instituto superior de engenharia de lisboa

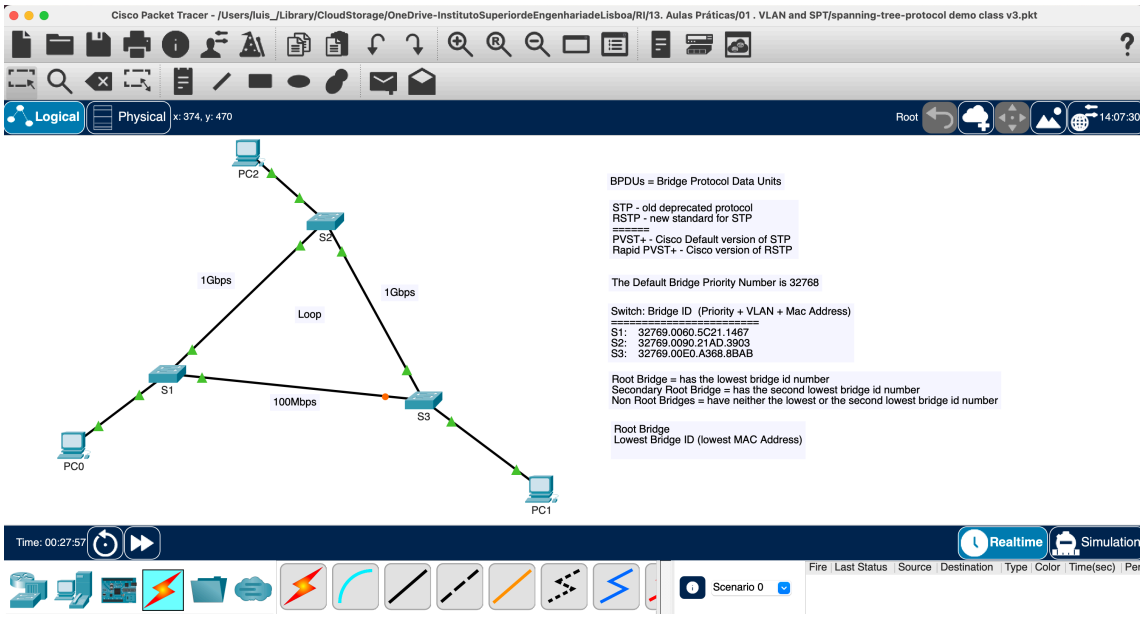
Redes de Internet / Internet Networks
Practical Lesson No. 2: STP Introduction

Context

The objective of this activity is to introduce Spanning Tree Protocol (STP) through the use of Cisco Packet Tracer. Students will learn the fundamental concepts of STP and its role in preventing switching loops, while gaining hands-on experience with network simulation in a controlled environment.

1. Spanning Tree Protocol Overview

1.1 Build the following network topology, involving the interconnection of three switches that create a closed loop. This topology can be obtained at the following link, where some configurations have already been made.



1.2 Fill in the table with the physical address of each switch and calculate the Bridge ID of each switch. Which is the root bridge?

Switch	MAC Address	Bridge ID (Priority + VLAN + Mac Address)
S1	0060.5C21.1467	32769.0060.5C21.1467
S2	0090.21AD.3903	32769.0090.21AD.3903

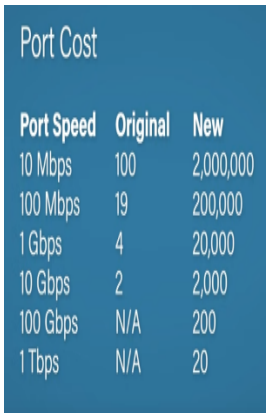
S3	00E0.A368.8BAB	32769.00E0.A368.8BAB

Note: The default priority for a bridge is Priority Number 32768.

1.3 Using the CLI console and the command: show spanning-tree, confirm that the root bridge is the one indicated in the previous question.

Hint: check which bridge is indicated as “This bridge is the root.” Also check with the command show spanning-tree summary, which is the default ST protocol in CISCO.

