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**CCENT/CCNA Chapter 1 – TCP/IP Networking**

Exam focuses heavily on TCP/IP

* **Enterprise network** – IT world refers to a network created by one corporation, or enterprise, for allowing its employees to communicate.
* Purpose move data from one device to another.
* **Networking model** – (network architecture or networking blueprint) – refers to a comprehensive set of documents.
  + IBM SNA (Systems Network Architecture)
  + **ISO (International Organization for Standardization**) created OSI to standardize data networking protocols to allow communication among all computers across the entire planet.
  + **IEEE (Institute of Electrical and Electronic Engineers)** – defines Ethernet LAN’s
    - Ethernet card built in to the computer implements some LAN standards by the TCP/IP model.
  + OSI model
    - **Application** – provides an interface from the application to the network by supplying a protocol with actions meaningful to the application (Telnet, HTTP, FTP, SMTP, POP3, VoIP, SNMP)
      * **PDU (Protocol Data Unit)** – represents the bits that include the headers and trailers for that layer as well as encapsulated data. LxPDU)
    - **Presentation** – This layer negotiates data formats, such as ASCII test, or image types like JPEG.
    - **Session** – This layer provides methods to group multiple bidirectional messages into a workflow for easier management and easier back out of work that happened if the entire workflow fails.
    - **Transport** – In function, much like TCP/IP’s transport layer. This layer focuses on data delivery between the two endpoint hosts. (TCP, UDP)
    - **Network** – Like the TCP/IP network, this layer defines logical addressing, routing (forwarding), and the routing protocols used to learn routes
    - **Data Link** – Like the TCP/IP data link layer, this layer defines the protocols for delivering data over a particular single type of physical network. (Ethernet, HDLC)
    - **Physical** – This layer defines the physical characteristics of the transmission medium, including connectors, pins, use of pins, electrical currents, encoding, light modulation, and so on. (RJ-45, Ethernet)
  + DOD helped build the TCP/IP architecture
    - TCP/IP avoids repeating work already done by others
    - 1 Architecture – TCP/IP Original
      * **Application** – HTTP, POP3, SMTP
        + **HTTP** – subsequent HTTP messages omit the header
        + **URL (Uniform Resource Locators)** – HTTP is used to transfer the web pages.
      * **Transport** – TCP/UDP
        + **TCP** – provides error recovery for Application layer. Guarantees delivery

**Segment** – TCP message with sequence number

Has each header and sequence number sent with each message.

* + - * **Internet** – IP
        + **IP** – defines that each host computer should have a different IP address

Routers act like the post office forwarding packets of data to the correct destination. Helps to be identified in the network.

**Packet** – message with an IP header

**Routers** - are networking devices that connect the parts of the TCP/IP network together for the purpose of routing IP packets to the correct destination.

**DDN (Dotted**-decimal notation) – 1.1.1.1

**Host** – refers to any device, regardless of size or power and has an IP address and connects to any TCP/IP network.

**IP Header** – includes a source IP address and a destination IP address of Bob’s IP

**IP Routing** – process of forwarding an IP packet.

**Data** – everything after the IP header

* + - * **Link (network access or network interface layer**) – Ethernet, PPP, Frame Relay, T1
        + Refers to physical connections, between two devices and the protocols used to control those links.
        + **Frame** – encapsulated IP packet between an Ethernet header and Ethernet trailer
    - 2 Architecture – TCP/IP Updated
      * **Application** – provide services to the application software running on a computer. Provides an interface between software running on a computer and the network itself. Defines services the application needs.
      * **Transport -** provides error recovery for Application layer. Guarantees delivery
      * **Network –** provides addressing and routing to the Transport layer. Upper layers ask lower layers to deliver a message. Provides a service for forwarding IP packets from one device to another.
      * **Data Link –** physical transmission of data and those indirectly related to the physical transmission of data.
        + **Encapsulation –** process of putting headers around some data.

Create and encapsulate the application data with any required application layer headers

Encapsulate the data supplied by the application layer inside a transport layer header

Encapsulate the data supplied by the transport layer inside a network layer IP header

Encapsulate the data supplied by the network layer inside a data link layer header and trailer

Transmit the bits.

