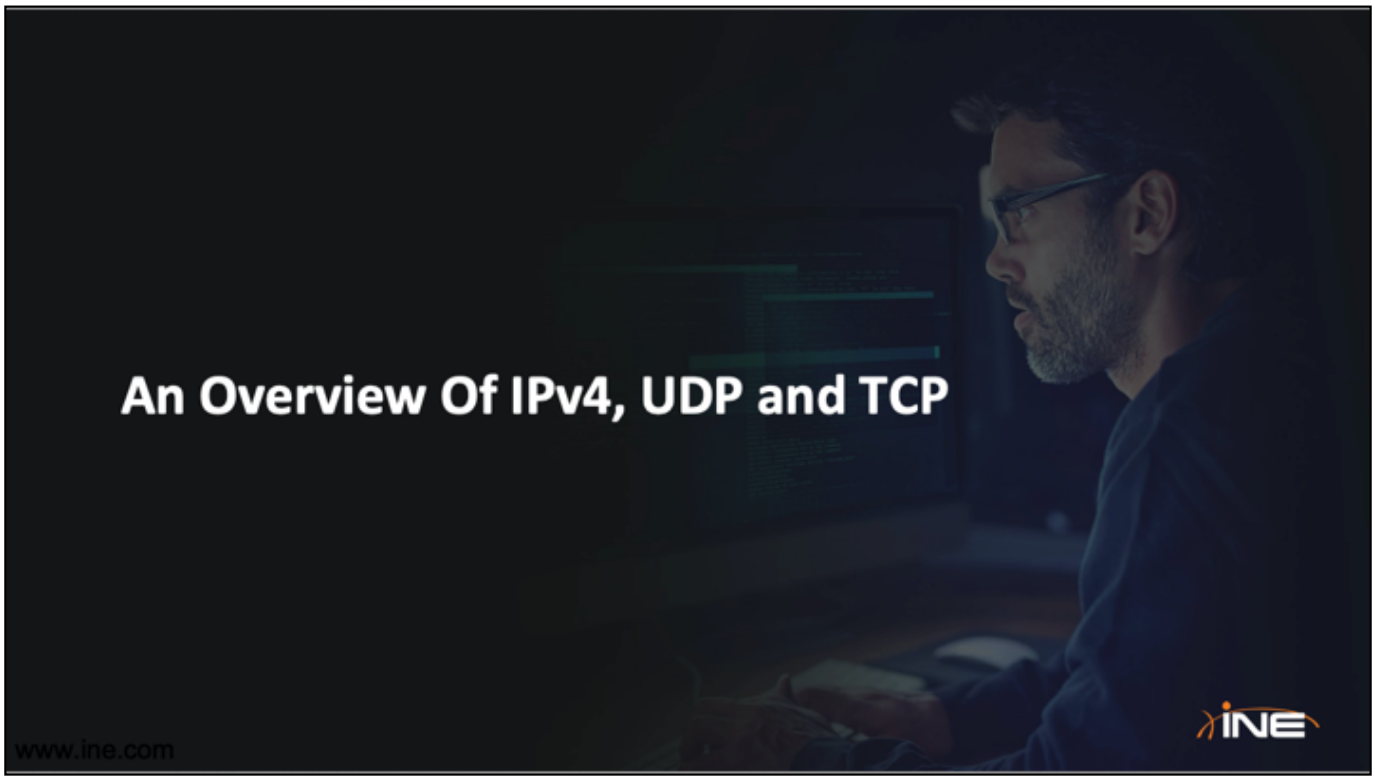
Course Introduction (continued)

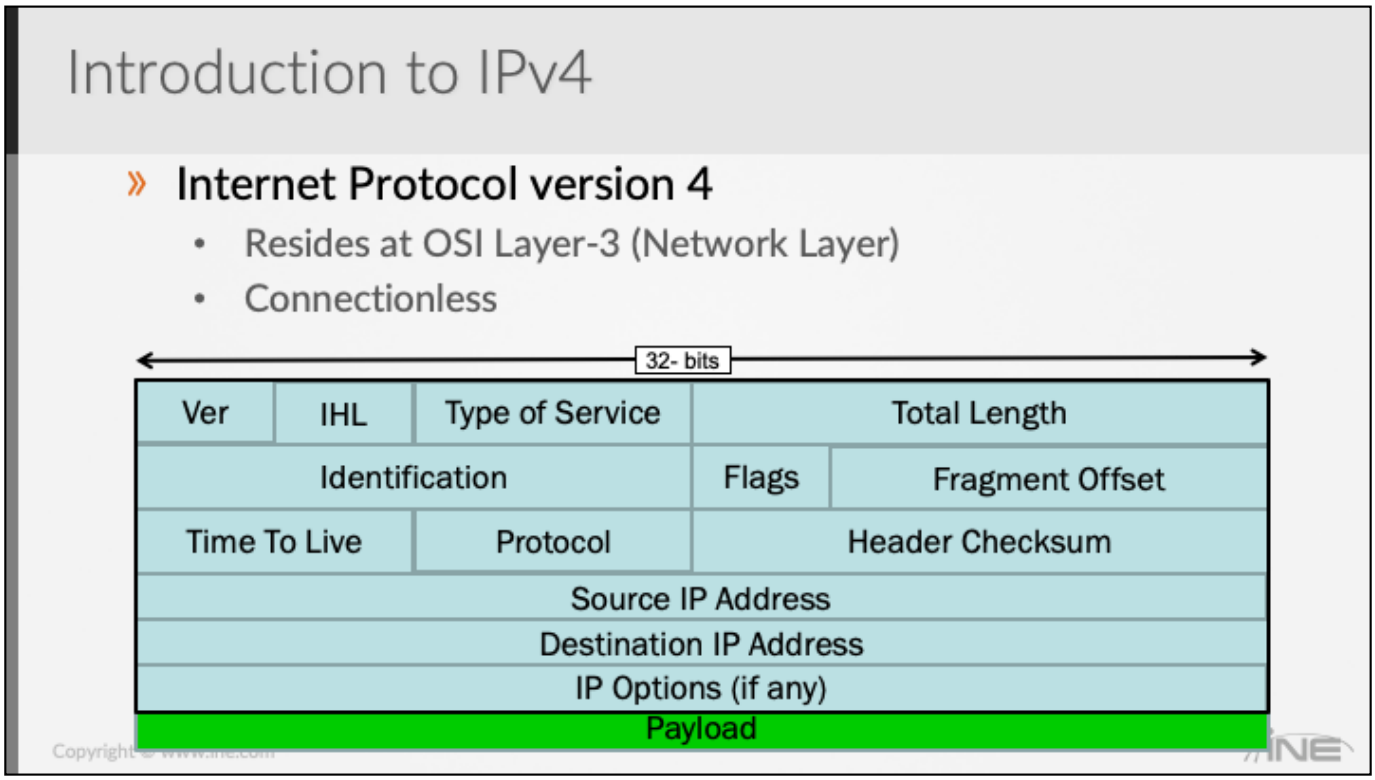
- Course Logistics
  - ✓ Start/End times
  - ✓ Breaks
- PLEASE ask questions! Otherwise the instructor will ASSUME you know something.
- Interactivity is crucial for a good learning experience.

- Prerequisites: You've watched all of the CCNA videos…or have read through all of the CCNA Certification Guides
- -
- Course Logistics – 9am until 7pm each day except Friday (we'll end by 3pm)
- -
- Breaks: 15-minute break every 90-minutes of class. / One 60-minute break at 12:30pm PST
- -
- I am assuming everyone has watched the CCNA video series. As such I'm assuming you have a base of knowledge. If I say something that you don't understand…RAISE YOUR HAND AND ASK!!
- Interactivity: Please answer my questions when asked…and please ask questions whenever you need to.

Course Agenda

- Networking & Cisco IOS Basics
- Switching (MAC Address-table, VLANs, Trunks, RSTP, etc)
- IP Routing
- Security with Access-Lists
- Wireless Networking
- Network Address Translation
- Network Programmability and SDN
- ...and much more (time permitting)





IHL = number of 32-bit “words” in the IP header.

Minimum size of IP packet = 20bytes

Maximum size of IP packet = 65,535 bytes

Common IP Protocol Numbers:

ICMP = 1

IGMP = 2

TCP = 6

UDP = 17

EIGRP = 88

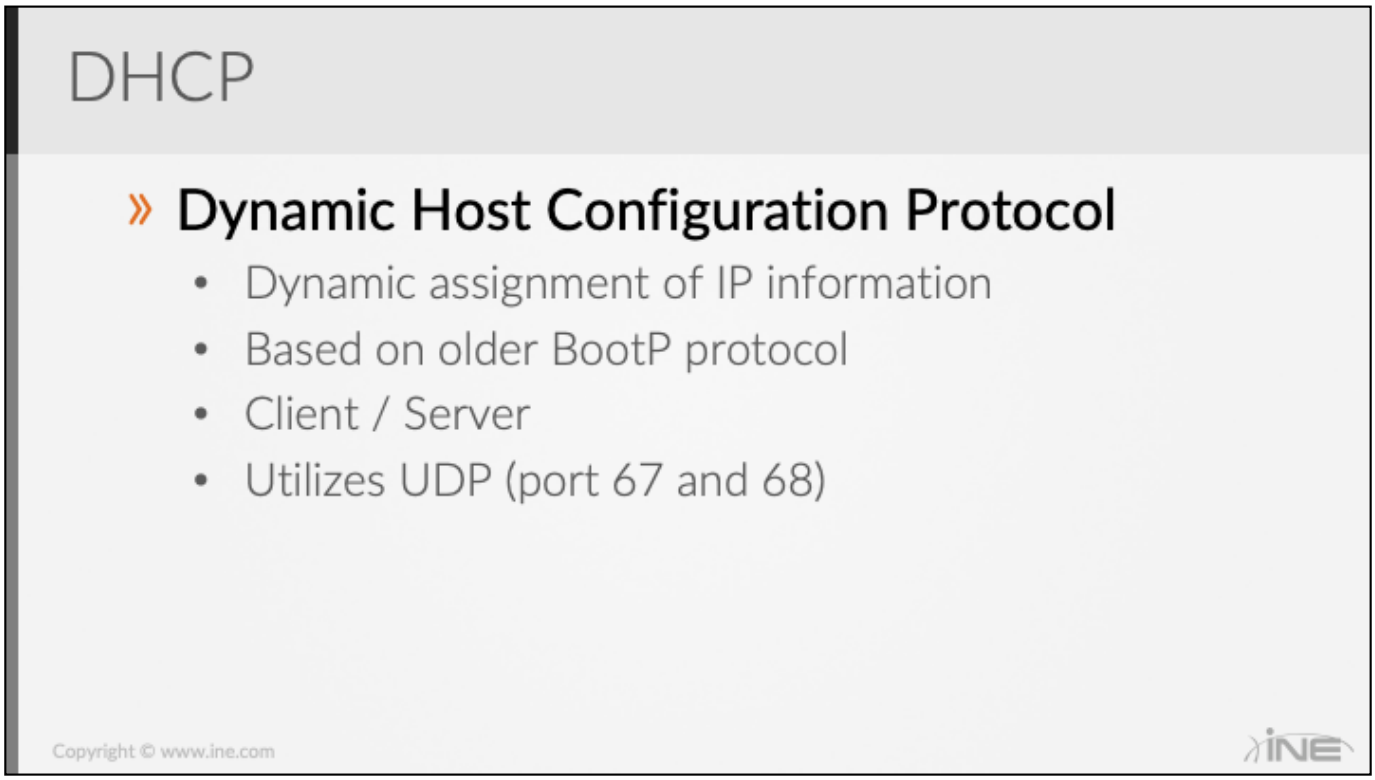
OSPF = 89

Mention that IP is not the ONLY protocol to work at Layer-3, there are other options: IPv6, IPX, Appletalk, etc

Introduction to IPv4

- 32-bit addressing system
- Logical address for a network defined by IANA
- IPv4 addresses are comprised of 4 octets
- Dotted decimal notation is used to segment the octet

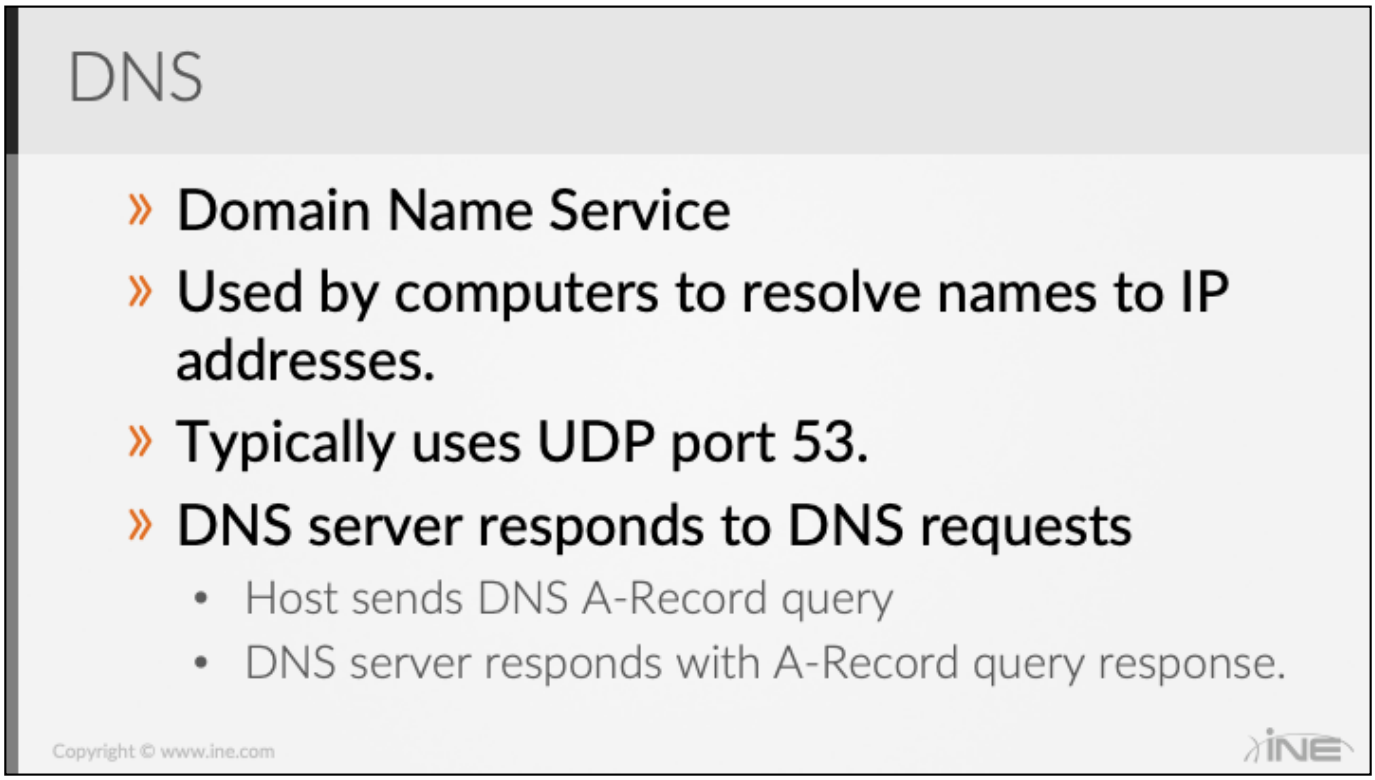
******* LAB TIME: "Lab Tasks" overview ___and___ Lab Access & Application Familiarization***