1.4 Identify your role at each port: RP, DP, BP



Porta	PC	RPC	RP	DP	BLK (alternate)
S1/Gig01	4	-		x	
S1/Fa10	19	-		x	
S1/Fa03	19	-		x	
S2/Gig01	4	4	x		
S2/Gig02	4	23		x	
S2/Fa11	19	-		x	
S3/Gig01	4	8	x		
S3/Fa03	19	19		x	
S3/Fa12	19	-			x

1.5 Confirm the previous results with Cisco Packet Tracer.

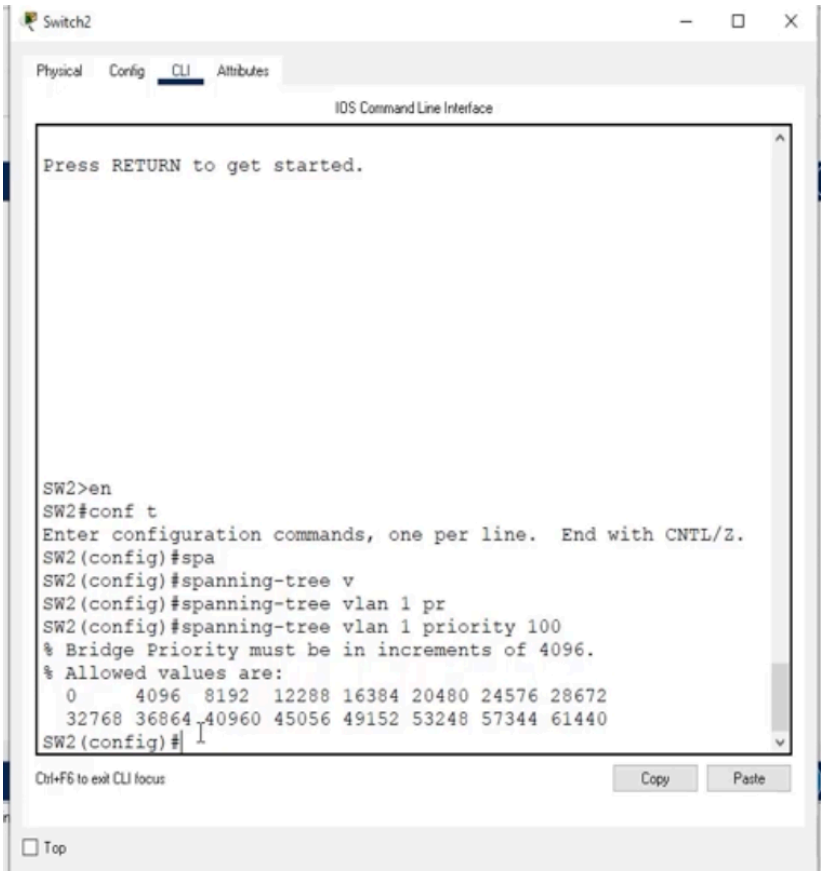
Hint: use the command: show spanning-tree.

1.6 Observe the sending of a PDU from PC0 to PC1 and observe the SPT in execution using the simulation mode of Packet Tracer (ICMP messages only).

1.7 Using the CLI console of each switch, use the commands: enable; configure terminal; no spanning-tree vlan 1 to disable the spanning tree algorithm. Repeat step 4.6 and observe the differences.

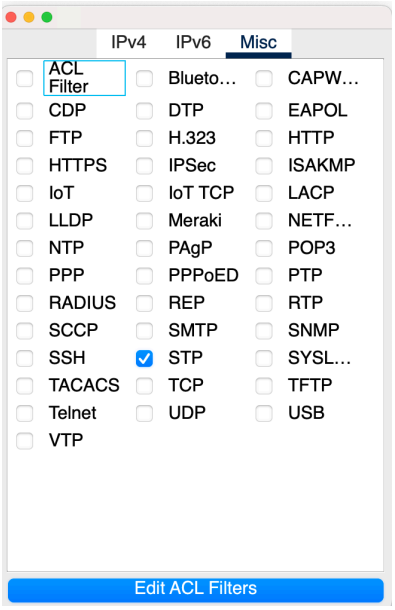
1.8 Manually changing the priority of a switch

Using the command spanning-tree vlan 1 priority x (see example below), it is possible to change the default priority and, as a result, affect the choice of root bridge. To test this, change the priority of the current root bridge to 24756 and check the impact on the election.

