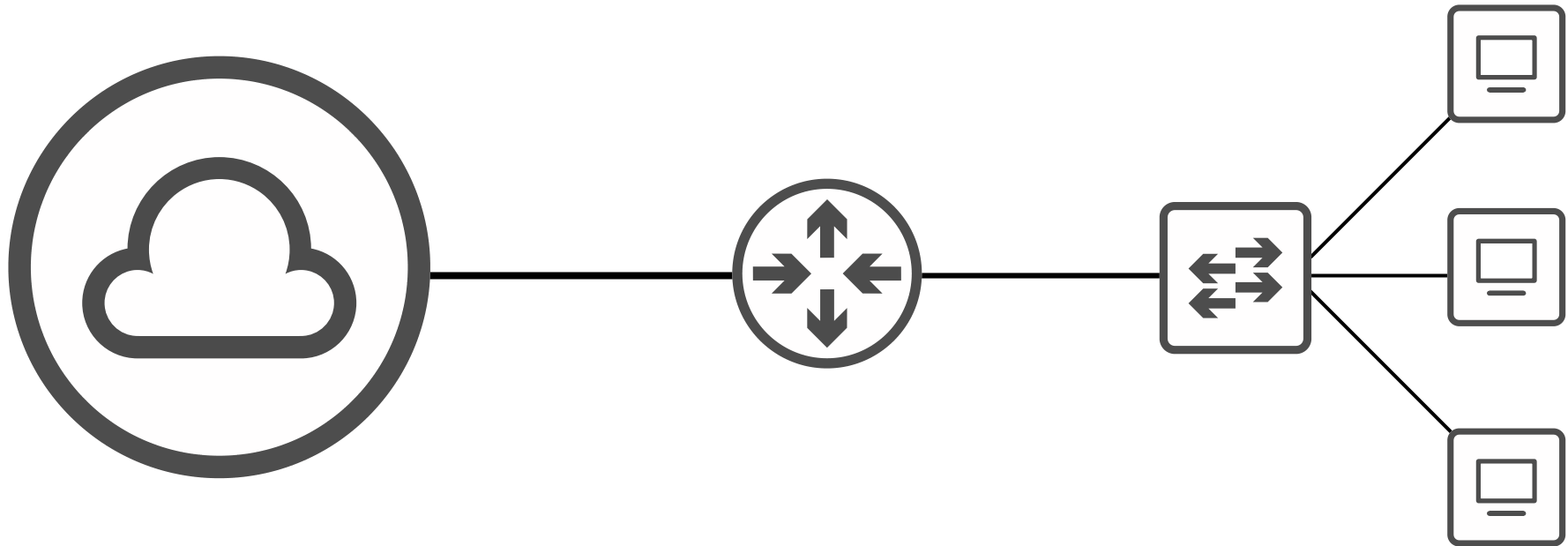


CCNA 200-301 Day 21

STP (Spanning Tree Protocol) Part 2



- STP states/timers
- STP BPDU
- STP optional features
- STP configuration

Spanning Tree Port States

STP Port State	Stable/Transitional
Blocking	Stable
Listening	Transitional
Learning	Transitional
Forwarding	Stable

(Disabled)

- Root/Designated ports remain stable in a **Forwarding** state.
- Non-designated ports remain stable in a **Blocking** state.
- **Listening** and **Learning** are transitional states which are passed through when an interface is activated, or when a **Blocking** port must transition to a Forwarding state due to a change in the network topology.

Spanning Tree Port States

STP Port State	Stable/Transitional
Blocking	Stable

- Non-designated ports are in a **Blocking** state.
- Interfaces in a Blocking state are effectively disabled to prevent loops.
- Interfaces in a Blocking state do not send/receive regular network traffic.
- Interfaces in a Blocking state receive STP BPDUs.
- Interfaces in a Blocking state do NOT forward STP BPDUs.
- Interfaces in a Blocking state do NOT learn MAC addresses.

Spanning Tree Port States

STP Port State	Stable/Transitional
Listening	Transitional

- After the Blocking state, interfaces with the Designated or Root role enter the **Listening** state.
- Only **Designated** or **Root** ports enter the Listening state (Non-designated ports are always Blocking).
- The Listening state is 15 seconds long by default. This is determined by the **Forward delay** timer.
- An interface in the Listening state **ONLY** forwards/receives STP BPDUs.
- An interface in the Listening state does **NOT** send/receive regular traffic.
- An interface in the Listening state does **NOT** learn MAC addresses from regular traffic that arrives on the interface.

Spanning Tree Port States

STP Port State	Stable/Transitional
Learning	Transitional

- After the Listening state, a Designated or Root port will enter the **Learning** state.
- The Learning state is 15 seconds long by default. This is determined by the **Forward delay** timer (the same timer is used for both the Listening and Learning states)
- An interface in the Learning state **ONLY** sends/receives STP BPDUs.
- An interface in the Learning state does **NOT** send/receive regular traffic.
- An interface in the Learning state **learns** MAC addresses from regular traffic that arrives on the interface.

Spanning Tree Port States

STP Port State	Stable/Transitional
Forwarding	Stable

- Root and Designated ports are in a **Forwarding** state.
- A port in the Forwarding state operate as normal.
- A port in the Forwarding state sends/receives BPDUs.
- A port in the Forwarding state sends/receives normal traffic.
- A port in the Forwarding state learns MAC addresses.

