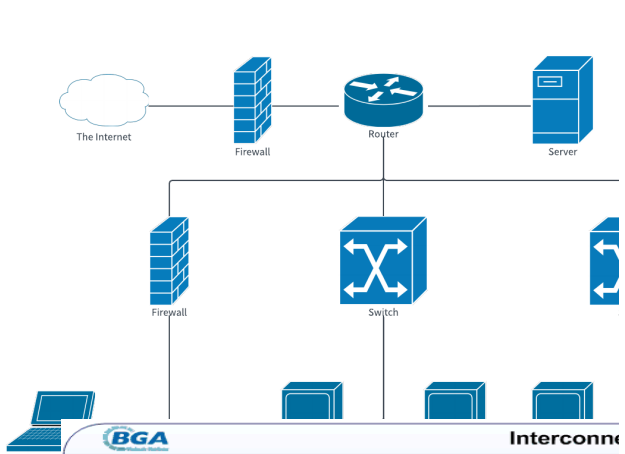
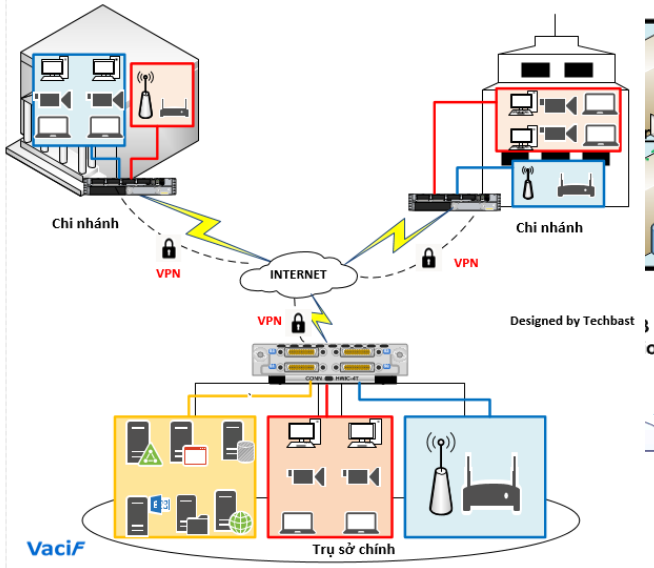
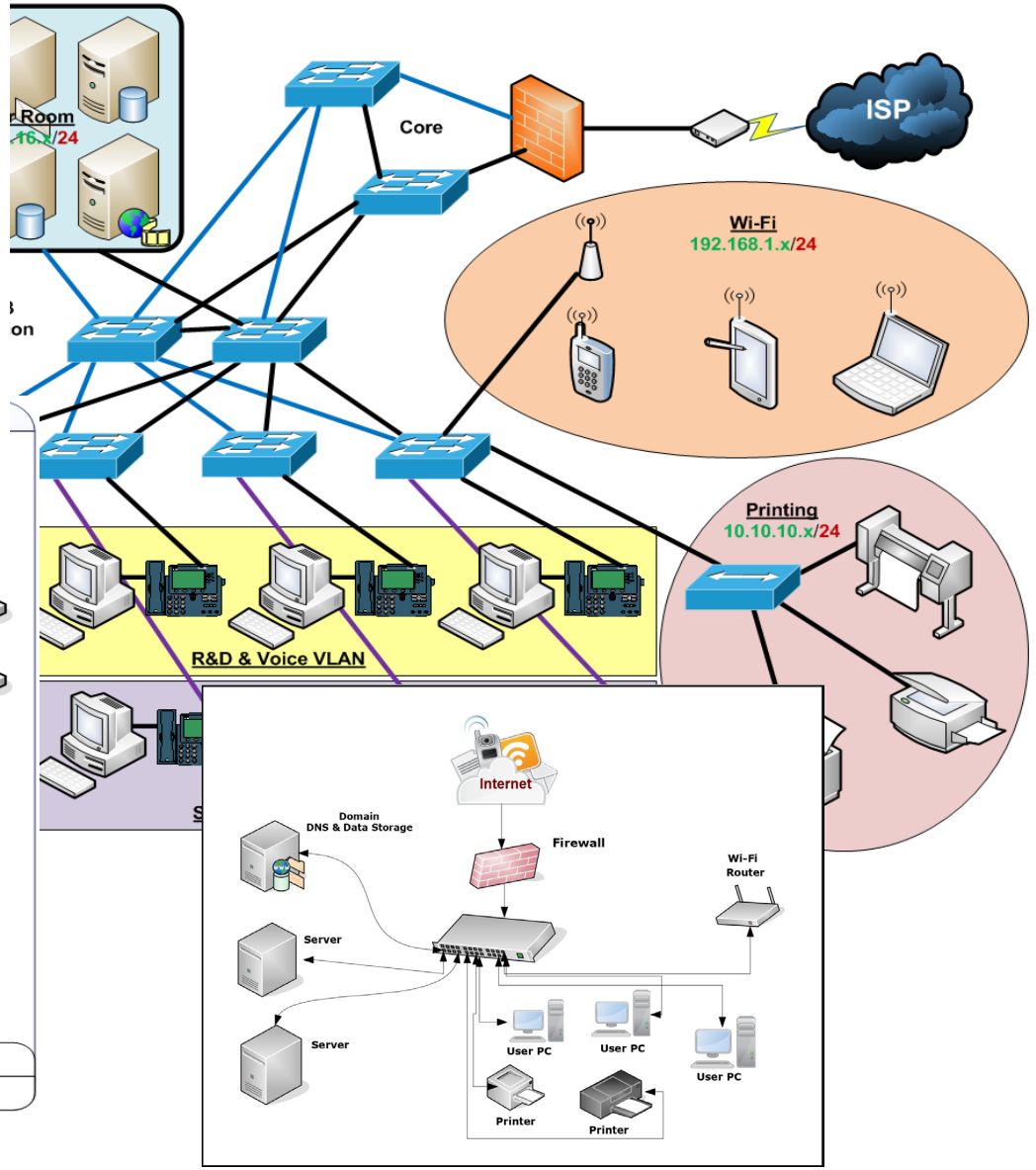
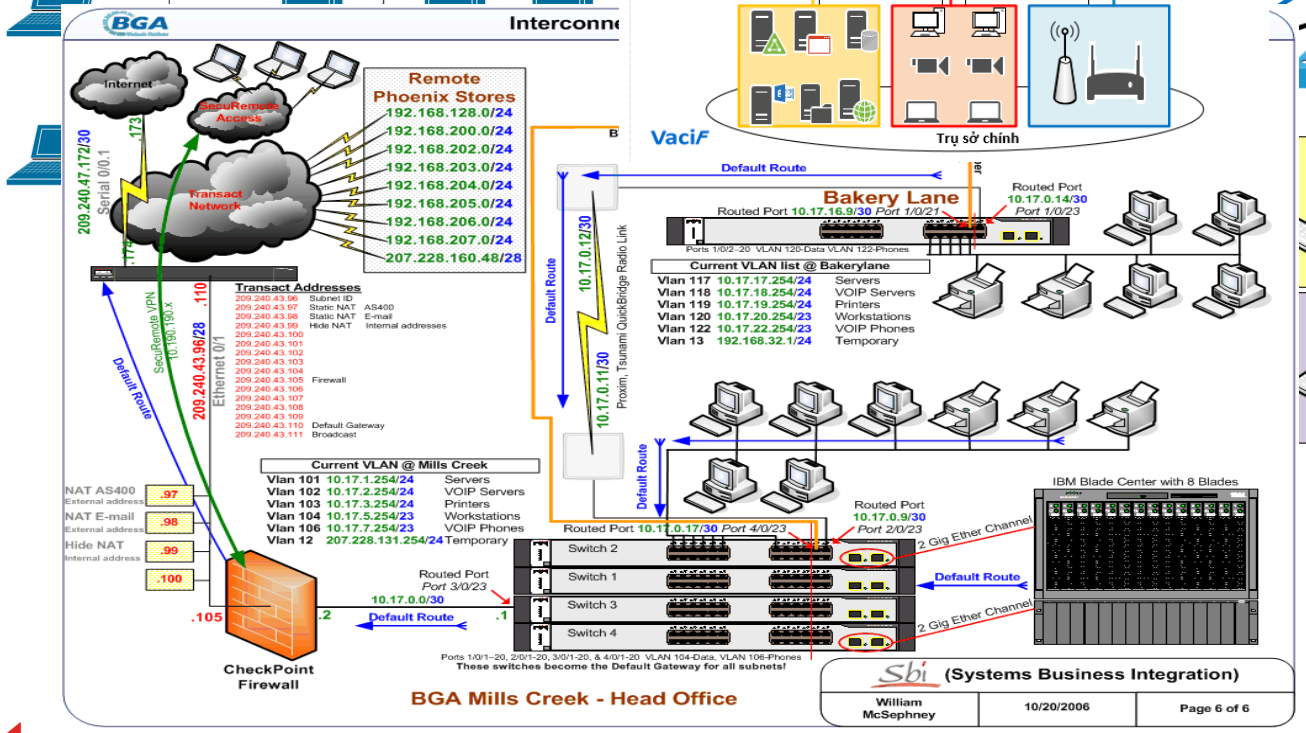
Basics of Routing