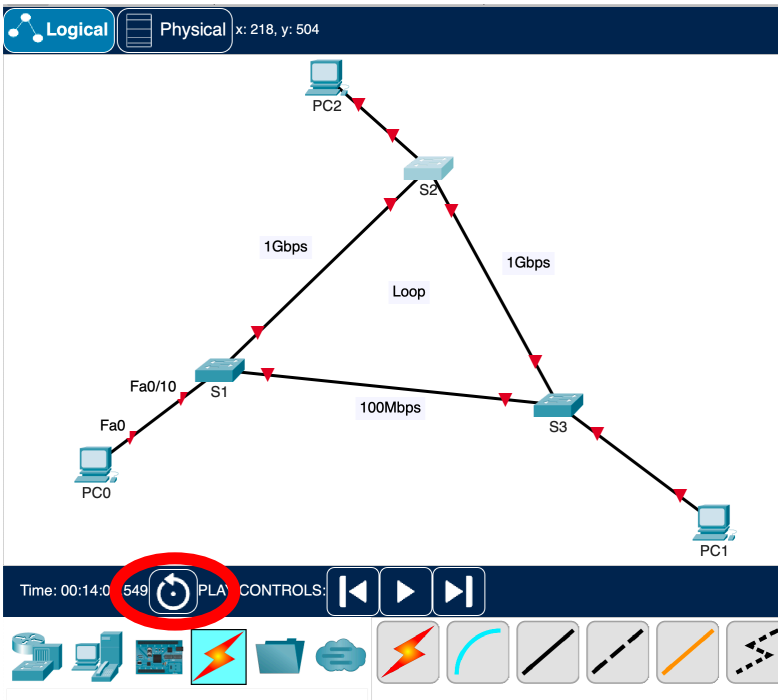


2. Analysis of BPDU Messages Before and After Root Bridge Election

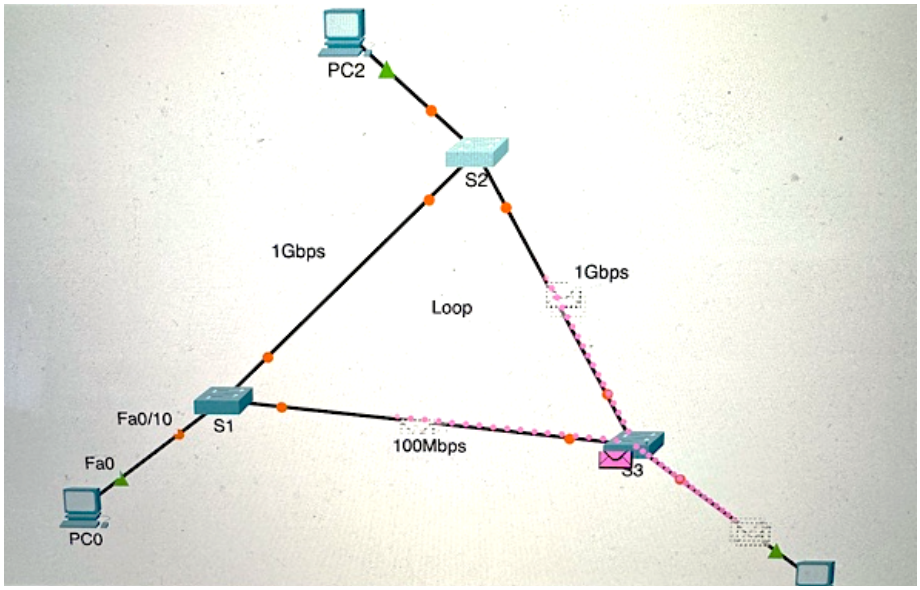
Consider again the original topology used in the previous point, containing three switches. Select simulation mode in packet tracer and ensure that the capture filters only select packets associated with STP.