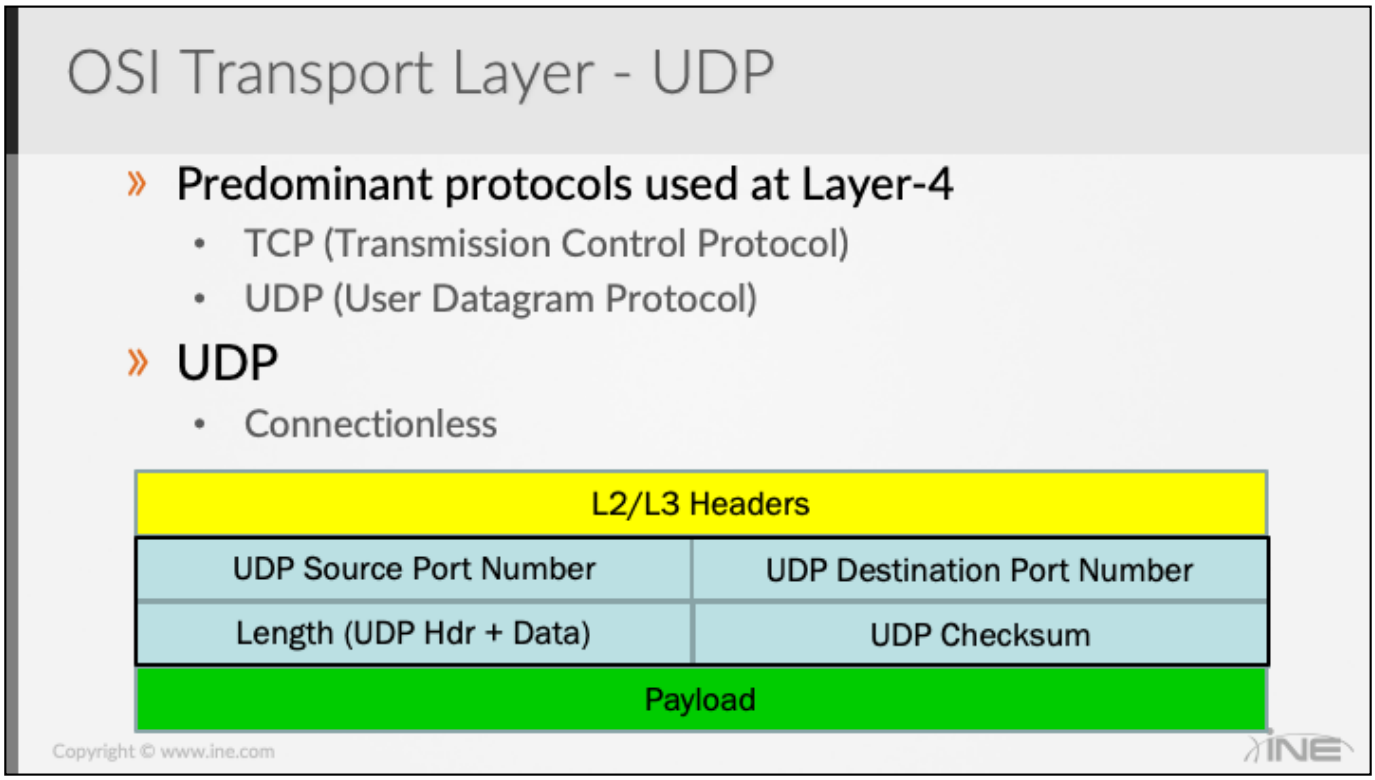
WHITEBOARD

ARP

- **Address Resolution Protocol**
  - Used to resolve Layer-2 address of hosts on same LAN.
  - Broadcast-based
- **Proxy ARP**
  - Optional feature on routers and Wi-Fi access points
  - Router replies on behalf of hosts



DNS can use TCP if the records being requested exceed the maximum size that DNS via UDP would allow…but this is rare (over 4096 bytes).

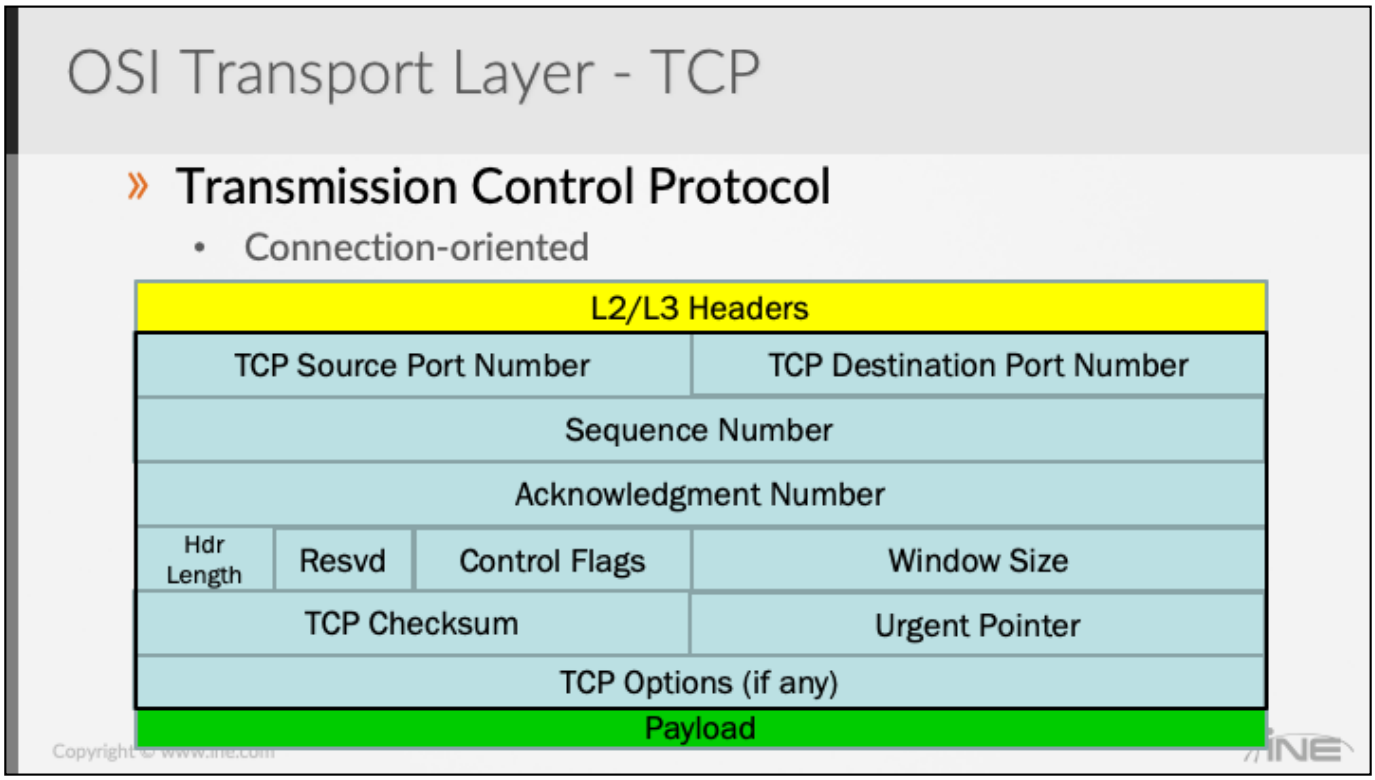


Examples of common protocols that use UDP:

TFTP – 69

DNS – 53 (can also operate with TCP)

RIP (520)



FIRST TALK ABOUT (before explaining headers) 3-way handshake

WIRESHARK Demo

Window Size = Maximum quantity of segments (in bytes) the sender is willing to accept.

Talk about: MSS (Maximum Segment Size) that is sent during TCP 3-way handshake.

Talk about: Common protocols that use TCP:

Telnet (23)

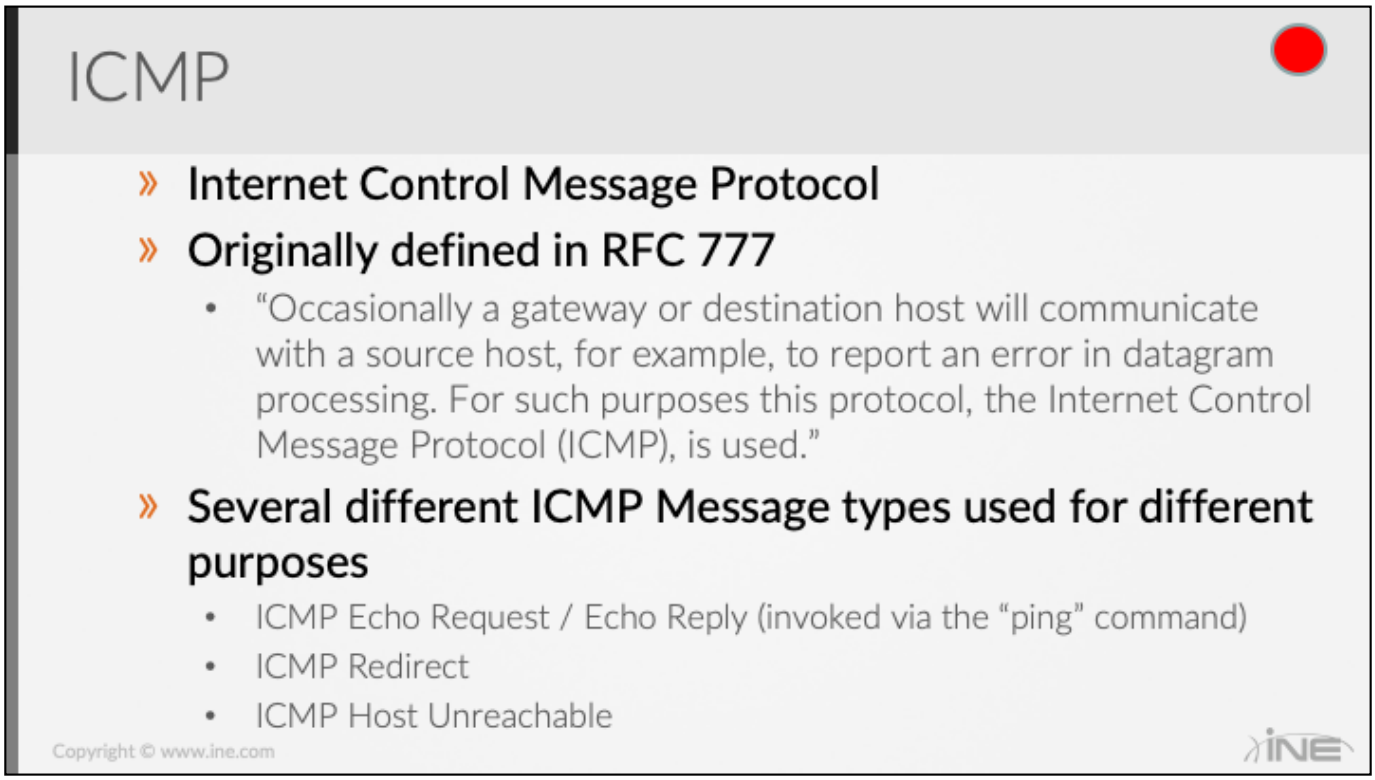
FTP (20 and 21)

POP3 (110)

SMTP (25)

HTTP (80)

HTTPS (443)



***** LAB TIME: Viewing TCP Segments**

Classes of IPv4

- **Classes:**
  - Class A: 0.0.0.0 through 127.255.255.255
  - Class B: 128.0.0.0 through 191.255.255.255
  - Class C: 192.0.0.0 through 223.255.255.255
  - Class D: 224.0.0.0 through 239.255.255.255
  - Class E: 240.0.0.0 through 255.255.255.255
    - Note: 127 ranges are considered as loopbacks
    - Note: 169.254 ranges are considered as APIPA

Subnet Mask

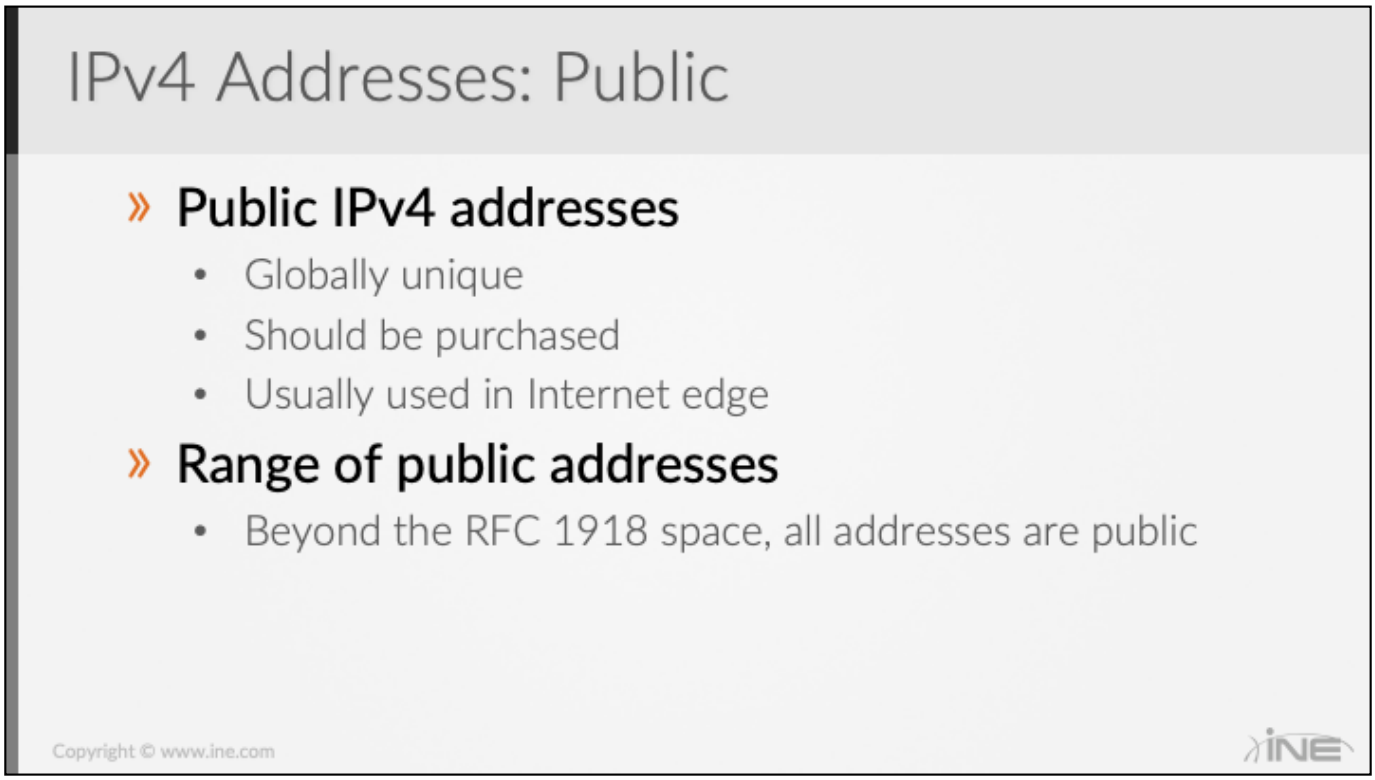
- Helps identify network and host portion of network
- Default subnet masks:
  - Class A: 255.0.0.0 or /8
  - Class B: 255.255.0.0 or /16
  - Class C: 255.255.255.0 or /24
- Typically called classful address

IPv4 Addresses: Public & Private

- IP addresses "leased" to a corporation are known as ***public IP addresses***.
- IP addresses that are unregistered and may overlap from one company to the next, are known as ***private IP addresses***.

IPv4 Addresses: Private

- **Private IPv4 address:**
  - Defined in RFC 1918
  - For internal use only
- **Range of private address**
  - Class A : 10.0.0.0 through 10.255.255.255
  - Class B : 172.16.0.0 through 172.31.255.255
  - Class C : 192.168.0.0 through 192.168.255.255



Binary to Decimal (vice-versa)

How a subnet mask is used along with an IP address to determine the subnet/network.