House Keeping

INFO-6047 Switching and Routing

ISM1 - Information Security Management (ISM1-ITY-20189) Detailed Weekly Content

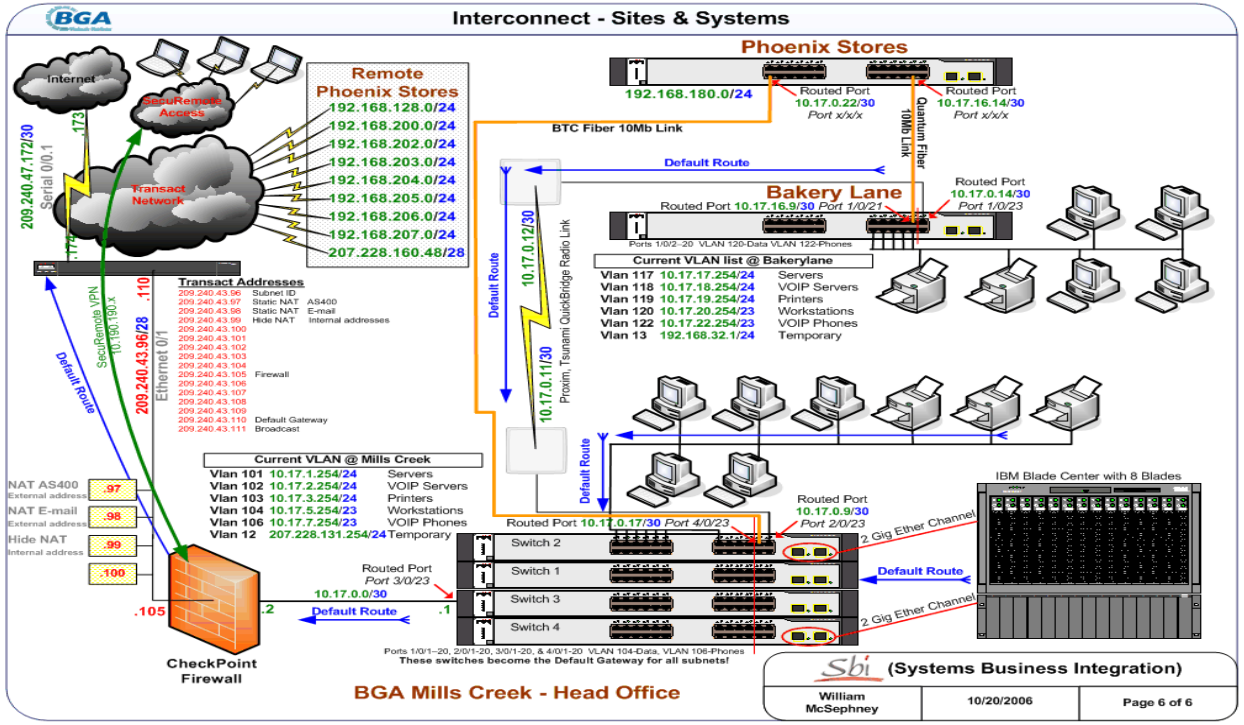
Week	Date of Lecture or Tests, 7:00 – 9:00 PM EST	Lecture/Test	Reading	Lab Time INFO-6047-01 Wednesday 5:00 – 8:00 PM EST INFO-6047-02 Tuesday 5:00 – 8:00 PM EST	Grade
Week 01	Monday, January 02, 2023	College-Wide Orientation			
Week 02	Monday, January 09, 2023	Introduction	N/A	Lab 01 - Basics of PT	3.0%
Week 03	Monday, January 16, 2023	Basics of Routing	**Chapter 01 & 02** *(Introduction to Networking, Network Media Copper)*	Lab 02 - Intro to Routing	3.0%
Week 04	Monday, January 23, 2023	Basics of Switching	**Chapter 03 & 04** *(Network Media Fiber Network Media Wireless)*	Lab 03 - Intro to Switching	3.0%
Week 05	Monday, January 30, 2023	VLANs	**Chapter 05** *(Data Encoding & Transmistion)*	Lab 04 - VLANs	3.0%
Week 06	Monday, February 06, 2023	Routing	**Chapter 06** *(Network OS & Comunications)*	Lab 05 - Routing	3.0%
Week 07	Monday, February 13, 2023	Mid-Term Test		Mid-Term (Test 1)	32.0%
Study Break	Monday, February 20, 2023	Study Break - No Class This Week			
Week 08	Monday, February 27, 2023	Inter-VLAN Routing	**Chapter 10** *(TCP/IP Fundamentals)*	Lab 06 - Inter VLAN Routing	3.0%
Week 09	Monday, March 06, 2023	Static Routing	**Chapter 11** *(Subnetting)*	Lab 07 - Static & Default Routs	3.0%
Week 10	Monday, March 13, 2023	Dynamic Routing - RIP	**Chapter 12** *(Additional Transmission Modalities)*	Lab 08 - RIP Protocol	3.0%
Week 11	Monday, March 20, 2023	Dynamic Routing - OSPF	**Chapter 14** *(RA & LD Communications)*	Lab 09 - OSPF Protocol	3.0%
Week 12	Monday, March 27, 2023	Access Control Lists	**Chapter 15** *(Network Security)*	Lab 10 - ACLs	3.0%
Week 13	Monday, April 03, 2023	DHCP	**Chapter 16** *Maintaining the Network)*	Lab 11 - DHCP	3.0%
Week 14	Monday, April 10, 2023	NAT	**Chapter 17** *(Troubleshooting Fundamentals of a Network)*	Lab 12 - NAT	3.0%
Week 15	Monday, April 17, 2023	Final Test		Final Test (Test 2)	32%

Labs and quizzes will open Monday at 00:01 AM EST and the quiz will close Sunday at 23:59 PM EST.
Tuesday Section-02 from 5:00 – 8:00 PM EST and Wednesday Section-01 from 5:00 – 8:00 PM EST

FANSHAWE

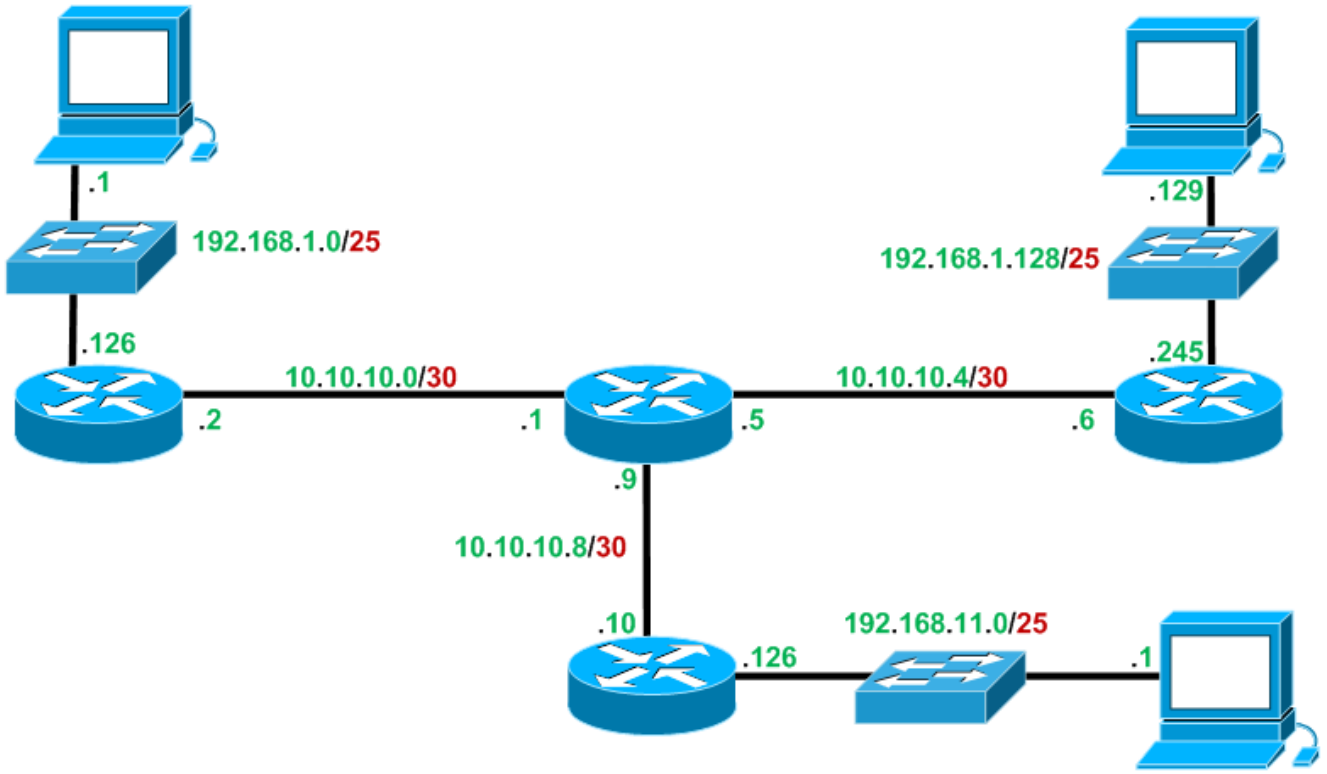
Review - Lecture 01 - Introduction

- Some History (History of the Ethernet Video)
- OSI Model & TCP Model
- TCP/IP Communication Process
- Collision Domain
- Broadcast Domains
- Switches & Duplex
- MDI & MDI-X Auto
- Complexity of Networks
- Borderless Switched Networks
- Role of Switched Networks
- Tools and Commands



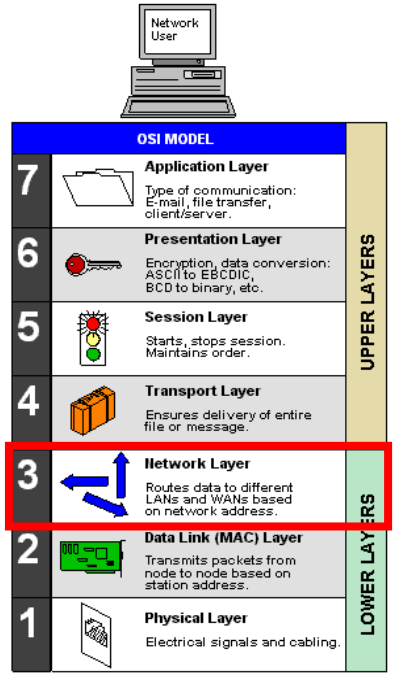
Summary - Basics of Routing

- OSI Model, **L3/Routing**
- IPv4 Address space (32 bit)
- IPv6 Address space (128 bit)
- Layer 2 vs Layer 3
- Switches as Routers ?
- The word "**no**"
- Network Topologies
- Physical Layer
- Routers
- Basic commands
- This weeks Lab
- This weeks quiz
- Cleaning out your switches & Routers

