
    - Personnel Management Controls
        - What people do in terms of work to keep our infrastructure as secure as possible.
        - Examples:
            - Mandatory vacations
                - Verifies dependency issues
                - Prevents collusion
                - Makes fraud more difficult
            - Job rotation
                - Redundancy and backup
                - Makes fraud more difficult
                - Allows for cross-training
            - Separation of duties
                - Requires dual or more execution
    - Role-based Data Controls
        - System owner
            - Management level
            - Maintains security of the system
            - Defines a system administrator
            - Works with all data owners to ensure data security
        - System administrator
            - Assigned by system owner to perform day-to-day administration
            - Implements security controls
        - Data owner
            - Defines sensitivity of data
            - Defines protection of the data
            - Works with system owner to protect data
            - Defines access to the data
        - User
            - Accesses and uses the assigned data responsibility
            - Monitors and reports security breaches
        - Privileged user
            - Has special access to the data beyond the user
            - Works closely with system administrators to adhere to security
        - Executive user
            - Read only access to all data on system

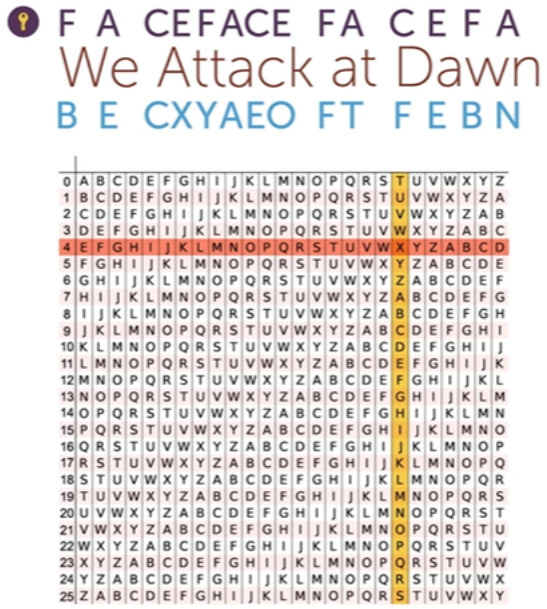
- Third party agreements
    - Business Partners Agreement (BPA)
        - Includes primary entities, time frame, financial issues, management.
    - Service Level Agreement (SLA)
        - Includes service to be provided, minimum up-time, response time (contacts), start and end date.
    - Interconnection Security Agreement (ISA)
        - NIST 800-47
        - Statements of requirement (Why are we interconnecting? Who is interconnecting?)
        - System security considerations (What information is interconnecting? Where is this information going? What services are involved? What encryption is needed?)
        - Topological drawings.
        - Signature authority (timeframe, technical reviews, security reviews)
    - Memorandum of Understanding/Agreements (MOU/MOA)
        - ISA's are typically reinforced by these.

- Not a contract, but looks like one.
- Includes purpose of the interconnection, relevant authorities, specify the responsibilities (downtime, billing, etc.), defines terms of the agreement (cost, etc.), termination/reconnection.

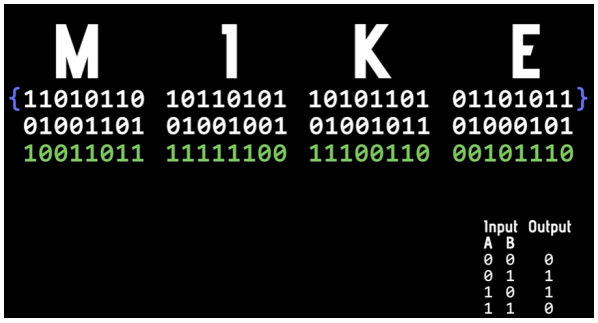
- **Section 2: Cryptography**
  - Cryptography Basics
    - Cryptography is the process of taking data, providing confidentiality to that data, and then outputting it again. The practice of disguising information in a way that looks random.
    - Obfuscation: To take data that looks like it makes sense and hide it.
    - Diffusion: Making an image blurry or fuzzy.
    - Confusion: Making an image stirred up or non-sensical.
    - Encryption/decryption
      - Ceaser Cipher
        - Includes substitution. One of the earliest known and simplest ciphers.
        - Example:



        - Easily decrypted with cryptanalysis.
      - Vigenère Cipher
        - Like a Ceaser Cipher with more confusion involved.
        - Example:



    - Classic cryptography components:
      - Algorithm
      - Key for encryption
    - Algorithms for binary data
      - Exclusive OR (XOR)
        - Example:

- 

    - Kerckhoffs' Principle
        - As long as you don't know what the key is to an encryption, you can understand the algorithm completely.
        - Today's algorithms are open standard.
        - By showing everyone the "lock", anyone can check the "lock" to see if it's pick-able.
        - Everyone knows the algorithm, but if you don't know the key, it doesn't do you any good.
    - Data at rest
        - Thumb drive, DVD, CD, etc.
    - Data in transit
        - VoIP call, text message, etc.
    - Data in process
        - Calculating in database where it is sitting in RAM/CPU.
    - Where do we encrypt/decrypt this data?

- Cryptographic methods
    - Symmetric Encryption is where the same key is used to encrypt and decrypt a piece of data.
    - In-band keys are sent with the encrypted data.
    - Out-of-band keys have a key sent separately from the encrypted data.
    - Symmetric encryption is the primary way that we encrypt data.
    - Ephemeral key is a key that is temporary. Provides perfect forward secrecy.
    - When a key is setup in a way that knowledge of a key used in a previous session keeps someone able to crack encryption in a current session, that is called perfect forward secrecy.
    - Asymmetric encryption does not use a key. It uses a key pair.
        - Public key
            - Given to anybody
            - Only used to encrypt
        - Private key
            - Kept by the sender of encrypted data
            - Only used to decrypt
    - Asymmetric encryption's big issue beyond key generations and exchanging, it is slow. It is mainly used to send a secure session key.
    - A cryptosystem is a highly defined piece of cryptography that programmers use to do their job and make cryptography work.
        - It defines key properties, communication requirements for the key exchange, and the actions taken through encryption/decryption.

- Symmetric Cryptosystems
    - Algorithms have to be known to everybody, and it has to have a key of different lengths that are kept secret.
    - Symmetric Key Algorithms is defined by the same key used for encrypting/decrypting.
    - A Symmetric Block Algorithm continues to take defined blocks of data, encrypting that data, and continuing to repeat the process until all of the target data is encrypted.
    - Data Encryption Standard (DES) was invented primarily by IBM and is still used by the US Government.

        - 64-bit plain text
        - Initial Permutation - stirring of the data.
        - Key, has last 8 bits dropped, split into two 28-bit chunks.
        - The first 24-bits of each chunk is then combined to make a SubKey (48-bits).
    - The initial data has a Feistel Function performed
        - Take the 64-bits and split into 32-bit halves.
        - A 32-bit half is expanded to 48-bit using an Expansion function.
        - An XOR function is applied, using the SubKey.
        - S Boxes are used. Each S Box takes in 64-bits and outputs 4-bits.
        - 8 different S Boxes with a different 4-bit output.
        - Apply all S Boxes to the data, creating a 32-bit output.
        - A final permutation is performed, where the two 32-bit pieces of data are put together but backwards.
    - DES had issues with a short key. DES can be hacked in certain circumstances.
    - Two alternatives to DES: Blowfish, and 3DES (Triple DES).
    - Three things we look at regarding symmetric block encryptions.
        - Key size
        - Number of rounds
        - Block size
    - DES:
        - Block Cipher
        - 64-bit Block Size
        - 16 Rounds
        - Key Size: 56-bit
    - 3DES:
        - DES, but tripled.
        - Block Cipher
        - 64-bit Block Size
        - 16 Rounds
        - Key Size: 56-bit x 3 = 168-bit.
    - Blowfish
        - 64-bit Block Size
        - 16 Rounds
        - Key Size: Variable 32 to 448-bits.
    - AES
        - Advanced Encrypted Standard. Supported by NIST.
        - Symmetric Block Encryption
        - In essence, un-hackable.
        - Block Cipher
        - 128-bit Block Size
        - Key Size: 128, 192, or 256-bit.
        - Rounds: 10, 12, or 14.
    - A streaming cipher is where each bit is encrypted once at a time, in a pseudo-random manner.
        - RC4 is one of the only streaming ciphers. It is asymmetric.
        - Rivest Cipher 4 (RC4):
            - 1-bit at a time.
            - 1 round.
            - Key Size: Variable from 40 to 2048-bits.

- Symmetric Block Modes
    - Electronic Code Book (ECB) can create patterns by using the same key to encrypt blocks repeatedly. Always outputs same results with the same input.
        - This can apply to voice, data, anything that is encrypted.
    - A binary block is plain text converted into 16-bit, 64-bit, or 128-bit binary ciphertext.

- We use different Block Modes to obfuscate the data better.
- All Block Modes creates a chain of encryption.
- The following Block Modes use an Initialization Vector, which ensures the output block is uniquely different.
    - Cipher Block Chaining (CBC)
        - Uses an Initialization Vector.
        - First block has XOR ran onto it.
    - Cipher Feedback (CFB)
        - Uses an Initialization Vector, that is encrypted. The output of that encryption is XOR'd to the first block.
    - Output Feedback
        - One Initialization Vector, encrypted, and the output is XOR'd to the first block. Same Initialization Vector continues to be used.
    - Counter (CTR)
        - Uses a Nonce Value + Counter Value that continues to increment in binary. Then it is encrypted, and the first block of the plain text is XOR'd to create the first block of Cipher Text.
- Nobody uses ECB anymore.

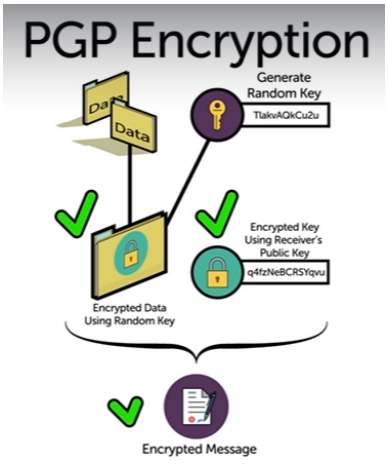
- RSA Cryptosystems
    - RSA is an asymmetric algorithm.
    - Two large prime numbers multiplied together to form a semiprime number to generate a key pair.
    - Each public key has a single private key. Without the private key, the information can not be decrypted.
    - RSA includes protocols to authenticate the intended recipient.
    - RSA now uses a 2048-bit minimum for a key size in today's society.
    - ECC: Elliptic Curve Cryptography
        - Provides very small keys to transfer with the same robustness as large RSA keys.
        - ECC is based on an Elliptic Curve formula:
            - $y^2 = x^3 + ax + b$
        - Key pair can be plotted on elliptic curve.

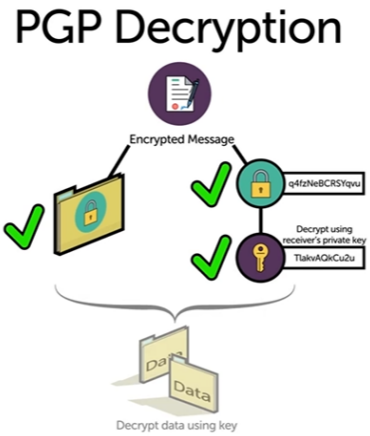
- Diffie-Hellman
    - An asymmetric algorithm, that is meant to provide a methodology for two parties to come up with the same session key.
    - Key Exchange (Agreement) Protocol
    -

Diffie-Hellman Groups	
Group 1	768 bit modulus
Group 2	1024-bit modulus
Group 5	1536-bit modulus
Group 14	2048-bit modulus
Group 19	256-bit elliptic curve
Group 20	384-bit elliptic curve
Group 21	521-bit elliptic curve

    - Subject to cracking due to large integers.
    - Groups help by defining the size or type of key structure to use.

- PGP/GPG
    - Invented for e-mail encryption, originally.

- Used to sign files, encrypt individual files, partition/disk encryption.
- PGP uses the idea of a random key generated by the encryptor.
  - 

  - 

- Public Key Infrastructure (PKI)
  - 

- PGP Certificates
  - Symantec Corporation
    - Encrypts mass storage
    - Signing
    - Disk encryption
    - Bitlocker/Filevault
    - Designed for enterprise cloud solutions
  - OpenPGP
    - Free
    - Open-source
    - Encrypted e-mail
    - PKI support
    - Works with S/MIME
  - GPG (GNU Privacy Guard)
    - Free toolset

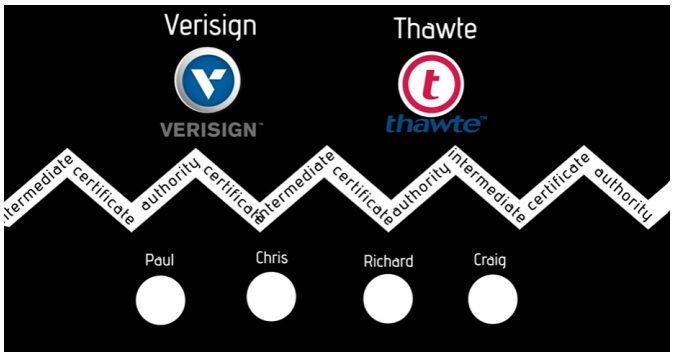
        - File and disk encryption

- Hashing
    - A hash provides integrity in regards to the CIA triad.
    - An algorithm that takes an arbitrarily large amount of data that runs through the hash, and comes out in a fixed value each time.
    - Hashes are one-way. Once a hash is generated, it is impossible to figure out what the original data was.
    - Hashes are used to verify sources.
    - Types of Hashes:
        - Message Digest 5 (MD5)
            - Invented 1992 by Ron Rivest
            - Uses 128-bit hash
            - Can create collisions.
        - Secure Hash Algorithm (SHA)
            - Developed by National Institute of Standards
            - SHA-1 is the earliest type. 160-bit hash.
            - Can create collisions.
        - SHA-256 (SHA-512)
            - Newer version of SHA with 256-bit or 512-bit hashes.
        - RIPEMD (RACE Integrity Primitives Evaluation Message Digest)
            - Not very common.
            - Open standard
            - 128, 160, 256, 320-bit versions.
    - Examples of hashes:
        - Password storage. Password saved as hash onto hard drive, not the plain text of the password.
        - Encryption and authentication

- HMAC
    - Hash-based Message Authentication Code (HMAC)
    - Takes one individual packet and adds information to the end of that packet.
    - Generates hash, but not just a hash of the message; it also uses the key.
    - www.freeformatter.com has an HMAC generator/tester tool.
    - Provides message integrity.
    - Requires each side of the conversation to have the same key.
    - Based on standard hashes (MD5, SHA-1, etc.)

