

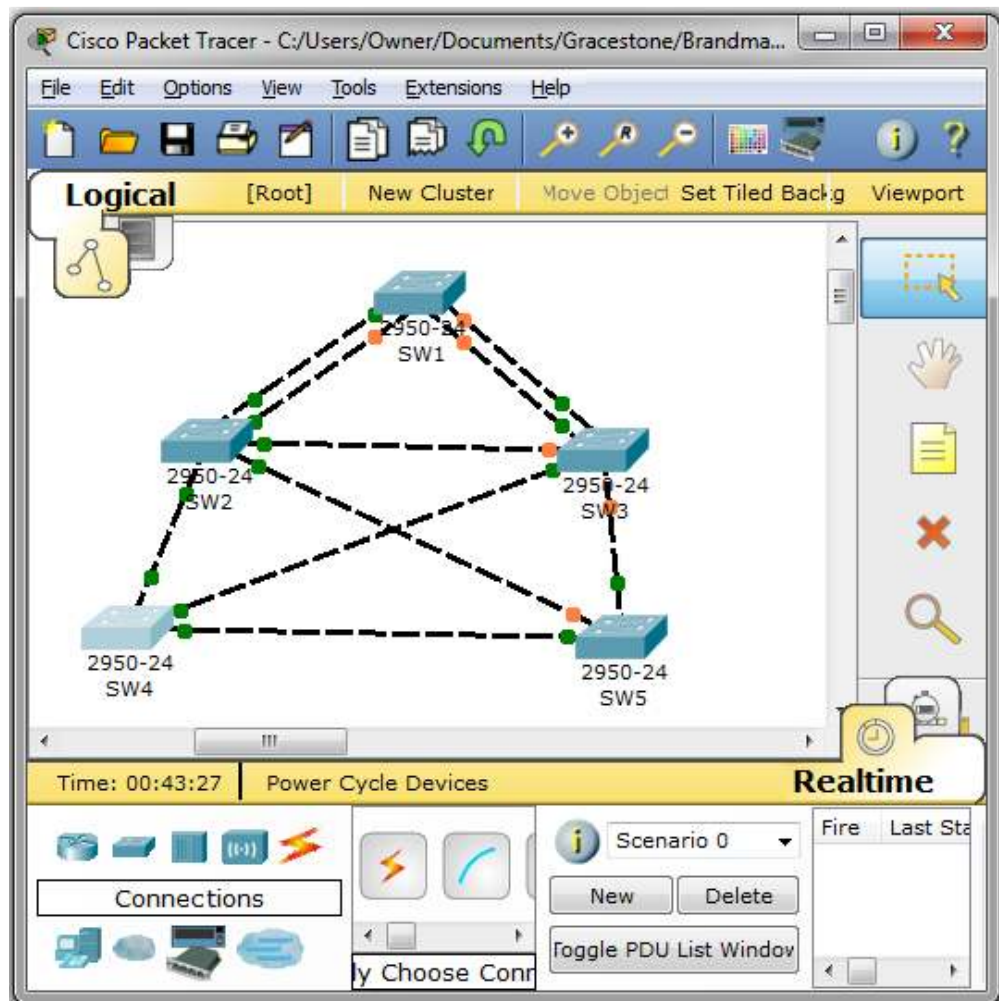
ICND2

Rapid Spanning-Tree Protocol

TOPOLOGY

- 5x2950 (Layer 2 Switches)

These exercises utilize build on the previous ones used in the last class sessions.