Spanning Tree Port States

STP Port State	Send/Receive BPDUs	Frame forwarding (regular traffic)	MAC address learning	Stable/ Transitional
Blocking	NO/YES	NO	NO	Stable
Listening	YES/YES	NO	NO	Transitional
Learning	YES/YES	NO	YES	Transitional
Forwarding	YES/YES	YES	YES	Stable
Disabled	NO/NO	NO	NO	Stable

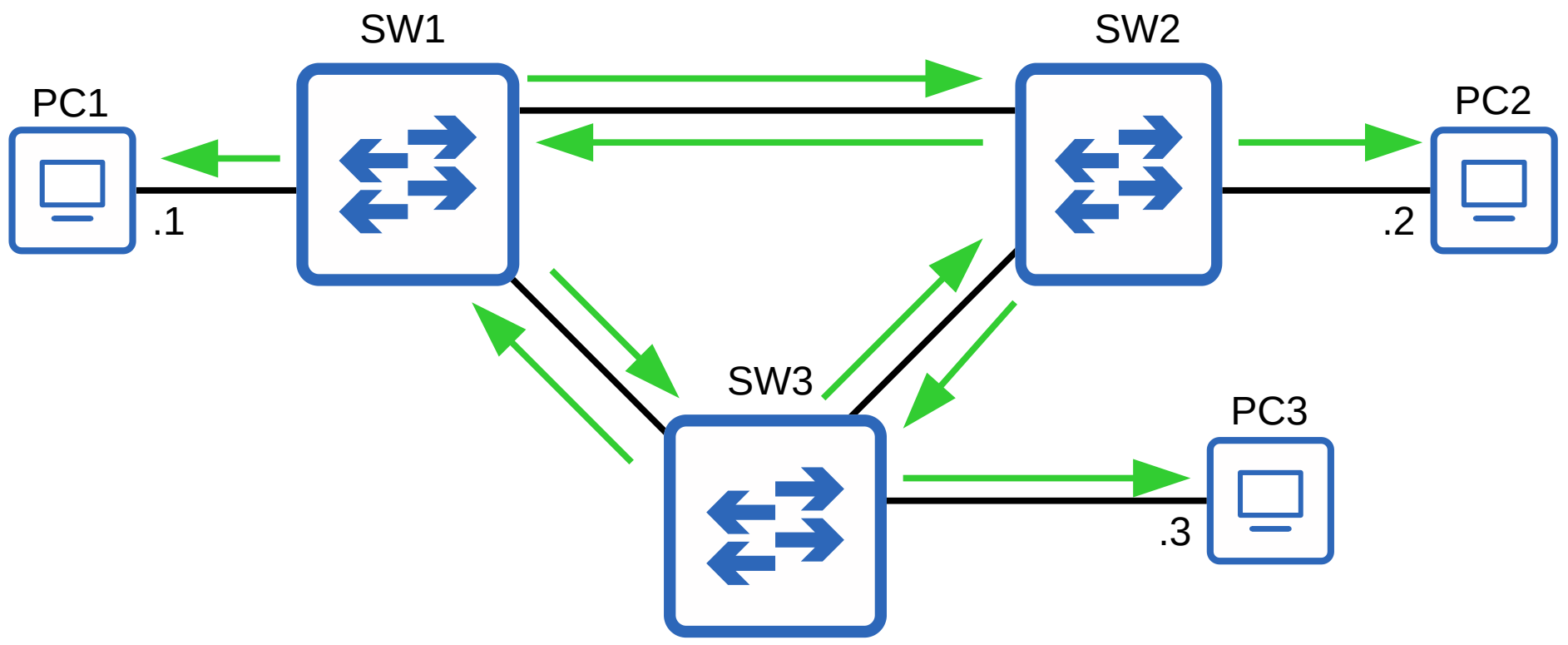
Spanning Tree Timers

STP Timer	Purpose	Duration
Hello	How often the root bridge sends hello BPDUs	2sec
Forward delay	How long the switch will stay in the Listening and Learning states (each state is 15 seconds = total 30 seconds)	15sec
Max Age	How long an interface will wait <u>after ceasing to receive Hello BPDUs</u> to change the STP topology.	20sec (10* hello)