- Steganography
    - Process and science of taking data and hiding it in other data.
    - The data itself may or not be encoded, but it is hidden in other data.
    - Text hidden within graphic images, most commonly.
    - Image Steganography: used to embeds data into .png, .jpeg, .bmp.
        - Tool used to input secret text into image.
        - In order to retrieve the data, the image must be decoded using the same tool by the recipient.

- Certificates and Trust
    - HTTPS websites will send public key to your system.
    - Key exchange
        - How do we determine where the public key comes from? Or that it is legitimate?
        - Either key in a private and public pair can be the public key.
        - Different strings of ones and zeroes.

        - A digital signature is just a hash. A webpage has its entire webpage encrypted and sent to the client, and the client hashes it and compares the hash with the server.
        - A public key can have the originator's digital signature as well as a third party's attached to it, used to verify trustworthiness.
        - A digital certificate is a document that includes a public key, a digital signature from the generator, and the third party's digital signature.
            - Third parties create the digital certificate for the user.
        - Ways of trust:
            - Generate your own certificate
                - Unsigned certificate
            - A web of trust requires maintenance and a lot of work.
                - This includes many end users certifying certificates.
            - PKI (Public Key Infrastructure)
                - A hierarchal structure.
                - CA (Certificate Authority)
                    - An organization that issues certificates.
                - Intermediate Certificate Authorities meant to load balance the CA's themselves.
                - 

- Public Key Infrastructure
    - PLI is a trust model.
    - The infrastructure that we use for every real world application that uses public keys/digital certificates.
    - Root certificate is the top of the hierarchy, distributes certificates to intermediate systems.
    - PKI is NOT a standard.
    - PKCS is the de facto "standard" for most systems.
        - Public Key Cryptography Standards = PKCS
    - PKI is based off of X.509, which defines organization through hierarchy to access data on a timely basis.
    - PKCS #7 is used to export certificates to an individual without private keys.
    - PKCS #12 is used to export certificates with private keys encrypted within it as a package.
    - CRL (Certificate Revocation List) Distribution Points
        - Gives your system the opportunity to audit trail the certificate.
        - CRLs can take up to 24-hours to react to "bad" certificates.
            - An expired certificate is not a "bad" certificate.
    - Since CRLs take so long, the modern era uses OCSP (Online Certificate Status Protocol).
        - OCSP is real-time in terms of checking if a certificate is bad.

- Cryptographic Attacks
    - Interpreted as cracking passwords.
    - Passwords are traditionally hashed.
    - Password attacks are typically cracking hashes.
    - One of the hardest aspects of attacking is how to get into a server or system in which passwords are stored.
    - If the password is stored in a hash, there's no way to reverse the hash.
        - Hashing attacks are comparative attacks. Generating hashes over and over until one matches the hash found.

- Brute Force Attack is when a hash is put into a program and ran repeatedly to generate a match.
    - Takes a lengthy amount of time.
    - Generating, based on predefined character range, hashes to find a match.
- Dictionary Attack uses a text file with dictionary words that manipulates them in an attempt to crack commonly-used human passwords.
    - Text files with hundreds of thousands of dictionary words can be downloaded and used to reference in an attack.
    - Takes advantage of the fact that human beings use words they are familiar with for passwords.
- Rainbow-Table Attack
    - A rainbow-table is a pre-generated bunch of hashes.
        - An indexed hash table.
        - Uses reduction formula.
        - Already has hashes in it.
        - A rainbow-table is massive. Small rainbow tables are over 10GB.
    - A hash table is nothing more than a bunch of words with a hash in it.
- Most good password storage obfuscates the password hash to make it harder to crack.
    - OpenSSH, for example, adds two random bytes to the end of a password hash.
- Salt
    - An arbitrary value
    - A salt situation example:
        - Password = Timmy
        - Password with salt 3456 = Timmy3456
        - This means that the password is altered BEFORE it is hashed.
    - Salted hash tables are very hard to crack.
- With wireless, key stretching is used.
    - A passphrase and SSID together generates a combined hash that is much harder to crack.
    - WPA for wireless uses PBKDF2
    - Key stretching technique - bcrypt
    - Proper key stretching is basically unhackable, with proper password precautions.
- Complex passwords are used to make cryptographic attacks harder.

- **<u>Section 3: Identity and Access Management</u>**
    - Identification
        - Identification, Authorization, Authentication
            - Identification just proves who the user is to the authenticating systems.
            - Authentication is the user proving they have rights to that system.
            - Authorization is what rights the user has to the system once authenticated.
        - Authentication Factors
            - Something you know.
                - Passwords, PIN codes, CAPTCHA, security questions.
            - Something you have.
                - Smart card.
                    - Embedded somewhere on the smart card has a chip with a unique identifying code.
                - RSA key (token)
                    - Can be software based or hardware based.
                    - Stores a secret code of some form.
                    - Generates a value that changes every so often.
            - Something about you.
                - Retinal scanners. Finger print scanners. Iris patterns.
            - Something you do.
                - Rhythm of typing, typing style.
            - Somewhere you are.

        - A credit/debit card detecting an interaction out-of-state, entering zip code for gas station.
    - Federated Trust
        - Trust inherited from a different trusted system.
        - Used in Windows Active Directory
        - Domains trusting other domains
    - Multi-factor Authentication (2FA/MFA)
        - Fingerprint scanner + username and password.
        - Password + hardware token.

- Authorization Concepts
    - Authentication is used to access a system, while authorization is used to determine what a user can do within a system.
    - Concepts:
        - Permissions
            - What are the things assigned to a user?
            - Administrators assign permissions
            - Groups/OUs are often assigned permissions as opposed to individual users.
        - Rights/Privileges
            - Rights or privileges are assigned to systems as a whole.
            - Do you have the right to change your password, or desktop wallpaper?
        - Least Privilege/Separation of Duties
            - Least privilege always says give your users the least amount of privilege to get their jobs done.
            - Separation of Duties
                - Keeping different people, groups, and permissions separated from conflict of interest areas.

- Access Control List (ACL)
    - Authorization Models
        - How over time have we developed the concepts of authorization?
        - Mandatory Access Control (MAC)
            - Label-based
            - "Secret/Top Secret" clearances
            - Classified/Unclassified
        - Discretionary Access Control (DAC)
            - Whoever created the resource is the owner/creator
            - The creator/owner defines access/permissions
        - Role-based Access Control
            - Applies access controls to a resource by a role.
            - Used by most all modern operating systems.
            - Groups are used to define roles.
        - Any good ACL will have an implicit deny.
            - An implicit deny is unless you specifically allow something to happen, it isn't going to happen.
        - Anything that needs to control access will have an ACL.

- Password Security
    - An example of a good security policy:
        - Complexity - Length and character requirements
        - Expiration or age - Reset and time triggers
        - Password History - Reusage and retention
    - GPOs can be used to create password security requirements applied within domains.
        - Also can be applied to sites, groups, OUs.

        - GPOs are only used within a Windows AD environment.

- Linux File Permissions
    - File and folder permissions
        - ls -l lists permissions within a directory.
        - 

        - R = Read
            - Opens a file, or views contents of a directory.
        - W = Write
            - Edit a file, or add/delete files within a directory.
        - X = Execute
            - Run a file, or change to a different directory.
        - chmod = short for change mode
            - Command example: chmod o= RunMe
                - Changes permission for others to have no rights, on the file RunMe.
            - Command example: chmod g=rx RunMe
                - Changes permission for group to have read/execute permissions, on the file RunMe.
            - Command example: chmod a=rwx RunMe
                - Changes permission for all to have read/write/execute permissions, on the file RunMe.
            - chmod can be used with binary/numbers instead of letters.
OCATAL	BINARY	PEAMISSIONS
0	000	---
1	001	--x
2	010	-w-
3	011	-wx
4	100	r--
5	101	r-x
6	110	rw-
7	111	rwx

    - 

    - chown is used to change ownership
        - Needs sudo to work.
        - Command example: sudo chown root RunMe
            - Changing the owner to root for the file RunMe.
    - passwd is used to change users password
        - Needs sudo to work.

        - Command example: sudo passwd
            - Changes password on logged in account. Requires the new password to be typed in and confirmed.

- Windows File Permissions
    - NTFS Permissions
        - Read & execute is for running files.
        - Read is only for viewing data files.
        - Full control is allowing all permissions.
        - List folder contents is where the files can be viewed directly, but the user (without the permission) cannot view the files within the parent folder.
        - Modify is for editing/saving files within the folder.
    - The best practice is following:
        - Create users, put the users into groups, and then permissions are put onto folders in terms of groups.
    - Inheritance
        - When NTFS permissions are set for an object, anything created within that object receives those permissions.
    - Copying and moving objects within NTFS formatted partitions
        - Copy from source drive will take on the NTFS permissions of the destination drive.
        - Copying within the same drive will lose its NTFS permissions.
        - Moving within the same with will keep its NTFS permissions.

- User Account Management
    - Continuous Access Monitoring
        - Monitor 24/7 what users are able to get into.
        - Track log on/log off activity.
        - Track file access.
    - Shared Accounts
        - Shared accounts are bad.
        - Biggest example is a workgroup with one account on each machine.
        - Don't share accounts.
    - Multiple Accounts (for one user)
        - Sometimes is a necessity.
        - If it happens, use different usernames/passwords across the accounts.
        - Use different groups. Monitor which users belong with which groups.
        - Use least privilege - enough necessary to complete a task.
        - If you give someone a second account with elevated privileges, make sure they only use that account for what is necessary and then log off.
        - Monitor and log activity of users with multiple accounts.
    - Default and Generic Usernames/Passwords
        - Use dedicated service accounts.
            - Makes it easy to log and track.

- AAA
    - Authentication, Authorization, and Accounting (AAA)
        - Remote Authentication Dial-In User Service (RADIUS)
            - Designed to support Dial-in Networking.
            - Uses RADIUS server within a LAN that is trying to be accessed.
            - A RADIUS client is the gateway being used.
            - A RADIUS Supplicant is the system trying to be authenticated.
                - Supplicant -> RADIUS Client -> RADIUS server
            - Used for wireless authentication (mainly corporate networks)

            - Every wireless access point can be used as a RADIUS client to send off to a RADIUS server for authentication.
        - Mainly used for network access.
        - Can use 4 UDP ports:
            - 1812
            - 1813
            - 1645
            - 1646
        - Does not handle authorization, only authorization.
    - Terminal Access Controller Access-Control System Plus (TACACS+)
        - Form of AAA
        - Proficient at managing a bunch of devices.
        - Takes care of the authorization aspect.
        - Decouples authorization from the authentication.
        - Once you are in (authorization), it defines in real time what you can do (authentication).
        - Uses TCP port 49.
    - Both TACACS+ and RADIUS do auditing (accounting) for log files.

- Authentication Methods
    - The process of Authentication requires encryption.
    - Password Authentication Protocol (PAP)
        - Oldest authentication method.
        - Client system sends username/password in clear text to server system.
    - Challenge-Handshake Authentication Protocol (CHAP)
        - First authentication protocol used in the PC world to protect authentication process.
        - Server and client have password key stored in them.
        - Client system sends "May I authenticate?" message to the server, in which the server makes a "Challenge Message" of the two keys (hashed). The client then generates the same hash and is sent to the server.
        - No passwords being passed, only hashes.
    - NT LAN Manager (NTLM)
        - Isn't used in advanced Windows authentication methods.
        - Still used with Windows systems in a workgroup.
        - Currently NTLM v2.
        - Starts initial hello between client and server, and then each side takes a challenge message (which is hashed), and challenge message each other.
        - Similar to a double CHAP.
    - Kerberos
        - Only used in authenticating to Windows domain controllers.
        - Domain controller is known as the Key Distribution Center (KDC).
            - Authentication service
            - Ticket granting service
            - Use TCP/UDP Port 88
            - Ticket Granting Ticket (TGT) shows that user is authenticated to the domain. Also knows as SID (Security Identifier) Not authorized at this point.
            - TGT generates a Session Key is what authorizes what resources the user can access. If the user wants to go anywhere else on the domain, a new session key is generation.
    - Security Assertion Markup Language (SAML) and Lightweight Directory Access Protocol (LDAP)
        - Neither one of these are authentication methods, but similar.
        - SAML is used exclusively for web applications.
        - LDAP is used to access someone else's directory. A structured language used to allow one computer to go into someone else's directory.
            - Main process to access file resources in Windows is based on LDAP.

        - TCP/UDP port 389.