Lab Exercise 1: Rapid Spanning-Tree Configuration

Equipment Involved: SW1, SW2, SW3, SW4 & SW5

STEP 1: Verify 802.1d STP Operation on SW1

- Double click on SW1 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)

```

SW1>en
SW1#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
            Address    0090.0C50.D436
            This bridge is the root
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    24577 (priority 24576 sys-id-ext 1)
            Address    0090.0C50.D436
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time 20

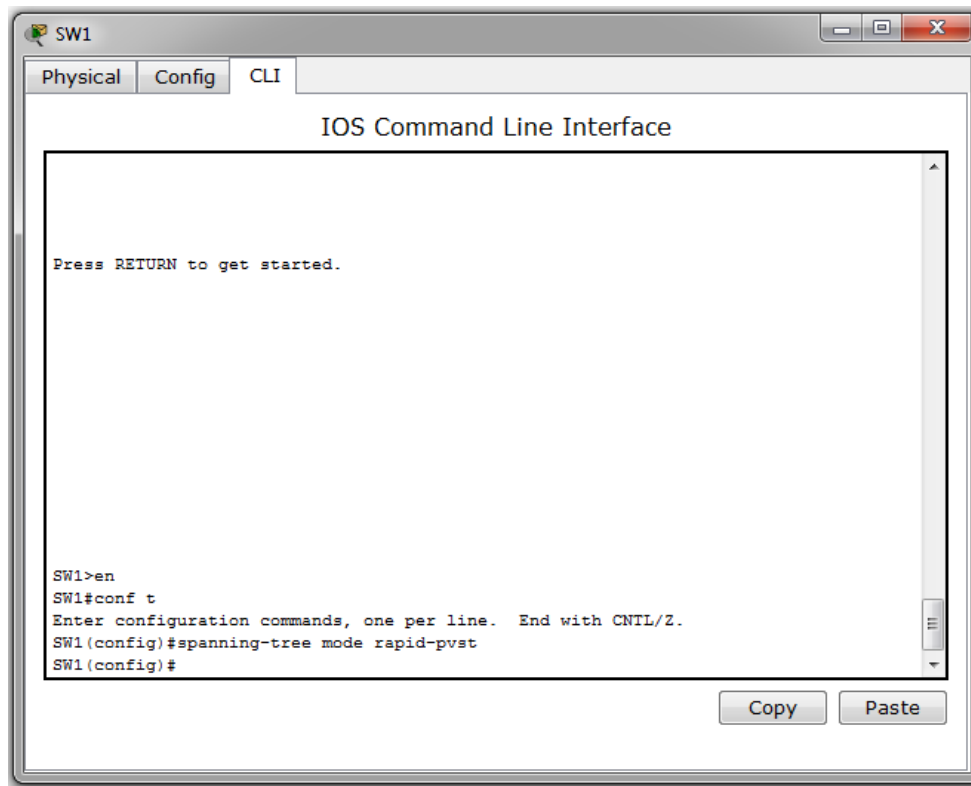
Interface          Role Sts Cost          Prio.Nbr Type
-----
Po1                Desg FWD 19           128.25 Shr
Fa0/1              Desg FWD 19           128.1  P2p
Fa0/2              Desg FWD 19           128.2  P2p
Fa0/3              Desg FWD 19           128.3  P2p
Fa0/4              Desg FWD 19           128.4  P2p
Po2                Desg FWD 19           128.26 Shr
SW1#

```

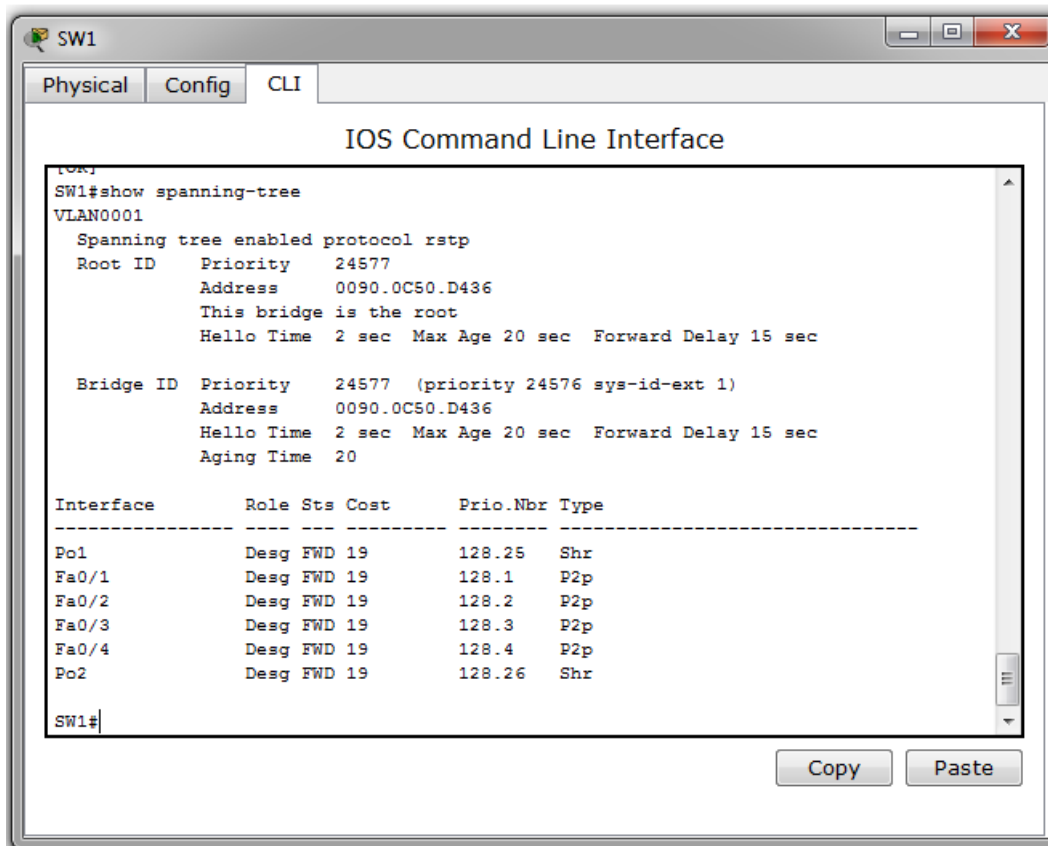
- Type the word **show spanning-tree** to display the current 802.1d settings for SW1
 - Note the fact that STP is enabled and running (**spanning tree enabled protocol ieee**), which indicate a traditional Spanning-Tree operation (802.1d)
 - Notice that the this bridge/switch is the root switch (**This bridge is the root**)
 - **All** of the ports are in forwarding mode
 - The typical timers for 802.1d are displayed:
 - **Hello:** 2 seconds
 - **MaxAge:** 20 seconds
 - **Forward Delay:** 15 seconds
- All of the displayed information indicates that Spanning-Tree Protocol is running as expected, in 802.1d mode