Spanning Tree Timers

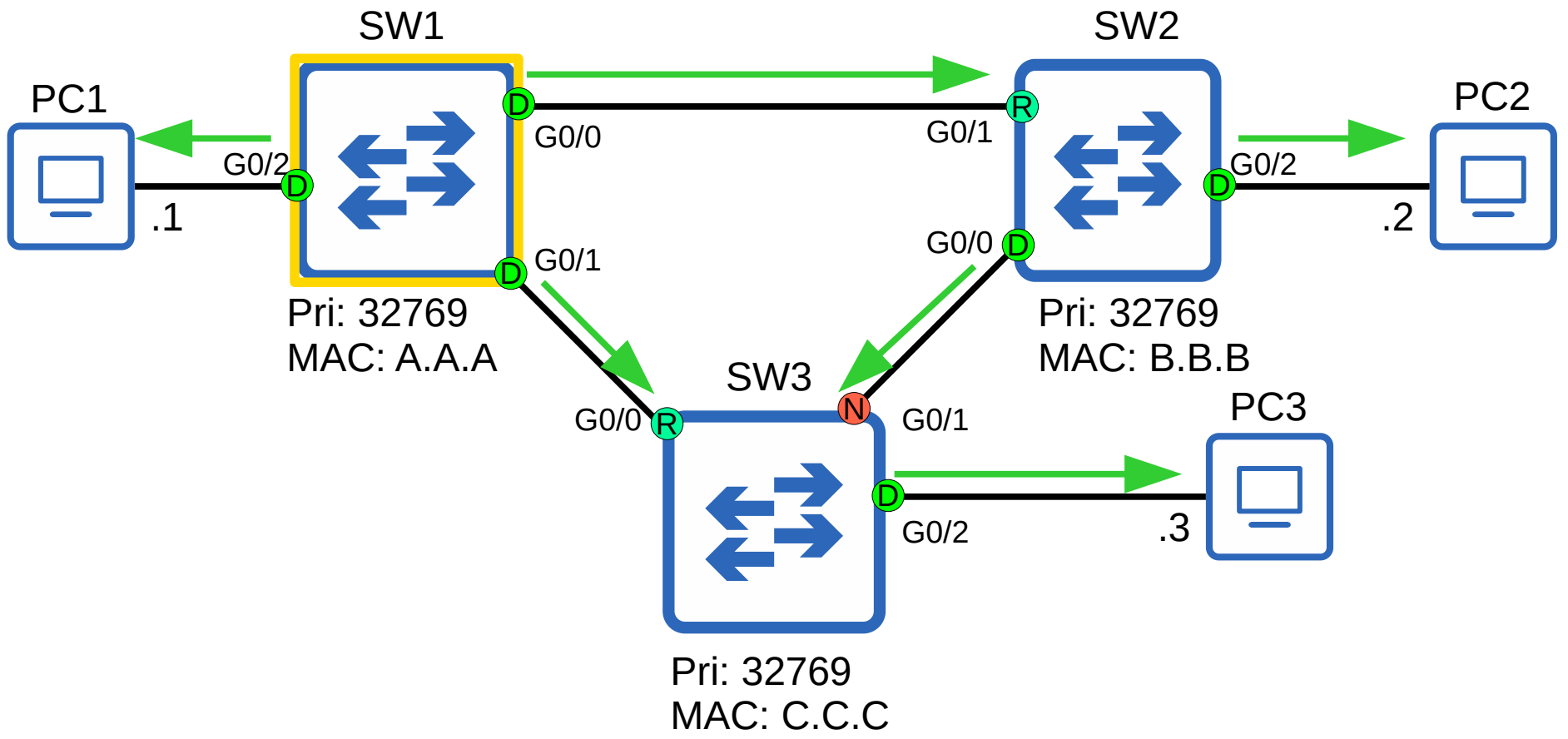
10.0.0.0/24

→ = Hello BPDUs



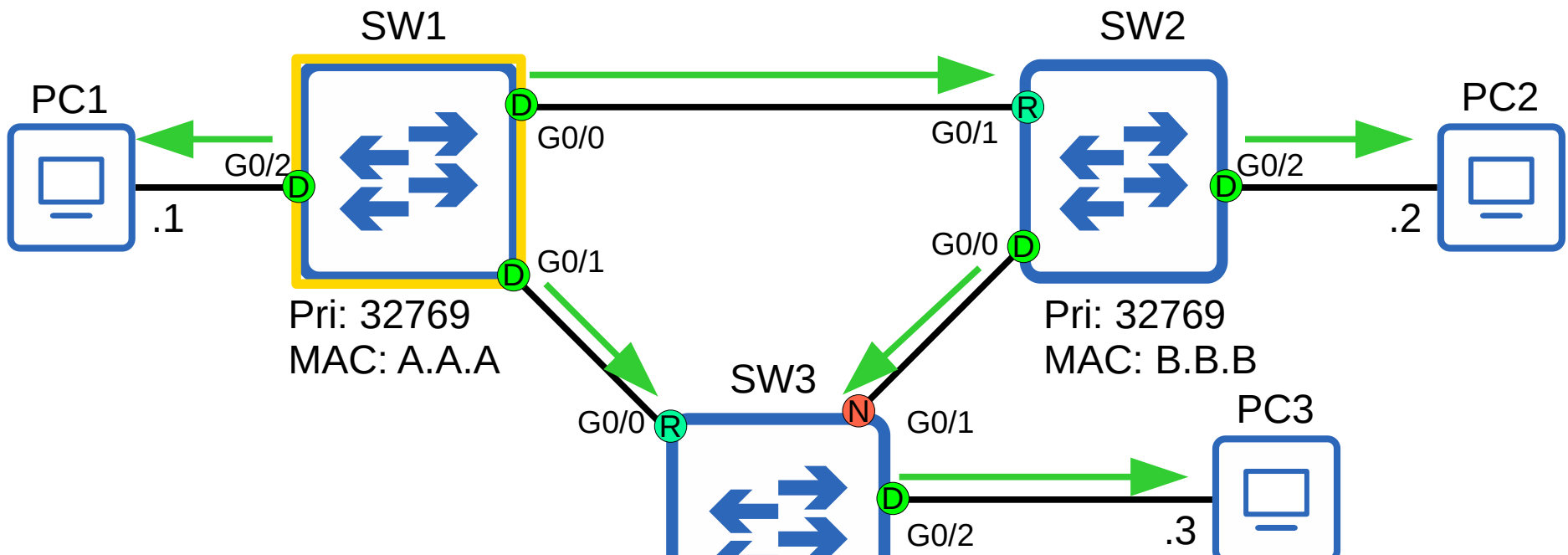
Spanning Tree Timers

→ = Hello BPDUs



Spanning Tree Timers

→ = Hello BPDUs



Switches do not forward the BPDUs out of their **root** ports and **non-designated** ports, only their **designated** ports.

Pri: 32769
MAC: C.C.C

Spanning Tree Timers

STP Timer	Purpose	Duration
Hello	How often the root bridge sends hello BPDUs	2sec
Forward delay	How long the switch will stay in the Listening and Learning states (each state is 15 seconds = total 30 seconds)	15sec