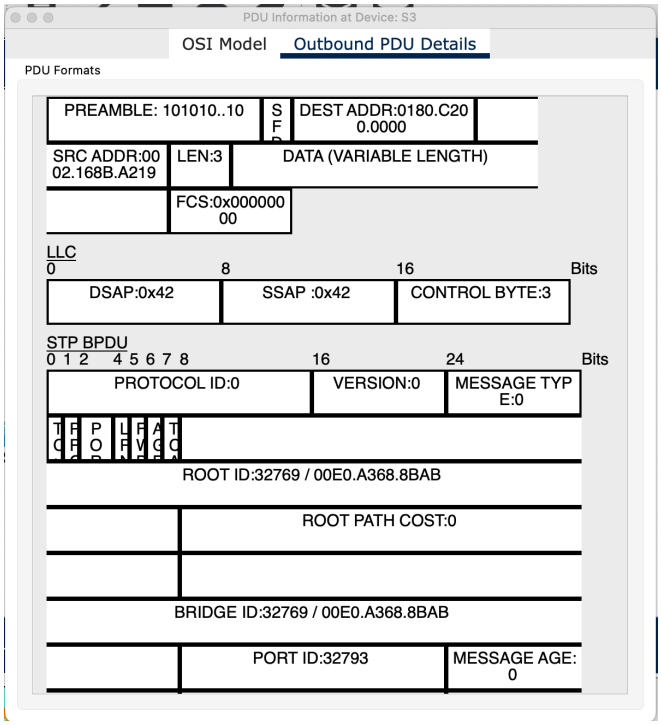
2.1 Observe the exchange of BPDUs before Root Bridge is elected. To do this, click the topology reset button and start packet capture.



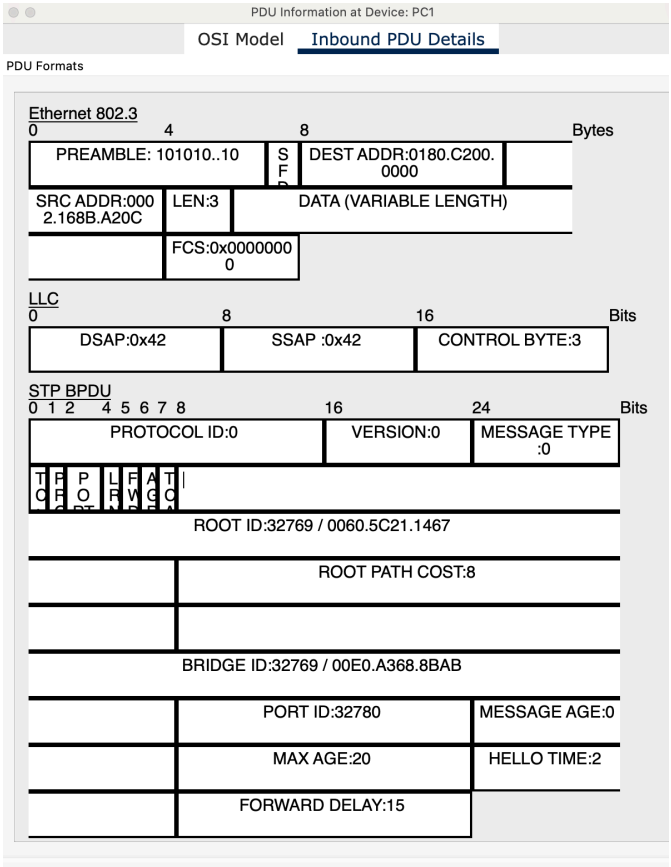
Verify that before the Root Bridge is elected, all switches send BPDUs. Why is this the expected behavior?



2.2 Look at the initial BPDU sent by switch S3, for example. Check that the BPDU is encapsulated in an Ethernet frame. Which bridge is identified as the root bridge in this first BPDU? Comment on this result.