* + - * **Physical -** physical transmission of data and those indirectly related to the physical transmission of data.
  + **Layers** – small number of categories broken down into functions
    - Each layer provides a service to the layer above it
    - **Adjacent-layer interaction** – refers to the concepts of how adjacent layers in a networking mode on the same computer work together.
    - **Same-layer interaction** – particular layer on one computer wants to communicate with the same layer on another computer.
* **Protocol** – set of logical rules that devices must follow to communicate.
  + RFC (Requests For Comments)
  + Use headers as a place to put information used by that protocol
* **SOHO** – smaller networks at home, when used for business purposes, often go by the name small office/home office
* **Cloud** – part of a network whose details are not important to the purpose of the diagram.

**Chapter 2 - Ethernet LANs**

Ethernet LANs are wired LANs

* **IEEE (Institute of Electrical and Electronics Engineers)** – defines cabling, the connectors on the ends of the cables, the protocol rules, and everything else required to create an Ethernet LAN (802.3).
  + **UTP** – unshielded twisted pair. Saves money. T suffix
  + **Optical fibers** – wires inside the cable to send data over electrical circuits. More expensive. Longer. X suffix. Contains long thin strands of fiberglass encoding the bits as changes in the light.
  + 10 Mbps– Ethernet – 10BASE-T (2 wires)– 802.3 – Copper, 100 m
  + 100 Mbps – Fast Ethernet – 100BASE-T (2 wires) – 802.3u – Copper, 100m
  + 1000 Mbps – Gigabit Ethernet – 1000BASE-LX – 802.3z – Fiber, 5000m
  + 1000 Mbps – Gigabit Ethernet – 1000BASE-T (4 wires) – 802.3ab – Copper, 100m
    - Transmits and receives simultaneously on each wire pair.
  + 10 Gbps – 10 Gig Ethernet – 10GBASE-T – 802.3an – Copper, 100m
    - Cross over 4,5 to 7,8 to 1,2 and 3,6)
  + **Ethernet header/trailer** – bytes of overhead data that Ethernet uses to do its job of sending data over a LAN
  + **Ethernet frame** – refers to the header and trailer of a data-link protocol, plus the data encapsulated inside that header and trailer
    - **Preamble** – 7 Bytes – Syncrhonization
    - **Start Frame Delimiter** – 1 Byte – Signifies tha the next byte begins the Destination MAC address
    - **Destination MAC Address** – 6 Bytes – Identifies the intended recipient of this frame.
      * **MAC Address (Media Access Control\_ = 6**-byte long binary numbers that represent a single NIC or Ethernet port. Also called Unicast. Universal MAC addresses are global MAC addresses
      * **Unicast** – formal way to refer to the fact that the address represents one interface to the Ethernet LAN.
      * **OUI (Organizationally Unique Identifier)** – manufacturer agrees to give all NICS a MAC address that begins with its assigned 3-byte OUI defined by IEEE. Also assigns last 3 bytes
      * **Universal Address** – emphasize the fact that the address assigned to a NIC by a manufacturer should be unique among all MAC addresses in the universe.
      * **Group Addresses** – identify more than one LAN interface card.
      * **Other names** – LAN address, Ethernet address, hardware address, burned-in address, physical address, universal address, or MAC address.
    - **Source MAC address** – 6 bytes – Identifies the sender of this frame.
    - **Type** – 2 bytes – Defines the type of protocol listed inside the frame.
      * Identifies the type of network layer packet that sits inside the Ethernet frame.
    - **Data/Pad** – 46-1500 Bytes – Holds data from higher layer.
    - **Frame Check Sequence (FCS)** – 4 Bytes – Provides a method for receiving NIC to determine whether the frame experienced transmission errors.