Max Age	How long an interface will wait to change the STP topology <u>after ceasing to receive Hello BPDUs</u> . The timer is reset every time a BPDU is received.	20sec (10* hello)

Spanning Tree Timers

SW2 Max Age Timer:

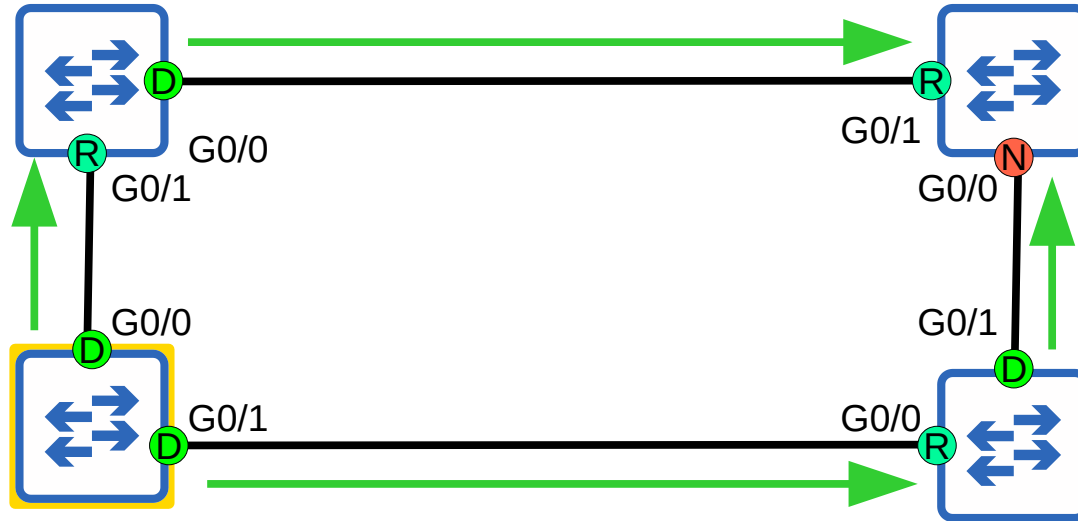
20

19

18

SW1
Pri: 32769
MAC: 014A.38F1.BA81

SW2
Pri: 32769
MAC: 193D.72DE.36E1



SW3
Pri: 32769
MAC: 014A.3821.2981

SW4
Pri: 32769
MAC:
83F1.2846.392F

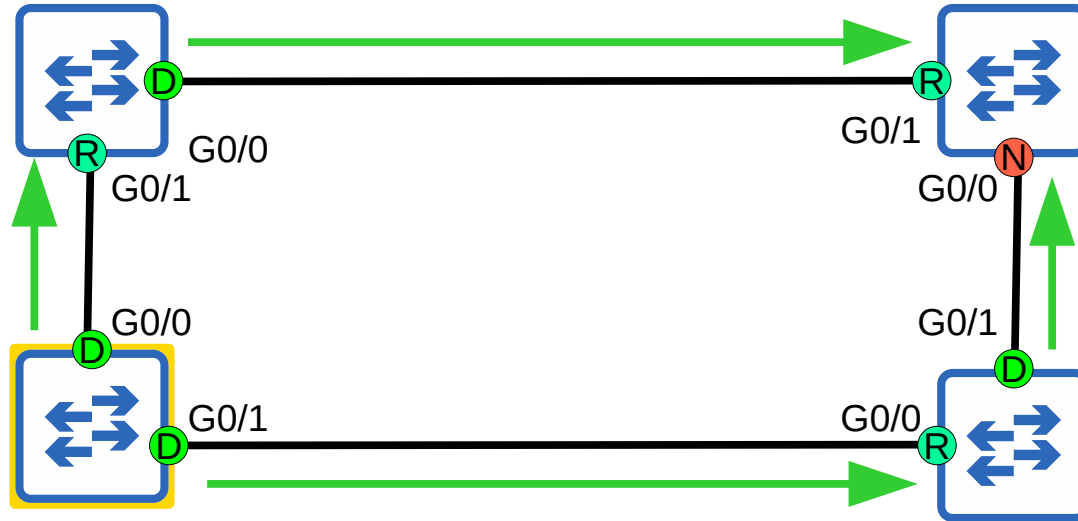
Spanning Tree Timers

SW2 Max Age Timer:

- 20
- 19
- 18
- 20
- 19
- 18

SW1
Pri: 32769
MAC: 014A.38F1.BA81

SW2
Pri: 32769
MAC: 193D.72DE.36E1

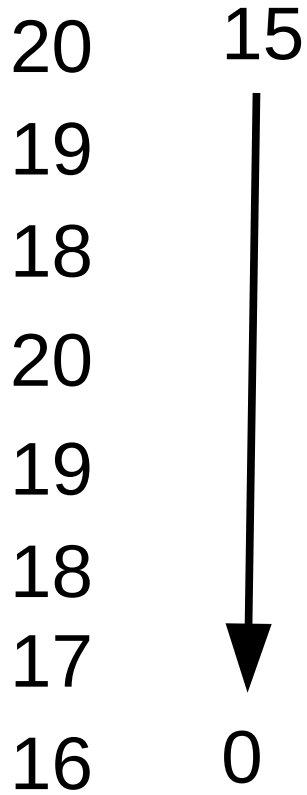


SW3
Pri: 32769
MAC: 014A.3821.2981

SW4
Pri: 32769
MAC: 83F1.2846.392F

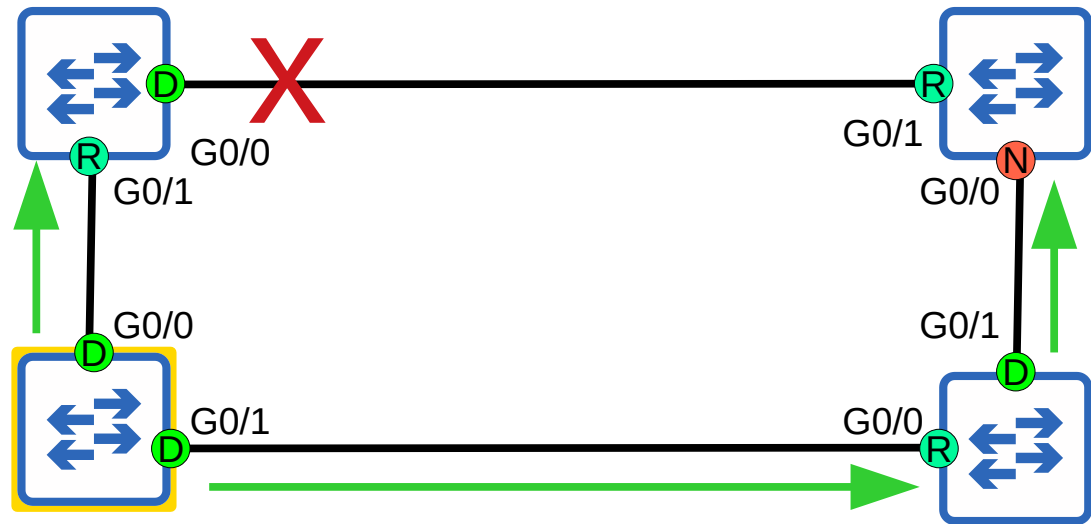
Spanning Tree Timers

SW2 Max Age Timer:



SW1
Pri: 32769
MAC: 014A.38F1.BA81

SW2
Pri: 32769
MAC: 193D.72DE.36E1



SW3
Pri: 32769
MAC: 014A.3821.2981

SW4
Pri: 32769
MAC: 83F1.2846.392F

Spanning Tree Timers

STP Timer	Purpose	Duration
Max Age	How long an interface will wait to change the STP topology <u>after ceasing to receive Hello BDPUs</u> . The timer is reset every time a BPDU is received.	20sec (10* hello)

- If another BPDU is received before the max age timer counts down to 0, the time will reset to 20 seconds and no changes will occur.
- If another BPDU is not received, the max age timer counts down to 0 and the switch will reevaluate its STP choices, including root bridge, and local root, designated, and non-designated ports.
- If a non-designated port is selected to become a designated or root port, it will transition from the blocking state to the listening state (15 seconds), learning state (15 seconds), and then finally the forwarding state. So, it can take a total of **50 seconds** for a blocking interface to transition to forwarding.
- These timers and transitional states are to make sure that loops aren't accidentally created by an interface moving to forwarding state too soon.

Spanning Tree Timers

A forwarding interface can move directly to a blocking state (there is no worry about creating a loop by blocking an interface).

A blocking interface cannot move directly to forwarding state. It must go through the listening and learning states.

- If another BPDU is received before the max age timer counts down to 0, the time will reset to 20 seconds and no changes will occur.
- If another BPDU is not received, the max age timer counts down to 0 and the switch will reevaluate its STP choices, including root bridge, and local root, designated, and non-designated ports.
- If a non-designated port is selected to become a designated or root port, it will transition from the blocking state to the listening state (15 seconds), learning state (15 seconds), and then finally the forwarding state. So, it can take a total of **50 seconds** for a blocking interface to transition to forwarding.
- These timers and transitional states are to make sure that loops aren't accidentally created by an interface moving to forwarding state too soon.