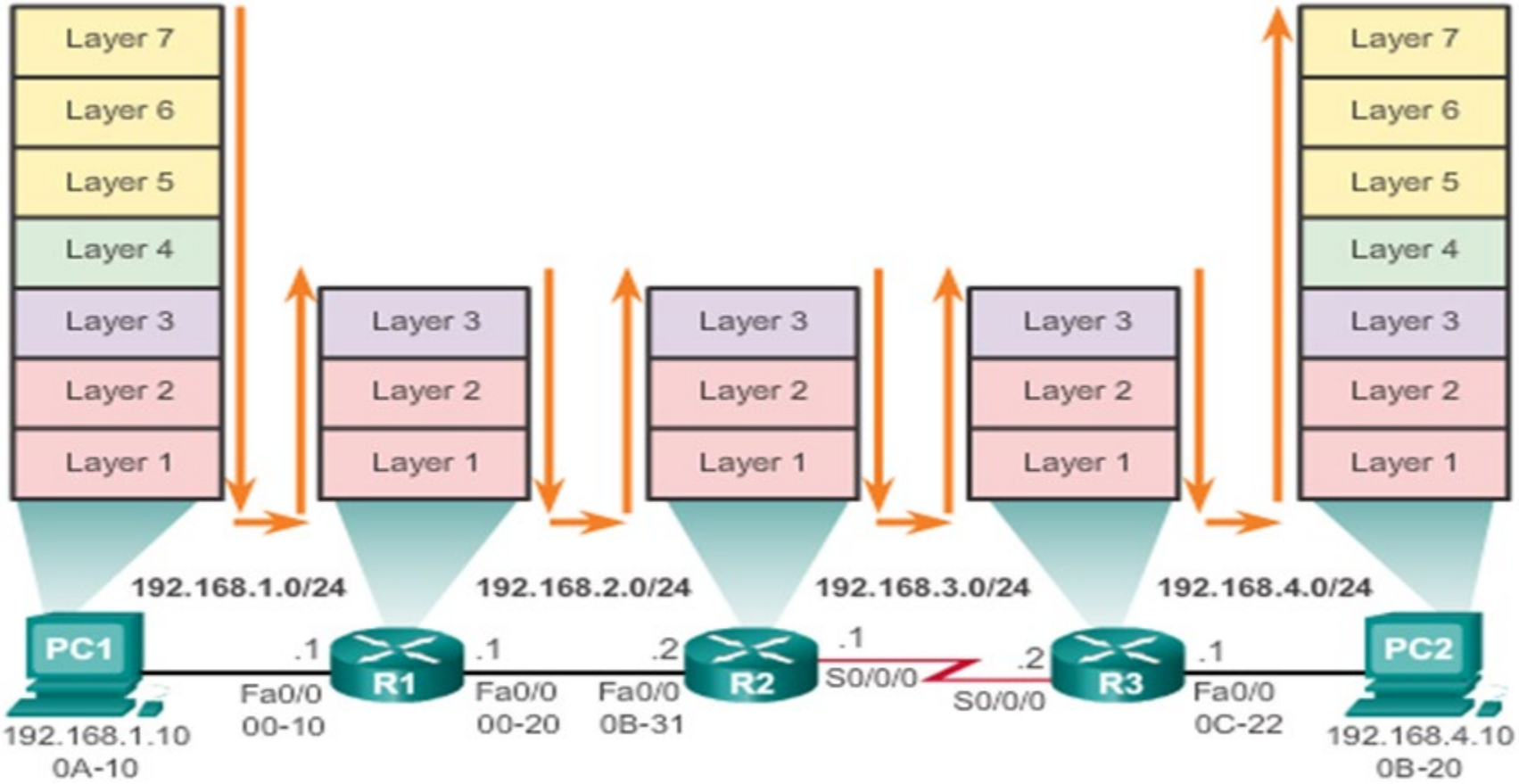


OSI Model, L3/Routing

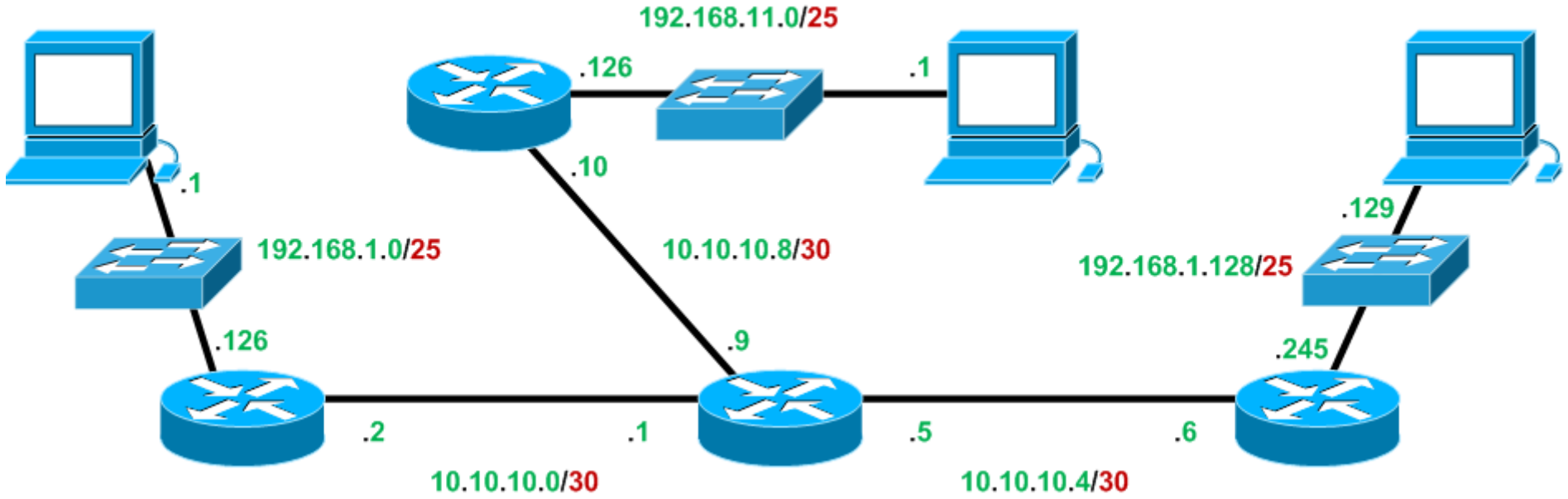
- L3 Network
  - Translate logical address into physical machine address
  - Establish logical connections to other networks to send larger data sequences (**datagrams**).
  - A large amount of data can be fragmented and sent via multiple packets.
  - Introduction of **routing.**
  - Fragmentation
  - Example of the most common L3 protocols
    - Internet Protocol (IP)
    - Address Resolution Protocol (ARP)
    - Routing protocols (RIP, OSPF, BGP, HSRP, VRRP….)
    - Internet Control Message Protocol (ICMP)
    - Internet Protocol Security (IPsec)
    - Network Address Translation (NAT)
  - Example of some of the uncommon L3 protocols
    - Internetwork Packet Exchange (IPX)
    - Signaling Connection Control Part (SCCP)
    - Connectionless Networking Protocol (CLNP)



OSI Model, L3/Routing (Continued)



OSI Model, L3/Routing (Continued)



- **What's important?**
  - Routers **can't** route **from and to the same network**…
    addresses on the legs of the routers **must be in different networks**.
    - Will this network work?
  - To understand routing, you must know how to subdivide networks (VLSM), and network addressing space!
    More information on VLSM can be found in FOL - - > Other Resources - - > **VLSM - CIDR** video.

IPv4 Address space (32 bit)

0000 0000 . 0000 0000 . 0000 0000 /. 0000 0000

Each group of 8 bits above, is counted in Binary the same way!

128 64 32 16 8 4 2 1 = **Adding these bit values together equals the decimal value between 0 and 255 depending on which bits are set to "1"**

0000 0000

HEX 0 0

Each bit of the 8, is represented by the digit above that bit. (the digit above the bit is the decimal value represented by that bit)

IPv6 Address space (128 bit)

1111 1111 1000 0000 : 0000 0000 0000 0000 : 0000 0000 0000 0000 : 0000 0000 0000 0000 : 0000 0000 0000 0000 : 0000 0000 0000 0000 : 0000 0000 0000 0000 : 1001 0110 0101 1010

F F 8 0 : 0 0 0 0 : 0 0 0 0 : 0 0 0 0 : 0 0 0 0 : 0 0 0 0 : 0 0 0 0 : 9 6 5 A

again lets look at just one Hextet for the moment

1001 0110 0101 1010

HEX 9 6 5 A **Hex value for this Hextet**

Now we do the conversion from binary to hex for this hextet, (reference chart is at the bottom of the screen if needed)
Now we do the conversion from Binary to hex for the other 7 hextets

Now for the next step, we can manipulate the IPv6 hex numbers (explanation is outside of the scope of this video)
This big long number **FF80:0000:0000:0000:0000:0000:0000:965A** will become **FF80:0:0:0:0:0:0:965A**
Finally this still kind-a big number **FF80:0:0:0:0:0:0:965A** will become **FF80::965A**

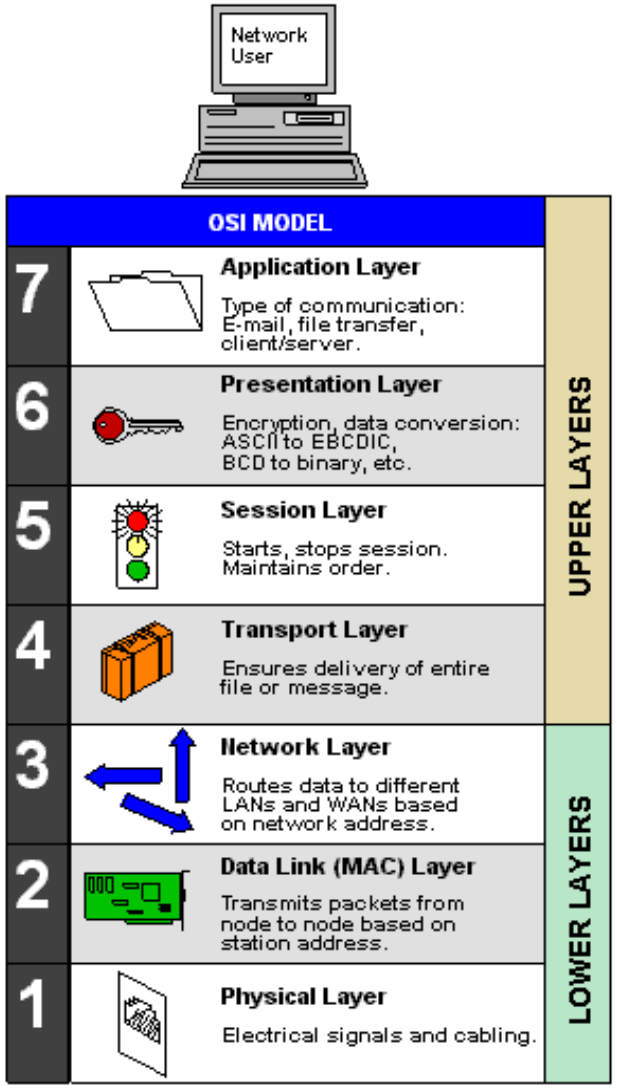
0000 = 0	0100 = 4	1000 = 8	1100 = C
0001 = 1	0101 = 5	1001 = 9	1101 = D
0010 = 2	0110 = 6	1010 = A	1110 = E
0011 = 3	0111 = 7	1011 = B	1111 = F

Layer 2 vs Layer 3

- Yes we are talking about the layers in the OSI model
- Don't confuse what happens at L2 and L3

  - A Layer 3 device (a Layer 3 switch) or a router can and may have to deal with IP addresses (IPv4 and or IPv6) to be able to accomplish its goals
  - Layer 3 implies routing

  - Whereas a Layer 2 switch only works with MAC addresses it does not care what the IP address (IPv4 or IPv6) is for it to do its task at the time.
  - Layer 2 implies the movement of data



Switches as Routers?

- Switches can do the work of a router?
  - **Yes**! If it is a **Layer 3** device
- Switches by default (out of the box) are configured as a Layer 2 device
  - **Yes**! Even if you purchased a **Layer 3** switch
- You will have to tell it to be a layer 3 device, and you may even have to tell it how to deal with IPv6.
  - To start using IPv6 on a Cisco Layer 3 Switch, you need to start by reconfiguring the switches memory with the SDM (**S**witching **D**atabase **M**anager) command

In "**enable**" mode use the show command to see the state of the "SDM"
SW-1# show sdm prefer

Now we need to actually tell the switch that we will be using IPv4 and IPv6 addressing
SW-1# conf t
SW-1(config)# sdm prefer ?
This will give you a list of possible SDM configurations, the one you want is:
dual-ipv4-and-ipv6 default

once you see the list of possible options the prompt at the bottom of the screen should be
SW-1(config)# sdm prefer
with the courser at the end of the line, so all you need to do is type in
"**dual-ipv4-and-ipv6 default**"
Press enter and follow the prompts which should have you doing:
SW-1(config)# exit
SW-1# reload

Of course this will not work on a L2 device

Switches as Routers? (continued)

- Routers are Layer 3 by default!
- BUT possibly not ready for IPv6….

