DEPARTMENT OF TELECOMMUNICATION ENGINEERING
MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO
COMPUTER COMMUNICATION & NETWORKING
(2nd Semester, 3rd Year) LAB HANDOUT # 5

Name: Karan _____ Roll No: 20ES62

Score:_____ Signature of the Lab Tutor:_____ Date: _____

OBJECTIVES

#	Topic	#. Of Lectures	CLO	Taxonomy level
5	To **understand** spanning tree protocol and **apply** the knowledge to **configure** it in L2 switches.	3	1,2	C3, P5

OUTCOME(S)

a. An ability to apply knowledge of math, science, and engineering	**PLO1**: Engineering Knowledge:

RUBRICS:

Performance Metric	Exceeds expectation (4-5)	Meets expectations (2-3)	Does not meet expectations (0-1)	Score
Knowledge and application [PLO1]	Applies the appropriate knowledge and concepts to the problem with accuracy and proficiency; shows precise understanding of these knowledge and concepts.	Applies the relevant knowledge and concept to the problem, possibly in a roundabout way; understands the major points of the knowledge, with possible misunderstanding or failure to recall minor points;	Fails to apply relevant knowledge and concepts to the problem; misunderstands or fails to recall critical points.	
			Total Score	

EQUIPMENT

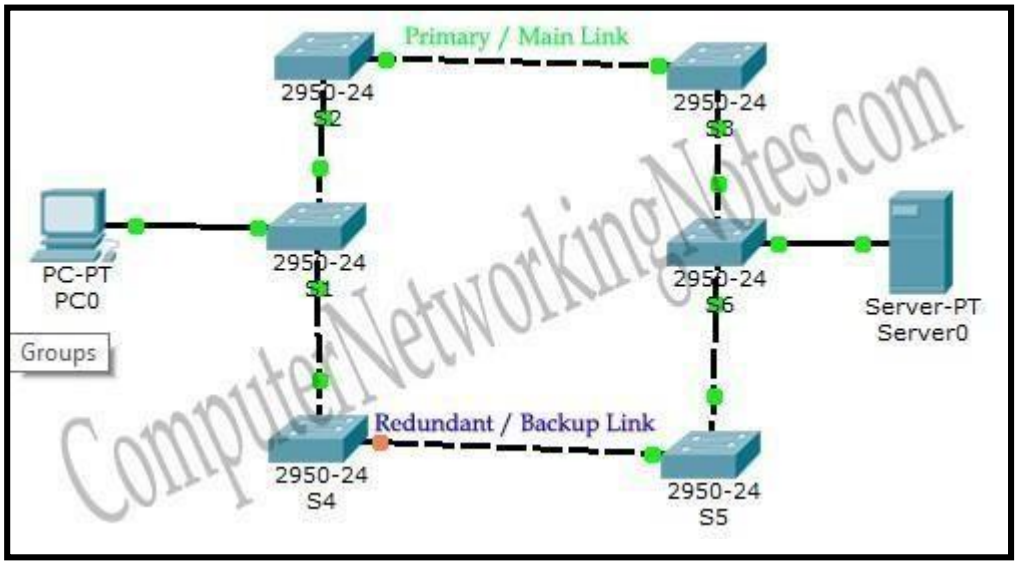
- Catalyst 2950 Switches
- 2 PC's with NIC installed
- 2 Straight through UTP cables
- 6 cross over UTP cables

DISCUSSION & CONFIGRATION:

Spanning Tree Protocol (STP)

For backup purpose we usually create redundant links. Redundant links are extremely useful in preventing entire network down situation that is triggered from single link failure. With all of its advantages, redundant link is a double edged sword. It creates network loops that flood down frames. STP removes loops as well as other evils of redundant link. illustrates a simple layer 2 loop. In this network, LAN segment has two links to server.