Spanning Tree BPDU

```
> Frame 999: 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface 0
> Ethernet II, Src: aa:aa:aa:aa:aa:ab (aa:aa:aa:aa:aa:ab), Dst: PVST+ (01:00:0c:cc:cc:cd)
> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 10
> Logical-Link Control
▼ Spanning Tree Protocol
  Protocol Identifier: Spanning Tree Protocol (0x0000)
  Protocol Version Identifier: Spanning Tree (0)
  BPDU Type: Configuration (0x00)
▼ BPDU flags: 0x00
  0... .. = Topology Change Acknowledgment: No
  .... ..0 = Topology Change: No
▼ Root Identifier: 32768 / 10 / aa:aa:aa:aa:aa:aa
  Root Bridge Priority: 32768
  Root Bridge System ID Extension: 10
  Root Bridge System ID: aa:aa:aa:aa:aa:aa (aa:aa:aa:aa:aa:aa)
  Root Path Cost: 0
▼ Bridge Identifier: 32768 / 10 / aa:aa:aa:aa:aa:aa
  Bridge Priority: 32768
  Bridge System ID Extension: 10
  Bridge System ID: aa:aa:aa:aa:aa:aa (aa:aa:aa:aa:aa:aa)
  Port identifier: 0x8002
  Message Age: 0
  Max Age: 20
  Hello Time: 2
  Forward Delay: 15
```

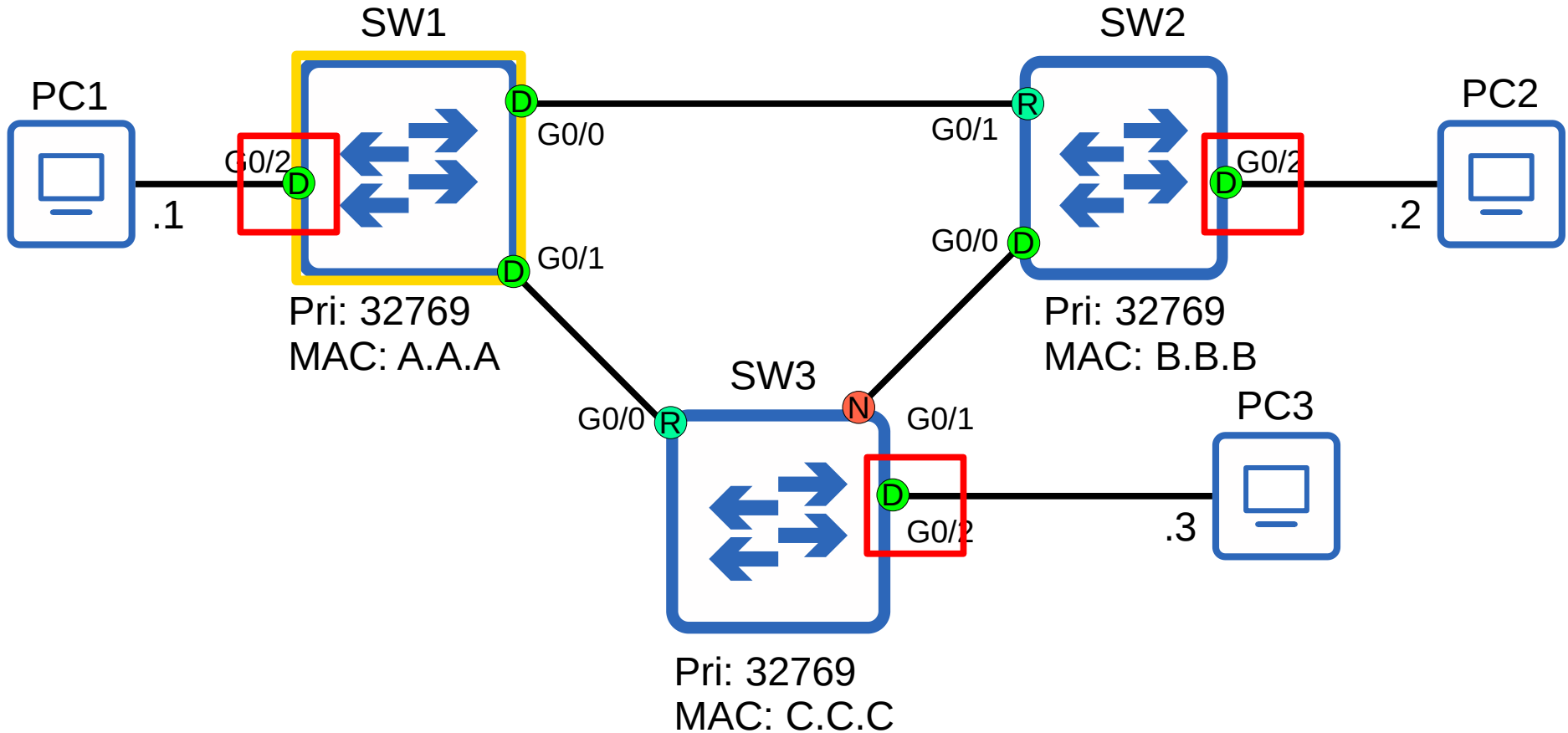
PVST = Only ISL trunk encapsulation
PVST+ = Supports 802.1Q

Regular STP (not Cisco's PVST+)
uses a destination MAC address of
0180.c200.0000

The STP timers on the root bridge
determine the STP timers for the entire
network.