- In Global configuration mode
  - **enable** (enter **Privileged** mode)
  - **config terminal** or **conf t** for short (enter **Global Config** mode)
- We need to turn on routing in general on a layer 3 switch (IPv4)
  - **ip routing** command will do this for the layer 3 switch, and should not be needed for the router (this should be on by default on a router)
- BUT possibly not for IPv6….
- We can turn on IPv6 routing on both a layer 3 switch and router
  - **ipv6 unicast-routing** command will do this for both a switch and router.

The word “no”

- Last slide
  - We just enabled IPv4 routing on a layer 3 switch
  - and IPv6 routing on both a router and a layer 3 switch….
- What if we what to turn this feature **off**?

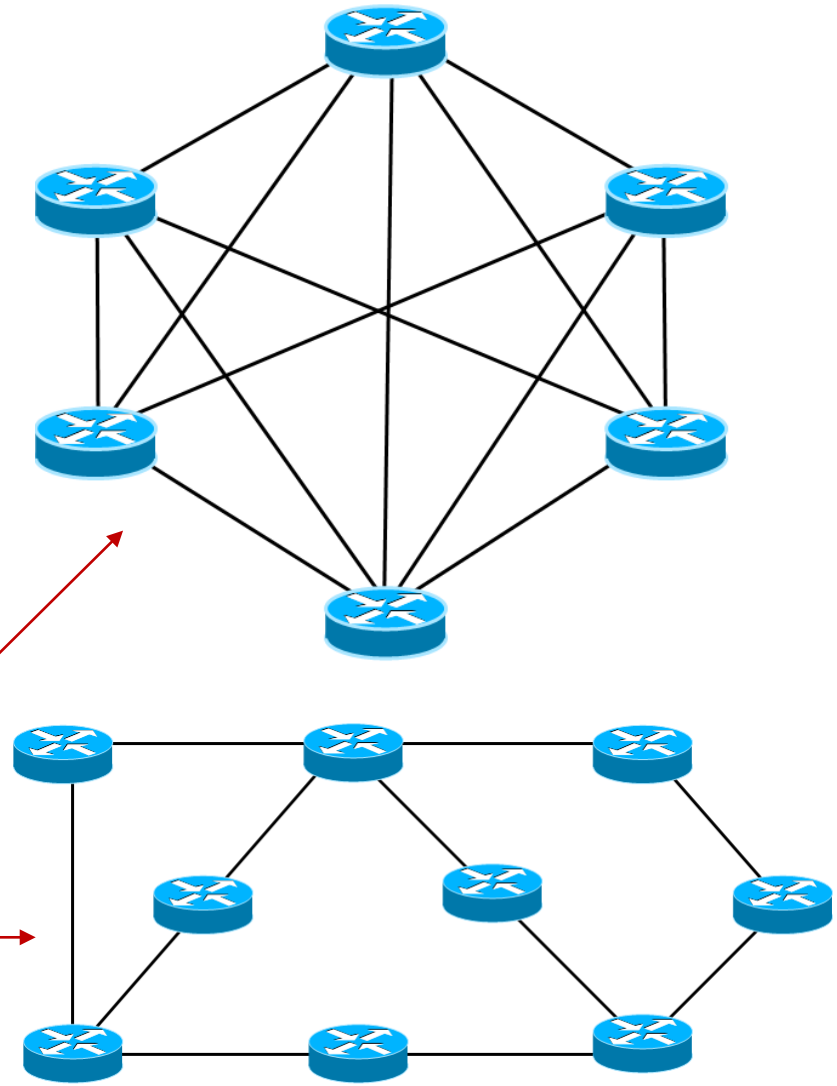
- This is where the word “**no**” comes in to play…
  - With most cisco commands we can add the word “no” to the front of a cisco command
    - **no ip routing** this will turn off IPv4 routing (YES, this will disable IPv4 routing on a router to, remember this is on by default on a router)
    - **no ipv6 unicast-routing** this will turn off IPv6 routing

  - This is only 2 examples of the word “no”
    - The word “no” can be put in front of most (not all) commands to disable/remove/turn off the feature.

Network Topologies

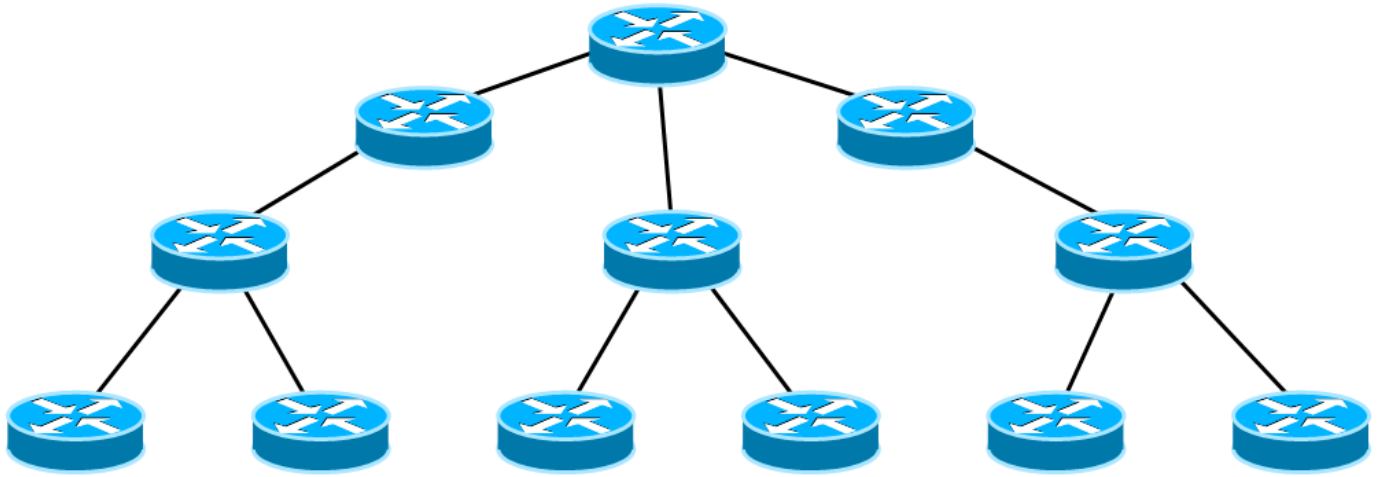
- Mesh Topology
  - In a mesh network, every network device is connected to every other network device with a point-to-point connection. This topology is mostly used in WAN and wireless networks. The route concept is introduced by mesh topology and this topology is used by routers to determine the best path.
  - Mesh network also provides physical link redundancy in the event of a link failure. As each device is connected to all other devices in a mesh network, this topology is the most expensive and difficult to maintain.

  - Two types of mesh topology are possible. If every device is connected to all other devices, it is called fully mesh. On the other hand, partial mesh also possible where some devices are connected to only indirectly to others.



Network Topologies (continued)

- Hierarchical Topology
  - The hierarchical topology is also known as tree topology. In a tree topology, a central 'root' node (top level of the hierarchy) is connected to one or more other nodes that are one level lower in the hierarchy with a point-to-point physical link.

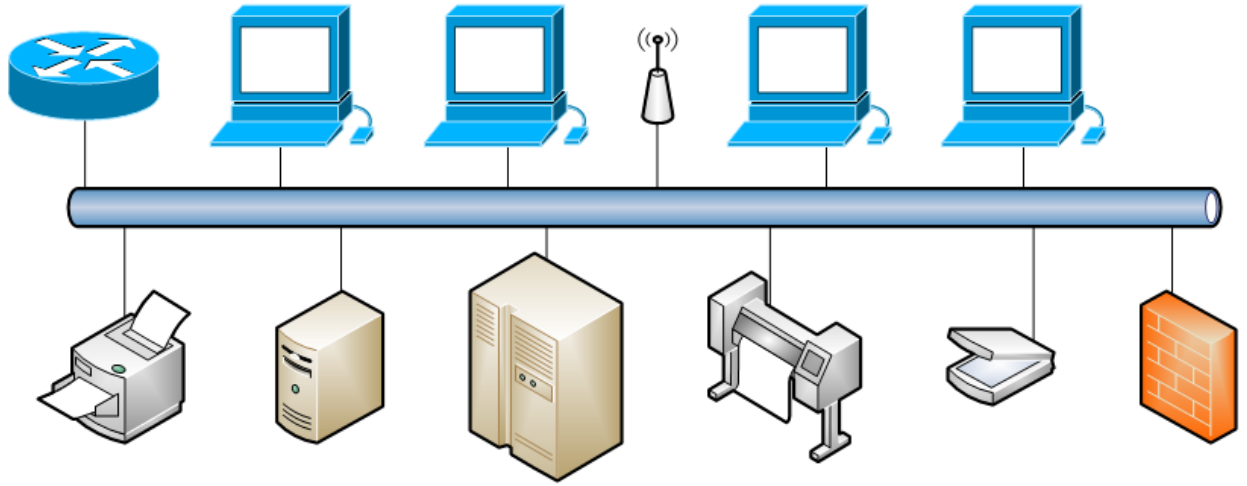


  - The second level node may also have connected to one or more other nodes that are one level down in the hierarchy with another point-to-point link. The top-level node ie. root node is the only node that has no other node above it in the hierarchy.

  - Multiple star networks can be connected with tree network where each hub node of a star network functions as the node of a tree network.

Network Topologies (continued)

- Bus Topology
  - In a bus network, a common backbone is connected to all network devices. The high-capacity bus backbone (generally a single cable) functions as a shared communications medium and it joins networks and central devices.