STEP 2: Change the Spanning-Tree mode on SW1 to Rapid Spanning-Tree

- Double click on SW1 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)



- Type **config t** to enter global configuration mode
- Type **spanning-tree mode rapid-pvst** to change from STP 802.1d to RSTP 802.1w
- Type **exit** to return to privileged exec mode
- Execute the **show-spanning tree command** again to verify the changes



- Notice that the indicator that Spanning-Tree is functional has changed to the phrase **protocol rstp** from **protocol ieee**
- Almost all of the other settings appear unchanged
- Type **copy running-config startup-config** (or **wr mem**) to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file

STEP 3: Explore the Spanning-Tree Settings on SW2

- Double click on SW2 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)

The screenshot shows the Packet Tracer CLI window for SW2. The window title is "SW2" and it has tabs for "Physical", "Config", and "CLI". The main content area is titled "IOS Command Line Interface" and displays the following text:

```

SW2# show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
            Address    0090.0C50.D436
            Cost      19
            Port      25 (Port-channel 1)
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
            Address    0001.9676.97AD
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time 20

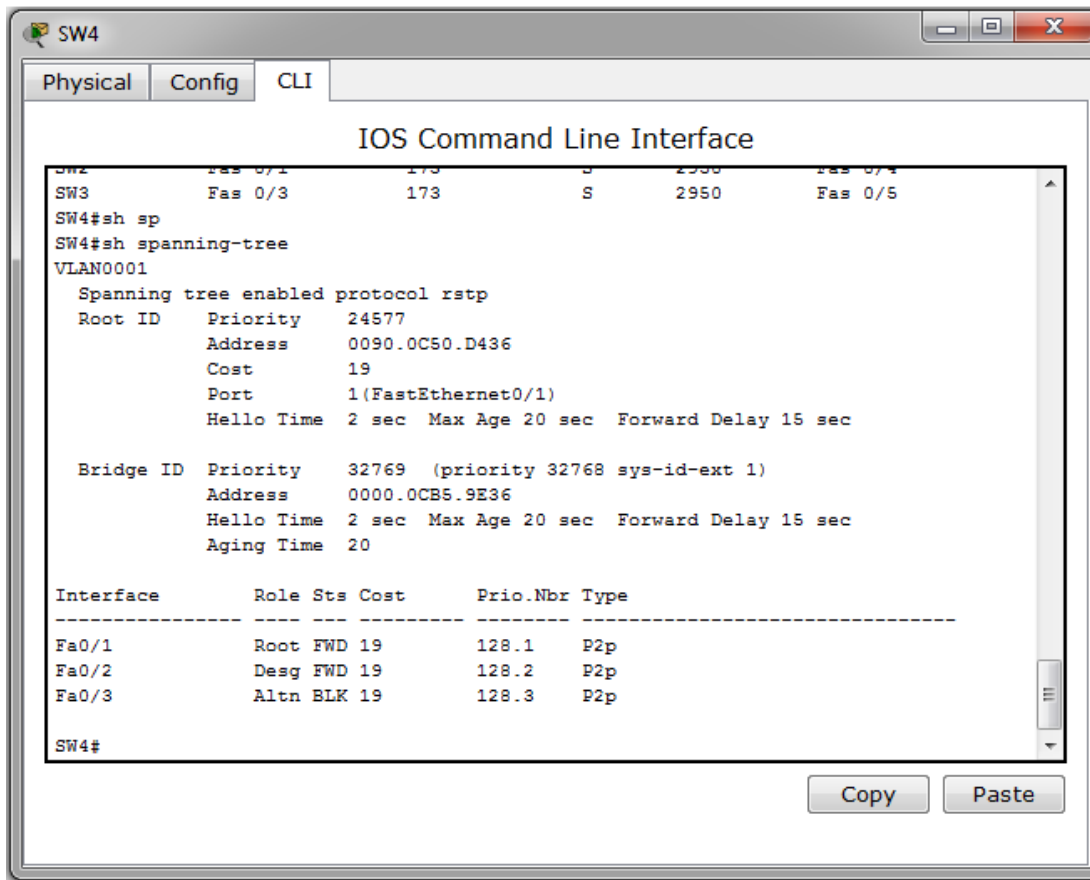
Interface    Role Sts Cost      Prio.Nbr Type
-----
Fa0/1        Desg FWD 19        128.1   P2p
Fa0/2        Desg FWD 19        128.2   P2p
Fa0/3        Desg FWD 19        128.3   P2p
Fa0/4        Desg FWD 19        128.4   P2p
Fa0/5        Desg FWD 19        128.5   P2p
Po1          Root FWD 19        128.25  Shr
  
```

At the bottom of the window, there is a "SW2#" prompt and two buttons labeled "Copy" and "Paste".