Layer 2 loop example



Above figure

1. Primary / Main Link (S1, S2, S3, S6)
2. Redundant / Backup Link (S1, S4, S5, S6)

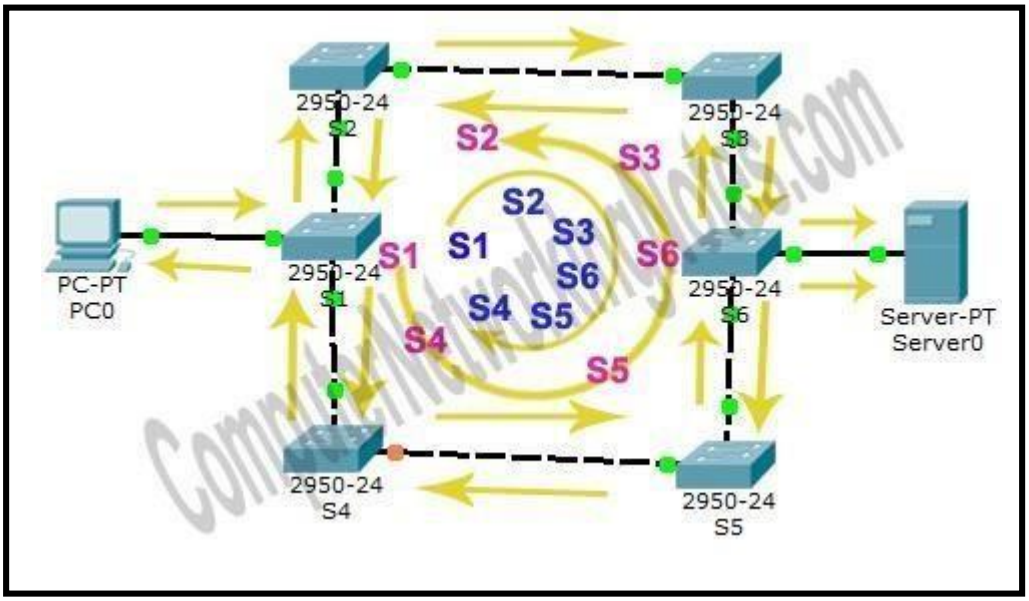
Multiple layer 2 connections between LAN segment and server create following problems.

3. Broadcast Storms
4. Duplicate Frame copies

Before we dig these problems in more detail remember that a switch always floods three kinds of frames: unknown unicast, broadcast and multicast.

Broadcast Storms

Assume that PC0 perform an ARP request to find the MAC address of Server. ARP (Address Resolution Protocol) uses broadcast method to locate the MAC address of device. In this circumstance PC0 will generate single broadcast frame. Switch S1 will receive it from PC0. Switch S1 will flood this broadcast frame from all remaining ports except the incoming port. Without any loop removing mechanism, switches will flood broadcasts endlessly throughout the network. This is known as broadcast storm. Below Figure illustrates how a broadcast frame is continually being flooded throughout the network.



Endless Cycle One

PC0 => S1 => S2 => S3 => S6 => (Server and) S5 => S4 => S1 => (PC0 and) S2 => S3 .....

Endless Cycle Two

PC0 => S1 => S4 => S5 => S6 => (Server and) S3 => S2 => S1 => (PC0 and) S4 => S5 .....

Duplicate frame copies

In looped network, a device could receive duplicate copies of same frame from different switches. Assume that PC0 sends a unicast frame to Server. Switch floods unknown unicast from all of its ports, except the incoming port. Above figure demonstrates how the Server will receive duplicate copies of unicast frame simultaneously. Duplicate frame copies create additional overhead on the network.

Basic Terms of STP

BPDU

BPDU (Bridge Protocol Data Unit) is a multicast frame that is used to share information about switch and its interface connections. Switches use BPDU to learn the network topology; other switches connections and any existing loops. BPDU frames are sent out as multicast in every two seconds.

Root Bridge

All decisions in STP are made from the perspective of Root Bridge. Switch with the lowest bridge ID is selected as Root Bridge. BPDU contains bridge ID. bridge ID is made from priority of the switch and MAC address of switch itself. Default priority is set to 32768. Switch with the lowest MAC address will be selected as the root switch, if you don't change the default priority value. You can override root selection process by changing the priority value. If you want one switch to be Root Bridge, change its priority value to less than 32768.

Selection process of Root Bridge runs each time a network change occurs like as adding new switch in topology, removing existing switch or Root Bridge failure. If other switches in network do not receive BPDUs from Root Bridge within 20 seconds, they assume that Root Bridge has failed and will begin a new election process to choose a new Root Bridge.

Non-Root Bridge

All other switches in network except Root Bridge are the non-Root Bridges. Non-Root Bridge receives updates from Root Bridge and update its STP database.