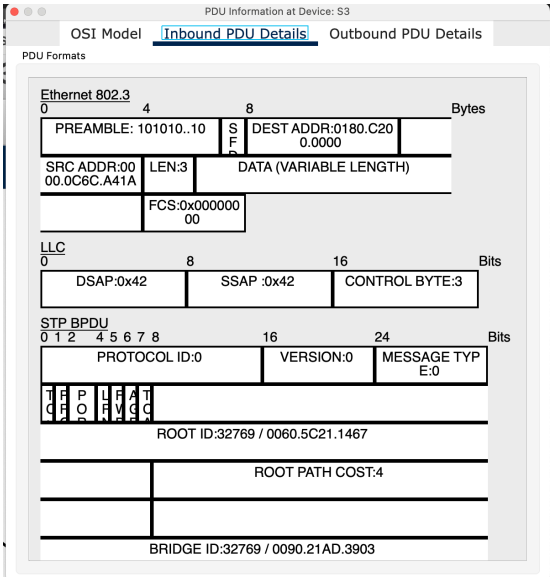


2.3. Advance the capture process forward until the topology converges to its final state. Open a PBDU sent after this state and check the difference in the Root Bridge.

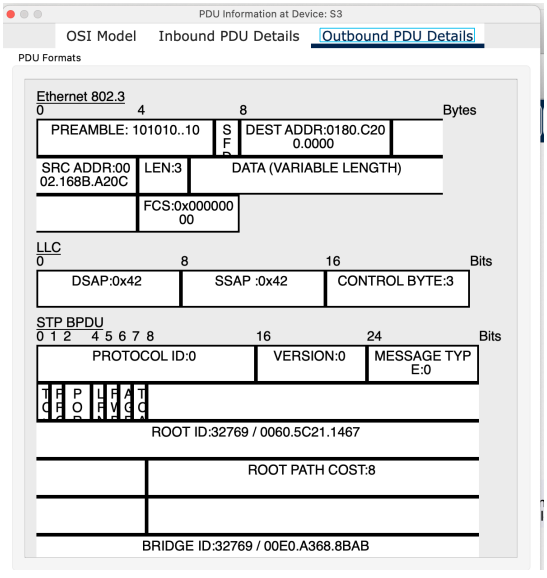


2.4 Continue with capture mode after topology convergence. Verify that now only the Root Bridge creates BPDUs, while the other bridges only forward them, adjusting their respective path cost to the Root Bridge.