- Type **show-spanning tree** and press **<enter>** to display spanning-tree data on SW3
- You will notice that nothing has changed on SW3, and that it is still running in 802.1d STP mode (**protocol ieee**). This is because switches attached to 802.1w Rapid Spanning-Tree switches run in compatibility mode, using the older protocol on those links
- Type **config t** to enter global configuration mode
- Type **spanning-tree mode rapid-pvst** to change from STP 802.1d to RSTP 802.1w
- Type **exit** to return to privileged exec mode
- Execute the **show-spanning tree command** again to verify the changes
- Type **exit** to exit configuration mode completely
- Type **copy running-config startup-config** (or **wr mem**) to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file
- Repeat the process for all other switches

STEP 3: Simulate a link failure on SW4 to demonstrate the more efficient convergence process

- Double click on SW4 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)



The screenshot shows a terminal window titled 'SW4' with tabs for 'Physical', 'Config', and 'CLI'. The main content is the 'IOS Command Line Interface' showing the output of the 'show spanning-tree' command. The output includes details for VLAN0001, such as the spanning tree enabled protocol (rstp), root ID (24577), bridge ID (32769), and a table of interface roles and costs.

```
SW3      Fas 0/1      173      S      2950      Fas 0/4
SW4#sh sp
SW4#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID    Priority    24577
            Address    0090.0C50.D436
            Cost      19
            Port      1(FastEthernet0/1)
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
            Address    0000.0CB5.9E36
            Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time 20

Interface    Role Sts Cost      Prio.Nbr Type
-----
Fa0/1        Root FWD 19        128.1   P2p
Fa0/2        Desg FWD 19        128.2   P2p
Fa0/3        Altn BLK 19        128.3   P2p

SW4#
```

- Type **show-spanning tree** and press **<enter>** to display spanning-tree data on SW4 (see above)
- Notice several settings that indicate that SW4 is successfully running in RSTP mode:
 - Running protocol is RSTP (**Spanning tree enabled protocol rstp**)
 - Fa0/3 is in blocking mode but is designated as an **Alternate Port** (secondary root port)
 - Link types are identified as point-to-point (**P2P**)
- Type **config t** to enter global configuration mode
- Enter interface configuration mode on the Fa0/1 root port using the command Type **interface fa0/1**
- Type **shutdown** to simulate a link failure
- Type **exit** twice to return to privileged exec mode

```

SW4>en
SW4#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW4(config)#int fa0/1
SW4(config-if)#shutdown

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively do
wn
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state t
o down
SW4(config-if)#exit
SW4(config)#exit
%SYS-5-CONFIG_I: Configured from console by console
SW4#

```

- Quickly execute the **show-spanning tree command** again to show the settings during the convergence process
- Note that the change to the new root port and the update process is remarkably brief

```

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively do
wn
SW4(config-if)#^Z
%SYS-5-CONFIG_I: Configured from console by console
SW4#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID    Priority    24577
            Address     0090.0C50.D436
            Cost        19
            Port        3(FastEthernet0/3)
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
            Address     0000.0CB5.9E36
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time  20

Interface    Role Sts Cost      Prio.Nbr Type
-----
Fa0/2        Desg FWD 19       128.2   P2p
Fa0/3        Root FWD 19       128.3   P2p
SW4#

```

- Restore the fa0/1 interface to service using the **no shutdown** command

- Type **exit** to exit configuration mode completely
- Type **copy running-config startup-config** (or **wr mem**) to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file