- Single Sign-On (SSO)
    - LAN uses Windows Active Directory for SSO tools.
        - Once a domain is established, the client PCs join the domain.
        - Once this is established, a trust situation and federated system is established.
    - Security Assertion Markup Language (SAML)
        - Designed for web applications.
        - Allows a single person in a single place to log onto multiple devices.
        - Starts with having an Identity Provider (IP).
            - Once a user signs onto an Identify Provider, all of the connected applications are called Service Providers.
            - The IP provides a token to log onto all the individual devices (service providers).
    - What type of security needs will be necessary?
        - Example: A local area network for folders/files will need Windows AD.
        - Example: Any wide area networks/public items will need SAML.

- **Section 4: Tools of the Trade**
    - OS Utilities Part 1:
        - ping
            - Used often to checking DNS, such as pinging a FQDN to check if it replies. If it replies, it shows DNS is working.
            - Used to check if an IP address can be connected to.
            - -4 is a switch used to make the command only respond in IPv4.
            - Used to check hardware/network issues and intermittent connection with the switch -t for a persistent ping.
            - Linux does not need a -t as it always uses a persistent ping.
        - netstat
            - Used to check sessions a computer has open.
            - -n displays addresses and port numbers.
            - -a displays hosted server ports.
        - tracert
            - If the trace route fails on the first two hops (internal router and machine interface) that shows the issue is in-house.
            - Everything after the second hop is ISP-related.
        - ARP
            - Address Resolution Protocol. Used to resolve ethernet MAC address from an IP address.
            - arp -a command shows cached ARP table.
            - Windows generations static ARP entries.
            - Dynamic ARP entries change based off ARP commands that the host picks up.

    - OS Utilities Part 2:
        - ipconfig
            - Ipconfig /all displays all data for "Who am I?"
            - Typically best server used in a known network.
            - -all finds MAC address.
        - ip addr
            - Linux command. Not used in Windows.
            - Ifconfig is depreciated.
        - nslookup
            - DNS servers have learned to not respond to these queries since they are exploited so often.
            - nslookup www.google.com

            - Makes query "What server am I using for DNS?" and the IP address of that server.
            - Running nslookup in interactive mode and changing the DNS server to another can be used to troubleshoot issues.
        - digg
            - Used in Linux, not Windows.
            - Also checks DNS entries similar to nslookup.
            - @192.168.0.1 added will change DNS server to the IP address.
            - dig mx google.com will query MX record of the website.
        - netcat
            - Can open/listen on ports, and can open/act as a client on any port.
            - Tool for aggressive use.

    - Network Scanners
        - Can be used to detect open ports, protocols, hardware and rogue systems.
        - Resource intensive, and intrusion prevention systems will be alerted.
        - Nmap
            - Useful for hardware inventory and reconnaissance.
            - nmap -v -sn 192.168.0.0/24
                - Searched local network for IP addresses and what they correspond to.
            - Nmap -v -A scanme.nmap.org
                - Verbose output, -A symbolizes listing operating systems.
                - Discovers open ports.
            - Zenmap is a GUI that runs nmap. It comes with the nmap download.
        - Wireshark SB Network Inventory

- Protocol Analyzers
    - Used to analyze network traffic in/out of specific host computer.
    - Any protocol analyzer has two main sections:
        - Sniffer
            - Like pcap, tools that actually grab data going out of a particular interface.
        - Analyzer
            - Reads pcap data, and analyzes/formats it in a way we can read.
    - Wireshark
        - Free and powerful tool used to scan network traffic.
        - Filters data by services and protocols.
        - Displays tremendous amount of information.
            - Information can be filtered by categories.
        - Helps find Broadcast Storms
            - When a NIC breaks and begins broadcasting huge amount of data.
        - Can be used with different sniffers than what comes with it.
            - An often-used one is TCPDump, which runs only on Linux.

- SNMP
    - Simple Network Management Protocol
    - A tool which allows administration and management of network devices from a single source.
    - Ports UDP 161 (unencrypted) and TLS 10161 (encrypted) are the ports the agent of the device listens on.
    - An SNMP Manager is the system that manages the managed devices.
    - A Network Management Station (NMS) is an SNMP Manager with the proper SNMP management software on it.
        - An NMS uses ports UDP 162 and TLS 10162 for listening.

        - Management Information Base (MIB) is a factory built-in database within a device that can be queried for communication.
        - Types of communication/queries:
            - Get
                - NMS sents "get" to managed device, in which the managed device sends a response.
            - Trap
                - Set up on the managed devices themselves.
                - A "trap" is set once a value meets a threshold.
            - Walk
                - Batch process of "gets".
                - More commonly referred to as SNMPWalk.
        - SNMP has three versions.
            - Version 1:
                - First version with a limited command set, no supported encryption.
            - Version 2:
                - Uses basic encryption, slightly expanded command set.
            - Version 3:
                - Uses TLS encryption.
        - An SNMP community is an organization of managed devices.
        - Read Only (RO) vs. Read Write (RW) can be added on the command to turn on the SNMP service.
        - Cacti is an open-source NMS for graphing SNMP data.
            - Nagios, Zabbix, and Spiceworks are also NMS brands.

    - Logs
        - Event logs, security logs, device logs, audit logs.
        - Exist anywhere on a system, depending on the system.
        - Non-Network and Network Logs
            - Non-Network Events happen on a host even though it's not connected to a network.
            - Typically have a date or time, process/source, account, event number, description.
                - Operating System Events
                    - Starting, shutdown, updates, service events.
                - Application Events
                    - Application installation, stop/start/crash
                - Security Events
                    - Logons, success/failure.
            - Network Events deal with the communication between the host and network.
                - OS/system-level events
                    - Remote logons (fail/success)
                - Application-level events
                    - Activity on web server, firewall.
            - Decentralized Logging is where each host has its own set of logs.
            - Centralized Logging uses a central repository, which can cause a drag on the network.
                - SNMP systems are utilized here.
                - Third-parties Monitoring as a Service (MaaS) are sourced for this often.

    - **<u>Section 5: Securing Individual Systems</u>**
        - Denial of Service
            - Designed to deny service in some form.
            - Types of DoS Attacks:
                - Volume attack
                    - Ping floods
                    - UDP floods
                - Protocol attack
                    - SYN flood/TCP SYN attack

        - Client continues sending SYN repeatedly with client never responding with SYN/ACK.
    - Application attack
        - Slow Loris Attack
        - Client initiates conversation, and does not give a response. Client continues initiating conversations without a response.
    - Amplification Attack
        - Smurf attack
        - Attacker spoofs IP address, sending out an ICMP which causes all clients on the network to respond to a spoofed target.
- Distributed Denial-of-Service Attacks (DDoS)
    - Uses multiple systems to attack a host.
    - Typically a BotNet (malware) is deployed.
    - Client machines infected with malware (zombies) report to a single machine controlling them all.

- Host Threats
    - Spam
        - Unsolicited e-mail. Normally not considered a threat, but more of an irritant.
    - Phishing
        - Simply spam but trying to obtain information from you.
        - Spear phishing obtains personal information before contacting you for more, such as name.
    - Whaling
        - Phishing targeting a high-level employee.
    - Spim
        - To receive spam via instant messaging.
        - Again, more of an irritant.
    - Vishing
        - Unsolicited use of voice to obtain information.
    - Clickjacking
        - When a website tricks you into clicking somewhere you didn't intend.
        - Typically referred to authorizing something, such as a download.
    - Typo Squatting & Domain Hijacking
        - Typo Squatting takes advantage of people mistyping URLs.
            - People buy domains and websites hoping people make typos.
        - Domain Hijacking
            - When a domain expires and someone buys that domain quickly to put offensive or obscene content on it, then contacts you to buy it back from them.
    - Privilege Elevation
        - Not truly a threat, but listed as one on the test.

- Man-in-the-Middle
    - On any TCP/IP network, communication exists between two computers. A third party sneaking between this communication is a Man-in-the-Middle Attack.
    - Uses the information to the third party's advantage.
    - Wireless communications (802.11 WiFi, Bluetooth, NFC) are susceptible to Man-in-the-Middle attacks.
        - Encryption is needed within wireless.
    - Wired Man-in-the-Middle Attacks often require IP or MAC address spoofing to trick networks to sending the attacker its information.
    - MAC Spoofing = Port Stealing
    - ARP Poisoning = IP Spoofing
    - The number one reason for deploying a Man-in-the-Middle attack is to gather data.

- Replay Attack is best used for secure connections.
    - By obtaining the username and password hash, you can "replay" that information to the server to log in.
- Downgrade Attack is querying a web server for a lesser protocol version, and then exploiting that weaker protocol.
- Session Hijacking is getting in the middle and injecting information of a current open session between machines in real time.

- System Resiliency
    - Scalability
        - Adding more of a resource to service demand.
    - Elasticity
        - Going from a large amount of resources to a smaller amount as needed to fit demand that changes.
    - Redundancy
        - More than one of the exact same thing for failover purposes.
        - Doesn't define much more than having more than one.
    - Distributive Allocation
        - Having redundancy in terms of multiple locations - such as offsite backups, or servers in different locations.
    - Non-Persistence
        - Not persistent/permanent.
        - Snapshot - Take the current state of an item, on a binary level, and saving it as a backup/copy.
        - Known state - While a snapshot talks about an entire machine, a known state is referencing one aspect of a machine.
            - Windows Update is an example, where reverting to a type of system build (Windows 10.x.x) is used to fix the state of a machine.
            - Configuration files for networking devices is another example.
        - Rollback
            - Tends to zero in on a very small part of a system, such as Windows drivers.
        - Live-CD
            - Not limited to only a CD, also a thumb drive or any bootable media.
            - You can boot into an OS off of the media and "try" something on that instead of writing to a hard drive.

- RAID (Random Array of Independent Devices)
    - Primary way that we provide security to stored data.
    - Instead of using one hard drive, use multiple hard drives to work together as one hard drive.
    - Provides integrity and improves data access, or both.
    - Types of RAID:
        - RAID 0
            - Known as striping.
            - Designed to increase data speed, provides no data integrity.
            - Disperses data across multiple drives.
            - Minimum of two drives.
            - Downside to striping is that losing any drive means the data is lost.
        - RAID 1
            - Requires an even number of drives.
            - Known as mirroring.
            - Provides data integrity with no speed increase (actually slows things down)
        - RAID 2
            - Minimum of three drives.

            - Data is saved in sections on two drives and the third drive (dedicated parity drive) saves the parity equation to it.
            - RAID 2-4 uses two or more data drives that store individual pieces of data (stripes) and then a dedicated drive that only handles parity.
        - RAID 5
            - Minimum of three drives.
            - Parity is spread out across all drives.
            - Downside is that one drive can be lost, but more than one drive cannot be lost.
            - Was the most popular RAID configuration for a long time.
        - RAID 6
            - Minimum of four drives.
            - Two parities are created, therefore two drives could be lost without data loss.
        - Raid 0+1
            - Referred to as RAID 01, it is a mirror of stripes.
            - Two hard drives working as one mirror, two hard drives working as the other side of the mirror.
            - One data mirrored to both drives, striped on both drives.
            - Generating a mirror of stripes.
        - RAID 1+0
            - Referred to as RAID 10.
            - Data is striped and mirrored on each drive.
        - Proprietary RAID
            - A big issue with established RAID levels is waste.
                - RAID 5 for example requires same size drives for all drives, otherwise the bigger drives will have their sizes reduced to meet the smallest.
            - Companies such as Synology have proprietary RAID configurations.

- NAS and SAN
    - Network Attached Storage
        - File-based sharing protocol.
        - File-level.
            - RAID arrays, formatted and partitioned, treated as a network share like Samba.
        - Usually running some type of OS.
        - Runs over a standard network, using TCP/IP.
        - Uses well-known protocols, showing as shares on a network.
        - Used often in small workgroups.
    - Storage Area Networking
        - Relies on some kind of technology to transfer data between systems and storage.
        - Work on the block-level.
            - Considered "Block-level storage".
        - The best SANs use Fibre Channel
            - Fibre Channel (FC) is its own network to move data around.
            - Requires Host Bus Adapter (HBA) into computer.
            - Fibre Channel switch connects to Fibre Channel Controller on a SAN.
        - Poor man's version of SAN is called iSCSI
            - Uses existing network, interconnecting to different devices - showing as a physical hard drive (block-level)
            - Initiator and Target - terms used in an iSCSI network.
                - Initiator looks for targets and makes the target one of its hard drives.
            - Once a target is made, the Extent of that target has to be made.
                - Once the target and extent is put together into a group with a LUN ID, it is able to be accessed via iSCSI initiator.

- Physical Hardening

- Removable Media Controls
    - Not referring to USB. Refers to optical media.
    - CD/DVD
    - Local computer policies can dictate what users are able to do with their removable media.
        - Can be configured system-wide or user-based.
- Data Execution Prevention (DEP)
    - Used to be a problem where programs could be executed in memory that isn't supposed to be accessed.
    - Under System > Advanced System Settings > Performance in Windows, DEP can be turned on/off.
    - DEP should always be turned on.
- Disabling Ports
    - BIOS/UEFI can have specific ports turned off.
    - USBs can be turned off as a whole depending on the motherboard's BIOS/UEFI.
    - USB Mass Storage Driver Support can be turned off, which means devices such as keyboards/mouse will work but drives which transfer data will not.
    - Serial/Parallel ports can be turned off as well, among others.

- RFI, EMI, and ESD
    - Electromagnetic Interference
        - AKA Electromagnetic Pulse
        - When radiation of a device interferes with other devices as a whole.
    - Radio Frequency Interference
        - Radiation interfering with devices in the radio range, like wireless access ports.
    - Electrostatic Discharge
        - Based on electricity.
        - Staying at the same potential to avoid charges.
    - Ways to protect against the above:
        - Isolate - move devices away from each other.
        - Shield - shielded ethernet cable.
        - Separate circuits - keeping currents on different circuits.