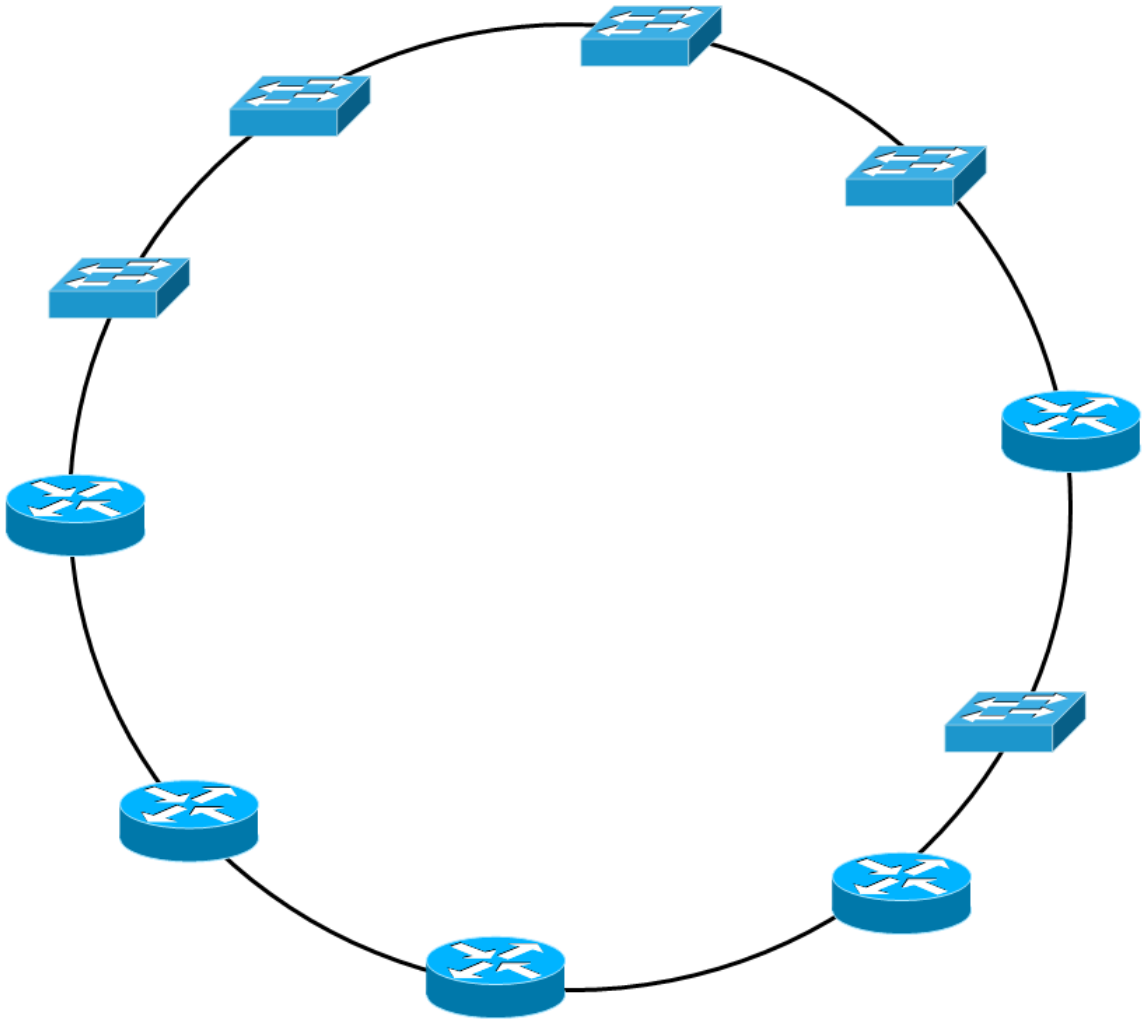


  - If any network device wants to communicate with another network device within a bus network, the device sends a broadcast message onto the backbone. All other devices will see the broadcast message but only the desired recipient will accept and process the message.

  - The performance of a bus network will be visual negatively if more than few dozen computers are connected to this network. In addition, failure of the backbone cable will damage the whole network.

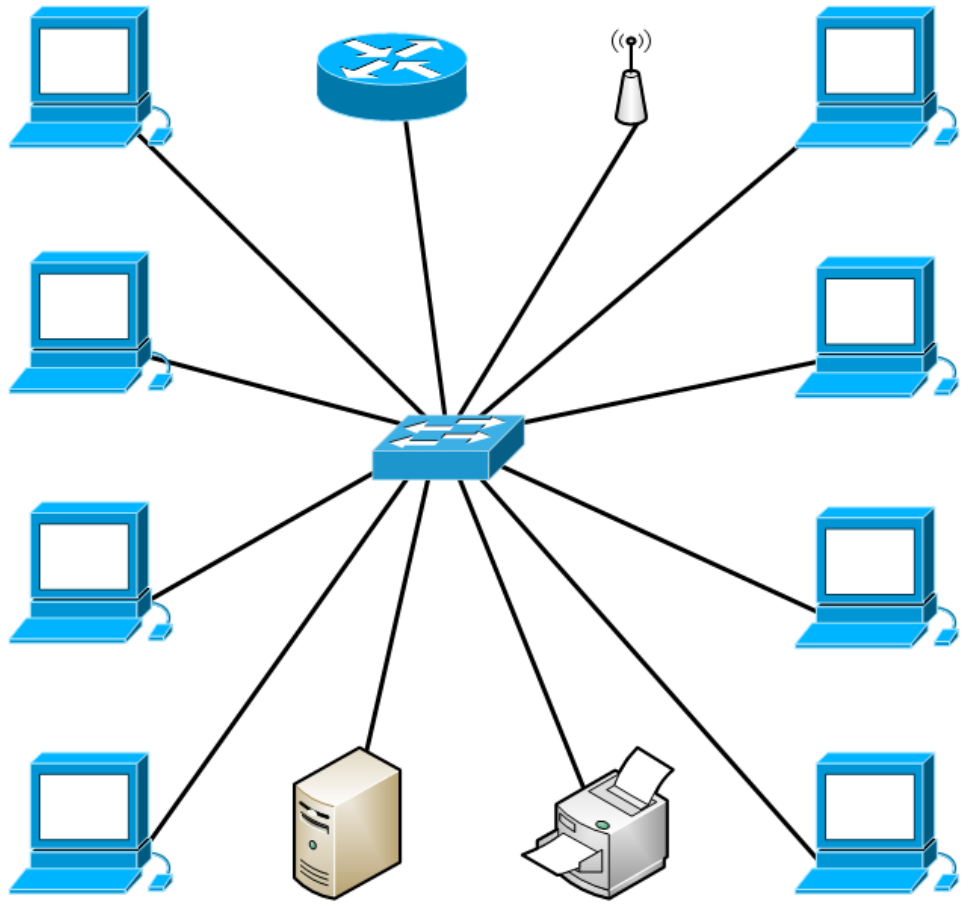
Network Topologies (continued)

- Ring Topology
  - In a ring network, every network device is connected to two neighbor devices with a point-to-point connection for communication purpose. All devices in a ring network make a loop. If any cable or device fails, the loop will break and break down the entire ring network. In the ring network, messages travel through the loop in the same direction (effectively either clockwise or counterclockwise). FDDI, SONET or Token Ring technology is used to implement a ring network. A Token is passed from one computer to another which enables each computer to have equal access to the network.



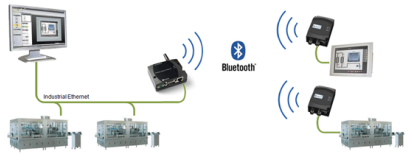
Network Topologies (continued)

- Star Topology
  - Star topology is the most popular network topology that is used in many business and home networks today.
  - A star topology is established with a central connection point called a hub node. The hub may be an actual hub device or a network switch or a network router.
  - Network devices generally connect to the hub with Unshielded Twisted Pair (UTP) Ethernet cables also known as RJ45 cables. The main benefit of a star network is that failure in any start network cable will only take down one computer's network access but not the entire LAN. However, if the hub node fails, the entire network will be down in a start network.

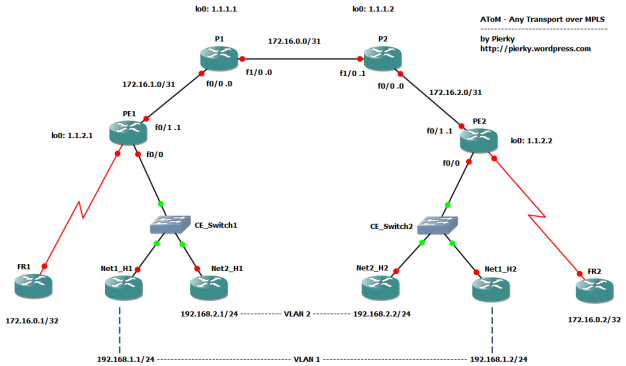


Physical Layer

- Defines specifications to **access** the **physical** communication **medium.**
  - Transmission mode: full duplex, half duplex
  - Transmission encoding: Manchest, QAM
  - Network topology used: mesh, bus, ring, ect...
- Example of the most common medium.
  - Copper (Ethernet, ATM, Token-Ring, Sonnet, ect…)
  - Fiber Optic (Ethernet, ATM, Sonnet, ect…)
  - Radio Frequency (Wi-Fi, Bluetooth, ect…)