Lab Exercise 2: Per-VLAN Spanning-Tree Configuration

Equipment Involved: SW1, SW2, SW3, SW4 & SW5

STEP 1: Create two additional VLANs on all switches

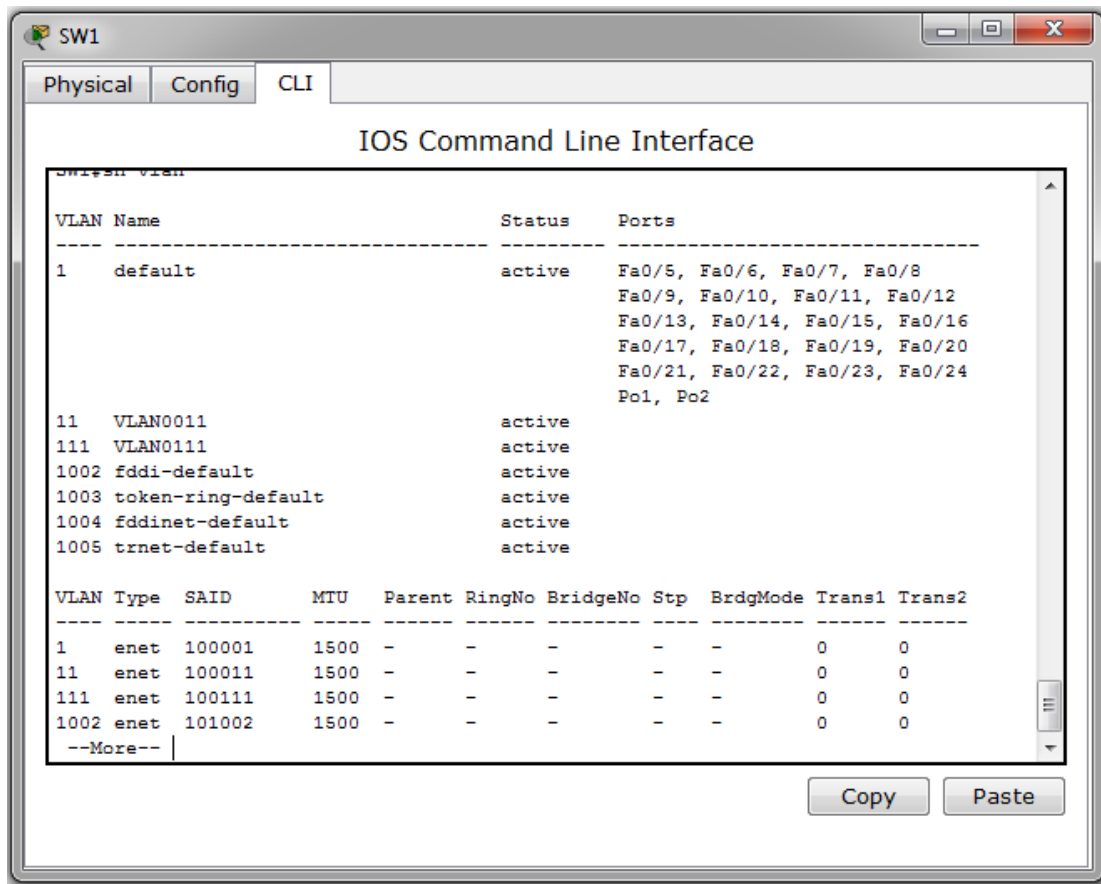
- Double click on SW1 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)

```

SW1>en
SW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW1 (config)#vlan 11
SW1 (config-vlan)#vlan 111
SW1 (config-vlan)#exit
SW1 (config)#exit
%SYS-5-CONFIG_I: Configured from console by console
SW1#

```

- Type **config t** and press **<enter>** to enter global configuration mode.
- Create an additional VLAN on SW1 using the command **vlan 11**
- Create another VLAN on SW1 using the command **vlan 111**
- Return to privileged command line mode by entering **exit** twice
- Execute the **show vlan** command to display all configured vlans, verifying that VLAN 11 and VLAN 111 appear in the output



- Type **exit** to exit configuration mode completely
- Type **copy running-config startup-config (or wr mem)** to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file
- Repeat the process on SW2, SW3, SW4 & SW5 so that the same VLANs exist on all switches in the domain

STEP 2: Explore the changes created by separate Spanning-Tree instances for each VLAN

- Double click on SW2 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)


```

SW2
Physical Config CLI
IOS Command Line Interface
Fa0/1 Desg FWD 19 128.1 P2p
Fa0/2 Desg FWD 19 128.2 P2p
Fa0/3 Desg FWD 19 128.3 P2p
Fa0/4 Root FWD 19 128.4 P2p
Fa0/5 Desg FWD 19 128.5 P2p

VLAN0111
Spanning tree enabled protocol rstp
Root ID Priority 32879
Address 0000.0CB5.9E36
Cost 19
Port 4(FastEthernet0/4)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32879 (priority 32768 sys-id-ext 111)
Address 0001.9676.97AD
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 FWD 19 128.3 P2p