Port Costs

STP assigns each port a cost, called port cost. Port cost is used to choose the best path when multiple links are available between two switches. Cost of port is determined by the bandwidth of connected media link. Switch always use lower port cost to forward the frames.

Bandwidth	10 Gbps	1 Gbps	100 Mbps	10 Mbps
Cost value	2	4	19	100

Root Port

Root port is a port that is directly connected with the Root Bridge, or has the shortest path to the Root Bridge. Shortest path is path that has lowest path cost value. Remember that switch can go through many other switches to get the root. So it's not always the shortest path but it is the fastest path that will be used.

Designated Port

Designated port is the port that is selected as having the lowest port cost. Designated port would be marked as forwarding port.

Non-Designated Port

Non-designated port is the port that is selected as having the higher port cost than the designated port. Non-designated port would be marked as blocking port.

Forwarding Port

Forwarding port is used to forward the frames.

Blocking Port

Blocking port remains disable to remove loops.

STP Port States

Ports on switch running STP go through the five different states. During STP convergence, switches will move their root and designated ports through the various states: blocking, listening, learning, and forwarding, whereas any other ports will remain in a blocked state.

Blocking

In blocking state, switch only listen and process BPDUs on its ports. Any other frames except BPDUs are dropped. In this state, switch try to find out which port would be root port, which ports would be designated ports and which ports would remain in blocking state to remove loops. A port will remain in this state for twenty seconds. By default, all ports are in blocking state, when we powered on the switch. Only root port and designated ports will move into next state. All remaining ports will remain in this state.

Listening

After twenty seconds, root port and designated ports will move into listening state. In this state ports still listen and process only BPDUs. All other frames except BPDUs are dropped. In this state switch will double check the layer 2 topology to make sure that no loops occur on the network before processing data frames. Ports remain in this state for fifteen seconds. Learning

Root port and designated ports enter in learning state from listening state. In this state ports still listen and process BPDUs. However, in this state ports start processing user frames. Switch examines source address in the frames and updates its MAC Address Table. Switch will not forward user frames to destination ports in this state. Ports stay in this state for fifteen seconds.

Forwarding

In forwarding state, ports will listen and process BPDUs. In this state ports will also process user frames, update MAC Address Table and forward user traffic through the ports.

Disable

Disable ports are manually shut down or removed from STP by an administrator. All unplugged ports also remain in disable state. Disable ports do not participate in STP.

Convergence

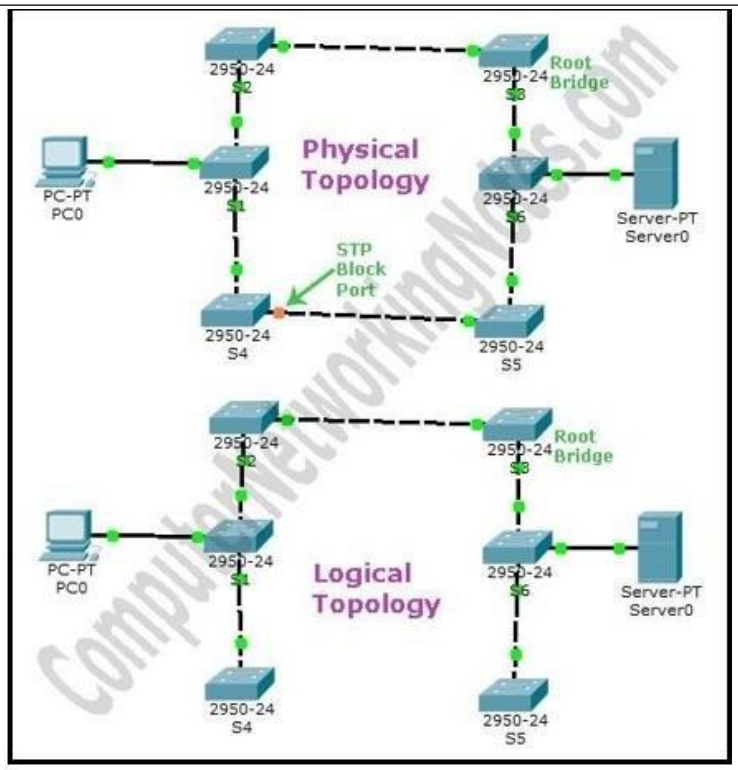
Convergence is a state where all ports on switch have transitioned to either forwarding or blocking modes. During the STP converging, all user data frames would be dropped. No user data frame will be forwarded until convergence is complete. Usually convergence takes place in fifty seconds (20 seconds of blocking state + 15 seconds of listing state + 15 seconds of learning state).