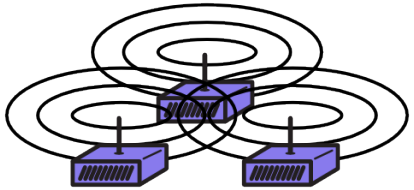
Bluetooth Wireless



ATM / MPLS / HDLC / Sonet

Ethernet Cable

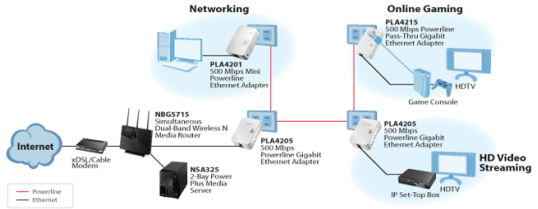
Token Ring Cable



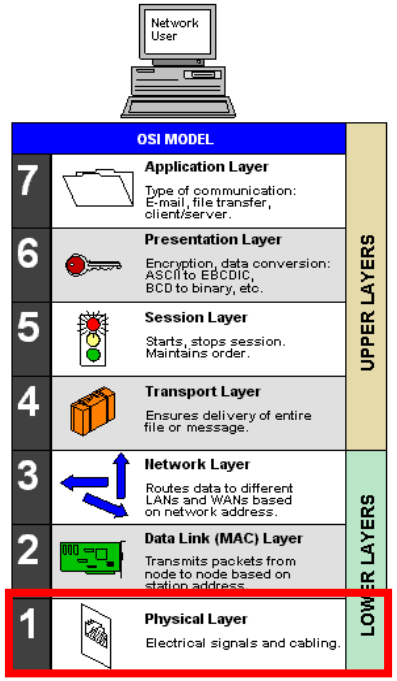
802.11 Wireless

Fiber Cable

HDMI Cable

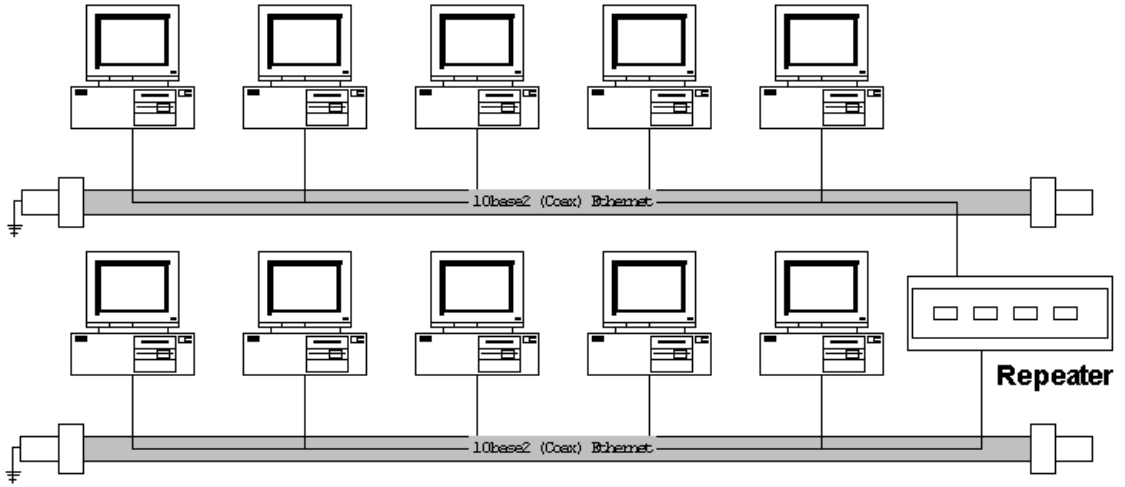


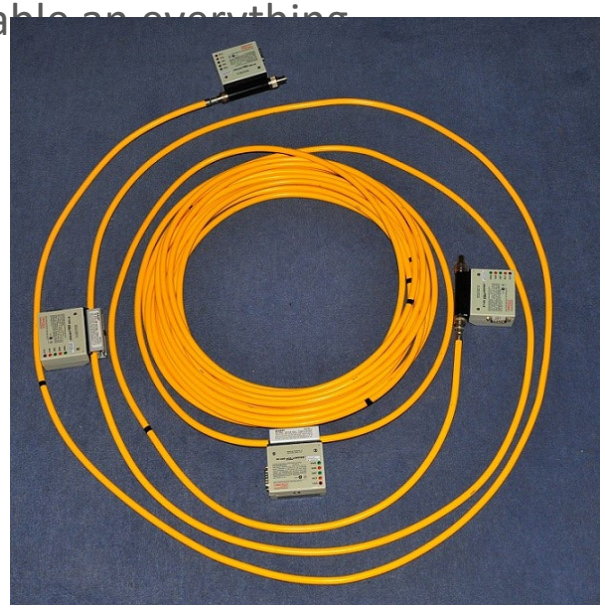
Ethernet over Power Line / Mains

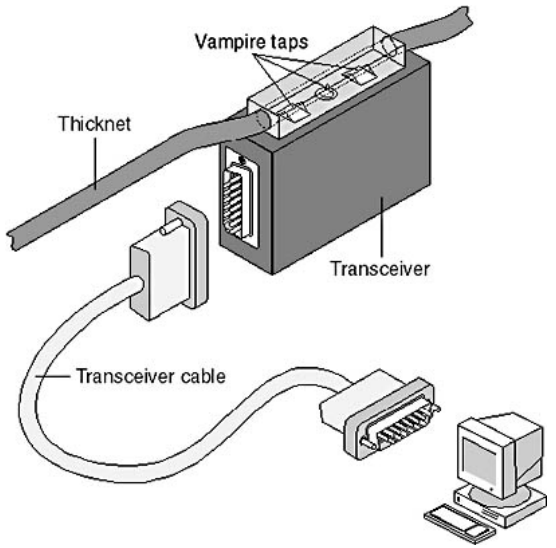


Physical Layer (Continued)

- Before all of that…
  - There was Thick Net (10Base5)
    - It had to be terminated correctly
    - It could only connect on the annal rings on the cable to mark the connection points
    - The transceivers were big and bulky
    - Connected to the computer with a thick 15 pin “D” connector and cable
    - A simple nudge of the cable an everything could/would stop!!!
    - Up to 500 meters
    - Up to 100 connections per segment
    - 10-megabit connections at best
    - Needed repeaters between segments

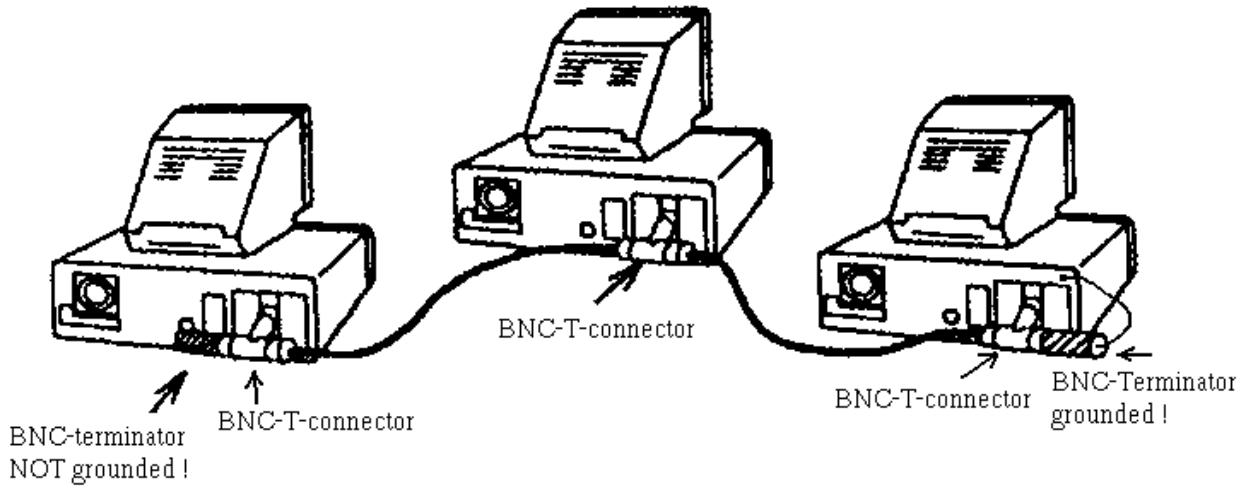






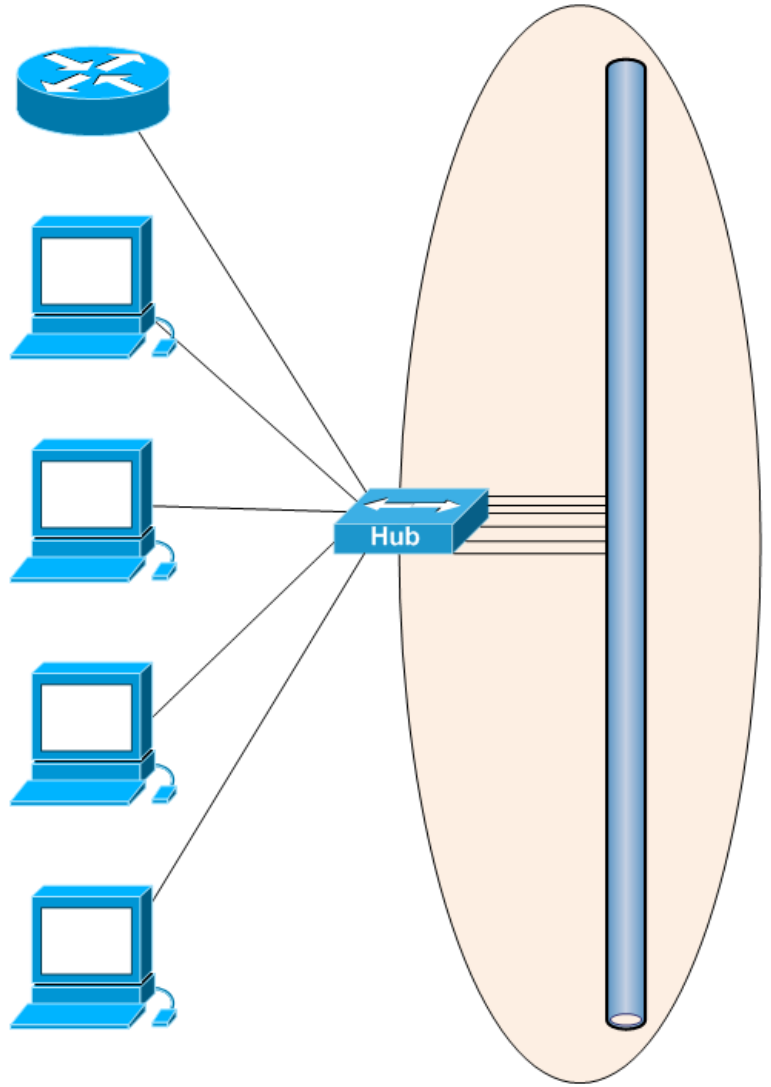
Physical Layer (Continued)

- After a few years it arrived "Thin Net" (10Base2)
  - It was more reliable
  - It was cheaper than Thick Net
  - Still only 10 megabit
  - Easier to put together
  - Still had to be terminated
  - Still had some rules about cable lengths (more of a minimum between connections)
  - Still needed repeaters between segments
  - Up to 200 meters per segment
  - Up to 30 nodes per segment



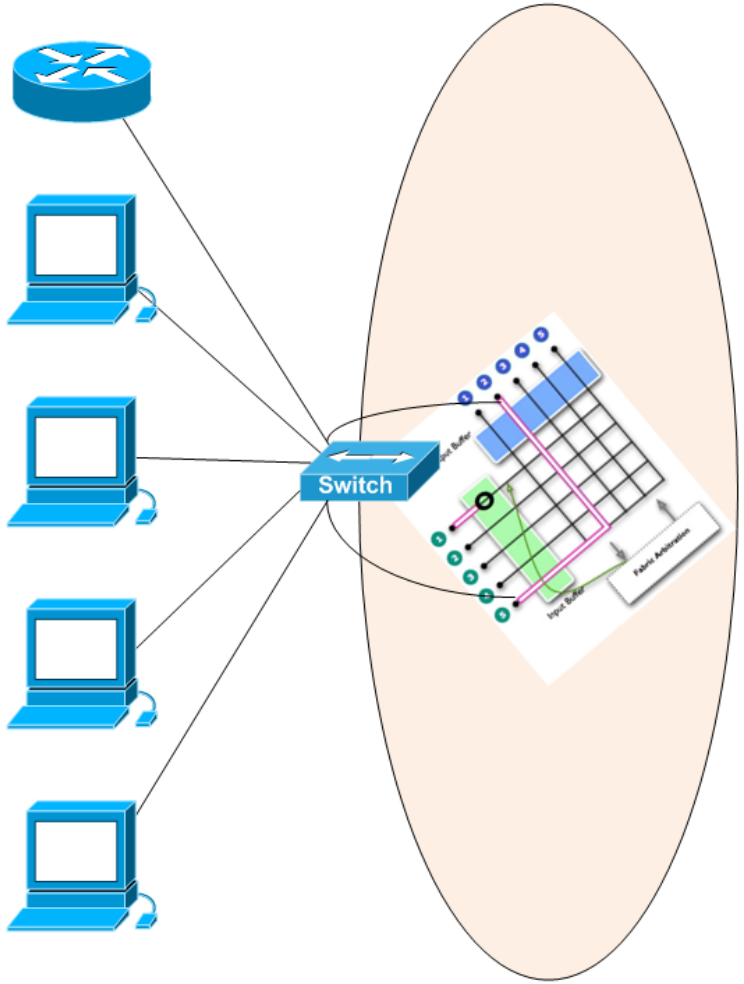
Physical Layer (Continued)