      * Gives the receiving node a way to compare results with the sender to discover whether errors occurred in the frame. Analyzed by a math formula. Discards the frame if there is any error
  + **Ethernet LAN** – combination of user devices, LAN switches, and different kinds of cabling.
    - **Electrical circuit** – two individual wires that are inside the UTP cable completing a loop using circuitry on their Ethernet ports which allows electricity to flow.
    - **Encoding scheme** – to send data, the two devices follow some rules. Transmits node changes the electrical signal over time and interprets the changes as either 0 or 1.
    - **EMI (Electromagnetic interference)** – interferes with the electrical signals in nearby wires, including the wires in the same cable.
    - **Crosstalk** – EMI between wire pairs in the same cable)
    - **Ethernet Link** – physical cable between two Ethernet nodes
    - **Pins** – 8 physical location into which eight wires in the cable can be inserted.
    - **Ethernet port** – connectors on the cable so that the connectors on the ends of the cable can be connect to each node.
    - **Broadcast address** – frames sent to an address should be delivered to all devices on the Ethernet LAN
    - **Multicast address** – frames sent to a multicast Ethernet address will be copied and forwarded to a subset of the devices on the LAN that volunteers to receive frames sent to a specific multicast address.
    - **NIC (Network Interface Card)** – expansion card on the PC or built into the system.
      * **Straight through cable pinout** – connect the wire at pin 1 on one end of the cable to pin 1 at the other end so on. Uses opposite pairs for transmitting data. If the endpoints transmit on different pin pairs. NIC transmitters use the pair connected to pins 1 and 1; the NIC receivers use a pair of wires at pin positions 3 and 6. (PC NICs, Routers, AP)
      * **Pinout** – refers to the wiring of which color wire is placed in each of the eight numbered pin positions
      * **Crossover cable** – crosses the pair at the transmit pins on each device to the receive pins on the opposite device. If the endpoints transmit on the same pin pair. (Hubs/Switches)
        + **Cisco switch feature Auto-mdix** – notices when the wrong cable is used and automatically changes its logic to make the link work.
* **Ethernet LAN Switch** – provides many physical ports into which cables can be connected
  + **Full duplex** – device does not have to wait before sending; it can send and receive at the same time.
* **LAN hub** – uses half-duplex logic. Uses different rules for forwarding data with physical layer standards. Repeats the signal out to all other ports. Can cause collisions in data transfer.
  + **Half-duplex logic** – device must wait to send if it is currently receiving a frame; in other words, it can’t send and receive at the same time.
    - **CSMA/CD (Carrier Sense Multiple Access/ Collision Detection)** – takes care of unfortunate timing. Checks to see if income frames are coming at the exact same time.
* **Wireless LAN Access Point** – acts somewhat like an Ethernet switch in that all the wireless LAN nodes communicate with the Ethernet switch by sending and receiving data with the wireless AP.
  + Needs single Ethernet link to connect the AP to the Ethernet LAN
* **Wireless LANs** – standards defined by the IEEE 802.11 using radio waves to send the bits from one node to the next.
* **Ethernet cables** – general reference to any cable that conforms to any of several Ethernet standards.
* **Router** – connects the LAN to the WAN with Ethernet LAN interface and an Ethernet cable.