- Host Hardening
    - Disabling Services
        - Going through process of disabling unnecessary services.
        - Some programs also do not have an interface or service running on them, but they act as a service.
            - For example, a machine running a web server or SSH server, do those need to be running?
            - This is technically not a service but essentially is.
    - Default Passwords
        - Typically Internet of Things (IoT) devices have default passwords turned on, which is the biggest issue with botnets.
    - Disabling Unnecessary Accounts
        - Domain Groups and Domain Users within those groups are unnecessary.
        - Having multiple groups or accounts with the same privileges/permissions instead of one bottleneck is an issue.
        - Too much group/user division can create attack surfaces.
    - Patch Management
        - Any modern OS has patches/updates.
            - This applies to any type of device. Switches, desktops, cameras, etc.
        - Patch Management Steps:
            - Monitor - Monitor new patches and their implications.

                - Small devices may not get reminders or automatic updates.
            - Test - Use a sandbox environment to test first before deploying.
            - Evaluate - Is this an important patch? Does this apply to us?
            - Deploy - Deploy the patch. Schedule the process in large environments.
            - Document - Take note of what patches have gone out/been skipped and their consequences.
    - Anti-Malware
        - Keep Anti-Malware as updated as possible.
        - Train users, as they are the number one line of defense.
        - Procedures should be in place once users encounter and recognize anti-malware.
        - Recognize and enforce good practices.
        - Monitor security logs, network flow diagrams, check DNS logs.
        - Intrusion Detection Systems (IDS) could be used as well.
    - Host Firewalls
        - Every computer in the network should have a host firewall.
        - Firewalls work on an application-level basis.
        - Enterprise environments should have white/blacklisted applications.
        - Centralized Management Tools should apply here in order to keep things tight and not allow users to alter any policy.

- Data and System Security
    - Data Security
        - Data integrity
        - Speed/quick access
        - High availability
            - Types of Data Security:
                - RAID
                    - Provides integrity
                    - Provides speed
                    - Affordable
                    - Only applies to drives/storage within a system.
                - Clustering
                    - Simply means having more than one computer doing the same job, sharing resources/data.
                    - If one system dies, the other kicks in and takes its spot.
                    - The downside is each computer has to keep the other one updated.
                    - Very expensive. One cluster machine typically does the work, while the others are backups.
                    - Load balancing can also take place with clustering.
                        - Workload distributed across clustered servers.
                - Virtualization
                    - If one server were to "die" or become corrupted, a snapshot can simply be spun up to remedy the issue.

- Disk Encryption
    - Encrypts data stored on mass storage.
    - Can slow systems down, such as a large file server.
    - Disk Encryption Usage
        - Mobile and portable devices.
            - Laptops, smartphones, tablets.
        - Desktop systems with limited security.
    - All encryption tools can be broken into two camps:
        - Trusted Platform Module (TPM)

        - A TPM chip that houses a public private key.
        - The private key cannot be removed from the TPM.
        - A hard drive encrypted with a TPM, for example, cannot be decrypted unless it is connected to the TPM chip.
    - Non-TMP Platforms
  - Activating TPMs often are done at the BIOS level.
  - PGP (Pretty Good Privacy) disk, TrueCrypt, BitLocker are all examples of encryption tools.
  - The recovery key must be recorded in some fashion, as the encrypted data cannot be viewed without it.

- Hardware/Firmware Security
  - Full Disk Encryption (FDE)
    - Best security for mass storage is to encrypt it.
    - Software or firmware-based tools are typically discussed here.
    - BitLocker takes advantage of TPM.
      - The TPM has to be turned on in order for BitLocker to run.
    - A recovery key must be documented in order to prevent data loss in the event of a motherboard dying.
  - Self-Encrypting Drive (SED)
    - A hard drive that has a TPM module built-in, which requires a password to be applied to the hard drive. Upon boot, the password must be entered to "unlock" the drive and boot.
  - Secure Boot
    - TPM 2.0 includes Secure Boot.
    - The OS will check the quality of all encompassing firmware and applications for signatures.
    - Secure Boot establishes the following:
      - Hardware Root of Trust
      - Secure Supply Chain
  - Hardware Security Module (HSM)
    - A HSM's only job is to calculate and check signage, store keys, etc. to make sure everything on a system is secure.

- Secure OS Types
  - What type of OS do I use in a particular situation?
  - Server OS: An OS version designed to support servers.
    - More hardware support, programs (DNS, DHCP, AD), support for server software, etc.
  - Workstation (Desktop) OS: Windows 10, Ubuntu, Mac OS.
    - Workhorse systems, good network functionality, good support for hardware, doesn't support full-blown RAID.
  - Embedded Systems: Routers, cameras, doorbells.
    - Individual devices that cannot be built-upon. No screen, keyboard, mouse.
    - Full-blown computers running operating systems.
    - Come with their own OS.
  - Kiosk: Some big screen (touch screen) with customized interfaces to display.
    - Slimmed-down versions of Linux.
    - A few dedicated Kiosk operating systems.
  - Mobile OS: Mainly iOS or Android.
    - Custom designed for smart devices such as phones and tablets.
    - Provides a good level of security compared to Windows 10.
  - Which OS has the least functionality but enough to do the job that it needs to do?
  - Any OS has a high degree of security, but some operating systems are set up for specifically security

        - Trusted Operating Systems, made by the Secure Computing Group, are operating systems certified (often for the government) to be at the highest level of current security.

- Securing Peripherals
    - Wired vs. wireless peripherals
        - Blue Jacking
            - Rare today
            - Definition: Connecting to Bluetooth device to use.
        - Bluesnarfing
            - Connecting to a Bluetooth device to steal data.
            - Grabbing and stealing data is bluesnarfing.
        - Bluetooth comes in three different classes.
            - Class 1: 328' connection distance.
            - Class 2: 33' connection distance.
                - Most phones, headsets are this class.
            - Class 3: 3" connection distance.
        - 802.11 feature WPS is used on some devices.
            - WPS is Wi-Fi Protected Setup
            - Press WPS button on device, press WPS button on router, and they will automatically connect.
            - WPS is insecure and a big problem.
        - Hidden Wi-Fi
            - Many devices have SD slots, and attackers will use Wi-Fi SD NICs to plug into these devices' SD card slots to take data.
        - Displays/Monitors
            - Relatively secure devices, with the exception of the USB ports on the device.
        - Think about what you are buying. Are these SD card slots or USB port necessary? Turn off unneeded ports. Don't forget peripherals need patches and updates too.

- Malware
    - Nothing more than malicious software running on your system.
    - Types of Malware:
        - Virus
            - Piece of software that is placed on your system and attach to other files, then propagate itself to other media and spread.
            - Activates execution, like removing files.
        - Adware
            - Programs that try to put ads up. Web-centric.
        - Spyware
            - Some form of malware hiding from you that reaches out to a central location.
        - Trojan Horse/RATs
            - Trojan is a piece of software that runs on a system that is compelling to have been downloaded, that is malicious.
            - Remote Access Trojans (RATs) aren't malicious until someone in a remote location turns it on.
        - Ransomware/Crypto-malware
            - Locks the system files/encrypts them in order to extort money.
        - Logic Bomb
            - Similar to a RAT.
            - Program sitting on a computer that has to be activated, but is triggered by an event.
        - Rootkit/Backdoor
            - A rootkit grabs admin privileges to propagate to other pieces of a system. Notorious to detect.

        - A backdoor is a piece of software that has an intention to be accessed again.
    - Polymorphic Malware
        - Malware that changes itself. Anti-Malware programs use digital signatures, and polymorphic viruses change their digital signature to avoid detection.
        - An armored virus is designed to make it hard for the anti-malware to recognize.
    - Keylogger
        - Records key strokes to capture data/information.

- Analyzing Output
    - Anti-Malware/Anti-Virus
        - Check logs for virus type and location on program.
        - Can compare on databases.
        - All software these days update definition databases automatically.
    - Host-Based Firewalls
        - Any firewall installed on an individual host.
        - Access Control List (ACL)/Rules List.
    - File Integrity
        - Can be system-based, application-based.
        - Checks file versions, dates, names.
    - Application Whitelist
        - Their job is to make sure everyone is running a standard program/version/application on individual enterprise systems.

- IDS and IPS
    - The firewall is the first line of defense.
    - Firewalls are imperfect, which is where Intrusion Detection Systems on the inside of the network come into play.
    - An IDS watches internal network traffic and sends alerts on suspicious activity.
    - An IDS can be software on a machine or a network appliance.
    - Once IDS became "active" where it began communication with the firewall to take action, is called Intrusion Prevention System (IPS).

- Automation Strategies
    - Automation makes repetitive tasks easier.
    - Automation is consistent.
    - Template restoration is a scenario in which automation is important. Applying the same base image to all machines in an enterprise.
    - Continuous monitoring is a scenario in which automation is important. SNMP, for example.
    - Windows Update is an example of automation.
    - Monitoring application whitelists - automating continuous monitoring on hosts for application whitelisting and installations.
    - Automated application development is used widely in a modern sense.
    - Built-in Tools vs. Shells
        - Most modern OS's have shells, like PowerShell.

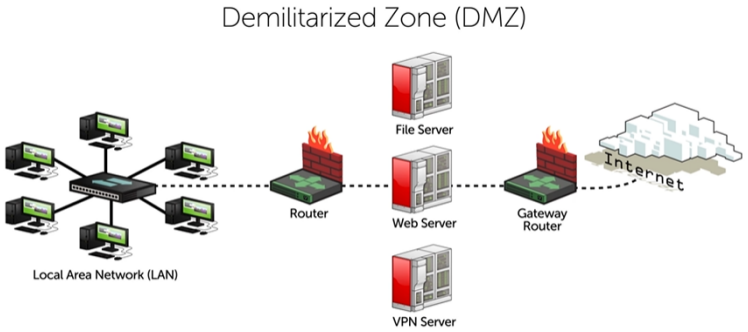
- Data Destruction
    - Media Sanitation is another term for Data Destruction - they are synonymous.
    - Three levels:
        - Clearing
            - Use some internal command within the mass storage device to erase data from the media.
            - Example: An erase command on the HDD.
        - Wiping

- Begins at the beginning of the drive to the end of the drive, writing random binary to remove all data.
- Purge
  - To do something to the device, externally, to make the data go away.
  - Crypto Erase
    - Destroying the keys for the encrypted drive, which in essence purges the drive because it's useless.
- Destroy
  - To ruin the media in such a way that it is no longer functional.
  - Paper media, tape media, floppy disks.
  - Burning, pulping (soak in water, grind it up), shredding, pulverizing.

- **Section 6: The Basic LAN**
  - LAN Review
    - Switches
      - Filter and forward data based on layer 2 (MAC addresses)
      - VLAN
        - Virtual LAN
        - Splitting single broadcast domain into multiple broadcast domains.
        - Layer 2 separation of networks.
      - Flood Guarding
        - Also known as Spanning Tree Protocol (STP).
        - Prevents floods or loops.
    - Router
      - Filter and forward based on layer 3 (IP addresses)
      - Gateway router (interface between internet and network) will always run NAT.
    - Firewall
      - Piece of software commonly run on a gateway router for security purposes.

  - Network Topologies Review
    - Local Area Network (LAN)
      - All computers on a broadcast domain.
      - A broadcast domain is when individual computers sends out a broadcast, all other computers that hear that broadcast are on a broadcast domain.
    - Wide Area Network (WAN)
      - Local Area Networks connected together with routers between them creates a Wide Area Network.
      - WANs can connect to one another.
    - Metropolitan Area Network (MAN)
      - Multiple WANs that span entire cities.
    - The protocol which runs the internet is TCP/IP.
    - Intranet is a private network which still runs on TCP/IP.
    - Extranet is a private connection into an intranet.

- Network Zone Review
  - DMZ (Demilitarized Zone)
    - Usage of two different routers in between the LAN and internet.



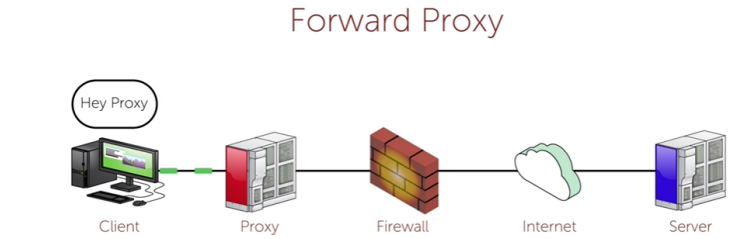
- Wireless Networks
  - A wireless connection is essentially the same as plugging in ethernet from a switch.
  - Guest Networks - Does not have LAN zone access. Separate VLAN.
- Virtualization
  - Using a virtualized network.
- Air Gap
  - Two LANs with a disconnect between them to provide real isolation to each LAN.

- Network Access Controls
  - Wireless access
  - Remote access
  - VPN access
  - These cases have some form of system acting as a gatekeeper to allow you to become a part of the target network.
  - This started with Point-to-Point Protocol (PPP) which was designed for dial-up networks.
    - Designed primarily to take a computer with a phone line to connect to a service provider.
    - Transport layer protocol
      - Initiates connection
      - Obtain address information
      - Make connection
    - Had very rudimentary authentication methods
      - Password Authentication Protocol (PAP)
        - Passwords in clear text
      - Challenge Handshake Authentication Protocol (CHAP)
        - Comparing hashes after a target creates a challenge.
    - Extensible Authentication Protocol (EAP)
      - More of a framework designed to run inside transport layer protocols, handling strictly authentication.
      - Was developed initially as an extension for just the authentication portion of PPP.
  - EAP Methods:
    - EAP-MD5
      - Basically MSCHAP. Takes passwords and hashes them into an MD5 hash.
    - EAP-PSK
      - Uses pre-determined symmetric keys.
      - Similar to WPA/WPA-2
    - EAP-TLS
      - EAP handles full blown TLS.
      - Needs a server and client certificate.
    - EAP-TTLS
      - Uses TLS exchange method.
      - Only requires server certificate.
  - 802.1X is a full blown authentication standard that allows connections between client system (supplicant) and the network itself.