- Finally, we got "Twisted Pair" (10Base-t)
  - 100-meter length
  - Still just 10-megabit speeds
  - One connection per port on the **hub**
  - Hubs could be cascaded with a limitations of 3 hops from one device to the farthest device in the network
  - Needed expensive repeaters to connect and repair timing between groups of hubs
  - Easer to maintain
  - Easer to install
  - All port on the hub connected to each other just as in the 10base2 and 10base5 networks
  - One large collision domain



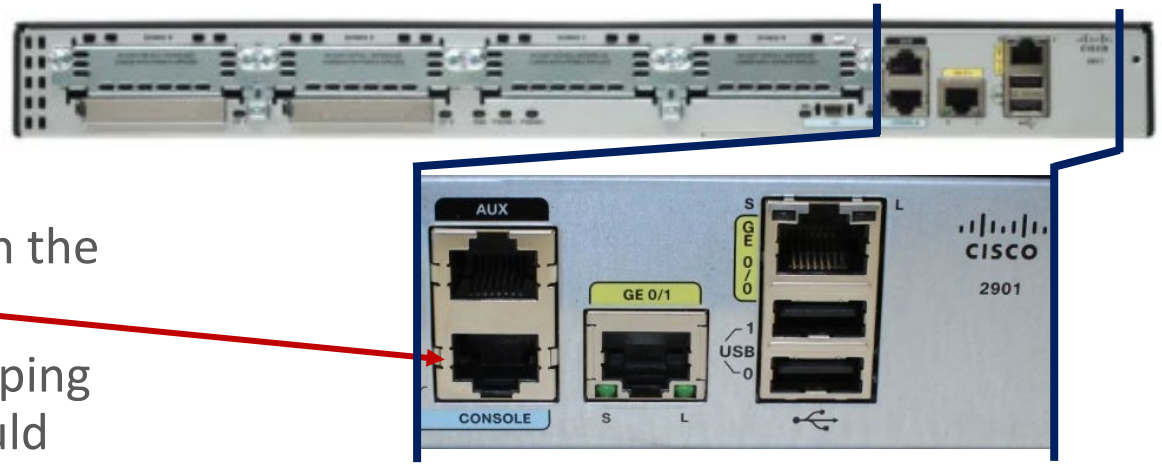
Physical Layer (Continued)

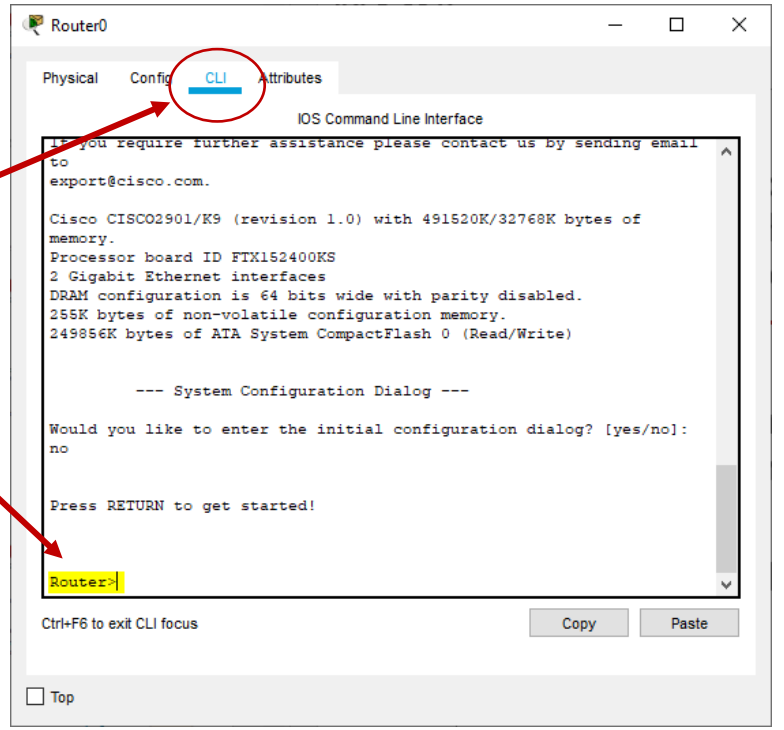
- Switches came to be
  - Now we can talk from one computer to the next with out broadcasting what we are doing to every system plugged into the switch
  - About this time 100Megabit support came to be
  - Along with 100Megabit, came full duplex communications
  - No more massif collision domains, every connection its own collision domain (this is not a broadcast domain…)



Routers

- Console Access…
  - Connection to a router, you would connect the blue rollover serial connector from your computer to the console port on the router
  - Using your Putty or Tara Term emulator, typing the “Enter” key a couple of times you should get a prompt like: → **Router>**
  - Using Packet Tracer, drag a 2901 router on to the desktop, click on it and then click on the “CLI” tab.
    Type the “Enter” key a couple of times.
  - If you get a question:
    Would you like to enter the initial configuration dialog? [yes/no]:
    always answer “**no**” then type “Enter”

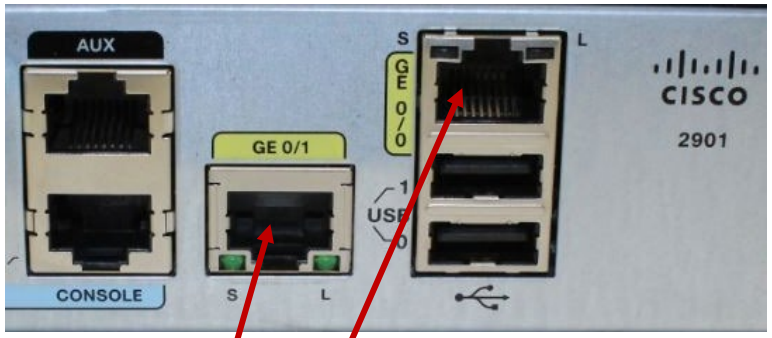


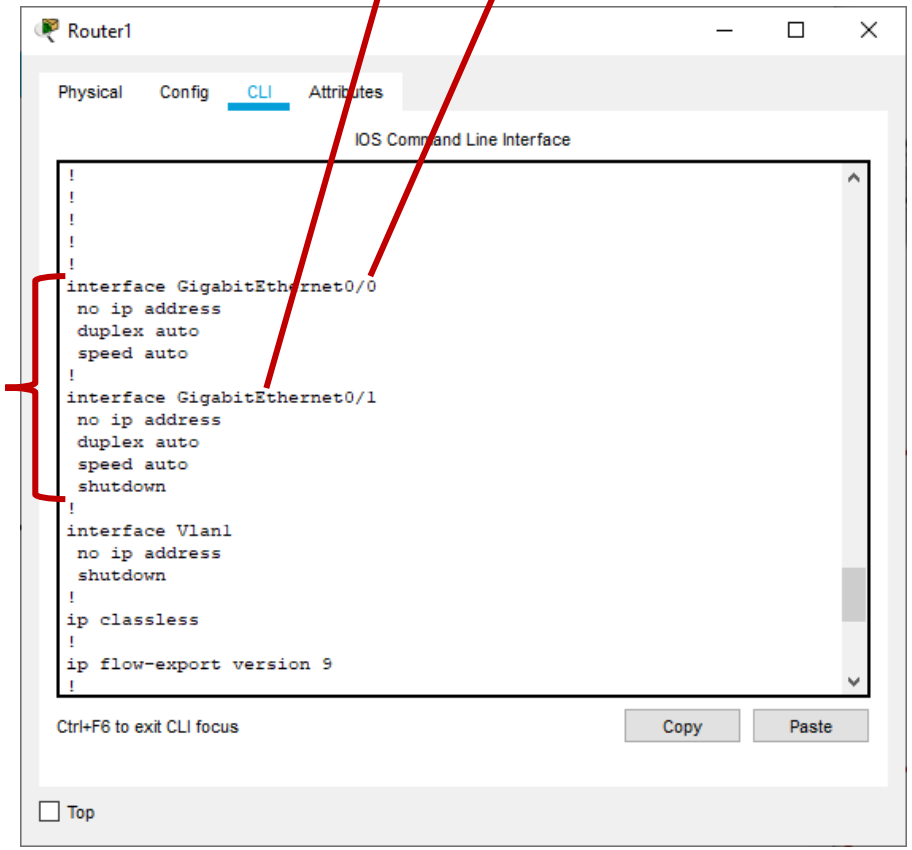


Routers (continued)

- Interfaces
  - The routers we will be using in this course are Cisco 2901 Routers.
  - At the **Router>** prompt type in

    Router> enable
    Router# show running
  - The space bar will display a page at a time
  - The important part you will find are the interface lines, the number of interfaces will change relation to the card plugged in to the expansion slots
  - There are time you may have to do this to get the name/number of the port/interfaces, so you know how to configure the system
  - In this the two basic ports GigabitEthernet0/0 and 0/1 (short form g0/0 and g0/1)





Basic Commands

The prompt should look like the following:

router>

To enter Privileged (enable) mode type

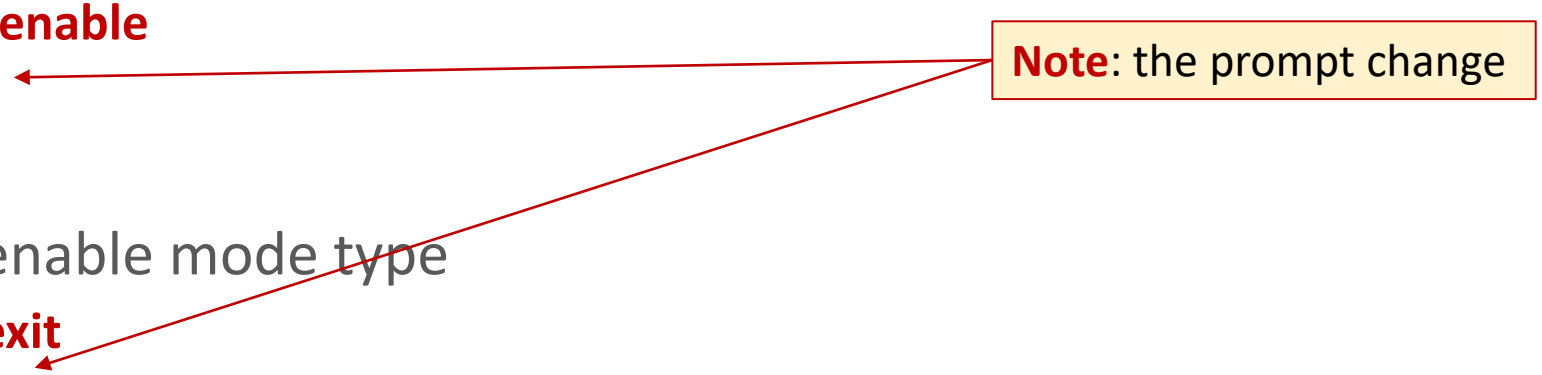
router> enable

router#

To leave enable mode type

route# exit

router>



Basic Commands (continued)

- Hostname
  - Must be set from Global Configuration Mode

    You must first be in **Privileged** (enable) mode

    To enter **Global Config** mode type

    switch# **conf t** (config terminal)

    switch(config)# hostname <*name*>

```
Press RETURN to get started!

Router> enable
Router# config term
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# hostname G2010
G2010(config)#
```