Spanning Tree Optional Features (STP Toolkit)

Portfast

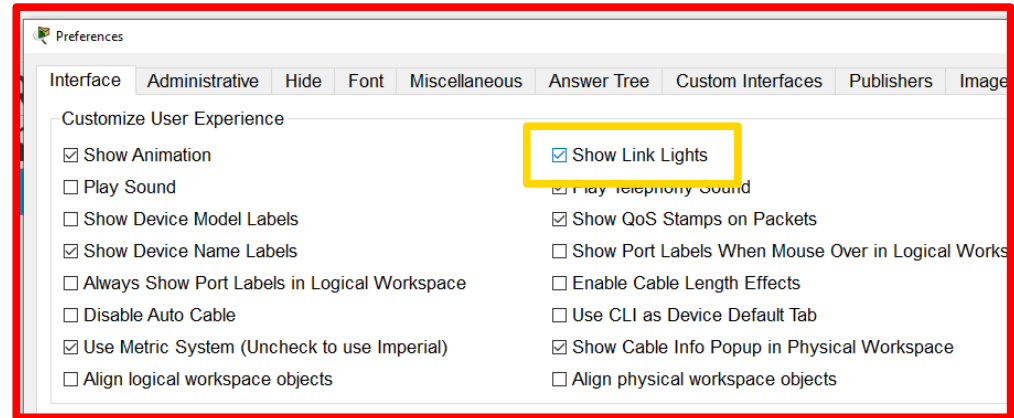
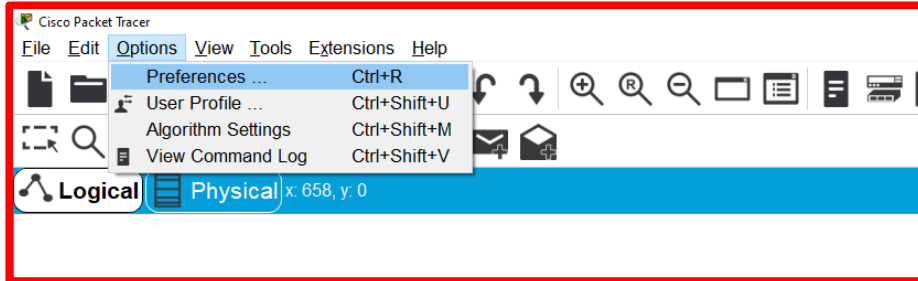


Spanning Tree Optional Features (STP Toolkit)

Portfast

Switch0

PC0



Spanning Tree Optional Features (STP Toolkit)

Portfast



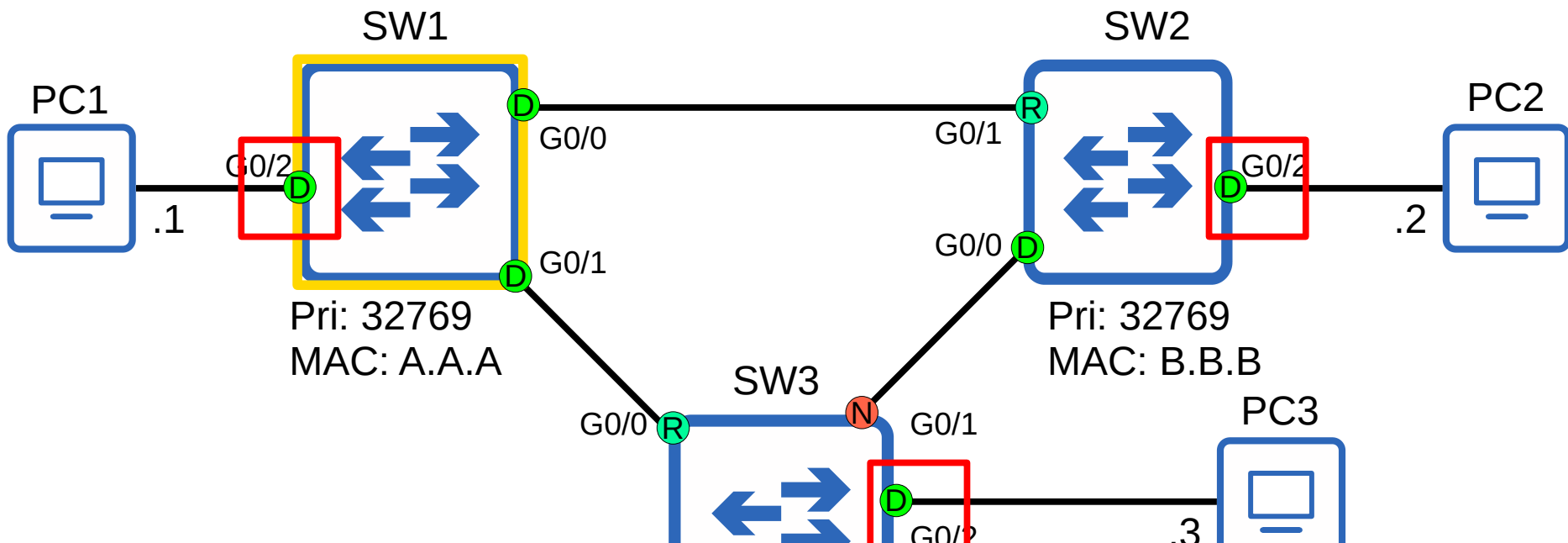
Spanning Tree Optional Features (STP Toolkit)

Portfast



Spanning Tree Optional Features (STP Toolkit)

Portfast



Portfast allows a port to move immediately to the **Forwarding** state, bypassing **Listening** and **Learning**.