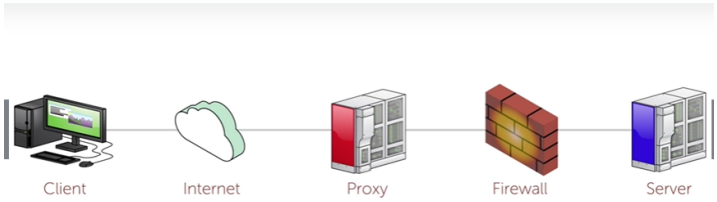
        - Also known as EAP over Ethernet or EAP 802.11.
        - Creates some form of connection between supplicant and the authenticator, then runs EAP within that for the authentication itself.
        - RADIUS lives on 802.1X.
    - LEAP was invented by Cisco before 802.11i standards. Cisco's high security wireless standard.
        - EAP with a password within a TLS tunnel. Not used anymore.
        - Supplanted by EAP-FAST.
    - PEAP was Microsoft's standard of EAP before EAP. EAP communication within a TLS tunnel. Not used anymore.

- The Network Firewall
    - Stateful vs. Stateless
        - A stateless firewall will filter and block stuff no matter the situation. Setting a rule to block a port or IP or any content, with no other context, is a stateless firewall setting. Stored into an ACL.
        - A stateful firewall doesn't have an access control list - it looks at what is going on and then makes a decision on what to do. For an example, a stateful firewall that seems a ping flood coming in would then decide to block pings.

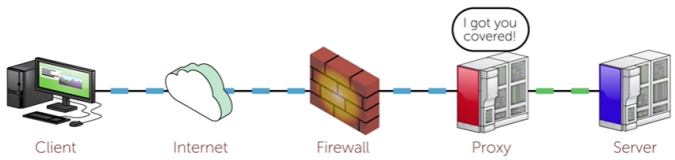
- Proxy Servers
    - Proxies are often application specific, such as a Web Proxy, and FTP Proxy.
    - A transparent proxy has to be in-line to go out to the internet.
    - Two kinds of Proxy Servers:
        - Forward Proxy Server: Hides the clients.



            -
            - Dedicated boxes within a network.
            - Provides caching, content filtering, acts as a firewall.
            - A nefarious forward proxy:



                -
                - It is easy to figure out who is using this proxy due to the internet connecting to the proxy.
                    - An encrypted tunnel (VPN) from the client to the internet to the proxy will fix this concern.
        - Reverse Proxy Server: Hides the servers.



        -
        - High security, handles DoS attacks, can provide load-balancing, caching, handles encryption acceleration (like HTTPS encryption/decryption).
- Honeypots
    - Nothing more than devices that are designed to emulate a host/network to allow you to let the bad guys in and then track what they're doing.
    - The idea of a honeypot is the emulate services that you'd find on a typical server.
    - Need to sit out on the public internet. Often, people put honeypots within a DMZ.
    - A sophisticated honeypot logs every single keystroke.
    - A network can be emulated by using a honeynet.
        - Honeynets are used often in a virtualized environment.

- Virtual Private Networks (VPN)
    - Connection Options for VPN:
        - Leased line (T3 line, very expensive)
        - Leveraging the internet itself (VPN)
    - A VPN Tunnel is a connection between two VPN endpoints (client and firewall/server)
    - Remote Access VPN - one computer connecting to a LAN.
    - Site-to-site VPN - Two LANs connecting together.
    - A VPN is slow compared to being within a LAN.
    - Split vs. Full Tunnel
        - A full tunnel is where all requests travel through the VPN.
        - A split tunnel is where traffic going to the LAN goes through the VPN tunnel, but any other traffic routes normally through the network card.
    - VPN Setup Steps:
        - Protocol to set up tunnel.
        - Protocol to handle authentication and encryption.
    - VPN Protocols:
        - Point-to-Point Tunneling Protocol (PPTP)
            - Oldest
            - Uses PPP for tunnel
            - Password only.
            - TCP Port 1723.
        - Layer 2 Tunneling Protocol (L2TP)
            - Cisco proprietary
            - Similar to PPTP
            - L2TP tunnel
            - IPsec Encryption (Fast)
            - UDP ports 500, 4500.
        - IPsec VPN
            - Uses IPsec for tunnel and encryption
            - UDP ports 500, 4500.
            - Great for IPv6.
        - SSL/TLS
            - TCP Port 443
            - Works within web browser, clientless.

            - TUN/TAP (Virtual Network Driver) Tunnel
            - TLS encryption
        - OpenVPN
            - Program with its own unique tunnel.
            - Encryption based on SSL/TLS.
            - TCP 1194, can be changed easily.

- IPsec
    - Type of IP security that works on a host-to-host basis.
    - A bunch of protocols that work together that come up with an idea of two hosts having a secure connection.
    - Two different modes:
        - Authentication Headers
            - Only provides integrity
            - Runs integrity check, inserts Authentication Header before TCP -> Data -> IP Address.
            - This is an HMAC.
        - Encapsulating Security Payload (ESP)
            - Goes through process of encrypting TCP -> Data -> IP Address.
            - Uses AES, 3DES, etc.
    - When referencing keeping the original IP address, we are referencing Transport Mode.
        - Transport Mode in the real world doesn't work well.
    - Instead, we use Tunnel Mode.
        - Get rid of IP header, add new IP address to the data. (AH)
        - The original IP header is encrypted, then a new IP address is added to the outside of the data. (ESP)
    - In IPsec, we use ISAKMP. Internet Security Agreement Key Management Protocol.
        - Its only job is to create a Security Agreement (SA) between two hosts.
        - Two hosts use a negotiation protocol, ISAKMP, to begin talking.
            - Provides Initial Authentication
                - Certificates
                - Key Exchange
                - Preshared keys
    - IPsec examples:
        - VPNs
            - Pure IPSec
            - IPsec with L2TP
        - RADIUS/TACACS+
            - No native encryption, so IPsec is used to create a VPN tunnel between hosts.
        - IPsec with IPv6
            - IPsec header information can be placed within an IPv6 header.
            - Not used often.
        - Using IPsec with non-secure protocols
            - Could be used, theoretically, with an insecure connection like telnet. It can be used to encrypt the telnet data.
- NIDS/NIPS
    - Network Intrusion Detection System
        - Passive
        - Often setup as "Out-of-band" which means out of the main LAN.
    - Network Intrusion Prevention System
        - Often setup as "In-Band", which means all network traffic goes through the device to the internet.
        - Active/inline
            - Block ports/username/IP addresses from router.
        - Detection methods

        - Behavioral/anomaly based
        - Signature based
        - Rule-based
        - Heuristic (signature files, behavior/anomaly, learns over time.)
    - How to set this up?
        - Sensors, like a Network Tap. Has In/Out port, which checks every single packet In/Out.
        - Port mirroring, where a switch can be configured to grab data from particular ports/VLANs.
        - Collectors, which are computers that take data from sensors and storing it into a single database.
        - Correlation Engines, which is a tool that does the behavioral anomalies, rule checks, signature checks, heuristic checks.

- SIEM
    - Security Information and Event Management (SIEM)
        - Aggregation - Grabbing data from different places and storing it.
            - Time synchronization, event deduplication, normalization, logs.
        - Correlation - Analyzing and reporting the data that is collected.
            - Alerting/triggering.
    - Write Once, Read Many (WORM)
        - WORM drives are dated.
        - Not used, most logs are stored on HDDs.
    - Popular SIEM software:
        - Splunk
        - ArcSight
        - ELK (Elastic Search, Log Stash, Kibana) Open-source/freeware.

- **<u>Section 7: Beyond the Basic LAN</u>**
    - Wireless Review
        - 802.11 Infrastructure Mode
            - Begins and ends with WAP.
            - WAP is a bridge between an 802.11 network and an Ethernet network.
            - Every WAP has a MAC address.
                - Configured with a Service Set Identifier (SSID)
                - SSID is broadcast out, and we associate the MAC address of the WAP with the SSID to create a Basic Service Set Identifier (BSSID).
                - Client sends request to WAP to join SSID, and once it is accepted the client becomes a part of the Associated List.
                - If multiple WAPs are connected to the same common Ethernet broadcast domain, they become known as an Extended Service Set Identifier (ESSID)
        - Wireless Equivalent Policy (WEP) provides basic authentication and encryption.
            - Uses RC4 streaming protocol, using an initialization vector like all streaming protocols.
            - Shared key concept (64-bit or 128-bit)
            - WEP has initialization vector issues and can be easily hacked to obtain the key.
        - Wireless Protected Access (WPA)
            - The draft 802.11i standard, not full. Predated WPA2.
            - Dumped concept of RC4 and replaces it with AES encryption.
            - WEP was replaced with Temporal Key Integrity Protocol (TKIP)
                - Still uses RC4 but fixes the Initialization Vector issue.
        - 802.11i became known as WPA2, once the industry caught up.

    - Living in Open Networks
        - Cookies, like session cookies, with authentication information within it can be exploited.

        - Even though the HTTPS website will secure data, the cookie itself causes a security vulnerability.
        - The cookies itself are not sent over a secure connection.
        - Replay attacks (SSL stripping) can be used when cookies are sniffed.
    - How do we protect our assets?
        - Use secure protocols on unsecure networks.
        - Use HTTPS on websites that collect information.
            - HTTP Strict Transport Security (HSTS) requires users to constantly use HTTPs.
        - Use VPN in non-secure networks.

- Vulnerabilities with Wireless Access Points
    - A Rogue AP is nothing more than an unauthorized access point.
    - An Evil Twin is a Rogue AP with the same intentional SSID the same of a private.
    - 802.11 jammers are illegal in the US. They can create denial of service attacks, or jam wireless channels that makes clients jump to the Evil Twin. This is now a Man in the Middle attack.
    - In the absence of an 802.11 jammer, someone can use a De-Authentication Attack.
        - Running a program to show all clients on a particular SSID, and then sending deauth commands to kick everyone off the network. Then, have all clients connect to the Evil Twin.

- Cracking 802.11 - WEP
    - WEP is the oldest 802.11 standard.
    - The initialization vector generation is susceptible to IV attacks within WEP.
    - Aircrack can be used to crack WEP keys.
    - Kali Linux listening on WLAN NIC using Airodump, selecting the target SSID, listening on that SSID and then using the dumpfile to crack the key for it.
    - Can mathematically be cracked by looking at packets.

- Cracking 802.11 - WPA
    - WPA is using RC4 but TKIP with it. WPA2 is using AES with CCMP.
    - The initial connection between a device and WAP using WPA/WPA2 uses a 4-way handshake.
        - This is the most vulnerable aspect of WPA/WPA2.
    - WPA/WPA2 crackers require a dictionary file in order to be cracked.
    - Once the handshakes are captured and put into a dumpfile while being monitored, the network can attempted to be cracked using a dictionary file.
    - Use long, complex private shared keys when using WPA/WPA2.

- Cracking 802.11 - WPS
    - WiFi Protected Setup (WPS) which is push-button configuration.
    - WPS Weaknesses:
        - 8 digit key for WPS is actually 7
            - 2 to the 7th power.
            - One of the eight digits is just redundancy check for the other seven.
        - Key exchange is first processed in 4-bits then 3-bits.
        - That means only 11,000 iterations are needed to crack it.
        - WPS capable access points can detect an attack and shut down or turn off WPS.
    - Prevention:
        - Get rid of older routers.
        - Firmware updates.
        - Consider a modern wireless router.

- Wireless Hardening
    - Survey/Installation Issues
        - Survey tools

            - Site survey programs find SSIDs, MAC addresses, bands/channels/signals.
            - Documents all of the above information.
            - Often has a heatmap, which shows the signal strength of all access points within an environment.
    - Maintaining existing wireless networks/Monitoring wireless networks
        - Good wireless documentation.
            - Take advantage of survey tools and continue to keep it documented.
        - AP isolation enabling
            - All wireless devices on that SSID can see the access point and get to the network, but they cannot see each other.
        - Implement 802.1X for encryption and crackability.
        - Scan the network. A wireless intrusion detection system will accomplish this constantly.
            - A WIDS can be software or physical systems.
            - Monitors wireless radios.
            - Watches for rogue access points.
            - Knows MAC addresses of authorized equipment
            - Watches working protocols
    - Defend wireless clients
        - Hardening wireless clients include training users to detect rogue access points/evil twins by simply looking at SSID lists.

- Wireless Access Points
    - Thick (Fat) client - Standalone wireless access point.
        - Device that has to be configured by itself.
    - Thin client - Centrally managed and configured. Controller-based.
    - Many wireless access points have the ability to have an external antenna plugged into it.
        - Antennas have their strength measured in Decibels, or DBI.
    - Antenna Types:
        - Omni/Omni-Directional
            - Signal goes every direction.
        - Dipole
            - Meant to be used on a single level or floor.
            - Has little adjustments.
            - Extremely common.
        - Directionals
            - Long beam signal.
            - Yagi - Designed to pick up and send a pointed signal.
            - Parabolics - Radar dishes, more powerful than a Yagi.
        - Patch
            - Half of an omni.
            - Half of a sphere. Sends signal in one direction 180 degrees, none behind it.
    - Antenna Placement:
        - Big basketball stadium, use an Omni.
        - Outdoors, use a Dipole.
        - Against wall, use a Patch.
        - Long distances between buildings, use a Directional.
    - Band Selections:
        - 2.4GHz or 5GHz bands.
        - How to choose? Determine the following: Technology used, speed wanted, and how crowded the area is.
        - With a 5GHz band, channel width is an issue.
            - Generally, the wider the channel, the better the throughput.
            - The channel width being wider makes it harder to hop channels as the options become limited.