STP Operations

First thing a STP enable network do, is the election of Root Bridge. Switches share BPDUs with each other to select the Root Bridge. Switch that has lowest priority will become root. Default priority is set to 32768. If priority value is same then switch with lowest MAC address would be selected as root. In our network switch S3 has lowest MAC address. Since we did not change priority value, switch S3 would be chosen as Root Bridge.

- Every switch selects single port (that has shortest path cost) from all its ports and marked it as root port.
- If two switches have multiple connections, only single connection that has shortest path cost would be marked as designated port.
- Any port that is not either a root port or designated port would be blocked.

Next figure show, how STP changes a physically looped topology in virtually looped free topology.



show

show spanning-tree command provides useful information about STP operation. This information could be divided in three subsets. First set contains information about Root Bridge. Second set contains information about switch itself. Third set lists active interfaces status those are participating in STP operation.

S1#show spanning-tree

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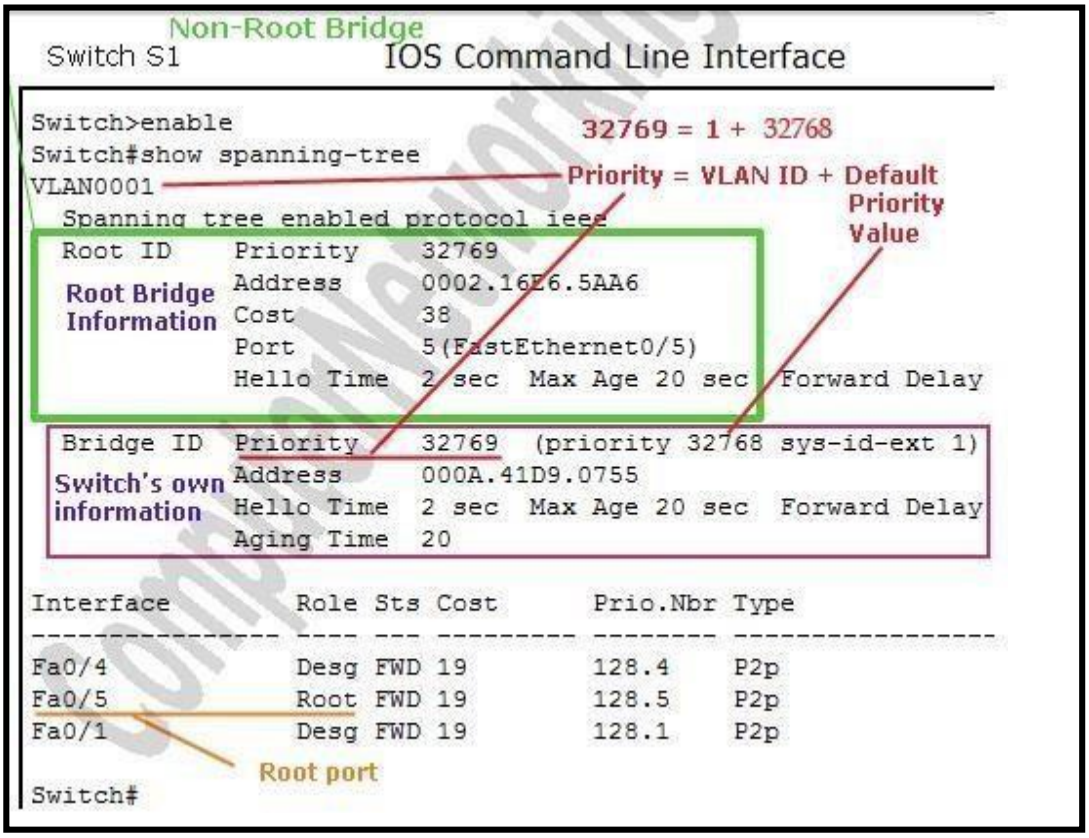


REVIEW QUESTIONS

1. What is bridge ID and what role it plays in election of root bridge?

Every switch has an identity when they are part of a network. This identity is called the bridge ID . The root bridge is selected by manually configuring its bridge priority to a low value. 32768 is the default value out of a range from 0 to 61440. If all switches in a single spanning tree have the same bridge priority, the switch with the lowest MAC address will become the root bridge.