**Chapter 3 – WAN fundamentals**

* **WAN**
  + You lease with WAN. Wide
  + **DSL (Digital Subscriber Line) –** uses analog phone lines that are already installed in homes. Provides a short physical link from a home to a telco’s network. RJ-11 connectors.
    - **PSTN (Public Switched Telephone Network) –** supports the ability to setup voice calls, take them down, and forward the voice through the worldwide voice network.
    - DSL equipment is added in the user home and at the CO.
      * DSL modem – connects to a spare outlet
    - **DSLAM (DSL access multiplexer)** – splits out the voice signals over to the voice switch on the upper right.
    - Support asymmetric speeds, downstream faster, upstream not as fast.
  + **Cable –** uses cable TV (CATV) cable.
    - Asymmetric speeds
  + **Ethernet WAN –** connects ethernet link using a router interface
    - **POP (Point of Presence) –** Ethernet link leaves the customer building and connects to some nearby SP.
    - **Ethernet emulation –** service acts like one Ethernet link
    - **EoMPLS (Ethernet over Multiprotocol Label Switching) –** point to point connection between two customer devices or behavior as if a fiber ethernet link existed between the two devices.
      * Can send data in both directions at the same time. Two routers can send Ethernet frames to each other over the link.
      * Uses the same Ethernet LAN link protocol
      * Used to forward IP packets from one site to another.
      * Uses layer 1 and layer 2. Each frame data link header and trailer are different. Discards old data-link header/trailer and adds a new set.
  + **Leased line WAN** – send data from the remote LAN back to the rest of the existing network and vice versa. Company using it doesn’t own it. Pay a monthly fee. Works like a crossover cable connecting two routers. Crooked line between routers described a lease line.
    - Uses two pair of wires one pair for sending data in each direction. Uses full duplex mode.
    - Longer lead times to get the service installed. High cost.
    - Telco installs a large network of cables and specialized switching devices to create its own computer network. It acts like a crossover cable.
    - Some physical path must exist between the two routers on the ends of the link.
    - **Central Office** – Telco’s put their equipment in builds. They install cables from the CO to most every other building in the city
    - **HDLC (High-Level Data Link Control) –** control the correct delivery of data over a physical link of a particular type. Provides similar functions to data link layer. Provide the means to encapsulate the network layer packet correctly so that it crosses the link between routers.
      * Frame can only go to one place. Has an address field, the destination is implied.
      * In the past telco’s offered multidrop circuits so there was more than one possible destination
      * ISO standard HDLC doesn’t have a type field. Cisco uses a variation of HDLC that adds a Type field.
      * **Flag** – lists a recognizable bit pattern so that the receiving nodes realize that a new frame is arriving
      * **Address** – identifies destination device
      * **Control** – Mostly used for purposes no longer in use today for links between routers.
      * **Type** – Identifies the type of layer 3 packet encapsulated inside the frame.
      * **FCS** - a field used by the error detection process.
    - **CPE (Customer Premise Equipment)** – includes the router, serial interface card, and CSU/DSU. Each router uses a serial interface card that acts like a NIC
    - **CSU/DSU (Channel Service Unit/Data Service Unit) –** physical link requires this. Integrates into the Serial interface card in the router or sit outside the router as an external device.
      * Includes a short serial cable plus the cable installed by the telco.
      * Serial cable connects the router serial interface to the external CSU/DSU with a RJ-48. Speeds come in multiples of 64 Kbps or 1.5 Mbps.
      * Lab:
        + **DTE (Data Terminal Equipment)** – serial cable used between a router and external CSU/DSU. Straight through.
        + **DCE (Data Communications Equipment)** – female connector in a cross over fashion
        + Need clock rate configured as the CSU/DSU controls that function when to send bit through signaling over the serial cable.
    - **Service Provider** – refer to a company that provides any form of WAN connectivity, including internet services.
    - **Other names:**
      * **Leased Circuit, Circuit –** used as synonyms. Circuit references to the electrical circuit between the two endpoints
      * **Serial Link, Serial line –** Serial refers to the fact that the bits flow serially, and that routers use serial interfaces.
      * **Point to point link, point to point line –** topology stretches between two points and two points only
      * **T1 –** specific type of leased line that transmits data at 1.544 Mbps
      * **WAN link, link –** no reference to any specific technology
      * **Private line –** data sent over the line can’t be copied by other telco customers. Data is private.
  + Connect LAN using a WAN, the internetwork uses a router connected to each LAN with a WAN link between the routers.
* **LAN**
  + You own and pay for LAN. Local
* **Internet core** – exists as LANs and WANs owned and operated by Internet service providers (ISP). Create a mesh of links between each other in the core.
  + **Internet access link** – phones create their WAN link using wireless technology.