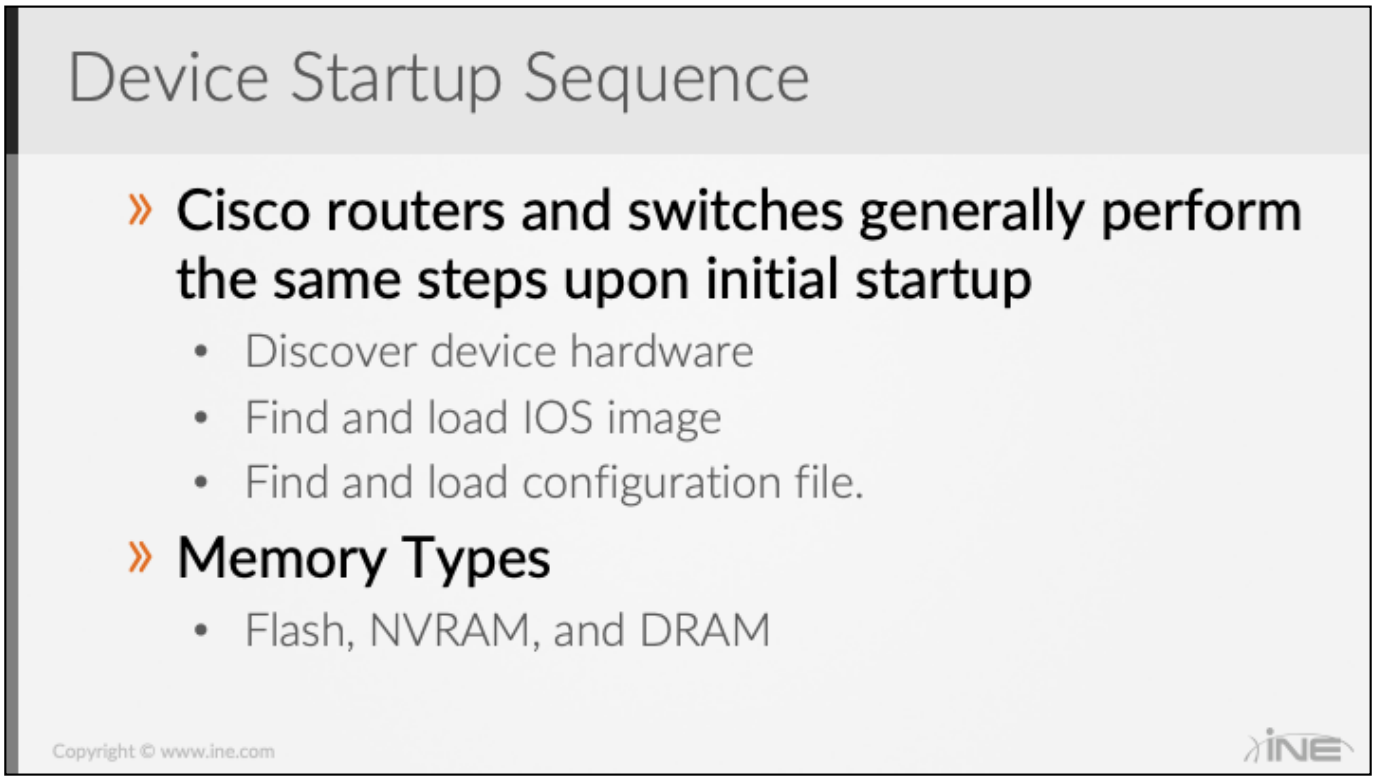
----Concept of network, broadcast, and host addresses

Given an address, be able to determine if it is a network, broadcast, or host address.

Given a host address, determine the network and broadcast addresses it belongs to.

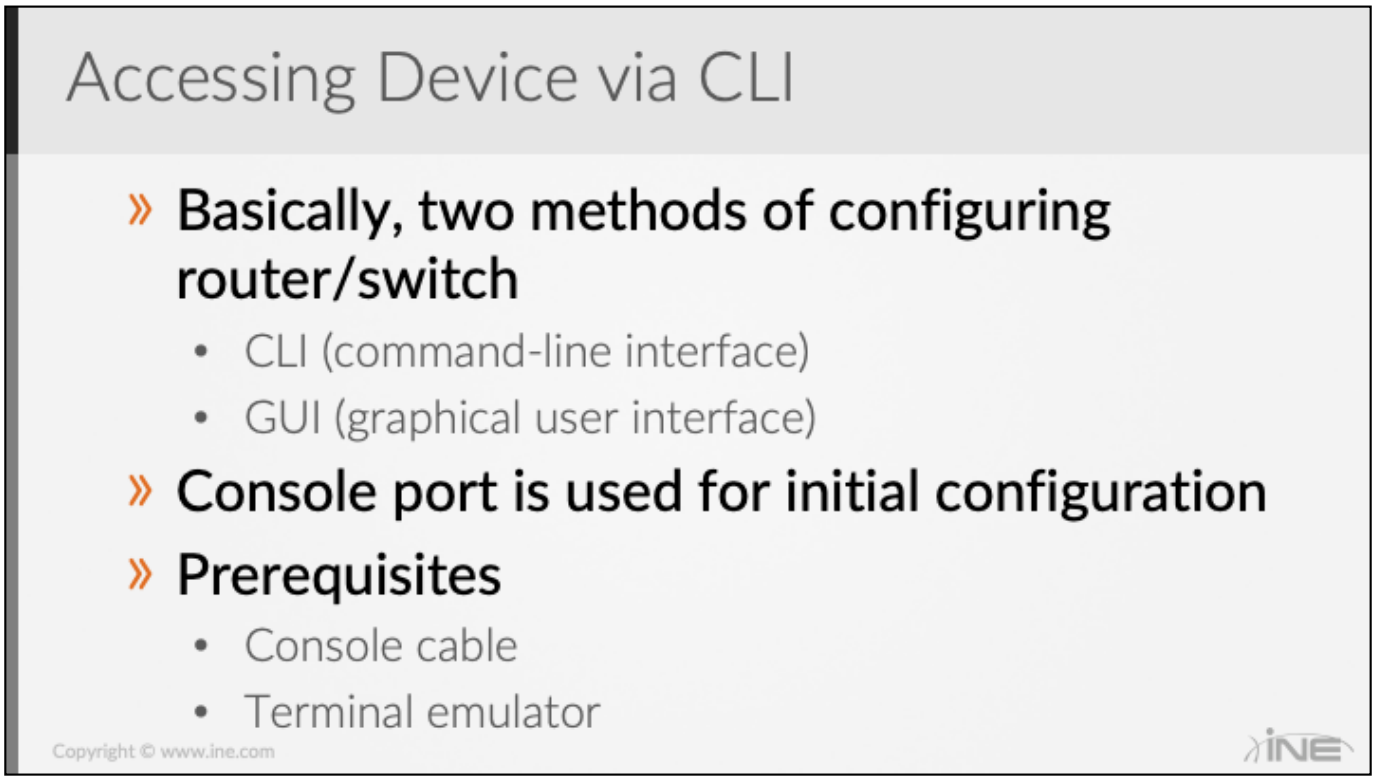
Introduction To IOS

- Internetworking Operating System
- Native software for Cisco routers and switches
- Cisco develops different IOSs for different platforms
  - Example: Cisco 1841, Cisco 2821, etc.
- Usually operated through CLI



WHITEBOARD: Memory types and what is stored

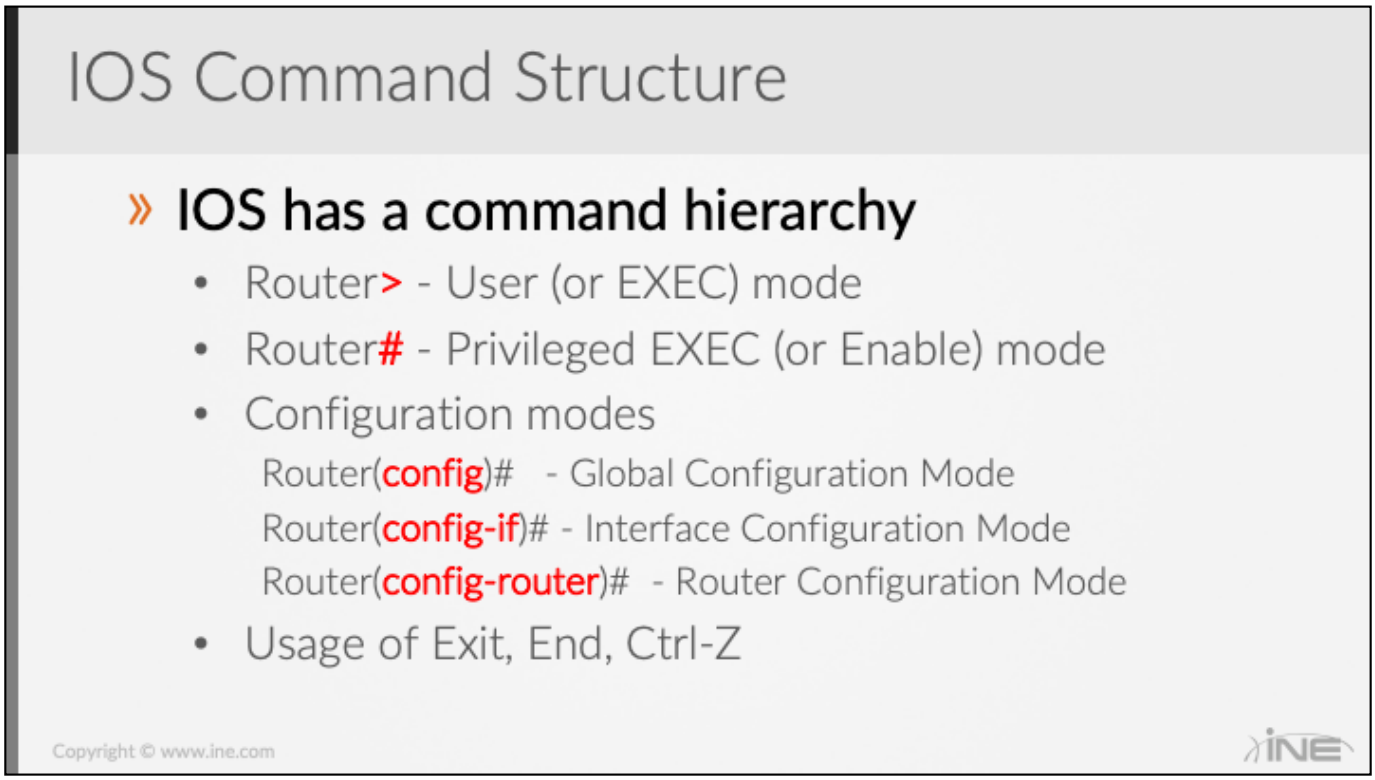
- Flash: Cisco IOS image
- NVRAM: Startup-config
- DRAM: Running-Config/ running IOS image (also called, “system” memory in output of dir all command)



9600 (baud)-8 (data bits)-None (parity bits)-1 (stop bit) – No flow control

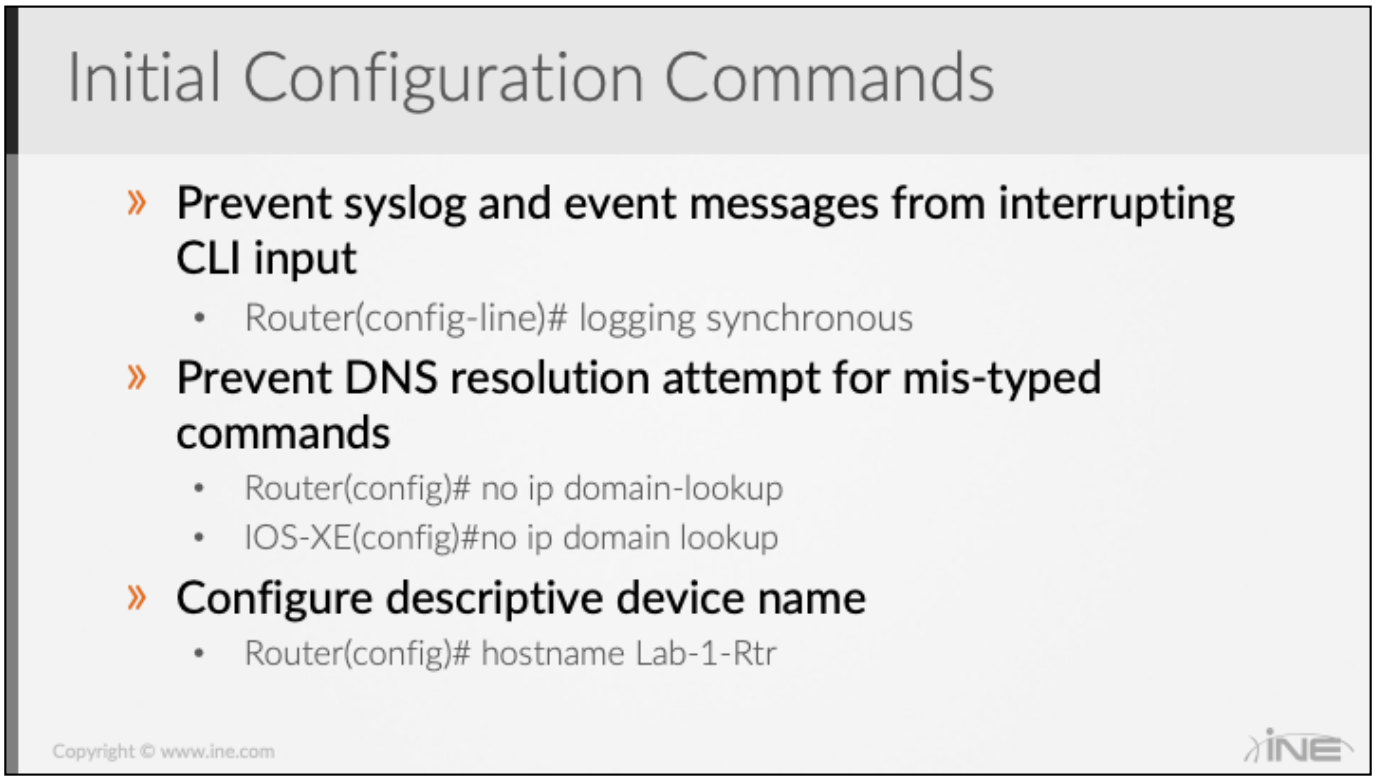
Accessing Device via CLI

- Connect console cable into the "console" port of a Cisco device
- Open terminal emulator software like Putty or SecureCRT
- Choose serial option with default baud rate, such as 9600



Demonstration

- **Initial Configuration Dialogue**
- **Usage of built-in help**
- **Tab Key**
- **Ctrl-A and Ctrl-E**
- **Command history**



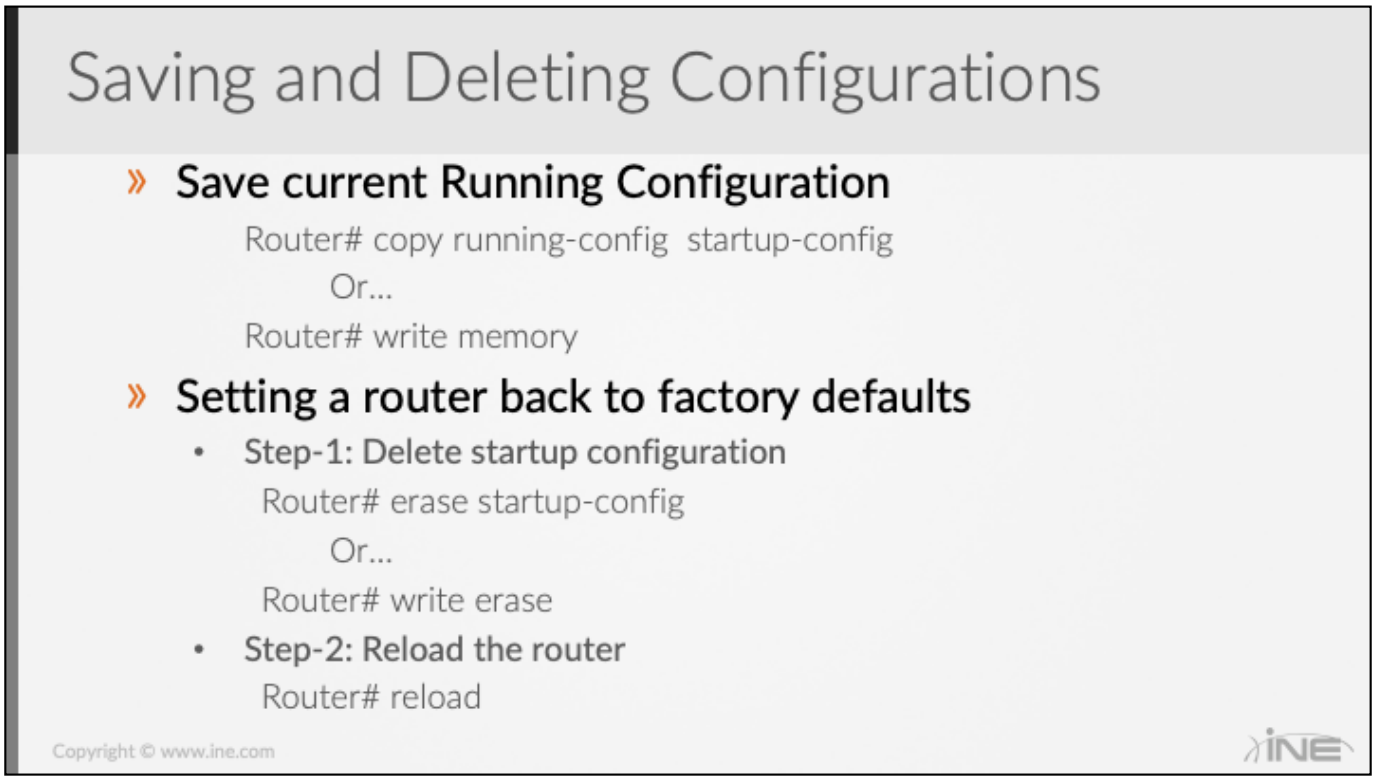
Note that CSR routers running IOS-XE don't have the hyphen in the command "no ip domain lookup".