2. What is the need of redundant links in networks and what are there pros and cons?

The redundant backup of the links can bring robustness, stability and reliability to the network. However, the backup link also causes loops in the network. The loop problem is the most serious problem faced by the backup link.

3. What mechanism switch uses to identify the loops in the network?

Switches use Spanning Tree Protocol (STP) to identify and remove network loops and prevent broadcast storms.

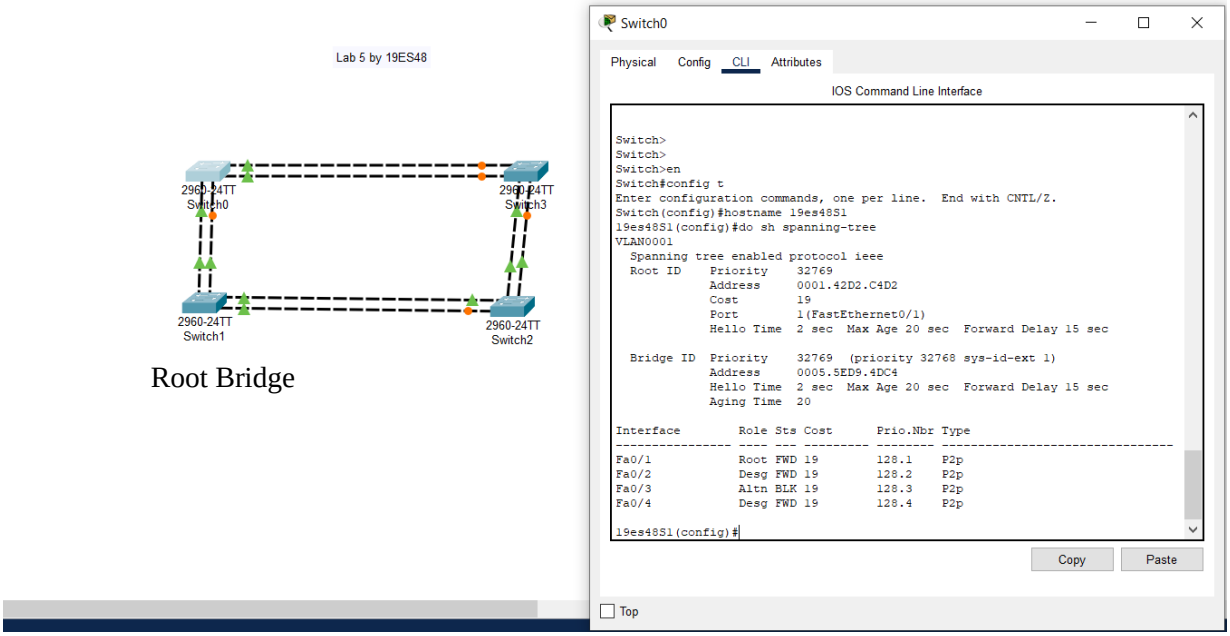
4. What command is used to set switch as a root bridge?

spanning-tree vlan vlan-id root secondary global configuration mode command. This command sets the priority for the switch to the predefined value 28,672. This ensures that the alternate switch becomes the root bridge if the primary root bridge fails.

LAB EXCERCISE

Create a scenario using four switches (SW1, SW2, SW3, SW4) where every switch has a redundant link in a network. Now using STP identify the following:

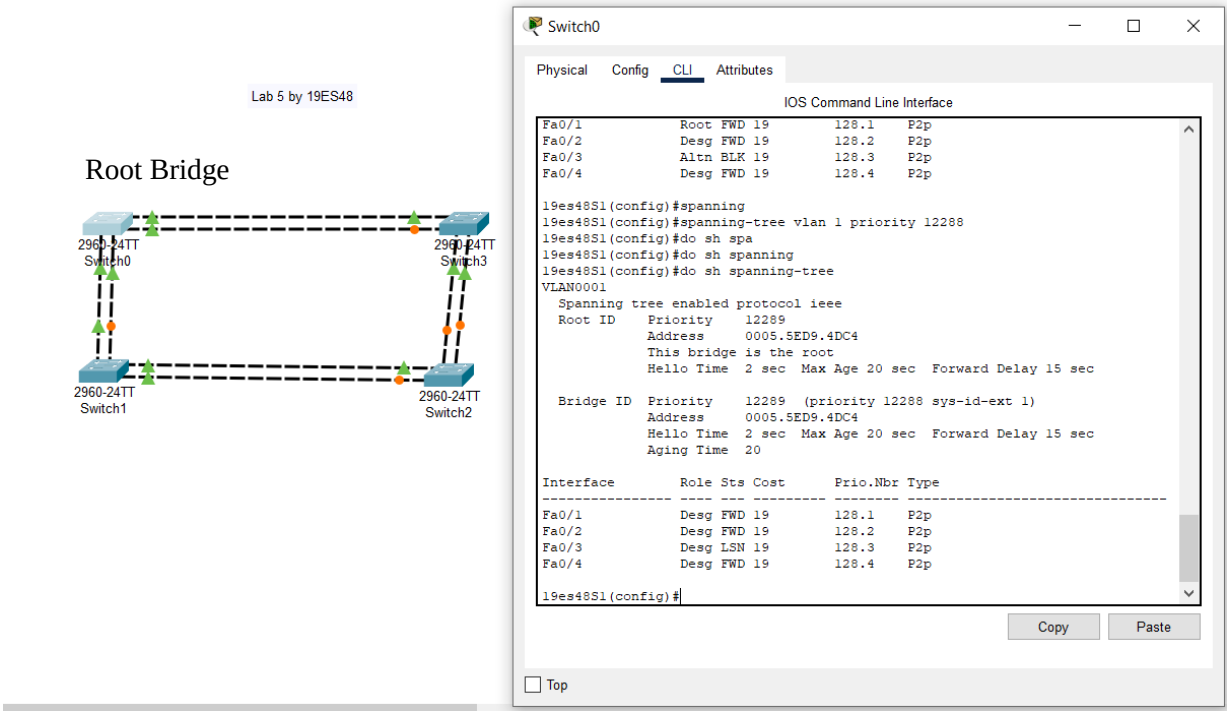
- Root bridge
- Root ports
- Designated ports
- Block ports



Root Bridge

In above scenario now change the priority of switch other than root bridge and identify