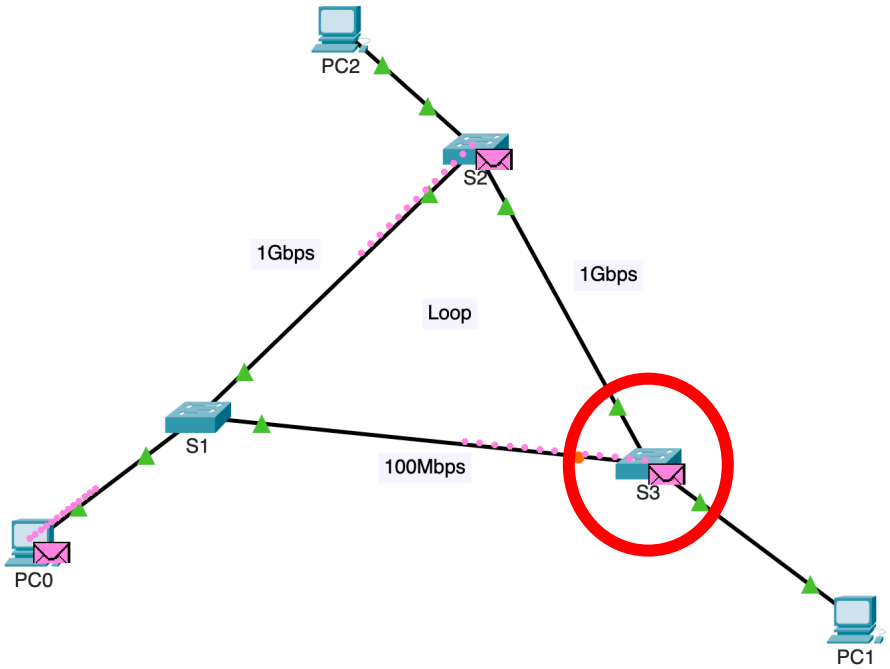
Example 1. Cost 4 (1 Gbps) on S2



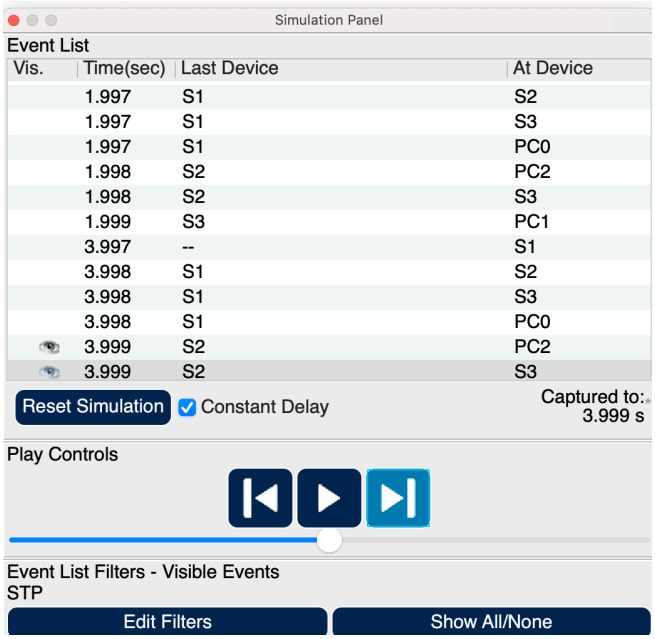
Example 2. Cost 8 (2 x 1 Gbps) on S3



2.5 Observe the path of the BPDUs after convergence. Verify that ports in a blocked state are also traversed by the BPDUs. Why is this the appropriate behavior?



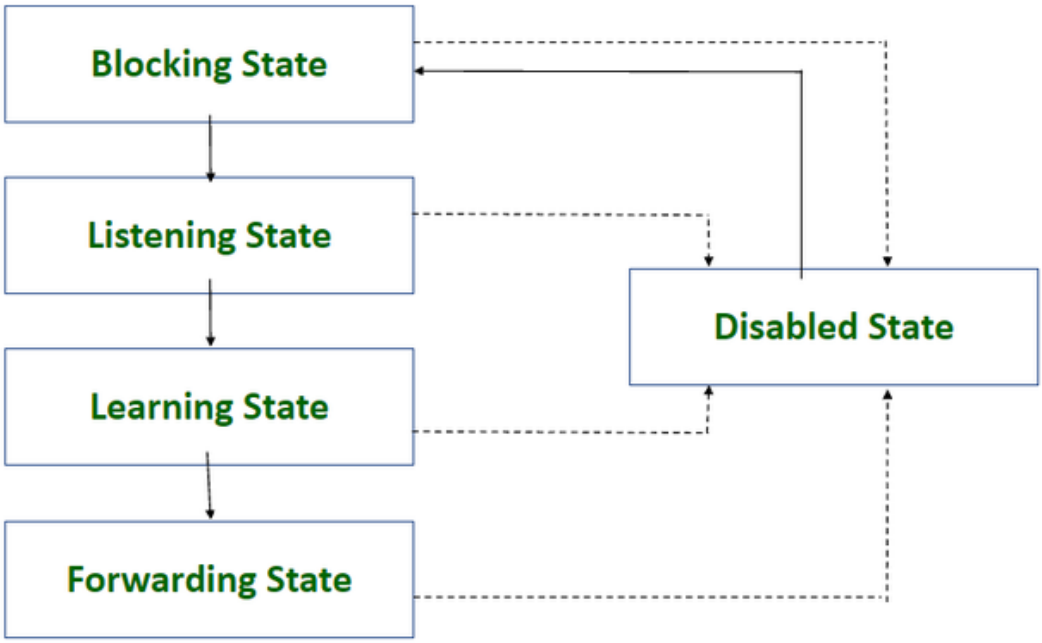
2.6 Check the Simulation Panel to see the time interval between BPDUs sent by the Root Bridge. What is the name of this timer?