Initial Configuration Commands

- **Configure informative banner**
  - Router(config)# banner motd
- **Add IPv4 address to an interface**
  - Router(config-if)#ip address <address><mask>
  - Router(config-if)# no shutdown
- Verifying interface naming conventions and IP address assignments:
  - Router#**show ip interface brief**

Monitoring Memory and Images

- Display current IOS version running
  - Router# show version
- Display all memory locations and file names
  - Router# dir all
- Display saved, startup configuration file
  - Router# show startup-config
- Display current running configuration
  - Router# show running-config



DEMONSTRATION: How to factory reset a router.

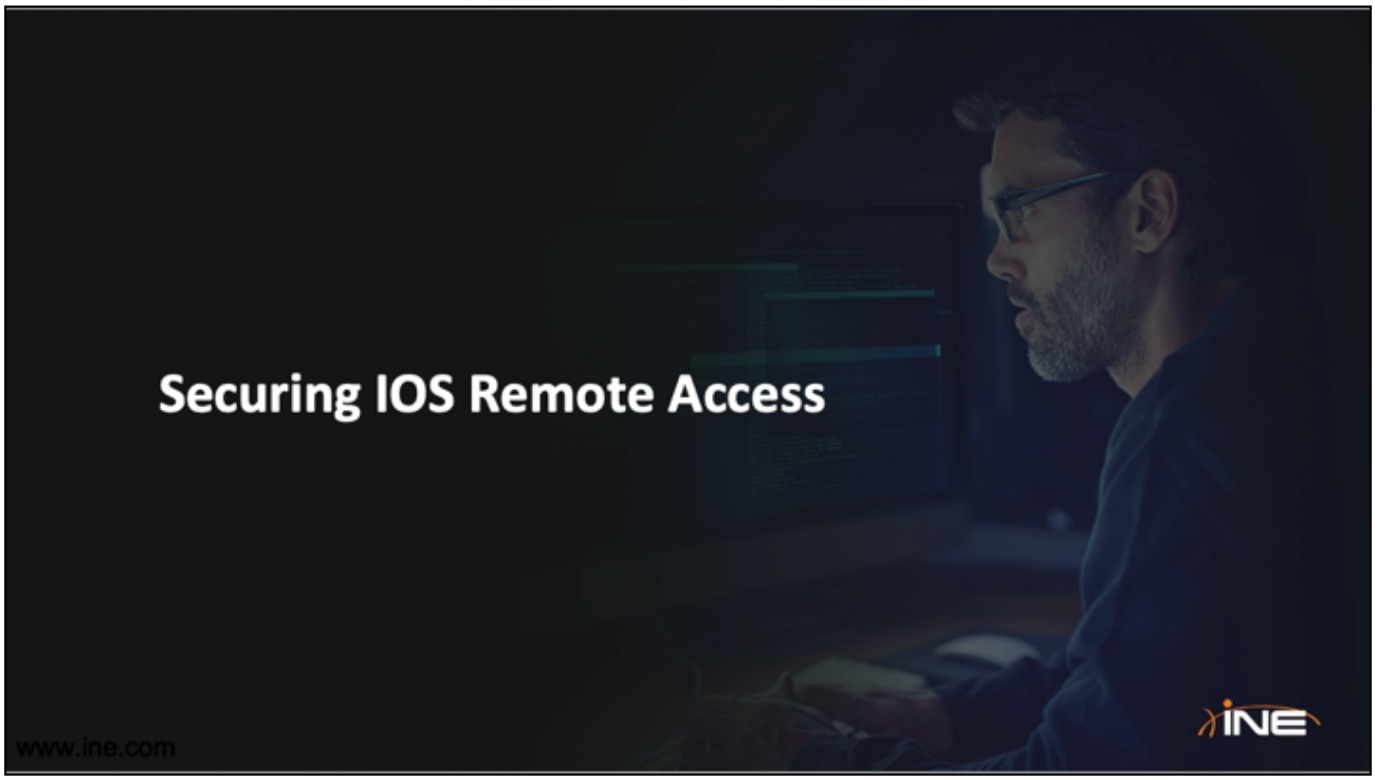
Reverting To Saved Configs

- Running Configuration can be saved with a unique name

  Router# copy running-config flash:Keith-config

- Current running-configuration can be swapped/replaced with saved configurations

```
Router#config replace flash:Keith-config
This will apply all necessary additions and deletions
to replace the current running configuration with the
contents of the specified configuration file, which is
assumed to be a complete configuration, not a partial
configuration. Enter Y if you are sure you want to proceed. ? [no]: y
```



Securing Device Access

- **Configuring enable password**
  - Switch(config)# enable password <password>

  OR
  - Switch(config)# enable secret <password>
- **Configuring console password**
  - Switch(config)# line console 0
  - Switch(config-line)# password <password>

Remote Device Access

- **Telnet**
  - TCP/IP protocol for connection to remote shells
  - Takes the same commands you enter in the console and wraps them in a TCP/IP header
  - Entire message body is sent in clear text
- **SSH (Secure Shell)**
  - Same objective as Telnet
  - Also utilizes TCP/IP
  - Encrypts the message body thus is more secure than Telnet

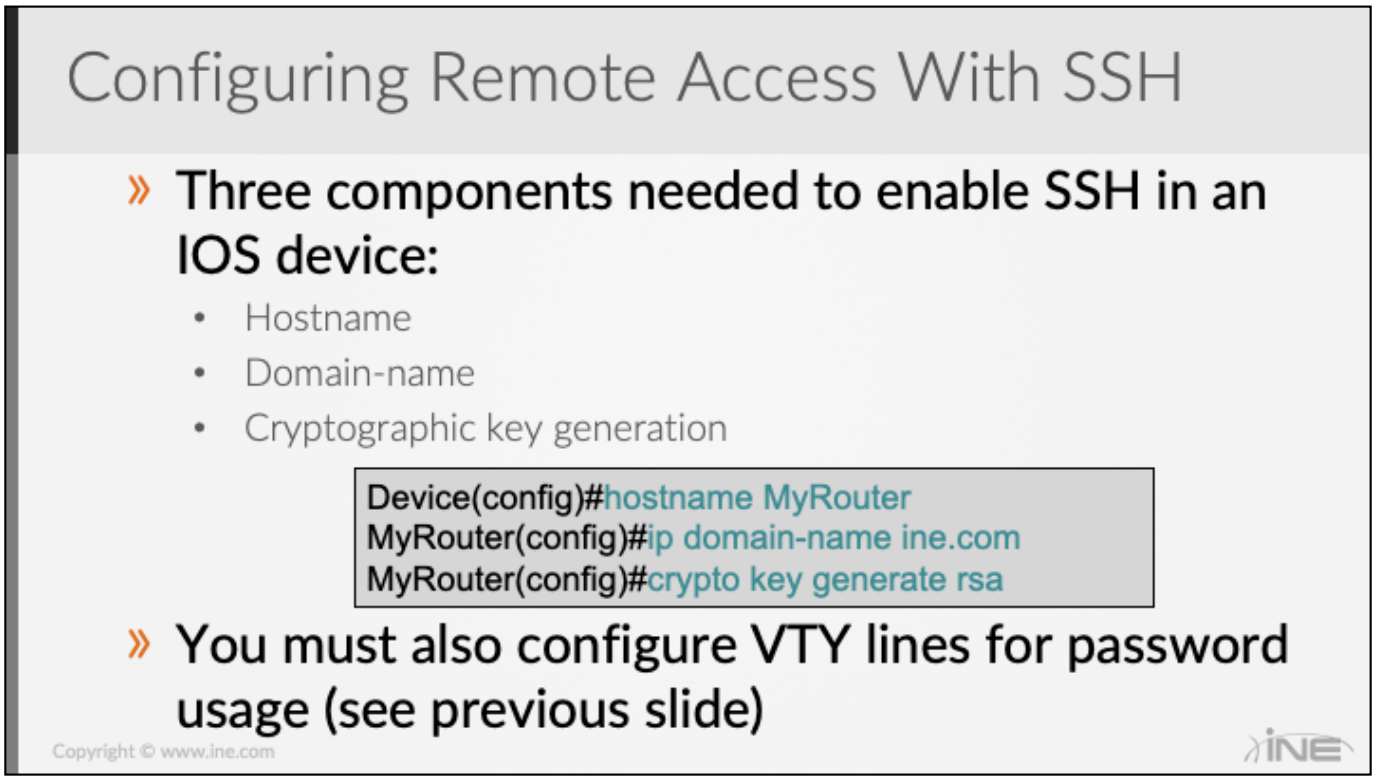
Configuring Remote Access With Telnet

Configuring Telnet password

- Switch(config)# line vty 0 4
- Switch(config-line)# password <password>
- Switch(config-line)# login

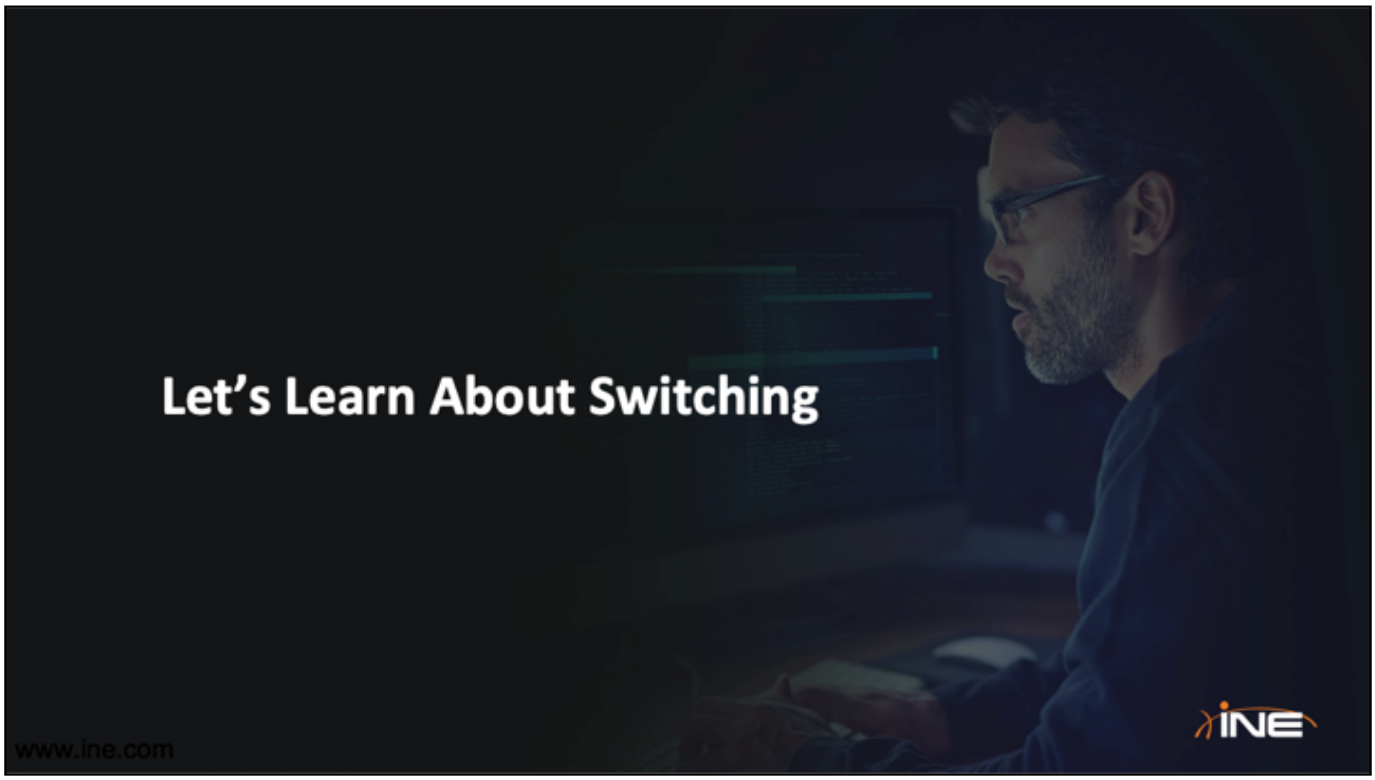
OR

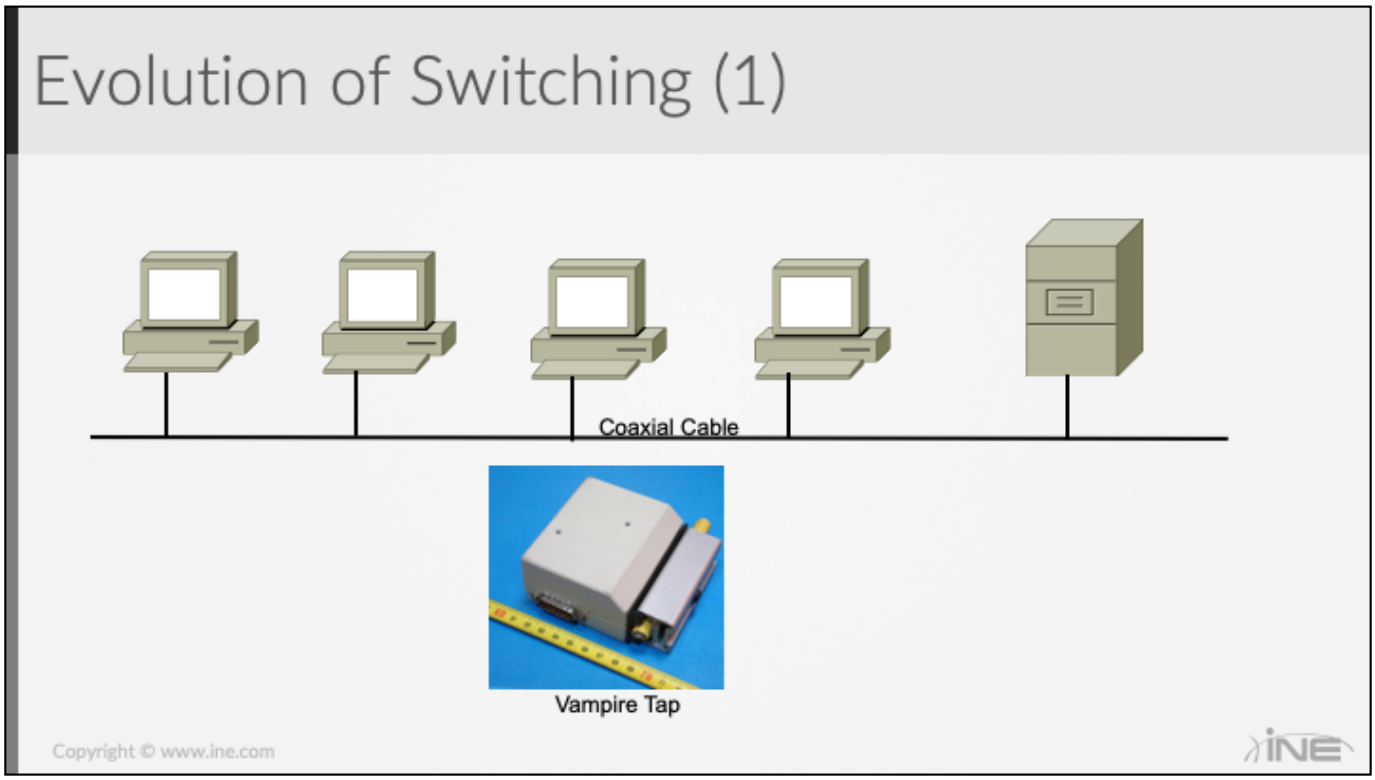
- Switch(config)# username <username> privilege 15 password <password>
- Switch(config-line)# login local



Although most routers will allow you to select the default size of 512-bits for your RSA Crypto Key, on some routers this will prevent SSH from working. As a best practice you should configure a size of at least 1024-bits.