Note: the prompt change

Basic Commands (continued)

- Login Passwords
  - Cisco stores console enable and telnet passwords in plain text in configuration file
  - For the **enable** password "**enable secret** <password>"
    - Depending on the OS version the enable password will be come a MD5 or a SHA256 encrypted password
  - **service password-encryption** command used to encrypt all stored passwords
  - Code 7 indicates service password encryption is being used
  - It's not great encryption, BUT it keeps the noisy looky-loos from looking over your shoulder and seeing the passwords
  - There are may sites on the internet where you can feed in a code 7 password, and it will decode it for you.

```
Switch(config)#show running
----------------------deleted output-----------
line con 0
password cisco
login
!
line vty 0 4
password cisco
login
line vty 5 15
password cisco
login

Switch(config)#service password-encryption

Switch(config)#show running
----------------------deleted output-----------
line con 0
password 7 0822455D0A16
login
!
line vty 0 4
password 7 0822455D0A16
login
line vty 5 15
password 7 0822455D0A16
login
```

Basic Commands (continued)

- Working from the privileged mode (**enable**)
- To configure the router, you must be in configuration mode

router# **config t** (**t** for terminal) full command is **configure terminal**
router(config)# **interface vlan 1**
router(config-if)# **ip address 10.10.10.10 255.255.255.0**
router(config-if)# **no shutdown**
router(config-if)# **exit**
router(config)# **hostname Toronto**
Toronto(config)# **exit**
Toronto# **exit**
Toronto>

Note: the prompt changes

Basic Commands (continued)

- Commands to verify your configuration
  - Show commands
    - show running-config
    - show ip interface brief ← interfaces used should be “up” and “up”
    - show interface (fa 0/1)
    - show vlan
    - show cdp neighbors ← one of my favorite command to see if cable are plugged in correctly
    - show version
    - show post ← Not available in Packet Tracer
    - show interface status

Basic Commands (continued)

- Interface Range

```
router(config)# interface range fa0/3/1 - 4
router(config-if-range)#
```

- A useful command if you want to put the same configuration on several interfaces
  - Place in VLAN
  - Set port security
  - Trunking

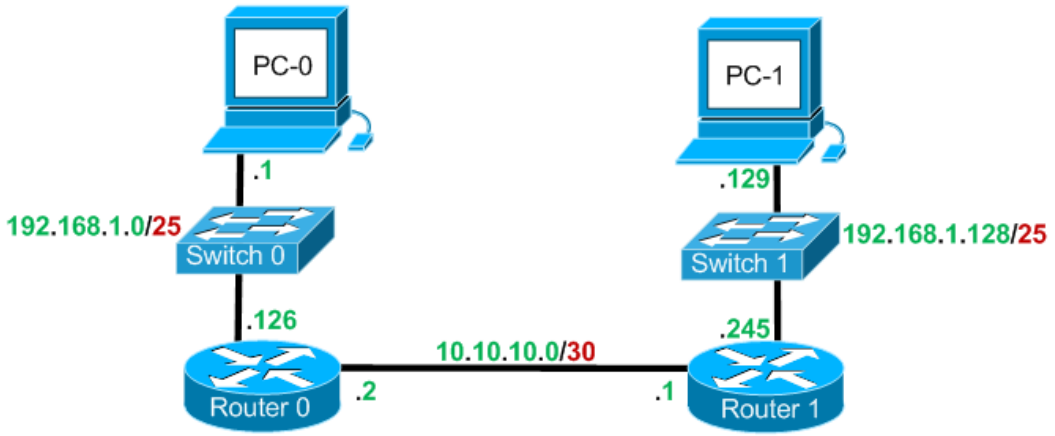
Basic Commands (continued)

- Save your Configuration
  - Your configuration should be saved to NVRam
    - **copy running-config startup-config**

    or
    - **write** for short or shorter yet **wr**
  - This will save your configuration to a text file called **config.text** in **NVRAM** (**N**one **V**olatile **RAM** (**R**andom **A**ccess **M**emory))
  - Can be copied from the CLI and saved as a text file
  - From the command line you can save a text file to a TFTP or FTP server

This weeks Lab

- This weeks lab
  - If we are working **on-line**:
    - Find the "`Lab-02 – Students.pkt`" file in this week's section of FOL

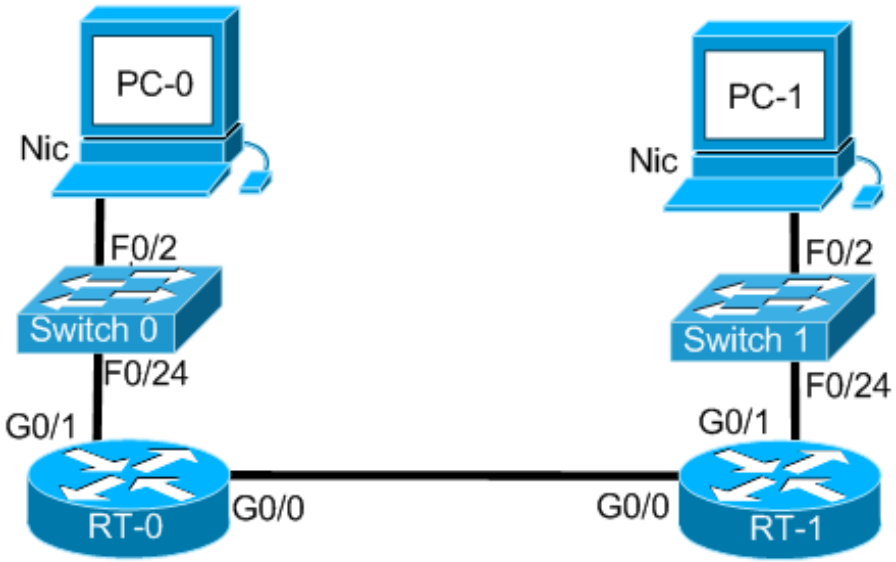


  - If we are working in the **classroom/lab**:
    - You will have to build this configuration in the equipment room
    - You can work in pairs today, each of you will be responsible for connecting up and programing your half of the equipment… then one of you will connect your equipment to your partners equipment completing the configuration.

  - Follow the instructions in the lab documentation
    - Following the instructions step by step
    - Do any gathering of data at the point in the lab where requested, you may not get the correct information if you wait to the end of the lab and gather all the data.

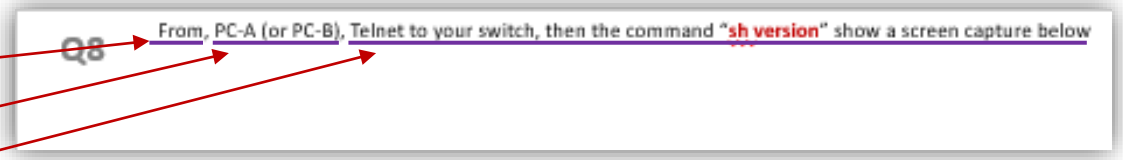
This weeks Lab (Continued)

- Topology
  - Please watch the connections for the cables laid out in the topology at the beginning of the lab.
  - If you do not follow the cabling in the topology, your lab will possibly not work!

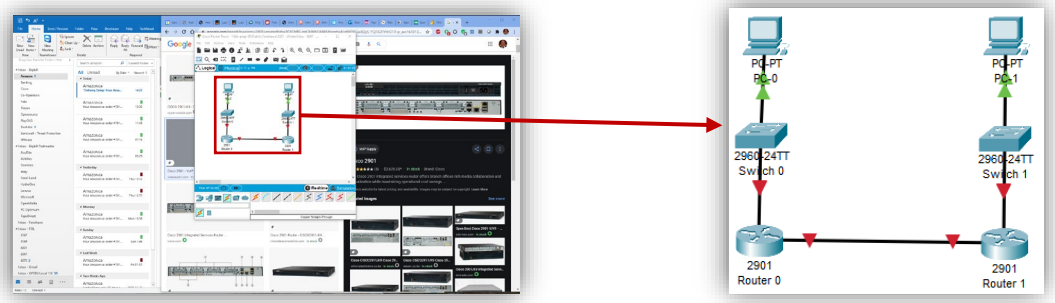


- Using the CLI on each of the routers, when in enable mode you can use the command **show cdp neighbours** to see if you have the cables plugged into the correct interfaces. Keep in mind that the interfaces must be up (no shutdown) before CDP will work.
- Routers the interfaces are down (shutdown) by default and switches are up (no shutdown) by default

This weeks Lab (Continued)

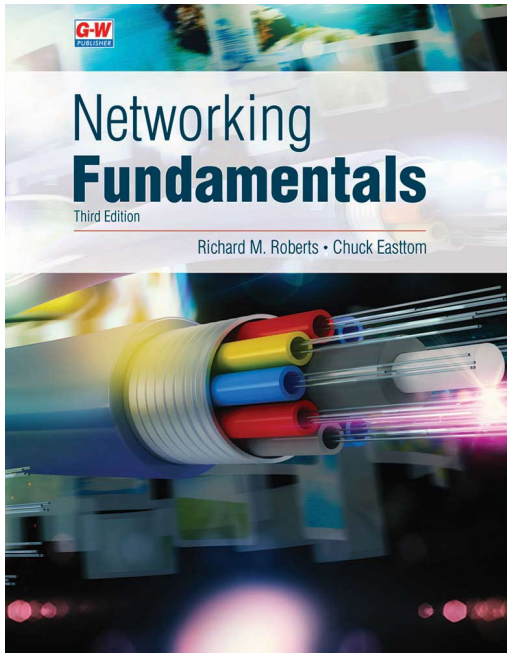


- PowerPoint Questions
  - From
  - This device / location
  - Do this instruction
- This should make sense… BUT there have been students in the past that could not figure out what was being asked of themselves?
  - "From, This device / location, Do this instruction" is one of the forma of question
  - Other types of questions may be a list of question and a place for you to fill in the answerer
  - Yet other question could even ask you to provide a screen snapshot, **please figure out how to use the built in snipping tool**.
  - Snip out only the important information hence you can then make what you have snipped out as large as possible in the space provided, making it easier to read later, when doing review.



This Weeks Quiz

- Have you obtained access to the reading material Yet?
  - I’m giving you a week's reprieve.
  - The quiz this week is again based on just week 2s lecture and lab.
  - What does this mean?
    - This week's quiz should also take into account that you should have read chapters 1 & 2 by now….. BUT I’m giving you the reprieve mentioned above.
    - It now means that next week's quiz will have question pertaining to next weeks lecture and lab and chapters 1 through 4 of the reading material



Cleaning out your switches & Routers

RT-1# erase startup-config

The response from the switch will be

Erasing the nvram file system will remove all files! Continue [confirm]

Press enter to confirm

RT-1# delete vlan.dat

Delete filename [vlan.dat]?

Delete flash:/vlan.dat? [confirm]

Press the enter key for both the prompts above

You may get an error message if there was no vlan.dat file found, this is OK

RT-1# reload

If the response says: “System configuration has been modified. Save?[yes/no]:”

Enter “no”

QUESTIONS