```

- Type **show spanning-tree** and press **<enter>**, and press the spacebar to scroll down the output. Notice the following:
 - A separate Spanning-Tree instance is running for VLAN 1, VLAN 11, and VLAN 111 respectively
 - SW1 is the root switch on the all STP instances
 - SW2 is running in RSTP mode
- Change the bridge priority for SW2 on VLAN 11 by entering the command **spanning-tree vlan 11 root primary**

```

SW2
Physical Config CLI
IOS Command Line Interface
SW2(Config)#
%SYS-5-CONFIG_I: Configured from console by console
SW2#sh spanning-tree vlan 11
VLAN0011
Spanning tree enabled protocol rstp
Root ID Priority 24587
Address 0001.9676.97AD
This bridge is the root
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

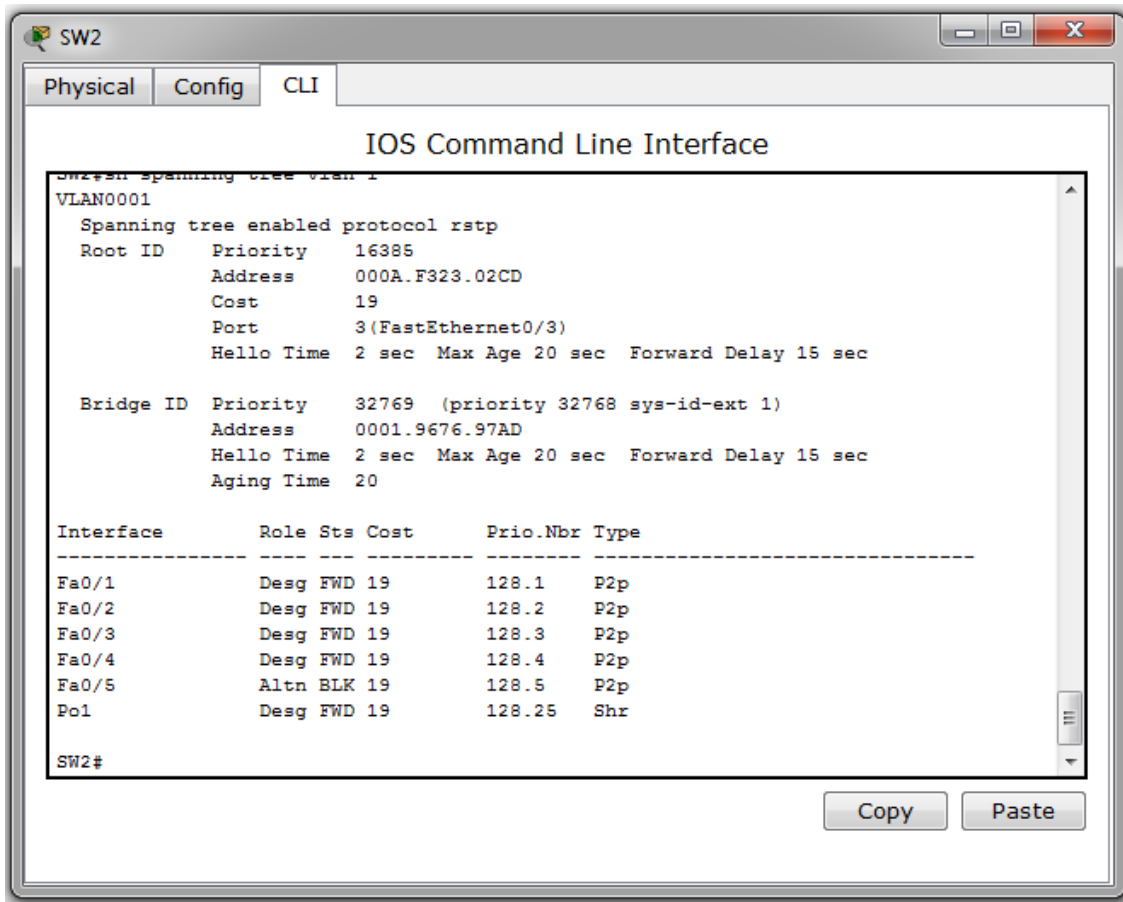
Bridge ID Priority 24587 (priority 24576 sys-id-ext 11)
Address 0001.9676.97AD
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 20

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 FWD 19 128.3 P2p
Fa0/4 Desg FWD 19 128.4 P2p
Fa0/5 Desg FWD 19 128.5 P2p

SW2#

```

- Verify that SW1 is still the root switch on VLAN 1 by typing **spanning-tree vlan 1**
- Verify that the phrase **This bridge is the root** is not present and that the MAC address of the root bridge is not the same as SW2



- Type **copy running-config startup-config** (or **wr mem**) to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file

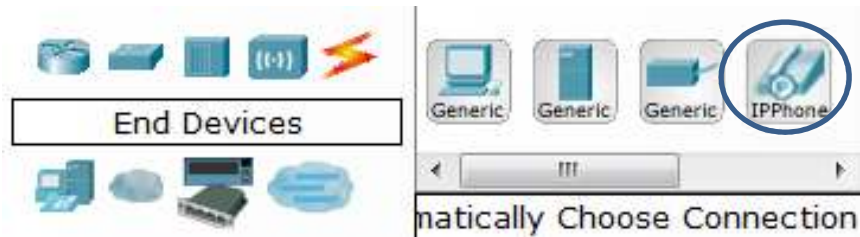
Lab Exercise 3: Voice VLAN Configuration