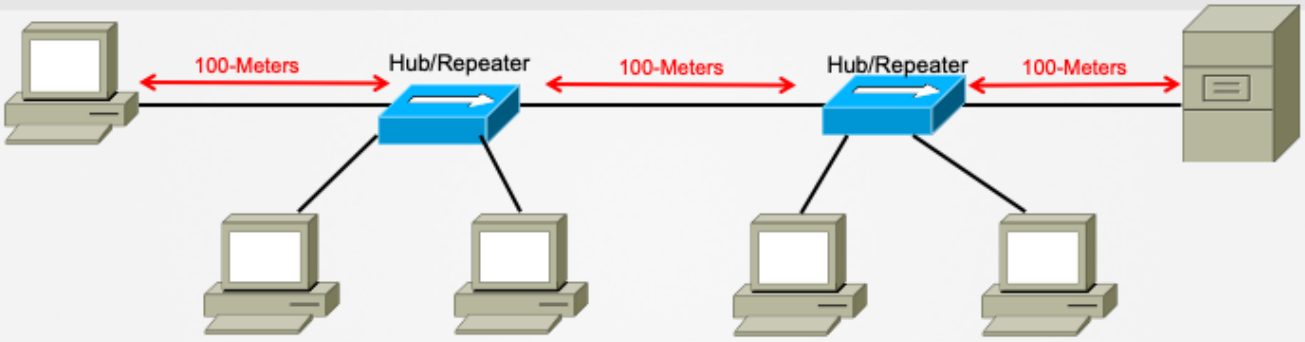
****** LAB TASK TIME: Introduction To Basic IOS CLI Commands**



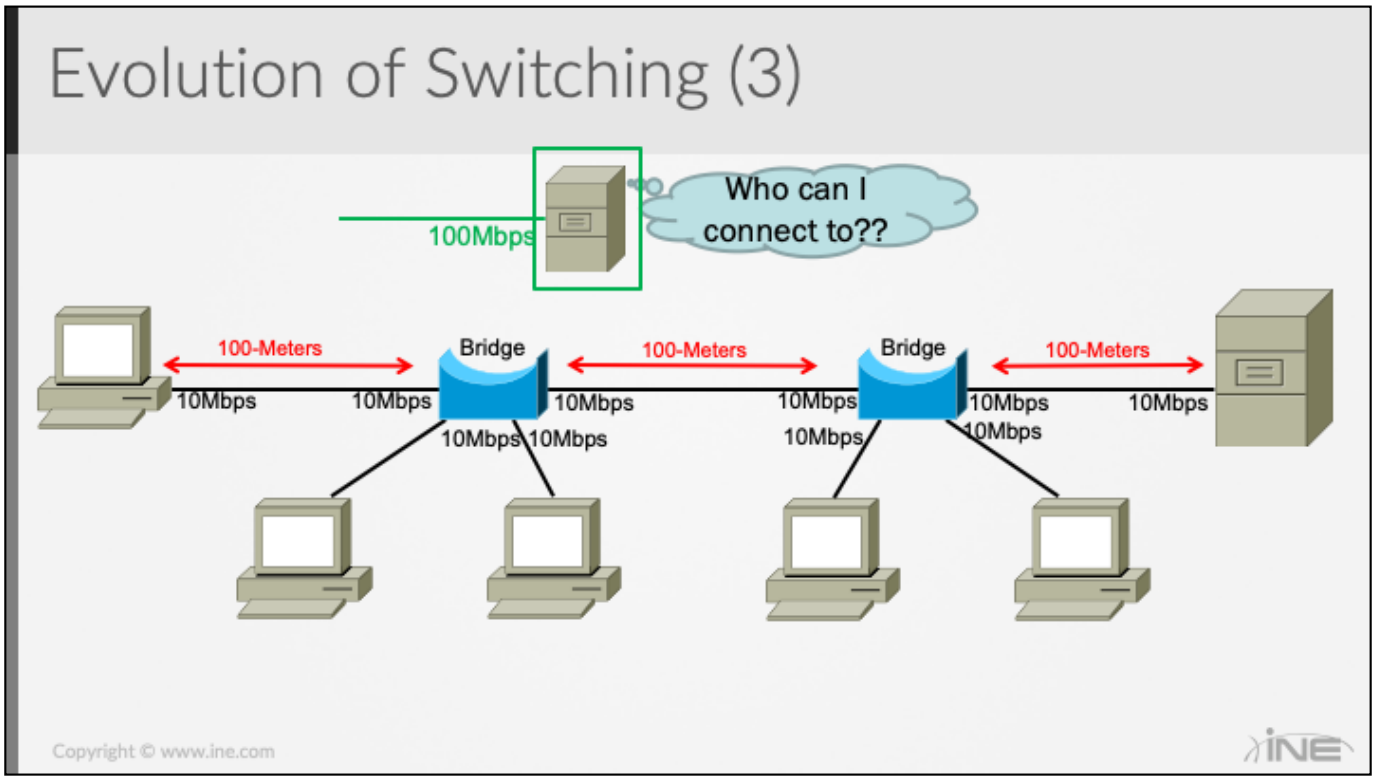


Distance limitations = 100-meters

Evolution of Switching (2)



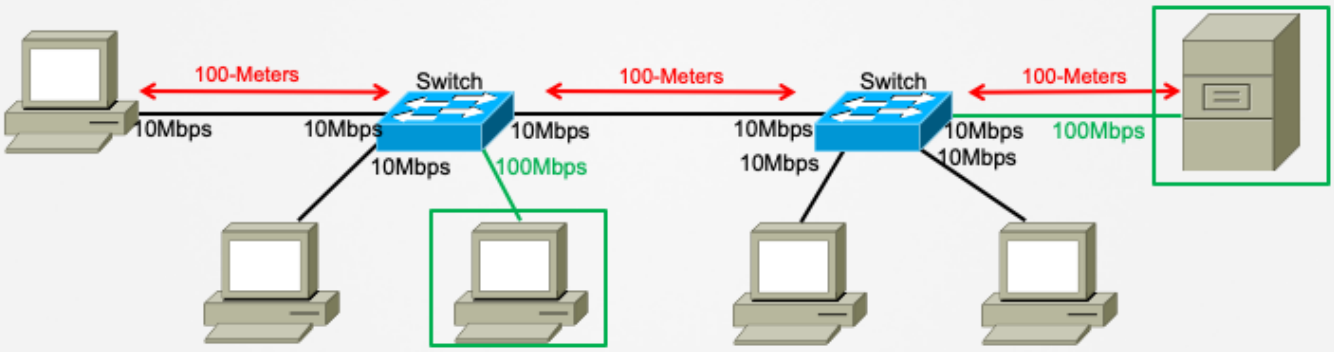
Ethernet Transceiver



Bridge:

- Limited qty of ports
- Ports all the same speed

Evolution of Switching (4)

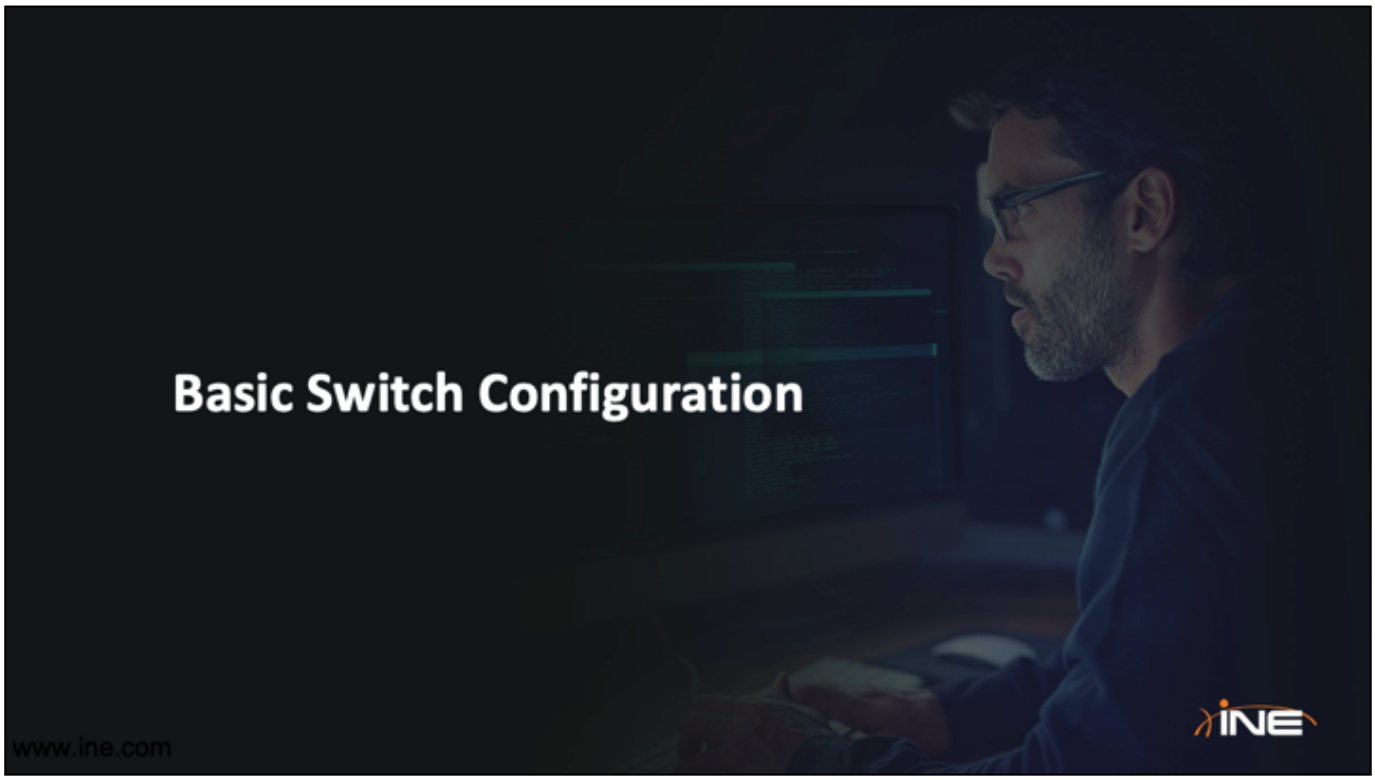


Intro to Switching

- Switch is a multiport bridge
  - More ports than a bridge
  - Mixture of port speeds & types
- Forwards frames based on the MAC address table
- Separates collision domain
- Operates in data link layer

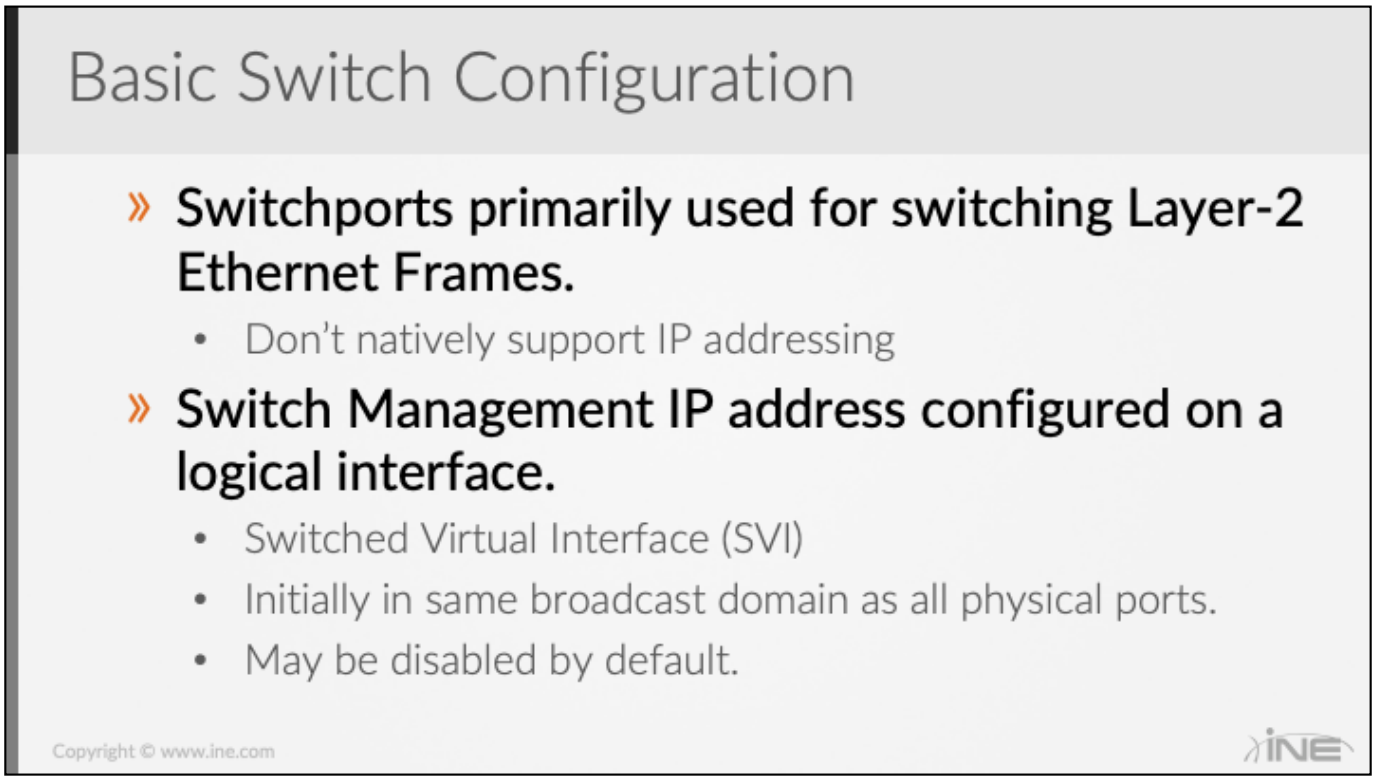
MAC-Address Table

- **Switch MAC Learning**
  - Based on Source MAC Address
  - Addresses age out after inactivity-timer
- **Switching forwarding**
  - Based on Destination MAC
  - Broadcast/Multicast/Unknown flooding
  - All ports initially in one, large, broadcast domain