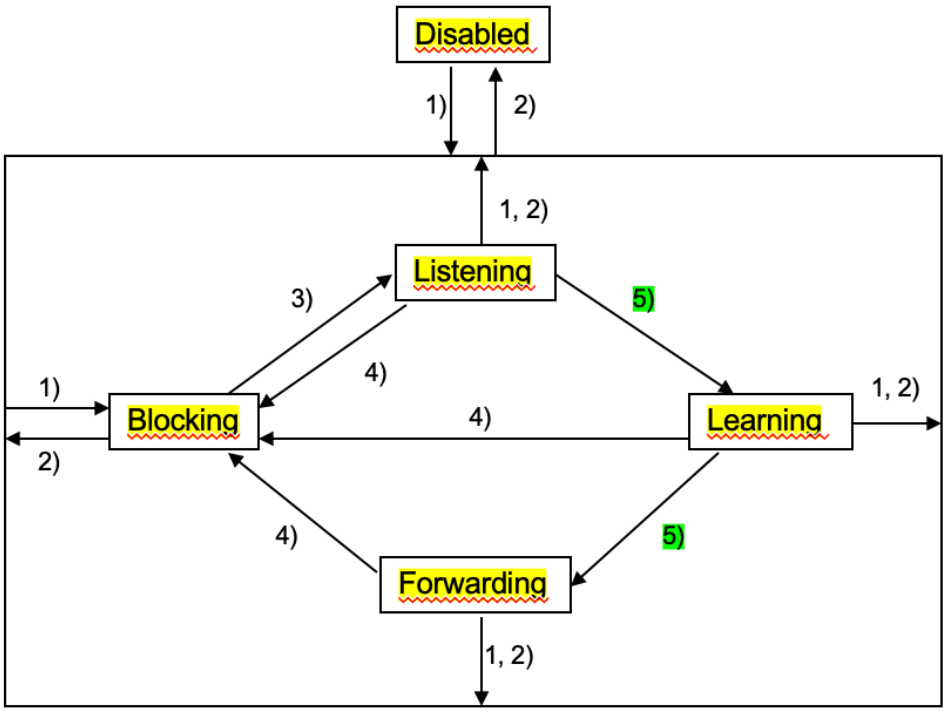


2.7 Observe the various timing parameters in the BPDU. Identify the timer referred to in the previous point.

	PORT ID:32794	MESSAGE AGE:0
	MAX AGE:20	HELLO TIME:2
	FORWARD DELAY:15	

2.8 Observe the state diagram that defines the possible transitions.



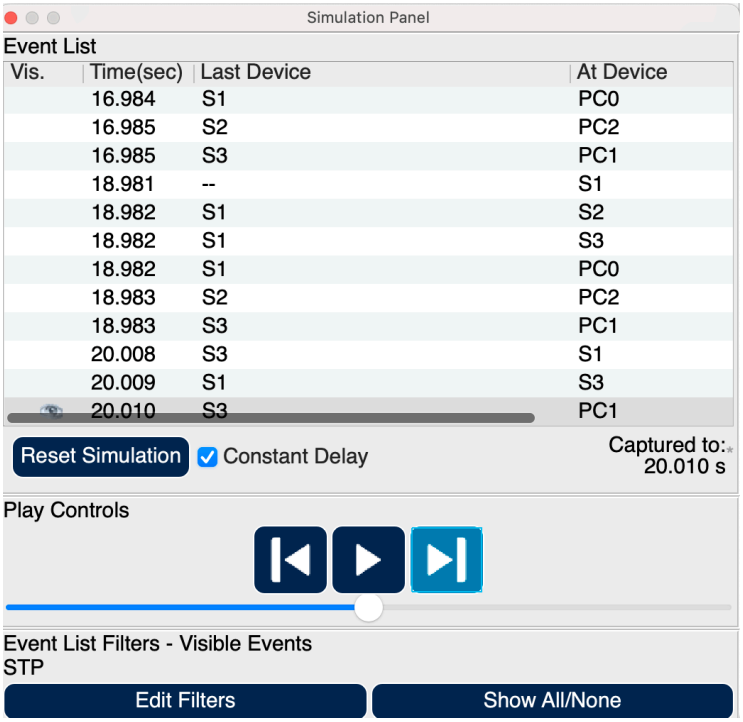


1) Activação por gestão ou por inicialização
2) Desactivação por gestão ou falha
3) Processo de aprendizagem do algoritmo
4) Bloqueio pelo algoritmo
5) Transição por expiração de tempo de aprendizagem