- New root bridge
- Root ports
- Designated ports
- Block ports


Lab 5 by 19ES48
Root Bridge
2960-24TT
Switch0
2960-24TT
Switch3
2960-24TT
Switch1
2960-24TT
Switch2
Switch0
Physical
Config
CLI
Attributes
IOS Command Line Interface
Fa0/1 Root FWD 19 128.1 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/3 Altn BLK 19 128.3 P2p
Fa0/4 Desg FWD 19 128.4 P2p
19es48S1(config)#spanning
19es48S1(config)#spanning-tree vlan 1 priority 12288
19es48S1(config)#do sh spa
19es48S1(config)#do sh spanning
19es48S1(config)#do sh spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 12289
Address 0005.5ED9.4DC4
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 12289 (priority 12288 sys-id-ext 1)
Address 0005.5ED9.4DC4
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
Interface Role Sts Cost Prio.Nbr Type
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/3 Desg LSN 19 128.3 P2p
Fa0/4 Desg FWD 19 128.4 P2p
19es48S1(config)#
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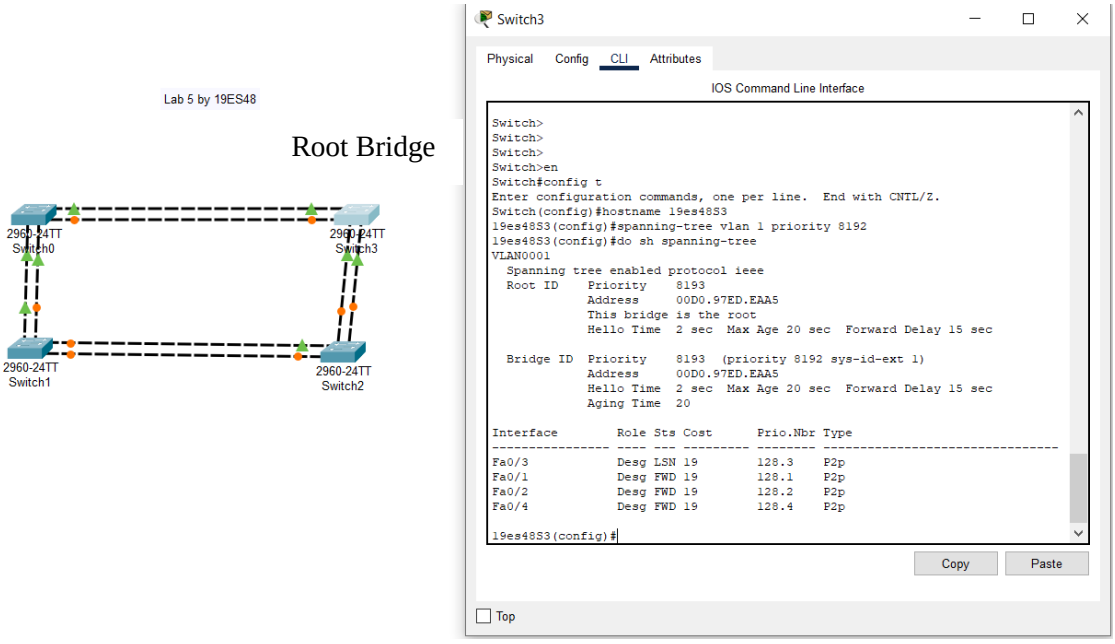
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Root Bridge
2960-24TT
Switch0
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Switch3
2960-24TT
Switch1
2960-24TT
Switch2
Switch3
Physical
Config
CLI
Attributes
IOS Command Line Interface
Switch>
Switch>
Switch>
Switch>en
Switch#config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname 19es48S3
19es48S3(config)#spanning-tree vlan 1 priority 8192
19es48S3(config)#do sh spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID Priority 8193
Address 00D0.97ED.EAA5
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Bridge ID Priority 8193 (priority 8192 sys-id-ext 1)
Address 00D0.97ED.EAA5
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20
Interface Role Sts Cost Prio.Nbr Type
Fa0/3 Desg LSN 19 128.3 P2p
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/4 Desg FWD 19 128.4 P2p
19es48S3(config)#
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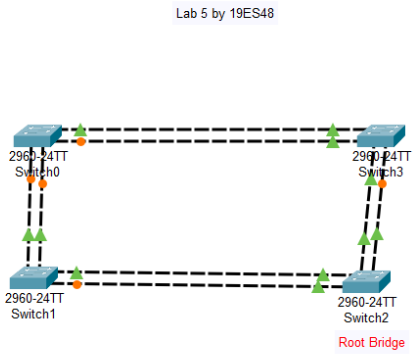

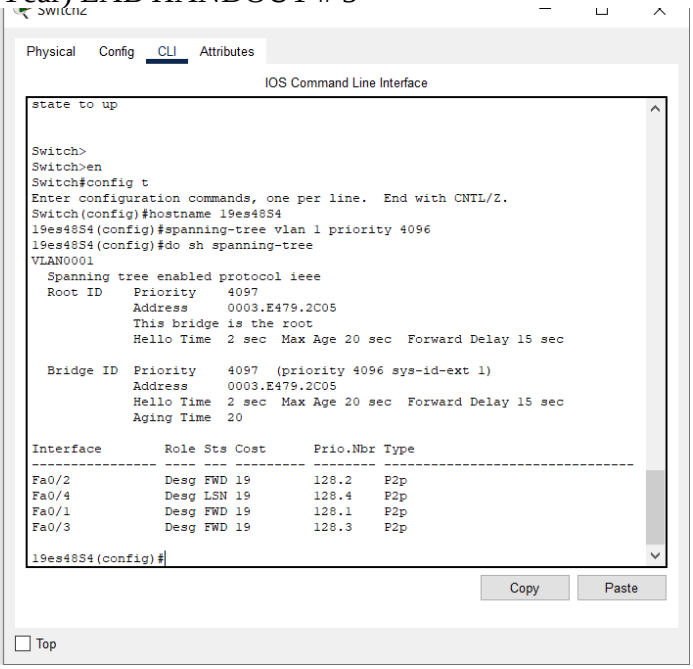

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