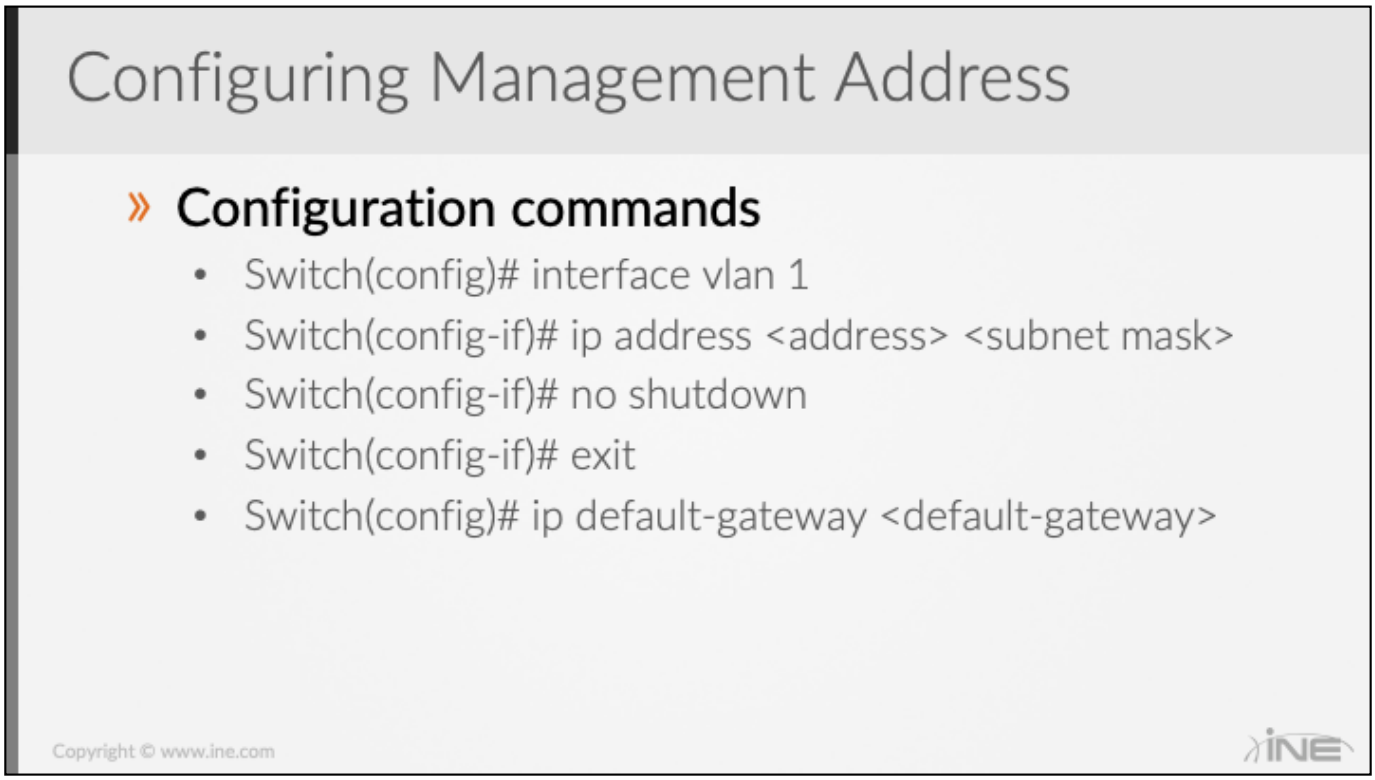
Initial Tasks

- **Perform initial configuration on Switch**
  - Hostname
  - Enable password
  - Console Password
  - Banner
  - "Convenience" commands
    - No ip domain-lookup
    - Logging synchronous
- **Verify naming convention of ports on your switch**
  - Show ip interface brief



EXPLAIN: Logical versus physical interfaces

Talk about the differences between routers (interfaces) and switches (ports and SVIs) and where IP addresses can be configured.



EXPLAIN: SVI must have associated physical ports that are “Up” in same VLAN for SVI to also be “Up”.

Verification

- **Verification commands**
  - PING (Packet Internet Grouper)
  - Traceroute
- **Show commands**
  - Show ip interface brief
  - Show running-configuration
  - Show version
  - Show mac address-table

Configuration Example (Switch-to-Host)

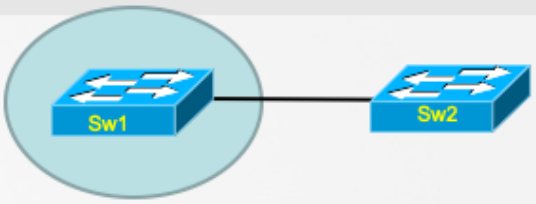
Configuration on Sw1

- Switch> enable
- Switch# configure terminal
- Switch(config)# hostname Sw1
- Sw1(config)# interface GigabitEthernet1/0/5
- Sw1(config-if)# description **Connection to Bob Laptop**
- Sw1(config-if)# switchport mode access
- Sw1(config-if)# no shutdown

Explain how some switches (Layer-2) have “Switch” as hostname (default) and some (Multilayer Switches) may have “Router” as the default hostname.

Configuration Example (Switch-to-Switch)

Configuration on Sw1



- Switch> enable
- Switch# configure terminal
- Switch(config)# hostname Sw1
- Sw1(config)# interface GigabitEthernet1/0/1
- Sw1(config-if)# description **Connection to Sw2**
- Sw1(config-if)# switchport mode dynamic desirable
- Sw1(config-if)# no shutdown

Explain how some switches (Layer-2) have “Switch” as hostname (default) and some (Multilayer Switches) may have “Router” as the default hostname.

Configuration Example (Switch-to-Switch)

Configuration on Sw2

- Switch> enable
- Switch# configure terminal
- Switch(config)# hostname Sw2
- Sw2(config)# interface GigabitEthernet1/0/1
- Sw2(config-if)# description **Connection to Sw1**
- Sw2(config-if)# switchport mode dynamic desirable
- Sw2(config-if)# no shutdown

Explain how some switches (Layer-2) have “Switch” as hostname (default) and some (Multilayer Switches) may have “Router” as the default hostname.

Configuring Interface Ranges

- **"Interface Range" can be useful when applying the same command(s) across multiple interfaces**
  - Switch(config)# **interface range** Fast0/1-7 , Fast0/12 , Gig1/1-2
  - Switch(config-if-range)#no shutdown
  - Switch(config-if-range)#switchport mode access

Viewing the MAC Address-Table

```
Switch#show mac address-table ?
  address       Address to lookup in the table
  aging-time    MAC address table aging parameters
  count         Number of MAC addresses in the table
  dynamic       List dynamic MAC addresses
  interface     List MAC adresses on a specific interface
  learning      Display learning on VLAN or interface
  move          MAC Move information
  multicast     List multicast MAC addresses
  notification  MAC notification parameters and history table
  secure        List secure MAC addresses
  static        List static MAC addresses
  vlan          List MAC addresses on a specific vlan
  |             Output modifiers
  <cr>
```


CCNA Emphasis:

Address

Dynamic

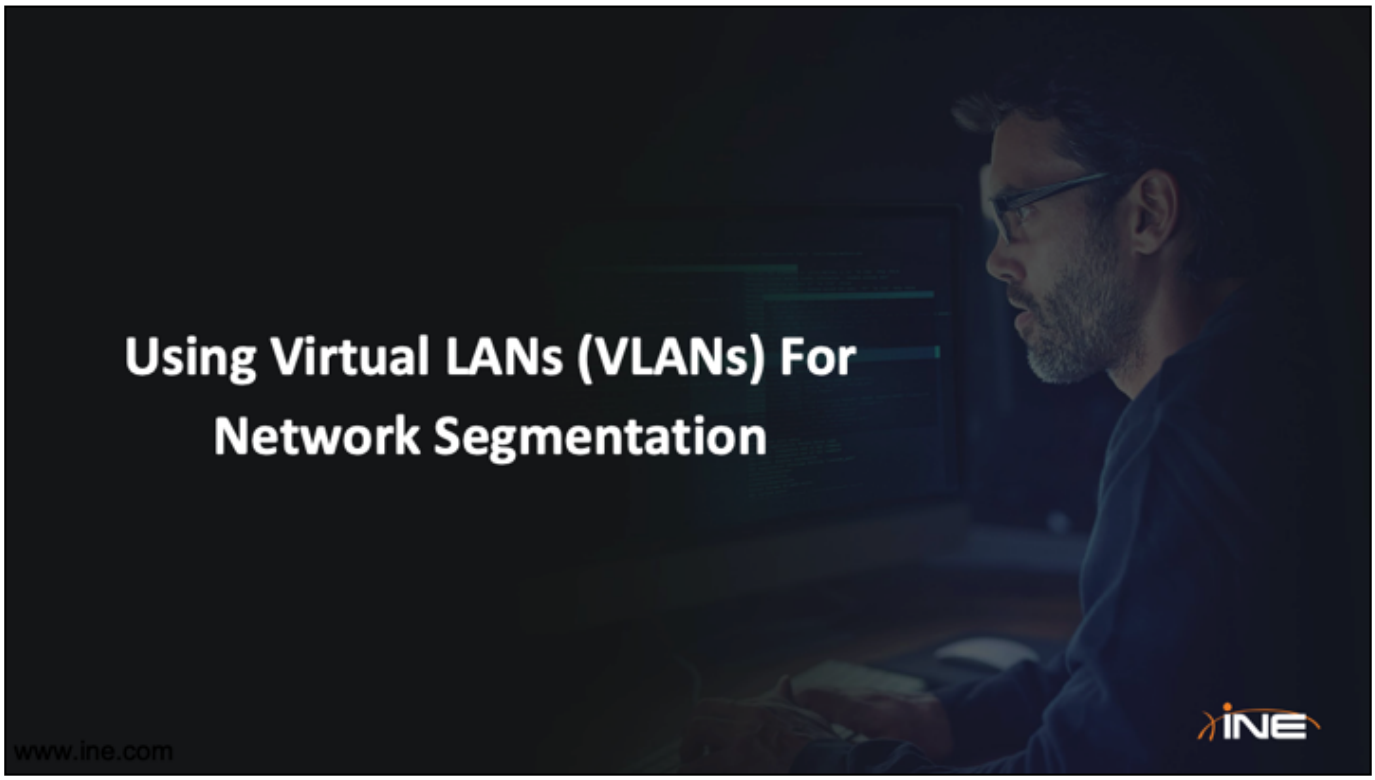
Interface

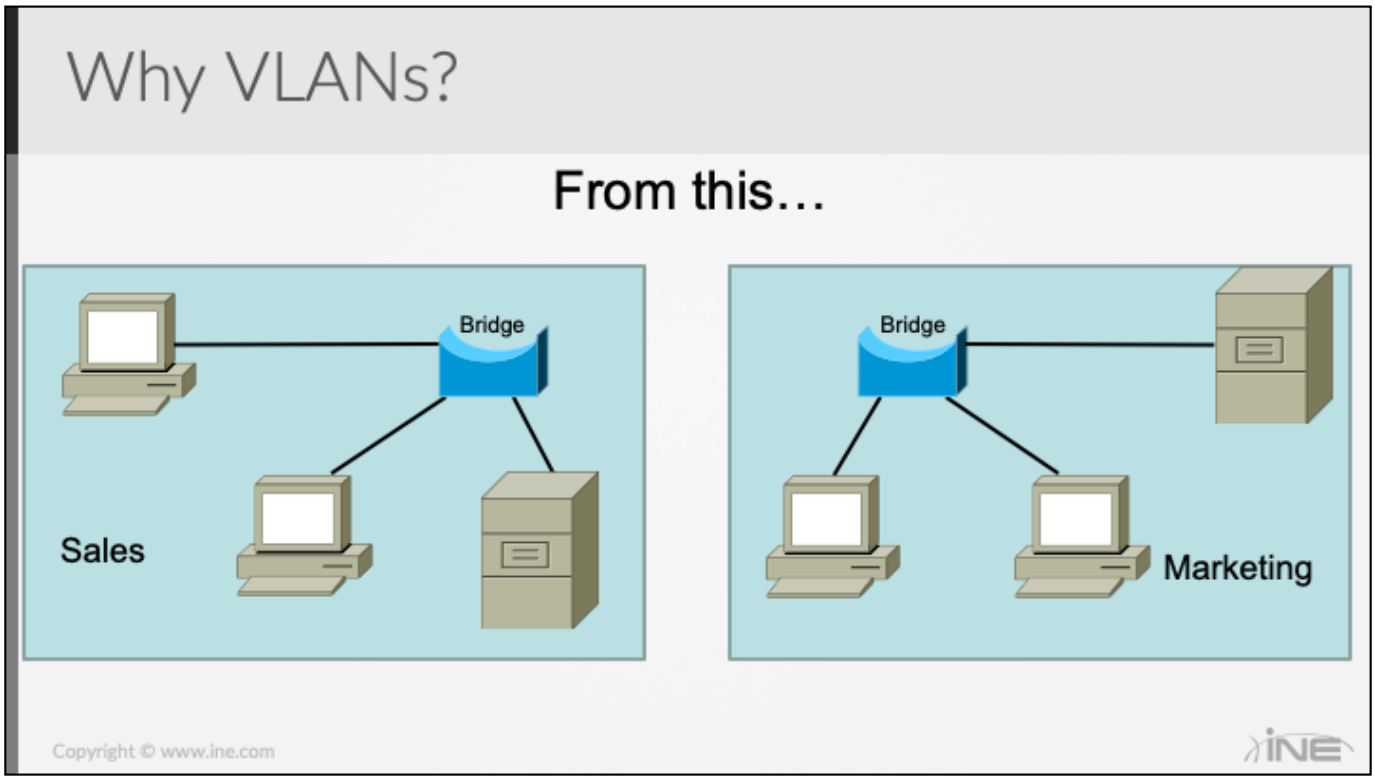
Adding Static Entries

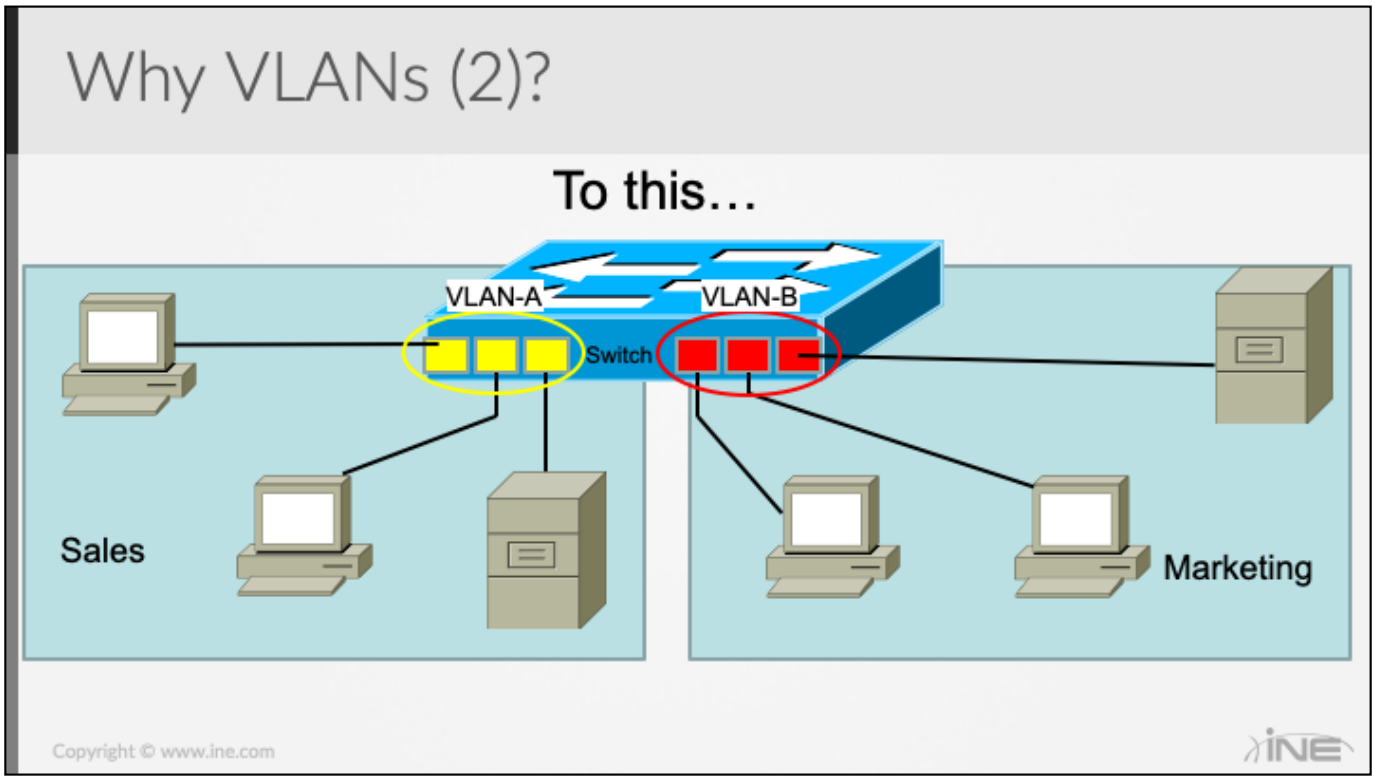
```
Switch#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#mac add
Switch(config)#mac address-table ?
  aging-time    Set MAC address table entry maximum age
  learning      Enable MAC table learning feature
  move          Move keyword
  notification  Enable/Disable MAC Notification on the switch
  static        static keyword

Switch(config)#mac address-table static ?
  H.H.H  48 bit mac address

Switch(config)#mac address-table static
```