**Chapter 4 – Fundamentals of IPv4 Addressing and Routing**

* **IP Routing** – process of hosts and routers forwarding IP packets (Layer 3 PDU) while relying on the underlying LANs and WANs to forward the bits
  + **Hosts** – end-user computers. OS has TCP/IP software, including the software that implements the network layer.
  + **Path selection** – routing protocols select the best route among the competing routes to the same destination.
    - PC on different LAN goes to nearby router to forward the packet.
    - Sender sends a data-link frame across the medium to the nearby router. (default router)
    - **Default router** = default gateway.
  + **IP Routing Table** = IP Address groupings – IP networks and IP subnets. Like driving on a highway. Compares packets destination IP address to the entries in the routing table and makes a match.
    - IP network like a zip code
    - Rest like addresses
  + Routers build new data-link headers and trailers, because the new headers contain data-link addresses.
  + **ARP (IP Address Resolution Protocol)** – dynamically learns the data-link address of an IP host connected to a LAN.
  + **Layer 3 protocol data units (L3 PDU)** – process of routing forwards Layer 3 packets based on the destination Layer 3 address in the packet.
  + The routing process uses the data link layer to encapsulate the Layer 3 packets into Layer 2 frames for transmission across each successive data link.
  + Network layer protocol groups addresses both by location and actual address values.
  + IP has 20-bit header- Version, Length, DS Field, Packet Length, Identification, Flags, Fragment Offset, Time to Live, Protocol, Header Checksum and Destination/Source IP
  + Hosts need to know IP address of default router and routers need to know routes so they can forward packets.
* **IP Addressing** – addresses used to identify a packet’s source and destination host computer. Addressing rules also organize addresses into groups, which greatly assists the routing process.
  + **Internetwork** – generally to a network made up of routers, switches, cables, and other equipment.
  + **IP Host** – any device that has at least one interface with an IP address can send and receive IP packets.
  + IPV4
    - 32-bit number written in DDN (Dotted Decimal Notation)
    - Octet is just a vendor neutral term for byte. 8-bit number. 0 – 255
    - IP networks – TCP/IP grouped IP addresses into sets of consecutive addresses
    - All IP addresses in the same group must not be separated from each other by a router
    - IP addresses separated from each other by a router must be in different groups.
    - Class A – 1-126, holds 126 networks with 16,777,214 hosts
    - Class B – 128 – 191, holds 16384 networks with 65,534hosts
    - Class C – 192 – 223, holds 2,097,152 networks with 254 hosts
    - Class D – defines multicast addresses
    - Class E – experimental addresses. Reserved for future use.
    - 127 is reserved
    - Network ID – just on reserved DDN value per network that identifies the IP network. Also network number or network address.
    - Classful IP network – refers to any Class A, B, or C network.
    - Subnetting – defines methods of further subdividing the IPv4 address space into groups that are smaller than a single IP network. Subnet = subdivided network.
* **IP routing protocol** – Protocol that aids routers by dynamically learning about the IP address groups so that a router know where to route IP packets so that they go to the right destination host.
  + If the destination IP address is in the same IP subnet as I am, send the packet directly to that destination host.
  + Otherwise, send the packet to my default gateway, also known as the default router.
  + Router Thinks
    - Network numbers and subnet numbers represent a group of addresses that being with the same prefix. This about those numbers as groups of addresses. In which of the groups does this packet’s destination address reside?
  + Router Forwarding Logic
    - Use the data-link FCS field to ensure that the frame had no errors; if errors occurred, discard the frame.
    - Assuming that the frame was not discarded at Step 1, discard the old data-link header and trailer, leaving the IP packet
    - Compare the IP packet’s destination IP address to the routing table, and find the route that best matches the destination address. This route identifies the outgoing interface of the router, and possibly the next-hop router IP address.
    - Encapsulate the IP packet inside a new data-link header and trailer, appropriate for the outgoing interface, and forward the frame.
  + Goals of a Router
    - Prevent routing loops
    - Dynamically learn and fill the routing table with a route to each subnet in the internetwork
    - If more than one route to a subnet is available, to place the best route in the routing table.
    - Notice when routes in the table are no longer valid, and to remove them from the routing table.
    - If a route is removed from the routing table and another route through another neighboring router is available, to add the route to the routing table.
    - Work quickly when adding new routes or replacing lost routes
    - **Convergence** – time between losing the route and finding a working replacement route.
    - **Routing Update** – routing protocol message.
  + Learning Routes
    - Router adds a route to its routing table for each subnet directly connected to the router
    - Each routers routing protocol tells its neighbors about the routes in its routing table, including the directly connected routes and routes learned from other routers.
    - After learning a new route from a neighbor, the routers routing protocol adds a route to its IP routing table, with the next-hop router of that route typically being the neighbor from which the route was learned.
* **Other utilities** – The network layer also relies on other utilities. For TCP/IP, these utilities include DNS, ARP, and ping.
  + **DNS (Domain Name Resolution)** - identify other computers by hostnames rather than IP addresses.
  + **ARP (Address Resolution Protocol) –** gives a way by which any host can dynamically learn the MAC address of another host or router on a LAN
    - **Request –** message that asks the simple request to see if your IP address and reply with MAC address.
    - **Reply –** indeed lists both the original IP address and matching MAC address
    - Details are kept in ARP cache or ARP table. (arp – a)
  + **Ping (Packet Internet Groper)** – uses **ICMP (Internet Control Message Protocol)** to ping another IP address
    - **Echo request**
    - **Echo reply**