Equipment Involved: SW4

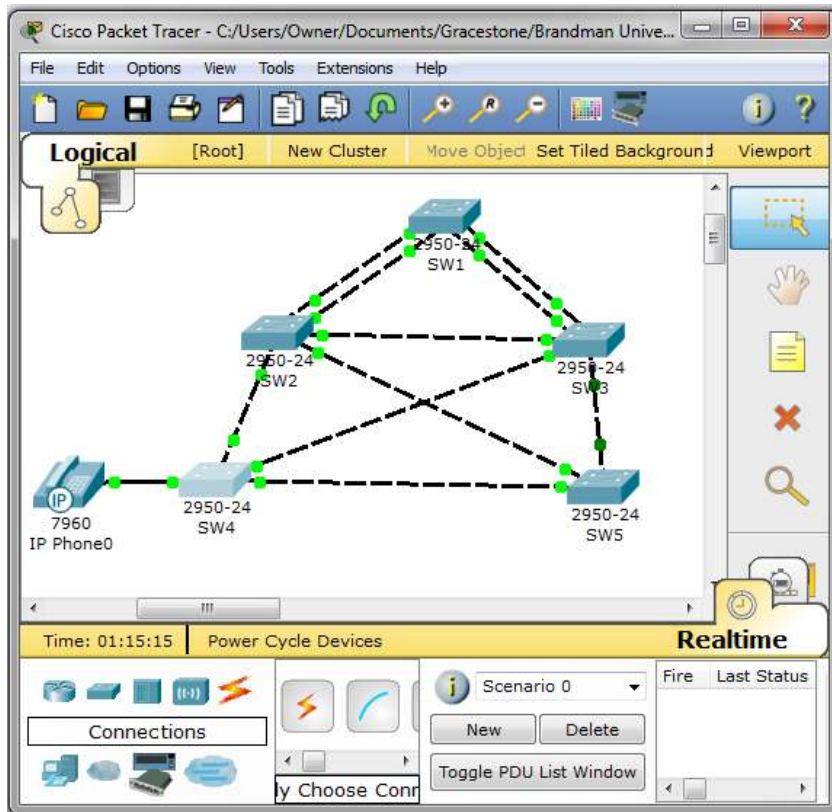
STEP 1: Add an IP Phone to the Lab Layout



- Locate the Devices dialog on the lower left-hand corner of the screen (see image above)
- Click on the End Devices Icon to display endpoint devices that you can add to the network



- Locate the IP Phone device on the devices menu (as displayed above), place the mouse over it, and click to drag the IP Phone next to SW4 (see below)

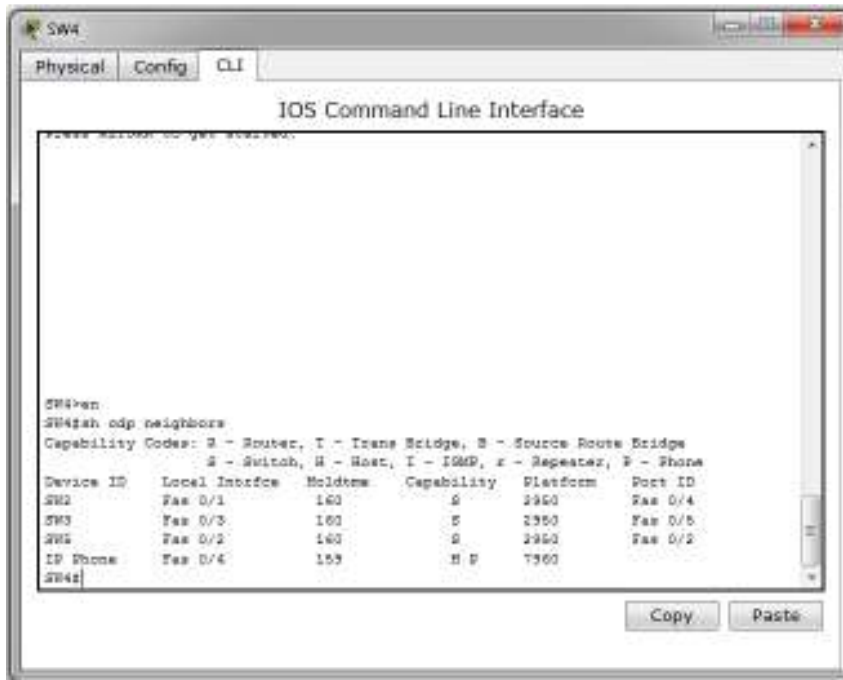


- Locate the IP Phone device on the devices menu (as displayed above), place the mouse over it, and click to drag the IP Phone next to SW4 (see below)
- Next, create a connection between the IP Phone and SW4 by selecting the connections menu by clicking the straight-through cable
- Place the mouse over the IP Phone and left click over it, which will reveal a drop-down style menu with two selections, **Switch** and **PC**; select **Switch**
- Finally, move the mouse over SW4 (a line will start to drag from the IP Phone, this is normal), and left click on SW4, which will display a drop-down style menu similar to the IP Phone. This time select Fa0/4 as the port
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file