Basic Troubleshooting

- Check for correct cable type
- Ensure `no shutdown` command in the interface (disabled by default)
- For interconnected Access Ports, check for same VLAN
- For interconnected Trunk, verify DTP compatibility modes







Features

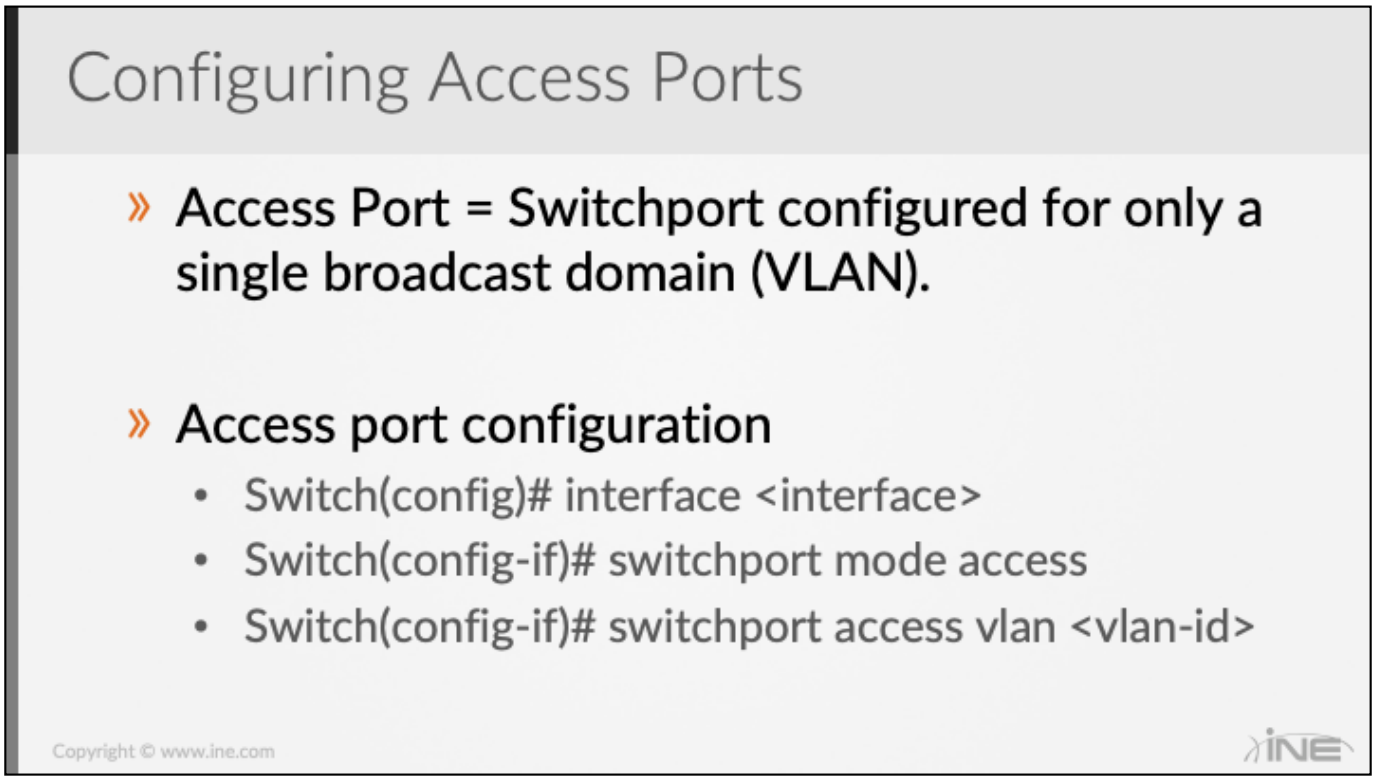
- Separates broadcast domain
- Provides better security
- Controls broadcast like ARP
- Provides hierarchical subnet usage

VLAN Ranges

- VLAN range is 1-4094
- 1-1001 are usable normal-range VLANs
- 1002-1005 are reserved for token ring
- 1006-4094 are extended-range VLANs

Configuring VLAN

- **Legacy method with VLAN database**
  - Sw1# vlan database
  - Sw1(vlan-database)# vlan <vlan-id>
  - Sw1(vlan-database)# end
- **Modern method of configuring VLAN**
  - Sw1(config)# vlan <vlan id>
  - Sw1(config-vlan)# name <vlan name>



- On some multilayer switches you may need to first enter the “switchport” command by itself – default = routed port.
- Switchport mode trunk command may not work without first entering “switchport trunk encapsulation” command.

Verifying VLAN

- **Verification commands**
  - Sw1# show vlan <brief>
  - Sw1# show interface <type><number> switchport

Port Types

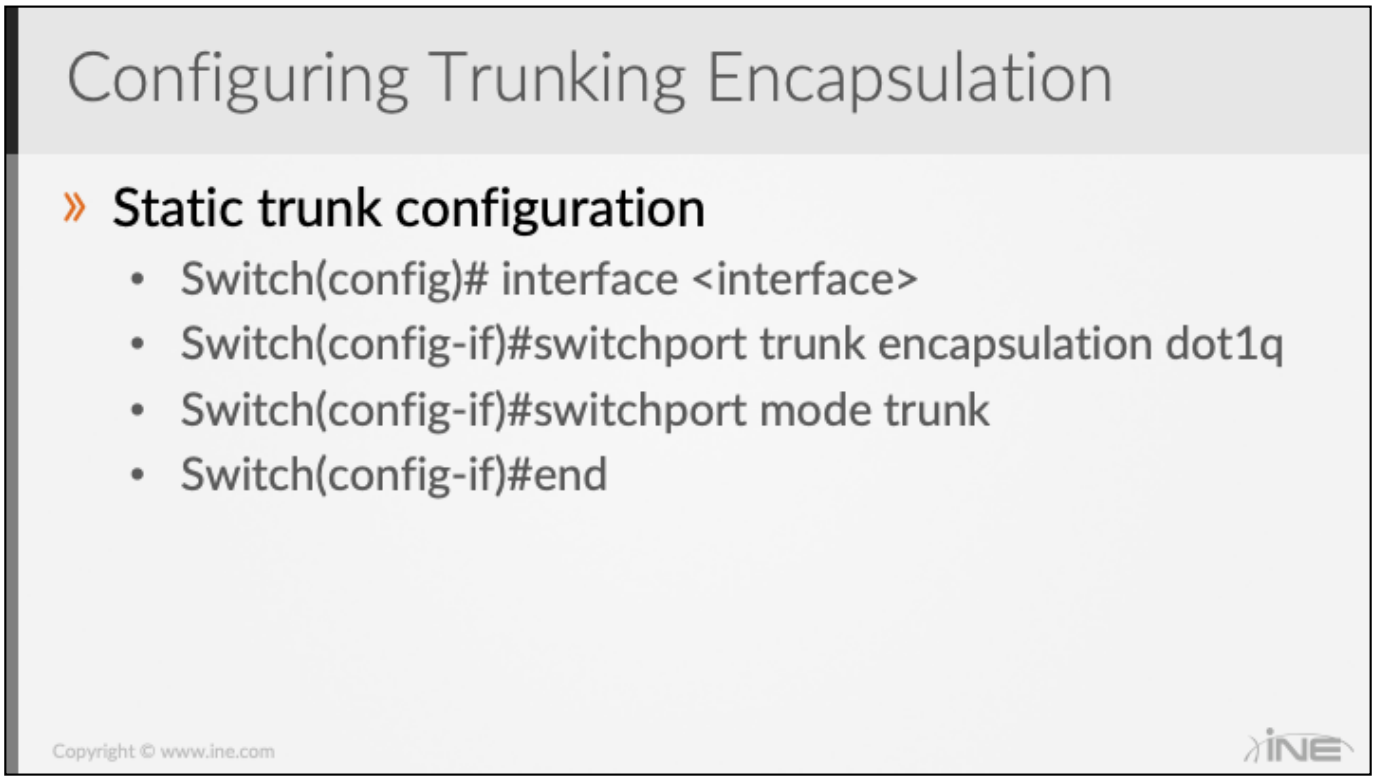
- **Trunk Port**
  - Can have two or more VLANs configured
  - Can carry multiple VLAN information
  - By default, all the VLAN traffic is allowed from a trunk port

Trunking Encapsulation

- 802.1Q
  - Open standard
  - All traffic except native VLAN is inserted with a 802.1q tag
  - Support concept of native VLAN

Native VLAN

- IEEE 802.1Q supported feature
- Frame without tag is considered native VLAN traffic
- Must match on both ends of the trunk
- By default, native VLAN is 1
- Can be changed using the **`switchport trunk native vlan <vlan-id>`** command



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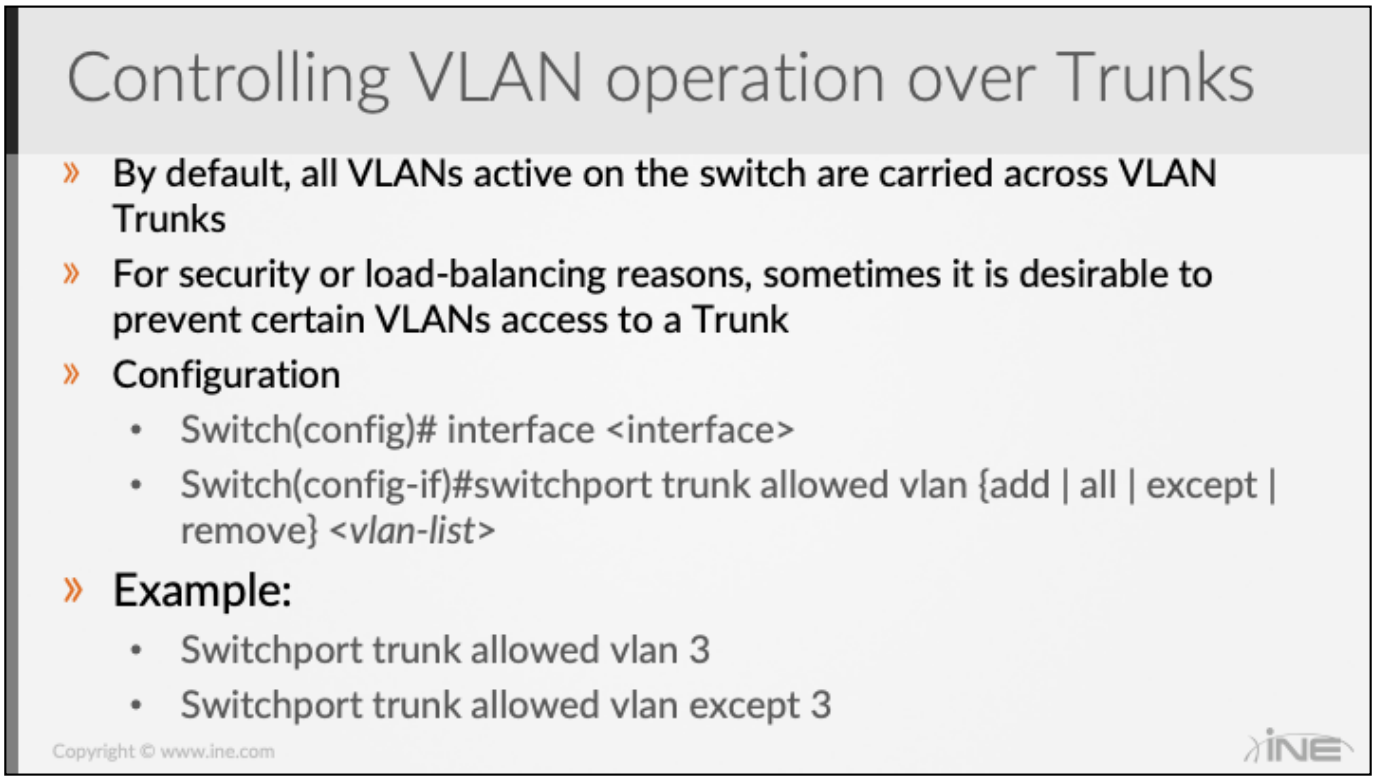
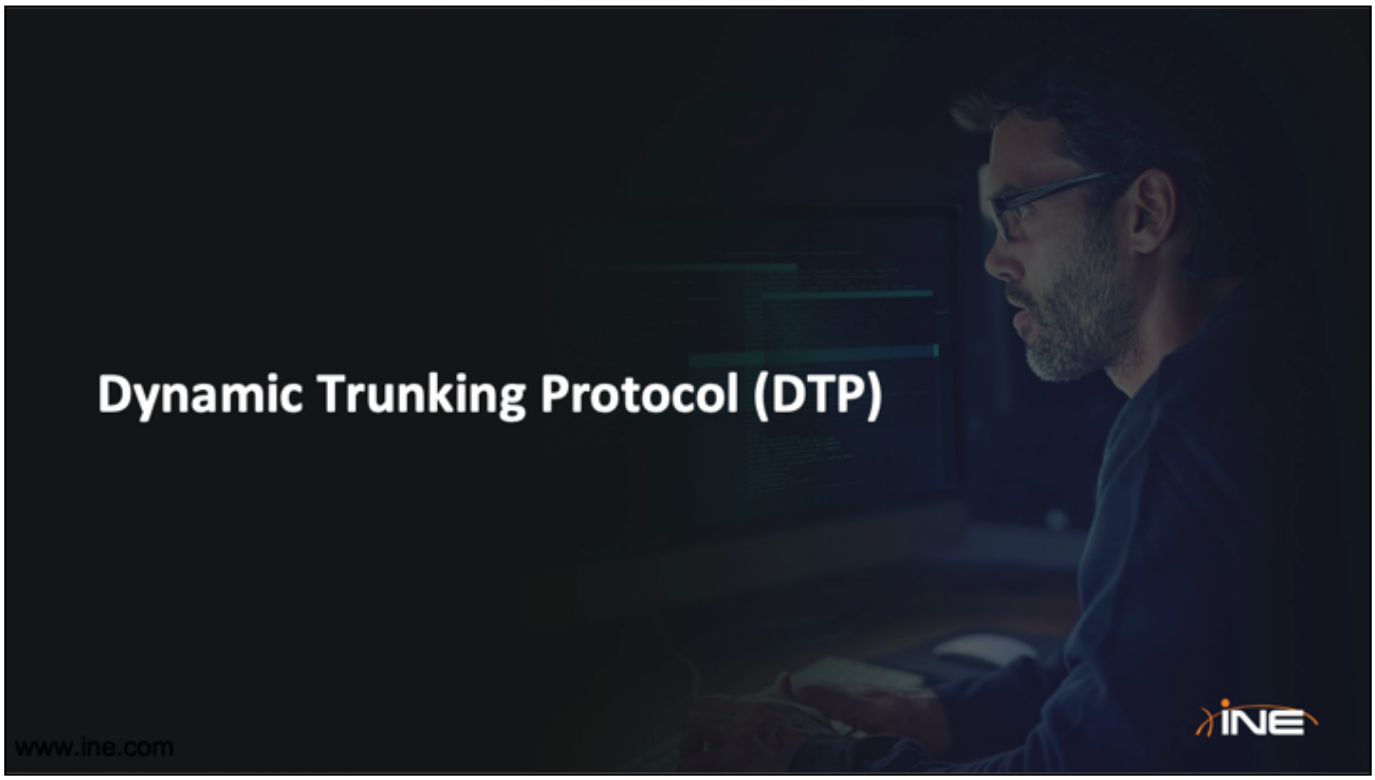


- In the first example, ONLY VLAN-3 is allowed across the trunk. Everything else is implicitly denied.
- In the second example, all VLANs EXCEPT VLAN-3 are allowed across the trunk.