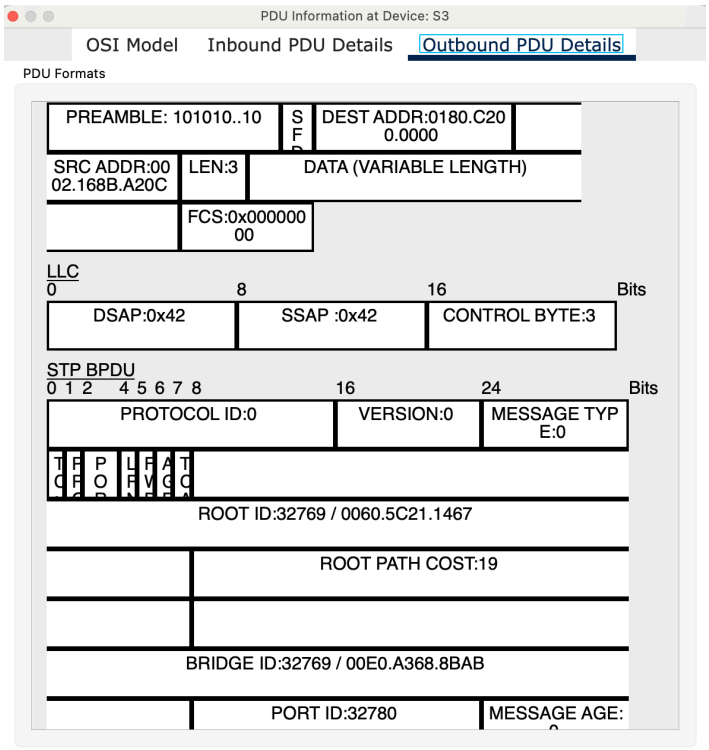
3. Analysis of BPDU messages before and after topology change

To introduce a topology change, we suggest removing the cable between S2 and S3.

3.1 After making the change, check that the status of the ports does not change immediately. This behavior means that STP waits for some time after a topology change before assuming that the change is permanent. Now advance (forward) the simulation mode and check how long it takes for the simulation window to show a change in the convergence of the new port states. What is this timer called and identify it in the figure in question 2.7.



3.2 Observe the new costs in the paths to the Root Bridge. Why did the upper cost change to 19?



3.3 Restore the original configuration after convergence and check the status of the ports in S3 using the “show spanning-tree” command.

```
S3#
S3#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0060.5C21.1467
              Cost        8
              Port        25(GigabitEthernet0/1)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     00E0.A368.8BAB
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/3            Altn BLK 19        128.3    P2p
Fa0/12           Desg FWD 19        128.12   P2p
Gi0/1            Root FWD 4         128.25   P2p
```

3.4 Create another interruption in the connection between S2 and S3 and observe the status of the ports on S3 again. Comment on the results.

```
S3#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
             Address     0060.5C21.1467
             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     00E0.A368.8BAB
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/3            Root LSN 19        128.3    P2p
Fa0/12           Desg FWD 19        128.12   P2p
```

3.5 Switch to real-time mode and repeatedly enter the “show spanning tree” command on the same switch until you verify that there are ports in the Learning state.

```
S3#sh spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
             Address     0060.5C21.1467
             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     00E0.A368.8BAB
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/3            Root LRN 19        128.3    P2p
Fa0/12           Desg FWD 19        128.12   P2p
```

3.6 Approximately how many seconds have passed since the Listening state changed to the Learning state? What is this timer called, and identify it in the figure in question 2.7. What is the consequence of this timer being too long or too short?

3.7 Return to simulation mode, repeat the topology change, and verify that while a port is in the listening state, it does not forward frames or learn MAC addresses (use the show mac-address-table command).

```
S3#sh mac-address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

S3#sh mac-address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

S3#sh mac-address-table
          Mac Address Table
-------------------------------------------
```

3.8 Verify that when the port is in Learning mode, it already learns MAC addresses (but does not forward frames).

```
S3#sh mac-address-table
          Mac Address Table
-------------------------------------------

Vlan    Mac Address       Type        Ports
----    -----------       --------    -----

   1    0040.0b58.9903    DYNAMIC     Fa0/3
S3#
```