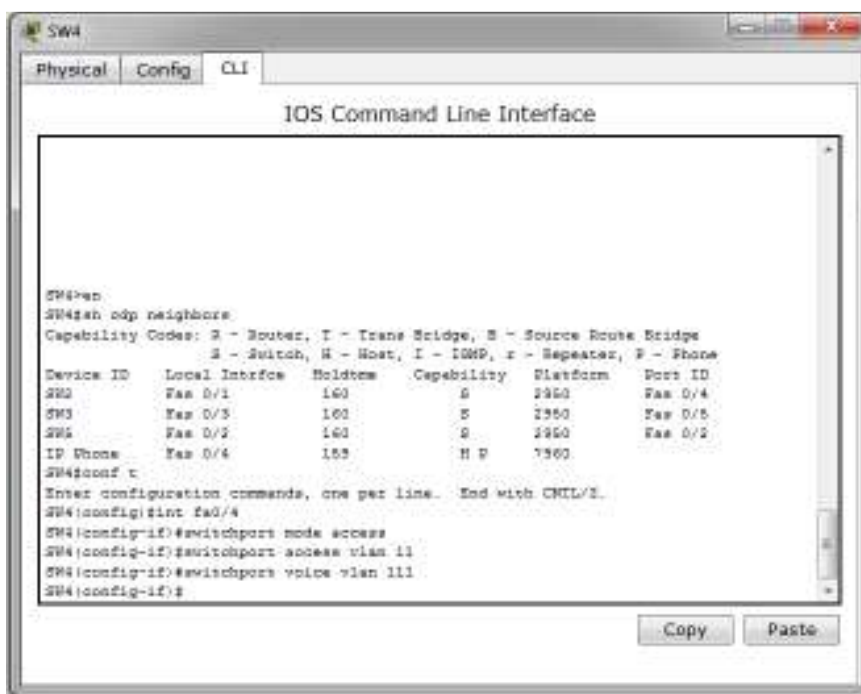
STEP 2: Configure the Fa0/4 port for Voice & Data VLAN Operation

- Double click on SW4 to open the command line interface window
- Press **<enter>** to get to user exec mode
- Type **en** and press **<enter>** to go into privileged mode (no password required)



```
SW4>en
SW4#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, S - Source Route Bridge
                 S - Switch, H - Host, I - IGMP, r - Repeater, F - Phone
Device ID      Local Interface  Holdtime  Capability  Platform  Port ID
SW2            Fa0/0/1         160      S           2950      Fa0/0/4
SW3            Fa0/0/3         160      S           2950      Fa0/0/5
SW5            Fa0/0/2         160      S           2950      Fa0/0/2
IP Phone       Fa0/0/4         153      H F         7360
```

- First, verify the presence of the IP Phone by executing the **show cdp neighbors** command from privileged mode on the CLI
- Verify the connection by finding the entry for IP Phone (as displayed above)
- Type **config t** and press **<enter>** to enter global configuration mode



```
SW4>en
SW4#sh cdp neighbors
Capability Codes: R - Router, T - Trans Bridge, S - Source Route Bridge
                 S - Switch, H - Host, I - IGMP, r - Repeater, F - Phone
Device ID      Local Interface  Holdtime  Capability  Platform  Port ID
SW2            Fa0/0/1         160      S           2950      Fa0/0/4
SW3            Fa0/0/3         160      S           2950      Fa0/0/5
SW5            Fa0/0/2         160      S           2950      Fa0/0/2
IP Phone       Fa0/0/4         153      H F         7360
SW4#conf t
Enter configuration commands, one per line. End with CNTRL-Z.
SW4(config)#int fa0/4
SW4(config-if)#switchport mode access
SW4(config-if)#switchport access vlan 11
SW4(config-if)#switchport voice vlan 111
SW4(config-if)#
```

- Enter interface configuration mode by entering the command **interface fa0/4** and press **<enter>**
- Set the port to access mode using the interface command **switchport mode access**
- Specify VLAN 11 as the data VLAN for the phone by using the command **switchport access vlan 11**
- Set voice traffic to use a separate VLAN by typing the command **switchport voice vlan 111**
- Return to privileged command line mode by entering **exit** twice
- Type **copy running-config startup-config** (or **wr mem**) to save the configuration to memory
- When finished, select **File > Save** on the main Packet Tracer screen in order to save your changes in the simulator file

The screenshot shows the Packet Tracer CLI window for SW4. The window title is 'SW4' and it has tabs for 'Physical', 'Config', and 'CLI'. The main area is titled 'IOS Command Line Interface'. The command entered is 'SW4#sh interfaces fa0/4 switchport'. The output shows the following details for interface Fa0/4:

```

SW4#sh interfaces fa0/4 switchport
Name: Fa0/4
Switchport: Enabled
Administrative Mode: static access
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: On
Access Mode VLAN: 11 (VLAN0011)
Trunking Native Mode VLAN: 1 (default)
Voice VLAN: 111
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
Administrative private-vlan trunk encapsulation: dot1q
Administrative private-vlan trunk normal VLANs: none
Administrative private-vlan trunk private VLANs: none
Operational private-vlan: none
Trunking VLANs Enabled: ALL
Pruning VLANs Enabled: 2-1001
Capture Mode Disabled

```

The lines 'Access Mode VLAN: 11 (VLAN0011)' and 'Voice VLAN: 111' are highlighted in blue. At the bottom right of the CLI window, there are 'Copy' and 'Paste' buttons.

- To verify the correct port settings, enter the command **interface fa0/4 switchport** and press **<enter>**
- In the command output, look for **Access Mode VLAN 11** and **Voice VLAN 111** to verify correct configuration
- Alternatively, you can use the command **show running-config** and look at the specific output under interface fa0/2