**Chapter 5 – Fundamentals of TCP/IP Transport and Applications**

* TCP
  + Provides a wide variety of services to applications.
  + **Error detection** – most data-link protocols notice errors and then discard frames that have errors
  + **Error Recovery** – retransmission helps to avoid congestion (flow control). Process of numbering and acknowledging data with Sequence and Acknowledgment header fields.
    - **Flow Control** - Process that uses window sizes to protect buffer space and routing devices from being overloaded with traffic.
      * **Sliding window or dynamic window** – window concept lets the receiving host tell the sender how much data it can receive right now, giving the receiving host a way to make the sending host slow down or speed up. Change how much data the sending host can send.
      * Tells the sender how much data can be sent over in transmission.
    - **Forward acknowledgement** – listing the next expected byte rather than the number of the last byte received
    - **Retransmission timer** – PC wait a few moments to make sure no other acknowledgments arrive.
  + **Multiplexing using ports** – function that allows receiving hosts to choose the correct application for which the data is destined, based on the port number.
    - **Socket** – contains an IP address, a transport protocol, a port number.
  + **Connection and establishment and termination** – process used to initialize port numbers and sequence and ack fields
  + **Ordered data transfer and data segmentation** – continuous stream of bites from an upper-layer process that is segmented for transmission and delivered to upper-layer processes at the receiving device, with the bytes in the same order.
  + Header (4 Bytes)
    - Source Port
    - Destination Port
    - Sequence Number
    - Acknowledgement Number
    - Offset
    - Reserved
    - Flag Bits
    - Checksum
    - Window
    - Urgent
  + **Segment** – message created by TCP with a TCP header uses Layer 4 PDU (L4PDU).
  + **Dynamic port numbers** – ports 0-1024 are reserved for known applications. Uniqueness in connection type. (20,21,22,23,25,53,67,68,69,80,110,161)
    - **SNMP (Simple Network Management Protocol, 161)** – application layer protocol used specifically for network device management.
    - **WWW (World Wide Web, 80)** – application exists through web browsers access the content available on web servers. Can be used to manage a router or switch via a browser. Transferring files between a web server and web client.
      * **HTTP Get** – get a file from a web server, 200 OK code
      * **404 code -** means file not found
      * **Objects –** web pages consist of multiple files.
    - **TFTP (Trivial File Transfer Protocol, 69)** – basic file transfer. FTP (File Transfer Protocol, 20/21)
    - **SMTP (Simple Message Transfer Protocol, 25)**
    - **POP3 (Post Office Protocol version 3, 110)**
    - DHCP Server – 67, DHCP Client – 68
    - Telnet – 23
    - SSH – 22
    - Syslog – 514
    - SSL – 443
  + 3-way Handshake
    - SYN – synchronizing the sequence numbers in the 2 bit flag field.
    - SYN, ACK
    - ACK
  + 4-way termination
    - ACK, FIN (finished)
    - ACK
    - ACK, FIN
    - ACK
    - If no acknowledgement happens, PC resends first segment repeatedly.
* UDP
  + Needs fewer bytes in its header compared to TCP resulting in fewer bytes of overhead in the network.
  + Does not slow down data transfer in cases where TCP can purposefully slow down.
  + Used in VoIP and Video oIP, DNS, and NFS
    - NFS preforms recovery with application layer code.
  + Doesn’t worry about terminating or establishing connections
  + Header (4 Bytes)
    - Source Port
    - Length
    - Destination Port
    - Checksum
* Applications
  + **Web servers** – consist of web server software running on a computer, store information that might be useful to different people
  + **Web browser (web clients)** – software installed on an end user’s computer, provides the means to connect to a web server and display the web pages stored on the web server.
    - **Links (Uniform Resource Identifier URI or URL (Uniform Resource Locator))** – clickable items on a web page, which in turn brings you to another web page.
      * **http://** protocol used to connect to the server
      * **// /** text that identifies the server by name
      * **/** text that identifies the web page.
      * DNS occurs before TCP connection happens. DNS gets the IP address via DHCP.
    - **W3C consortium** – a consortium that develops web standards