Verifying Trunk

- **Verifying VLAN and trunking**
  - Switch# show vlan <brief>
  - Switch# show interface trunk
  - show interface status
  - show interface <interface> switchport

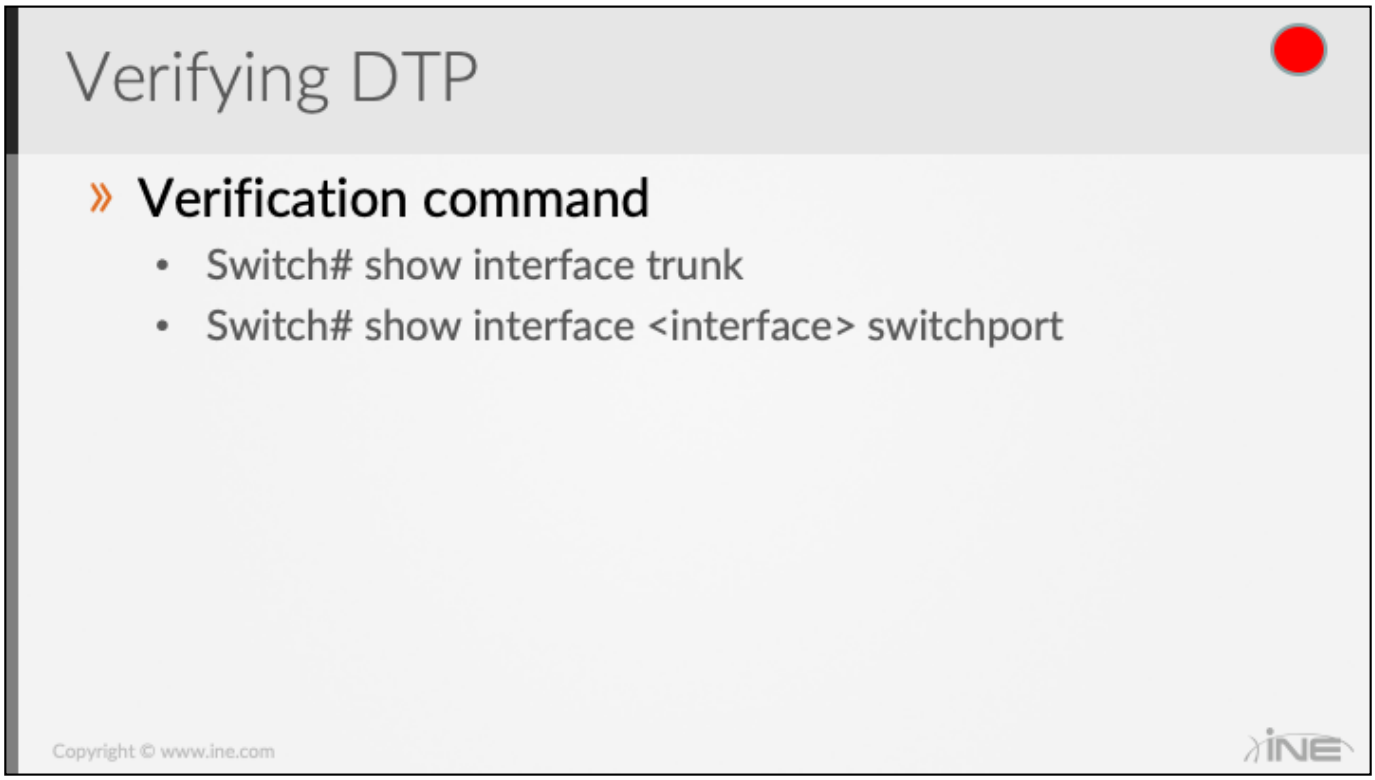


Dynamic Trunking Protocol

- Cisco proprietary feature that allows Cisco switches to negotiate trunk dynamically
- Three modes:
  - Auto
  - On
  - Desirable
- Desirable initiates the trunk, whereas Auto responds only

Implementing DTP

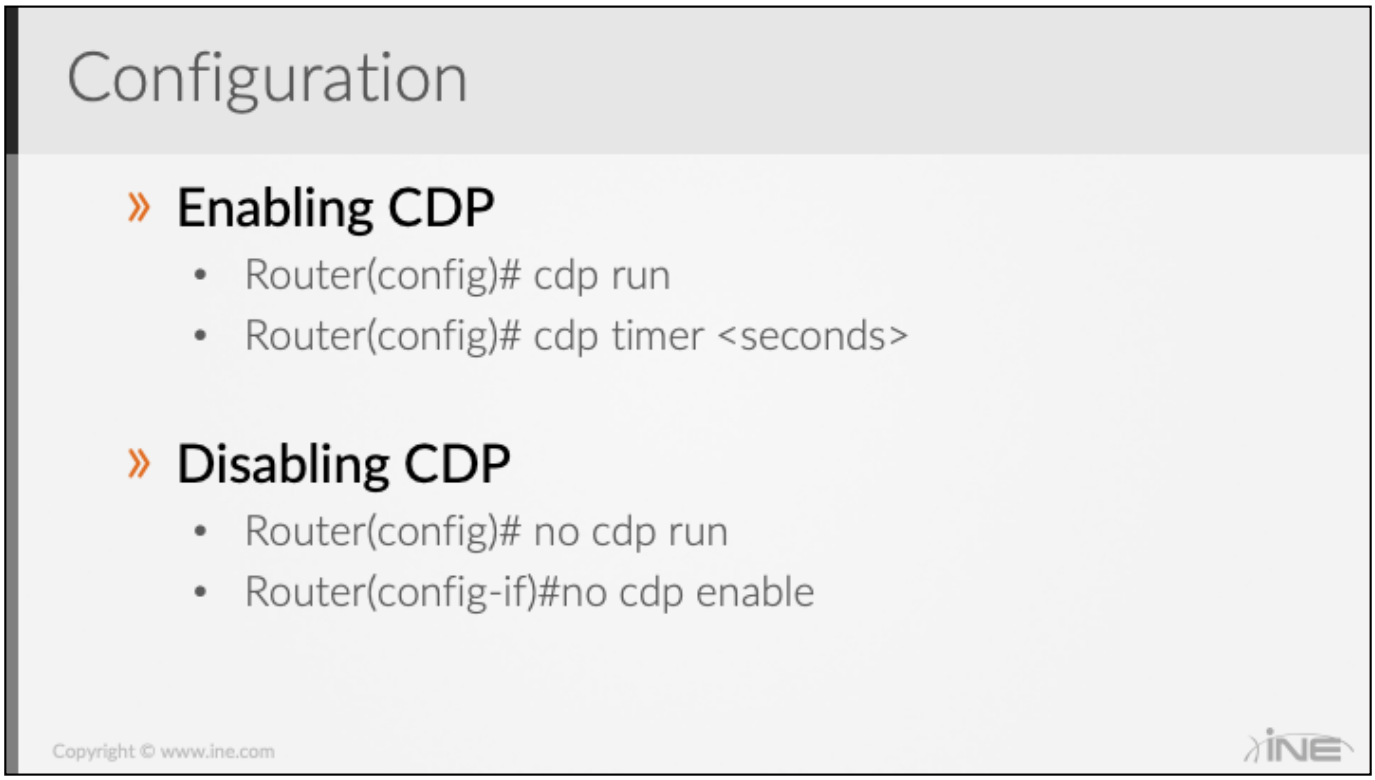
- Configuring DTP
  - Switch(config-if)# switchport mode dynamic [desirable|auto]
- Disabling DTP
  - Switch(config-if)# switchport nonegotiate



****** LAB TASK TIME: Introduction To Cisco Switching**

Cisco Discovery Protocol (CDP)

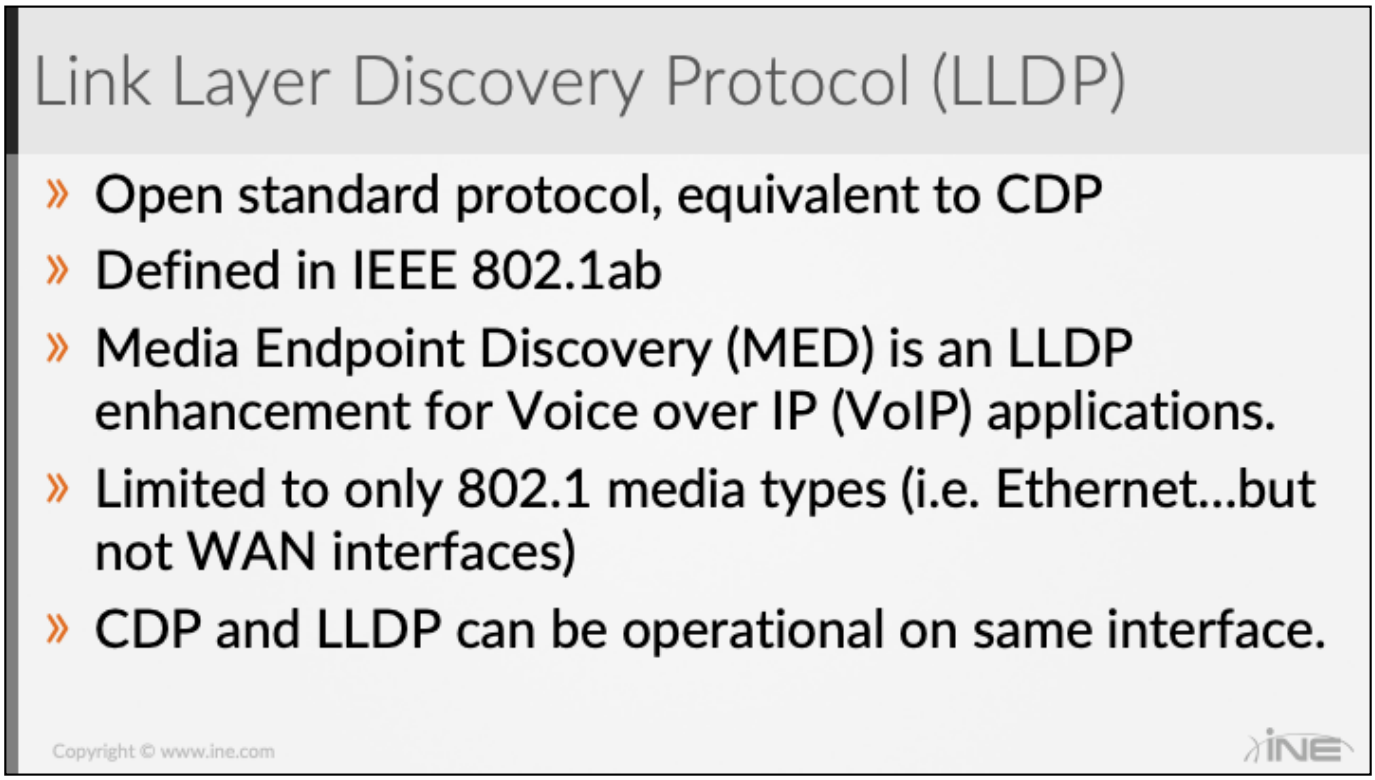
- Cisco proprietary
- Layer 2 protocol for neighbor discovery
- Provides information of platform, interface, IP address, and OS version
- Helps with preparing network diagram



Default CDP timer is 60-seconds.

Verifying CDP

- **Verification commands**
  - Router# show cdp neighbor
  - Router# show cdp neighbor < interface>
  - Router# show cdp neighbor <interface> detail



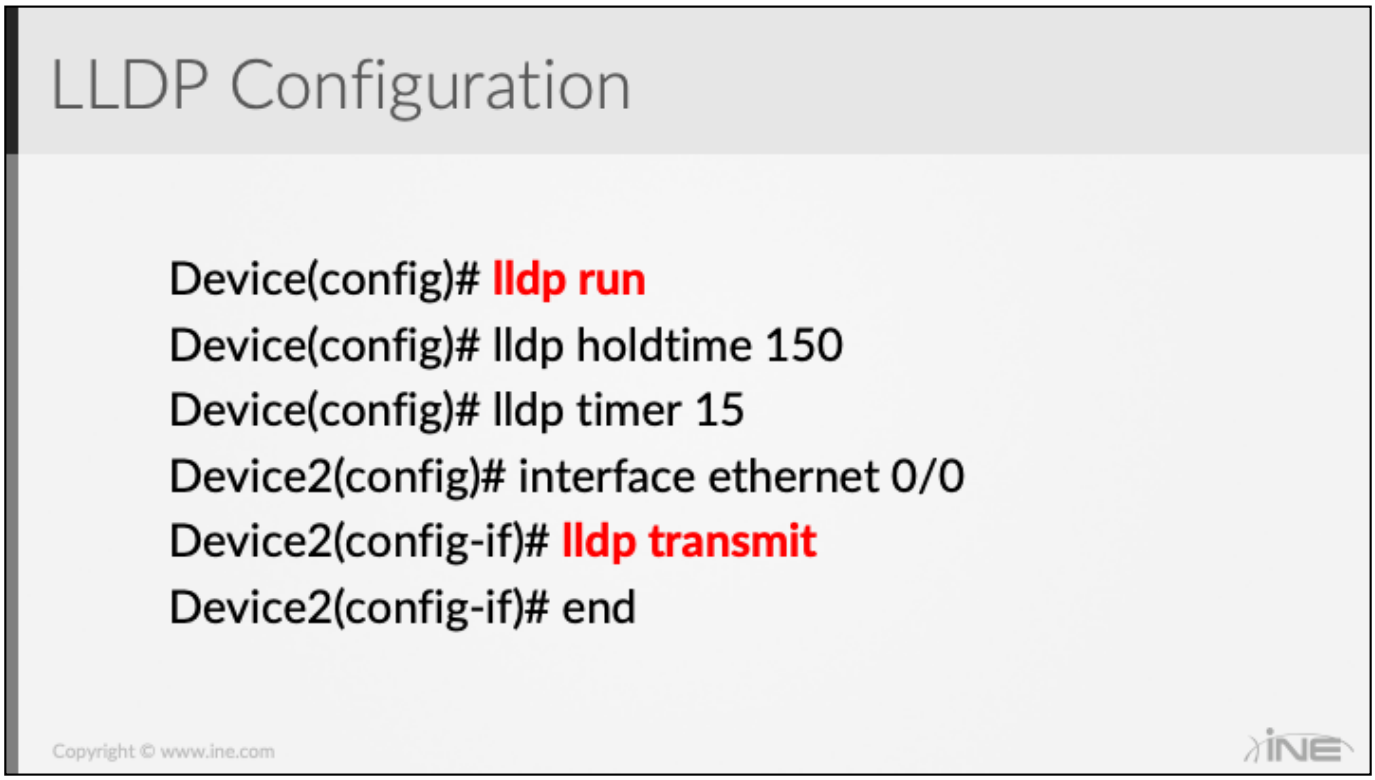
LLDP-MED frames used to support MED. Provide detailed information on Power over Ethernet, network policy, media endpoint location for Emergency Call Services and inventory.

-

Default is to only transmit LLDP unless an LLDP-MED frame is RECEIVED.

-

Mostly supported on Cisco switches…many routers don't support it.



Can't demonstrate this…our devices don't support it.

Verifying LLDP

```
Device1# show lldp traffic
LLDP traffic statistics:
    Total frames out: 20
    Total entries aged: 0
    Total frames in: 15
    Total frames received in error: 0
    Total frames discarded: 0
    Total TLVs unrecognized: 0
Device1# show lldp neighbors
Capability codes:
    (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
    (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
Device ID           Local Intf     Hold-time  Capability      Port ID
Device2             Et0/0          150        R               Et0/0
```