        - Automated channel selection is common.

- Virtualization Basics
    - Virtualization simply means to virtualize everything about a computer into a virtual system.
    - The idea behind virtualization:
        - Host system with real hardware, virtualizing it.
        - A virtual computer takes advantage of the real hardware by using it.
    - Emulation uses software to imitate hardware.
    - Virtualization provides power saving, space saving (multiple virtual servers on one physical device), better system recovery, better duplication, research.
    - Hypervisor - Virtual Machine Monitor (VMM)
        - Hypervisor, type 2 - Runs on top of Host OS.
        - Hypervisor, type 1 - Runs directly on top of hardware, independent of host OS.

- Virtual Security
    - Virtualization by itself is a security feature.
        - Patch management
        - Centralized hardware maintenance
        - Resilient and high availability
        - Great testing and sandboxing environment
        - Network separation
            - Virtual switching allows this to happen.
            - VLANs
        - Snapshots and backups
    - Virtual threats
        - Anything that can happen to a physical machine, can happen to a virtual machine.
        - Malware
        - Bad patch management
        - Policy management
    - Cloud-based infrastructure providers will provide their own security-as-a-service (SaaS)
    - VM sprawl is where, within one network, multiple types of hypervisors and VMs are deployed with multiple means.
    - VM escape is where a hacker is able to "get out" of the VM itself and cause damage to the hypervisor.
    - Virtualization Hardening
        - Remove remnant data
        - Make good policies
        - Define user privileges
            - Within the hypervisor itself, who can create/edit/delete VMs?
        - Patch everything
        - Cloud Access Security Brokers (CASB)
            - A CASB acts as an intermediary between your infrastructure and the cloud.
            - Typically a cloud-based service.
            - Makes sure policies are controlled, watches for malware.

- Containers
    - A container is an application and all of its libraries and binaries running on top of a kernel.
    - A container runs isolated instances of programs and services.
    - Containers are self-contained applications that can communicate with network resources that have been explicitly allowed.
    - Whatever is inside a container can only see what is inside its container. No access to any underlying operating system's files or folders, cannot see any networking information, etc.

        - The container stays isolated, therefore there is less attack surface. If a container is compromised, they would not have access to anything else but what is inside the container.

- IaaS
    - Infrastructure-as-a-Service
        - An entity sets up a virtual infrastructure to sell to an administrator.
        - Physical equipment hosted by another company.
        - Examples:
            - Microsoft Azure
            - Amazon Web Services
        - Ability to create an infrastructure of an entire network, server setup, public IP address, firewall/security policies, etc. all at the click of a button.

- PaaS
    - Platform-as-a-Service
        - Usually has some IaaS aspect within it.
        - Typically meant for developers to create and deploy applications.
        - Examples:
            - Heroku
            - Google App Engine
            - OpenShift
        - Program/code that is written will be uploaded within the PaaS, check the code, bring libraries, etc. and then create a URL to be deployed.

- SaaS
    - Software-as-a-Service
        - Predates virtualization.
        - A subscription-based license.
        - Gets rid of optical media
        - Examples:
            - Microsoft 365/Office 365
            - Google Apps
            - DocuSign

- Deployment Models
    - Referencing deploying applications once created.
    - Examples:
        - On-Premise Deployment
            - Using physical servers in an environment to continue to scale with the application's scale.
        - Hosted Application
            - Using resources from another company to host the application.
            - This turned into cloud-based hosting, through virtualization.
    - Types of Clouds:
        - Private Cloud
            - Virtual machines built within an organization, for that organization. It is private.
        - Public Cloud
            - Open-for-business virtual machines, like Microsoft Azure or Amazon AWS.
        - Hybrid Cloud
            - Partially segregated as private, with some as public to be resold.
        - Community Cloud
            - Differing organizations putting in money to build one cloud shared amongst those organizations.
    - Virtual Desktop Environment (VDE)

        - Local client that is controlling a remote system.
        - RDP within Windows, for example, is a type of VDE.
        - The local client essentially becomes a terminal to send commands to the target machine.
    - Virtual Desktop Integration (VDI)
        - Complete operating systems that are deployed in a cloud environment to be accessed by a terminal client.
        - Accessing a virtualized environment within the cloud.

- Static Hosts
    - Refers to devices that have embedded OS and some type of network awareness, from a Google Home to a Nest Thermostat, to a game controller, etc.
    - A static host is typically referred to as a device designed for a specific (single) purpose.
    - Also referred to as an Internet-of-Things (IoT) device.
    - Industrial Control Systems (ICS) is a general term that encompasses control systems for process control, like an HVAC unit that has a specialized single-purpose.
    - Supervisory Control and Data Acquisition Systems (SCADA) are just like ICS but typically have a cellular WAN connection and have autonomy to accomplish their tasks.
    - Securing Static Hosts
        - Change default passwords
        - Turn off unnecessary services
        - Monitor security and firmware updates
        - Defense-in-depth, or creating layers of protection around that device.
        - Network segmentation
        - Treat a static host like any regular host.

- Mobile Connectivity
    - SATCOM
        - Satellite Communication
    - Bluetooth
    - Near-field Communication (NFC)
        - Very short range wireless connectivity, similar to Bluetooth.
        - Physical contact/near-physical contact needed.
        - When it's turned on, no security.
    - ANT/ANT+
        - Simple form of wireless communication.
        - Slow, but well-protected.
    - Infrared
        - Often times, Android phones have Infrared transmitters. Not receivers
    - USB
        - USB On-The-Go (OTG) is a two-way USB type that can be ingoing or outgoing, which isn't part of the USB standard itself.
        - This is a security vulnerability.
    - Wi-Fi Direct/Tethering
        - 802.11 Ad Hoc mode - Rare connection type, where two devices (such as smartphones) connecting to one another.
            - Wi-Fi Direct is used on many streaming devices today, such as Roku. It uses WPS, which is a security vulnerability.
        - Tethering - Linking a computer to a smartphone or vice versa in a wired connection, to leverage the resources of either or.
        - Wireless Tethering - A mobile hotspot, that needs to be secure.

- Deploying Mobile Devices
    - Mobile Device Management Tools - A central management device for mobile devices linked to that software.

        - Mobile Application Management - Containerized management scoped to only the applications on the mobile device.
        - Corporate vs. Personal Use
            - Corporate Owned, Business Only (COBO)
                - Company Owned
                - Company decides what to do, such as:
                    - Encryption
                    - Applications
                    - Wireless types
            - Corporate Owned, Personally Enabled (COPE)
                - Everyone has the same device.
                - Devices are controlled by company
                - People will still want to use their own devices
                - Learning curve
            - Choose Your Own Device (CYOD)
                - Users select from approved devices
                - Less of a learning curve
            - Bring Your Own Device (BYOD)
                - Users choose based on their experiences.
                - Learning curve decreased
                - Heavy device/application management

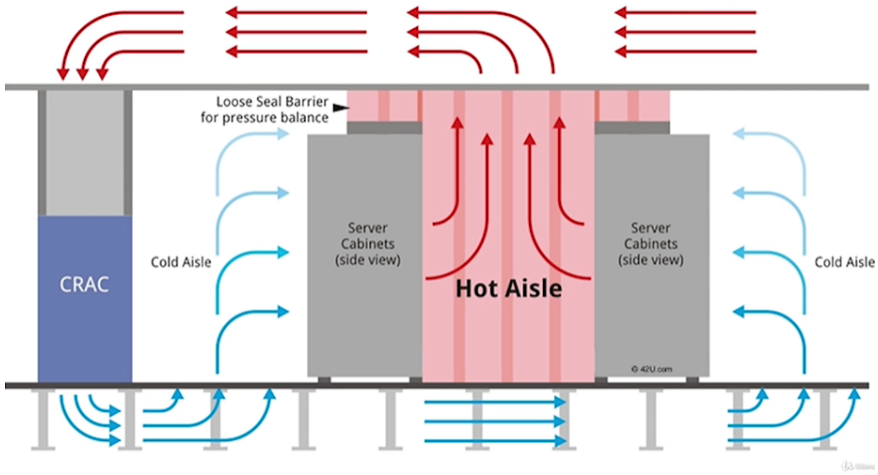
- Mobile Enforcement
    - Sideloading
        - Process of getting around an application store (Google Play, Apple Store) to upload product to consumers.
        - Often times, developers use this to test products.
        - Extremely difficult to do on Apple platform, easy on Android.
            - Android devices can have this limited through mobile management.
    - Carrier Unlocking
        - In the US, companies are required by law to allow phones to be unlocked.
        - Small security issue is really only when the device is being managed, and the user unlocks that phone from the carrier.
    - Rooting/Jailbreaking
        - You do not have root access when you purchase a phone.
            - This makes it harder for users to reformat firmware, install malware, or abuse the system.
            - The manufacturer retains root access.
        - Issues with rooting:
            - Auto updates are disabled.
            - Trouble access the store, such as Google Play.
            - Exposure to malware
    - "Big Brother" monitor points when managing mobile devices:
        - Firmware OTA updates
        - Camera Use
        - SMS/MMS (Texting)
        - External media
        - Microphone/GPS tagging
        - Payment methods

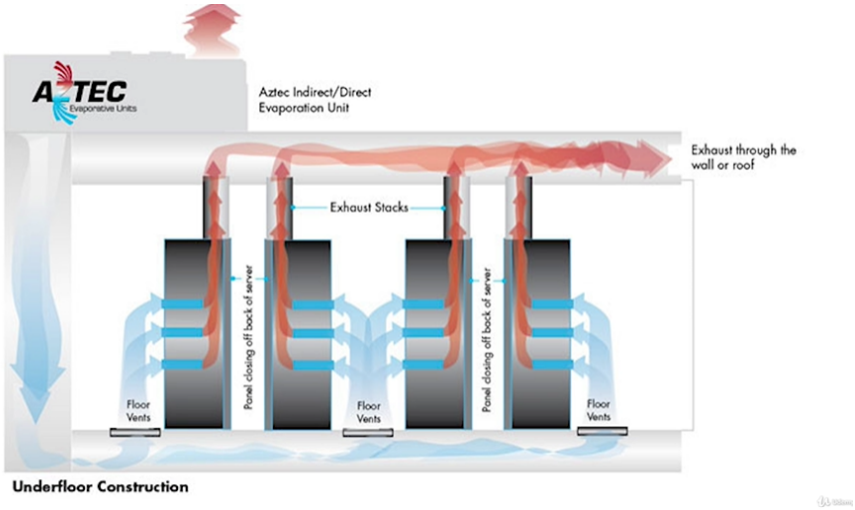
- Mobile Device Management
    - Content Management
        - Applications management
        - Databases

        - Documents
        - Geolocation
        - Geofencing
            - Geolocation with a geographic trigger to take action
        - Push notification services
            - Applications will push notifications if you want
        - Passwords/PINs
            - Set requirement of use.
            - Can recover passwords.
        - Biometrics
            - Fingerprints
            - Facial recognition
            - Vocal recognition
            - Can be used to configure applications, lock/unlock devices
        - Screen locks
        - Remote wipe
    - Application Management (MAM)
        - Versioning
        - Updates
        - Patches
        - Specific to application
        - Context-aware authentication
            - Where is the user?
            - What time of day are they trying to authenticate?
            - What OS is being used?
        - Storage Segmentation
            - Dedicated a storage space of the mobile device for our applications
        - Full device encryption
            - Encrypting entire storage of the device.
        - Containerization
            - One container for an application or group of applications to keep them separate

- Physical Controls
    - Deterrent Physical Controls
        - Designed to prevent malicious access to physical infrastructure.
        - Outside lighting
        - Signage
        - Security guards
    - Preventative Controls
        - Fences
        - Barricades
            - K-Ratings - Super strong fences meant to stop vehicles.
            - K4 - 30mph
            - K8 - 40mph
            - K12 - 50mph
        - Mantrap
            - Entry system that consists of two-doors.
        - Airgap
            - Separating important cabling infrastructure from everything else.
        - Safe
        - Locked cabinets/enclosures
        - Faraday Cages
            - Meant to block EMI/radio frequency to protect sensitive electronic equipment.
        - Locks/Key Management

        - Cable locks
        - Screen filters
    - Detective Tools
        - Detects malicious intent being carried out.
        - Alarms
        - Cameras
        - Infrared detectors
        - Log files
    - Compensating and Corrective Controls
        - Example: Extra security guards in the middle of a breach.
        - Not as detailed or important for physical controls.

- HVAC
    - The cooler a piece of electronic is, the better it runs.
    - Infrared Cameras (Thermal Imagers) are important within HVAC systems, to detect hot zones and leaks.
    - Zone-based HVAC is used in office environments in which specific areas have their own thermostat.
    - Hot and Cold Aisles
        - 

    - Contained System
        - 

    - Securing HVAC
        - Leave an air gap - keep the HVAC system separated from the network.
            - Use VLAN for isolation, if an air gap cannot be used.
                - MAC filtering can be used here.
        - Remote monitoring - This can be a security concern. Work with vendors/suppliers for SLA, to make sure VPNs are being used.