**Chapter 6 – using the command-line interface**

* **Interface/Ports** – switches physical connectors with an interface type and interface number
* **Gigabit Ethernet** – 10/100/1000
  + Interface number (x/y), (x/y/z)
* **IOS (Internetwork Operating System)** – controls logic and functions performed by the switch.
  + CLI allows the user to use a terminal emulation program which accepts text entered by the user.
  + Supports console, Telnet, and SSH. SSH & Telnet used over Network
  + **Telnet client** – device that sits in front of the user, accepts keyboard input and sends those commands to the Telnet server.
  + **Telnet server** – accepts the text, interprets the text as a command and replies back.
    - Poses security risk by sending everything in the open.
    - SSH more secure.
    - Port 23
* Cables
  + USB port to USB converter to RJ45
  + USB Port to USB Console
  + Serial Port to RJ45 Console
    - **Serial Port** – D-shell connector with nine pins called a DB-9.
  + **Rollover cable** – 8 wires rolling from 1 to 8, 2 to 7, 3 to 6, etc. used by the UTP cable connecting the Ethernet
* Console port settings to make sure it can be configured
  + 9600 bits/second
  + No hardware flow control
  + 8-bit ASCII
  + No parity bits
  + 1 stop bit
* **User EXEC mode (>)** – allows the user to look around but not break anything.
  + **Show running-config** – lists the current configuration in the switch
  + **Show** – find the status of almost every feature of the IOS
  + **Show mac address-table dynamic** – lists the table the switch uses to make forwarding decisions.
  + **Debug** – tells the user details about the operation of the switch. Issues messages that any switch user can choose to see.
  + **!** is a comment line
  + **Line console 0 –** identifies the console, meaning next commands apply to the console only
  + **Login –** tells IOS to perform simple password checking at the console
  + **Password faith –** defines the password the console user must type when prompted
  + **?** – help for all commands available in this mode. Executes the command automatically
  + **Command ? – with a space between the command and the ? the switch lists text to describe all the first parameter options for the command**
  + **Com?** – a list of commands that start with com
  + **Command parm?** – lists all parameters beginning with the parameter typed so far.
  + **Command parm<Tab>** - spell out the rest of the word
  + **Command partm1 ?** – space is inserted before the question mark, the CLI lists all the next parameters and gives a brief explanation of each.
  + **Up arrow or Ctrl + P** – displays the most recently used command
  + **Down arrow or Ctrl + N** – take you forward to the more recently entered commands
  + **Left arrow or Ctrl + B** – moves cursor backward
  + **Right arrow or Ctrl + F** – moves cursor forward
  + **Backspace** – deletes characters
* **Privileged EXEC mode (#)** – gives user more powerful privileges when executing commands like reload. Enabled by the command enable. Disabled by disable command.
  + **Enable secret love** – defines the password that all users must use to reach enable mode.
* **Configuration Mode** – commands that tell the switch the details of what to do and how to do it.
  + Changes are made to the configuration mode and occur immediately each time the enter key is pressed.
  + **Context-setting commands** – move from one configuration sub command mode or context to another.
  + **Interface** – displays only commands that are useful when configuring ethernet interfaces or sub-commands or interface subcommands
  + **Configure terminal** – move from enable mode to global configuration mode
  + **Hostname Fred-** to configure switches name
  + **Speed 100** – setting 100 Mbps for interface Fa0/1
  + Hostname(config)# = Global
  + Hostname(config-line)# = line
  + Hostname(config-if)# - Interface
  + Hostname(config-vlan)# - VLAN
  + **Startup-config** – stores the initial configuration used anytime the switch reloads Cisco IOS.
  + **Running-config** – stores the currently used configuration commands. This file changes dynamically when someone enters commands in configuration mode.
  + **Copy running-config startup-config** – backups up the running-config to the startup-config file.
    - **Write erase**
    - **Erase startup-config**
    - **Erase nvram:**
* Switches Hardware Memory
  + **RAM (DRAM/ dynamic random-access memory)** – used by the switch just as it is used by any other computer for working storage. Running active configuration file is stored here.
  + **Flash memory** – chip inside the switch or removable memory card, flash memory stores IOS images and is the default location where switch gets its Cisco IOS at boot time. Used to store any other files, including backup copies of configuration files.
  + **ROM (Read-Only Memory)** – stores a bootstrap program that is loaded when the switch first powers on. Finds the full Cisco IOS image and manages the process of loading IOS into RAM at which point IOS takes over operation of the switch
  + **NVRAM (Nonvolatile RAM)** – stores the initial or startup configuration file that is used when the switch is first powered on and when the switch is reloaded.