- Fire Suppression

        - Fire Extinguisher Classes
            - Class A: Designed for ordinary solid combustibles, like wood.
            - Class B: Designed for flammable liquids and gases.
            - Class C: Designed for energized electrical equipment.
            - Class D: Designed for combustible metals.
            - Class K: Designed for oils and fats.
        - Do not use water to put out an electrical fire.
        - FM-200 is the golden standard today for server room fire suppression.
        - Seal off the server room.

- **Section 8: Secure Protocols**
    - Secure Applications and Protocols
        - SSH Protocol
            - Secure Shell. Port 22.
            - Always has the server pass the key for a key exchange for encryption.
            - SSH applications have built-in encryption.
        - HTTP protocol
            - The webpage itself is not encrypted.
            - TLS acts as an intermediary between the web page and web browser to perform the encryption.
            - TLS was invented for websites, but can work with multiple other applications.
        - Anything on the internet will either be an application with encryption built-in, or taking advantage of protocols.

    - Network Models
        - OSI Seven-Layer Model
            - 7 - Application
            - 6 - Presentation
            - 5 - Session
            - 4 - Transport
            - 3 - Network
            - 2 - Data Link
            - 1 - Physical
        - TCP/IP Model
            - 4 - Application
            - 3 - Transport
            - 2 - Internet
            - 1 - Network Interface

    - Know Your Protocols - TCP/IP
        - IP addressing
            - IPv4
                - Four octets separated by three dots, each octet is a binary value of 8. This makes a 32-bit address.
                - Private vs. Public IP addressing
                    - An ISP will assign a public IP address for internet access for a network, and all the devices within the internal network will have private IP addresses.
                    - A private LAN will have a router separated from the internet using Network Address Translation (NAT).
                    - Private Ranges:
                        - 10.0.0.0 - 10.255.255.255
                        - 172.16.0.0 - 173.31.255.255
                        - 192.168.0.0 - 192.168.255.255

        - IPv6
            - Up to 128-bits.
            - A device will have two IPv6 addresses:
                - Link Local - FE80
                    - Generated automatically by individual hosts.
                - Internet address
    - Transport Protocols:
        - TCP
            - Does most of the work on the internet.
            - Connection-oriented protocol
            - A client sends a "Hello" to the server, the server will "ACK", and then the client sends its data.
            - This is a three-way-handshake.
        - UDP
            - Connectionless
            - No acknowledgment
            - Sends lots of packets
            - Used with a high degree of confidence that the target is listening.
        - ICMP
            - Main job is to handle ARP, Pings, and small things.
            - One packet.

- Know Your Protocols - Applications
    - Hypertext Transfer Protocol (HTTP)
        - Port 80
    - Secure Hypertext Transfer Protocol (HTTPS)
        - Port 443
    - Telnet
        - Port 23
    - Secure Shell (SSH)
        - Port 22
    - File Transfer Protocol (FTP)
        - Port 20 and 21
    - FTP/SSH
        - Port 22
    - FTPS
        - FTP with SSL/TLS security.
        - Port 20 and 21
    - Secure File Transfer Protocol (SFTP)
        - Port 22
    - Secure Copy (SCP)
        - Port 22
    - Trivial File Transfer Protocol (TFTP)
        - Port 69
    - NETBIOs
        - Port 137, 138, 139
    - Server Message Block (SMB)
        - Port 445
    - Simple Mail Transfer Protocol (SMTP)
        - Port 25
    - IMAP
        - Port 143
    - POP
        - Port 110

        - Domain Name System (DNS)
            - Port 53
        - DHCP
            - UDP Port 67/68
        - Simple Network Management Protocol (SNMP)
            - Port 161/162
        - LDAP
            - Port 389
        - Remote Desktop Protocol (RDP)
            - Port 3389

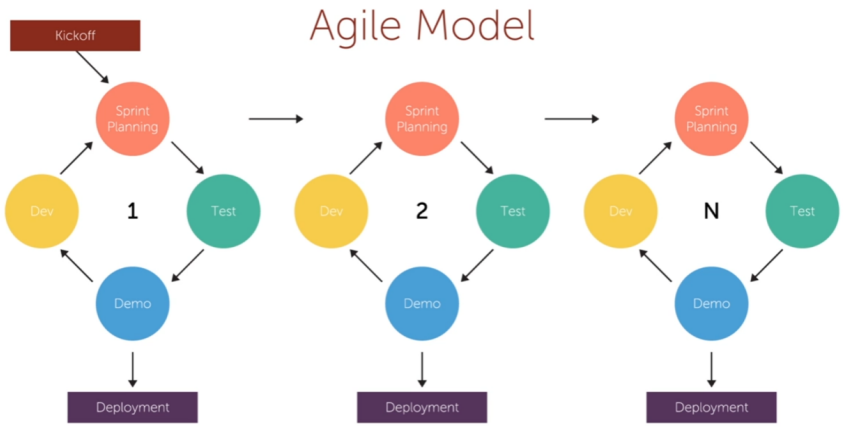
- Transport Layer Security (TLS)
    - Originally invented for websites, but it is used all over the internet.
    - Secure Sockets Layer (SSL)
        - Series of security protocols
        - Been around for a long time
        - Usurped by TLS
    - TLS is newer than SSL, but accomplishes the same things.
        - TLS is more secure than SSL.
- Secure Connection (SSL/TLS key points):
    - Encryption
        - A symmetric encryption, which is faster than asymmetric.
    - Key exchange
    - Authentication (SSL/TLS uses RSA certificates)
    - HMAC (Hashing)

- Internet Service Hardening
    - Using secure protocols are always preferable to insecure protocols.
    - DNS (Domain Name Services)
        - Runs on port 53.
        - Nonsecure protocol.
    - DNSSEC
        - In the 90s, DNSSEC was forwarded as a tool to make DNS servers have some form of security/authentication.
        - DNS server generates a key pair and the upstream DNS server signs them, creating new DNS records for each zone.
        - One key is a Public Signing Key.
        - Not an encryption, it is purely an authentication tool.
        - Popular for public DNS servers, like Google's 8.8.8.8.
    - Email
        - SMTP/POP/IMAP have always been insecure, but secure versions of them all have become more secure.
        - SMTP
            - Secure SMTP creates a TLS connection between the client and server, so the data is sent with authentication and encryption.
            - SMTP uses 25. Secure SMTP does 465 or 587.
        - IMAP/POP
            - Now, StartTLS is used. It is an extension to IMAP/POP.
            - An encrypted TLS tunnel is created.
            - IMAP uses port 143, SSL/TLS IMAP uses 993.
            - POP uses 110, but SSL/TLS POP uses 995.

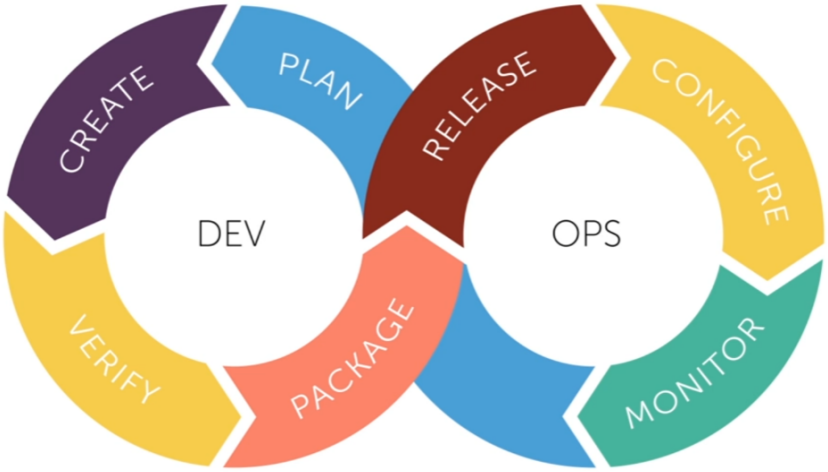
- Protecting your servers
    - SSL Accelerator

        - If a lot of asymmetric encryption is used, SSL/TLS will be used a lot. This is a burden for CPUs.
        - A special card can be installed into each server, and their only job is to encrypt/decrypt asymmetric encryption on the fly.
            - Or, a special SSL Accelerator device can be installed behind the router facing the servers that serves the same purpose.
            - This is better for environments with large amounts of servers.
    - Load Balancer
        - Actually like a proxy, as it takes all incoming requests from the router and sends them to the servers.
            - This can be determined by workload, DNS names, IP, etc.
    - DDoS Mitigator
        - A device placed between the router and servers.
        - Detects when DDoS attacks come through.
        - Reaches out to a third party like CloudFlare upon detection, which then those CloudFlare servers on the internet acts as a proxy to filter out the bad data.

- Secure Code Development
    - Waterfall Model (Old fashioned and rigid model)
        - Requirements
        - Design
        - Implementation
        - Verification
        - Maintenance
    - Agile Model (New and common model today)



        -
        - Toolsets within the Agile Philosophy
            - Sprint: A short time period of deadline where whatever can be achieved, is.
            - Scrum: A short meeting about work done, roadblocks, next tasks.
    - DevOps
        - Methodologies and tools allowed for development and operations to get a product out of the door.



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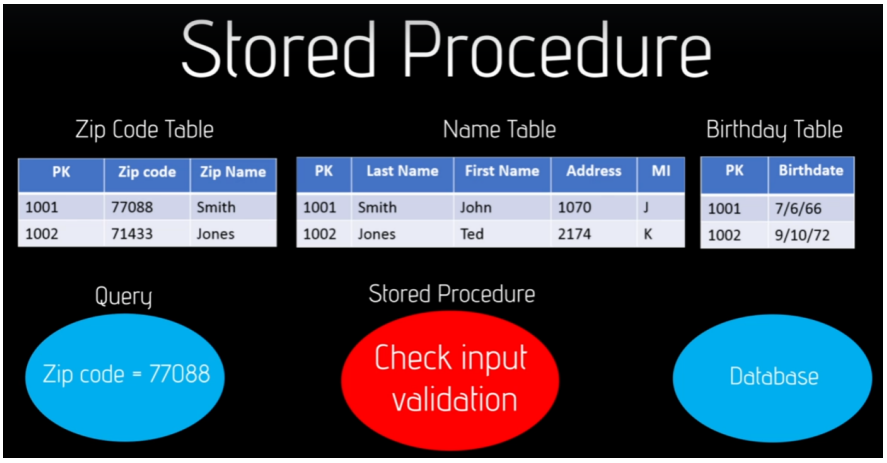
- Just because a product is delivered doesn't mean that the development on it has ceased.
- Secure DevOps
  - Run security automation tools.
    - Fuzzer tools, static testers, Intrusion Detection
    - Always look for vulnerabilities in code.
  - Change management/version control
    - Change will happen.
    - Organization, authorization, documentation
    - Continuous integration
  - Baselining
    - Baselining critical security objectives
      - Encryption
      - Input validation
      - Any baseline set forth
  - Consider immutable systems
    - An immutable system has interchangeable parts
      - Embedded firmware device
      - Virtual machine
  - Infrastructure as code
    - Create preset definition files

- Secure Deployment Concepts
  - Compiled vs. Runtime Code
    - Most applications ran today are Runtime Applications.
    - Runtime code is not compiled; it is not executable. It is read by whatever you are running, like a web browser, and shown to you.
    - Compiled code is executable code.
  - Proper error handling
    - Any application generates errors.
    - The application should recognize errors and put up a screen saying "Oops!" or similar.
  - Proper input validation
    - Validating an input in a type box to display to the user that it does not meet the requirements somehow.
  - Normalization
    - Avoid replication of data.
    - Tools like indexing are used for databases that are normalized.
  - Stored Procedures



- Encryption/Code Signing
  - Digitally signing code to ensure it is good order.
- Obfuscation (Camouflaged)
  - Not a full blown encryption of code, but the desire is to keep it from being copied.
  - A minifier tool can be used to remove all spaces and excess carriage returns to leave just the code itself.
- Code reuse/Dead code
  - If known-good code can be reused, do it.
  - Dead code is also referred to code that is no longer being used. A good rule of good code is to cut it out; it can be taken advantage of.
- Server-side vs. Client-side Execution/Validation
  - Client-side execution puts a lot of code and security on the client.
    - Security is only as good as the client's security.
  - Server-side execution puts a lot of work and load on the server.
- Memory Management
  - All applications use memory.
  - The process of memory management is involved and requires testing.
- Third-Party Libraries
  - Security issues can arise from these.
  - A backdoor can be found in a weakness within a third-party library to exploit the application.
- Data exposure
  - If data is a part of your application, that data is always at risk of exposure.
  - Today, we always go through aggressive encryptions client-side and server-side to protect data that is exposed.

- Code Quality and Testing
  - Static Code Analyzers
    - Look at actual code for standard types of errors that happen often.
    - Not running code, just reading it.
  - Dynamic Analysis
    - Runs the code.
    - Looks for logic errors, security holes, memory leaks, fuzzing ability.
  - Staging
    - Staging is the point where more realistic environments are created to see how the code holds up.
    - Stress Test
      - Putting the code under load to check for security/stability vulnerabilities.
      - Often times in a sandbox environment.
    - Model Verification
      - Verifying the "model" - is this code doing what we envisioned it to do at the beginning?

        - Production
            - Taking code off the sandbox, putting it onto production servers.

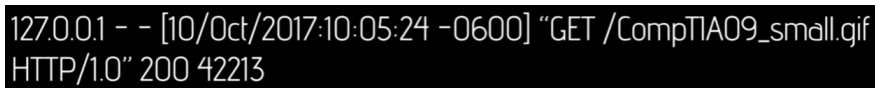
- **Section 9: Testing Your Infrastructure**
    - Vulnerability Scanning Tools
        - Tracert
            - Used to gather network information as part of an assessment.
        - Advanced IP Scanner
            - Freeware tool used to scan an internal network for NIC types, MAC addresses, IP addresses, shared folders.
        - Nmap
            - A powerful network discovery tool.
            - Finds clients on a LAN and discovers open ports.
        - Microsoft Baseline Security Analyzer
            - Uses the Microsoft Knowledge Base to check for patches, security vulnerabilities, Windows firewall status on an individual system.
        - To check entire infrastructures, Vulnerability Assessment tools are needed.
            - Nessus
            - Nexpos
            - OpenVAS

    - Vulnerability Scanning Assessment
        - Vulnerability assessments require authorization from management.
        - Credentialed vs. Non-Credentialed
            - A credentialed VA means you have the usernames and passwords, from an insider perspective.
            - Non-credentialed is not having any usernames and passwords, from an outsider perspective.
        - Intrusive vs. Non-Intrusive
            - Intrusive is trying to exploit and actually perform an action to corrupt something, whereas non-intrusive is just scanning and assessing.
        - Misconfigurations
            - Often times, a misconfiguration (like a default username/password) can present a vulnerability.
        - False positives
            - When an assessment flags a problem, but in reality it isn't a problem.
        - Compliance
            - PCIDSS, for example, monitor credit card usage.
                - These compliance rules have to be applied to items that handle credit card data.
        - Remember to get authorized!

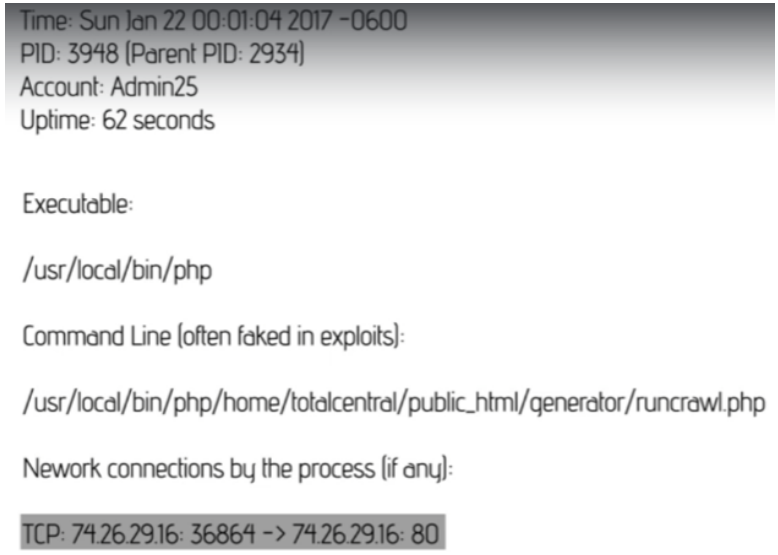
    - Social Engineering Principles
        - Social engineering is simply people tricking people.
        - Social engineering principles:
            - Authority
                - To impersonate or imply a position of authority
            - Intimidation
                - To frighten by threat
            - Consensus
                - To convince of a general group agreement
            - Scarcity
                - To describe a lack of something
            - Familiarity
                - To imply a closer relationship

        - Trust
            - To assure reliance on their honesty and integrity
        - Urgency
            - To call for immediate action

- Social Engineering Attacks
    - Types of attacks:
        - Physical Attacks
            - Tailgating
                - Waiting for someone with access to a building/door and following them.
            - Shoulder surfing
            - Dumpster diving
        - Virtual Attacks
            - Phishing
                - E-mails
            - Spear Phishing
                - Directed towards specific person or organization.
            - Whaling
                - Spear phishing directed towards executives
            - Vishing
                - Uses telephone system to steal private information.
            - Hoax
                - Warns someone that something bad is happening when it's not.
            - Watering hole attack
                - An attempt to infect websites that a group of end users frequent to gain access to their information or network.

- Attacking Web Sites
    - In order to recognize an attack, you need to be able to read log files.
    - Common Log Format (CLF)
        - All web servers generate logs in the same format.
        - 

        - This log has, in order from left to right:
            - Host IP address: 127.0.0.1
            - Ident (Identity Check): - -
                - Authuser
            - Date/time
            - Request (within quotes)
                - Also known as the data payload.
            - Status (three digit HTTP status code): 200
            - Bytes (excludes HTTP headers): 42213
    - Some websites have a central control panel, like cPanel, that monitor connections to it that it views as malicious.
        - Here is an example of an email that cPanel can send to the administrator:



- Web site attack types:
  - Cross-site scripting
    - Also known as XSS.
    - Client-side script injected into trusted web sites.
  - XML injections
    - Inserts XML information that shouldn't be there altering the logic of the program.

- Attacking Applications
  - Typically there are web-based applications, or local applications.
  - Types of attacks:
    - Injection Attacks
      - Adding extra information into an input/application that causes malicious intent.
        - Code injections: adding extra code to manipulate the program.
        - Command injections: using the application to get to the underlying OS.
      - SQL (Structured Query Language) Injection
        - Using SQL commands to access SQL database.
        - SQL query terms:
          - Inner join
          - Select from
          - Insert into
      - LDAP Injections
        - LDAP is based on X.500 and uses TLS encryption.
        - Poorly formed applications can be taken advantage of by putting LDAP information into them and creating LDAP injections.
    - Buffer Overflow
      - Anytime data is entered into an application, it enters a buffer.
      - A buffer is a reserved part of memory to store data before it is input into the application itself.
      - Locking a system up by repeating the same action so much that the buffer crashes.
    - Integer Overflow
      - Any variable within an application usually is declared at the beginning of the program itself.
      - Generating errors based on exploiting a fixed value limit, such as multiplying a number on a calculator to be too large to calculate.

- Exploiting a Target
  - A vulnerability assessment is from an insider perspective, never trying to grab any data. A penetration test is from an outsider perspective in which data is obtained.

- Pen Test Steps:
  - 

  - An attack model defines what an attacker knows before starting the penetration test.
    - White box:
      - Attackers have extensive knowledge of the target.
      - Attackers are more like trusted insiders.
      - Cheapest and fastest.
    - Black box:
      - Attackers know nothing about the target.
      - Attackers are more like stranger outsiders.
      - External hacking.
      - Potentially expensive and slow.
    - Gray box
      - Somewhere between the two.
  - Reconnaissance
    - Passive discovery
      - Not putting any packets on the target; just making phone calls, just doing WHOIS lookups.
    - Semi-passive discovery
      - Putting packets onto the target, but nothing that will raise alarms.
    - Active discovery
      - Putting packets onto the target, running scanners, running actions that could potentially flag alarms.
  - Exploiting the target
    - Banner grabbing
    - Pivot: Uses compromised system to attack other systems.
    - Persistence: To connect again easily with your target with open timelines.
    - Privilege Escalation: Ability to gain access to data and resources.
    - Metasploit, for example, is a framework tool that uses banner grabs to gain information on a system and make listings of the known vulnerabilities with that system from databases.
      - The tool can then be used to scan and inject systems.

- Vulnerability Impact

- Embedded System
  - An immutable system that never changes. They are easily forgotten and can often be behind on patches.
- Lack of vendor support
  - Big issue with primarily hardware.
  - Typically happens when the vendor tries to move on, or if the vendor company no longer exists.
  - The issue is the device/system will not have any patches/new parts.
- Misconfiguration
  - A default configuration is a misconfiguration and massive vulnerability.
  - There are massive databases of default credentials that can be leveraged.
  - Could also refer to a misstep, such as turning on/off a service that needs to be off/on and is now vulnerable.
- Improperly configured account
  - A user/system account with the incorrect permissions, for example.
  - It is not just permissions, it is also rights.
  - Potential for too much privilege or too little.
- Vulnerable business processes
  - Unconsidered business processes that cause vulnerabilities.
  - An example is onboarding/offboarding processes of employees/clients, or incorrect storage of sensitive information.
- Memory/buffer vulnerabilities
  - Resource exhaustion, memory leak, DLL injection, buffer/integer overflow, pointer dereference.
    - Running out of memory: Resource exhaustion or memory leak.
      - Either get more RAM or stop the process doing this.
    - Overflows: Buffer or integer overflows will cause systems to behave unintentionally.
    - Backdoors: Pointer dereference/DLL injection.
- System sprawl/Undocumented assets
  - A system/device being undocumented or unknown means it is not being controlled and/or protected as an asset, which means it is vulnerable due to lack of administration.

- **Section 10: Dealing with Incidents**
  - Incident Response
    - The CompTIA Security+ is heavily based on the *NIST 800-61 Computer Security Incident Handling Guide*.
    - Incident Response Process:
      - Preparation
        - The big plan.
        - Who is doing what?
        - Organize the types of incidents that might happen.
      - Reporting
        - What reports go to whom?
        - Escalation
      - Practice Scenarios
      - Identification
        - Recognize what incident has occurred.
        - Check monitoring tools, alerts, logs.
        - Expect reports from users.
        - Assess the impact.
        - Define who is involved.
      - Containment
        - Mitigate the damage

        - Stop the attack
        - Segregate the network, shutdown the system, turn off a service.
    - Eradication
        - Remove the malware, close off the vulnerability.
        - Add new controls.
    - Recovery
        - Restore from backups, pull snapshots
        - Hire replacement personnel
        - Monitor to ensure good operations
    - Documentation
        - What failed?
        - What worked?
        - Generate final report.
- Incident Response Plan
    - Cyber Incident Response Team (CIRT)
        - A group of people whose job is to respond to all cyber incidents.
        - Consists of an IT Security Team
            - Includes IT department and HR.
            - Legal matters may be included, as well as PR.
    - Document incident types/category definitions
        - Physical access
        - Malware
        - Phishing
        - Data access
        - Social engineering
    - Roles and responsibilities
        - Users: How do they report an issue?
        - Help desk
        - Human Resources
        - Database manager
        - Incident hotline: A hotline used to report incidents.
            - IR Manager/Officer
            - IR Team
    - Reporting requirements/escalation
        - Determine severity/level
        - Have a clear chain of escalation.
        - Informing law enforcement
    - Practice
        - Annual scenario drills.

- Digital Forensics
    - Typically forensics occurs within IT Security for the following reasons:
        - Incident occurs
        - Legal hold
    - Chain of Custody
        - Gathering evidence
        - Presenting evidence with data of high integrity
        - Chain of Custody Form:

Property Record Number: _____

Anywhere Police Department

EVIDENCE CHAIN OF CUSTODY TRACKING FORM

Case Number: _____ Offense: _____
Submitting Officer: (Name/ID#) _____
Victim: _____
Suspect: _____
Date/Time Seized: _____Location of Seizure: _____

Description of Evidence		
Item #	**Quantity**	**Description of Item** (Model, Serial #, Condition, Marks, Scratches)

Chain of Custody

- Define the evidence
- Document collection method
- Date/time collected
- Person(s) handling the evidence, with contact information.
- Function of person handling evidence
- All locations of the evidence

- Order of volatility
  - Memory
    - Process/services, caches, routing tables, ARP tables
  - Data on the disc
    - Applies to optical/flash drives
    - Cache files, temp files, swap files
    - Write blocker enabled tools
  - Remotely logged data
    - Web site data
    - Remote file server logs
  - Backups
    - Identifying trends
    - Low volatility takes time to gather data
- Checklist for digital forensic data acquisition:
  - Capture the system image
    - Write-blocking tools are preferred here.
  - Network traffic and logs
  - Capture video
    - Taking video of physical surroundings of system.
    - Capture files of video/audio on system.
    - Security cameras nearby.
    - Record time offset.
  - Take hashes
    - Hash every file and image.
    - Most forensic tools use built-in hashing.
  - Take screenshots
  - Interview witnesses
  - Track man hours

- Contingency Planning
  - Disaster Recovery
    - How do we recover from a specific disaster?
    - Evacuation plan
      - Backup site
        - Cold site
          - Takes weeks to bring online. Basic office space.
        - Warm site
          - Takes days to bring online. Has some operational equipment, but little to no data.
        - Hot site
          - Takes hours to bring online. Real-time synchronization.
          - Almost all data ready to go. Often a quick update.
      - Distance and location should be considered for a backup site.
      - Internet requirements need to be considered.
      - Housing and entertainment for employees.
      - Legal issues
  - Business Continuity
    - How do we keep our business churning?
    - Order of Restoration
      - Check power. All outlets, checking AC power.
      - Check wired LAN.
      - ISP link
      - Active Directory/DNS/DHCP servers
      - Accounting servers
      - Sales and accounting workstations
      - Production servers
      - Production workstations
      - Wireless
      - Peripherals (Printers, cameras, scanners)
  - Annual exercises
    - Can be tabletop exercises, or physical drills.
    - Failover tests
  - Alternative processing sites
    - Larger organizations may have different processing sites for specific departments. Sharing spaces.
  - Alternative business practices
    - How do we take credit card information?
    - Sales taxes for being in a different state in a disaster.
  - After action reports
    - Clear and detailed documentation of everything that happened for future preparation.

- Backups
  - Backup methods:
    - External HDDs, tapes, clouds.
    - Full backup: Backup everything.
    - File systems have features to know when files have been changed.
      - Differential backup: Backup all of the changes since the last full backup.
        - Less backup sets, but a larger size.
      - Incremental backup: Only backs up changes made from last backup of any type.
        - More backup sets, but a smaller size.
    - Snapshots
      - Typically under virtual machines.
      - Making a copy of something that happened in the past.

        - Typically not stored on separate media.
- Backup media:
    - Local
        - Tapes, NAS, hard drives, etc.
    - Offsite
        - Backed up in a different location
    - Cloud backups
        - Take larger time to get full backup, however once it is made, most do a continuous incremental backup.