If used, it must be enabled only on ports connected to end hosts.

If enabled on a port connected to another switch it could cause a Layer 2 loop.

Portfast

```
SW1(config)#interface g0/2
SW1(config-if)#spanning-tree portfast
%Warning: portfast should only be enabled on ports connected to a single
host. Connecting hubs, concentrators, switches, bridges, etc... to this
interface when portfast is enabled, can cause temporary bridging loops.
Use with CAUTION

%Portfast has been configured on GigabitEthernet0/2 but will only
have effect when the interface is in a non-trunking mode.
SW1(config-if)#
```

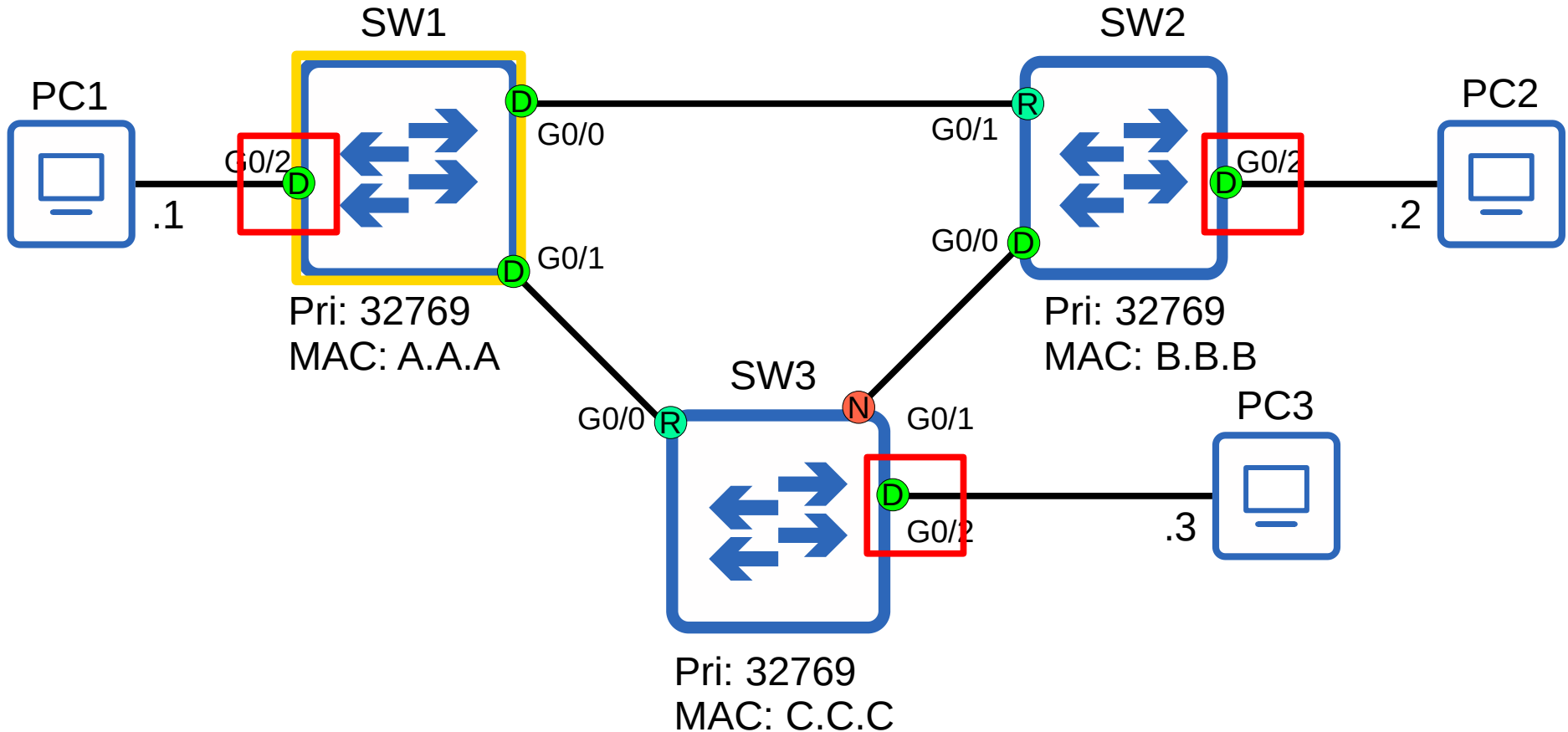
You can also enable portfast with the following command:

```
SW1(config)# spanning-tree portfast default
```

This enables portfast on all access ports (not trunk ports).

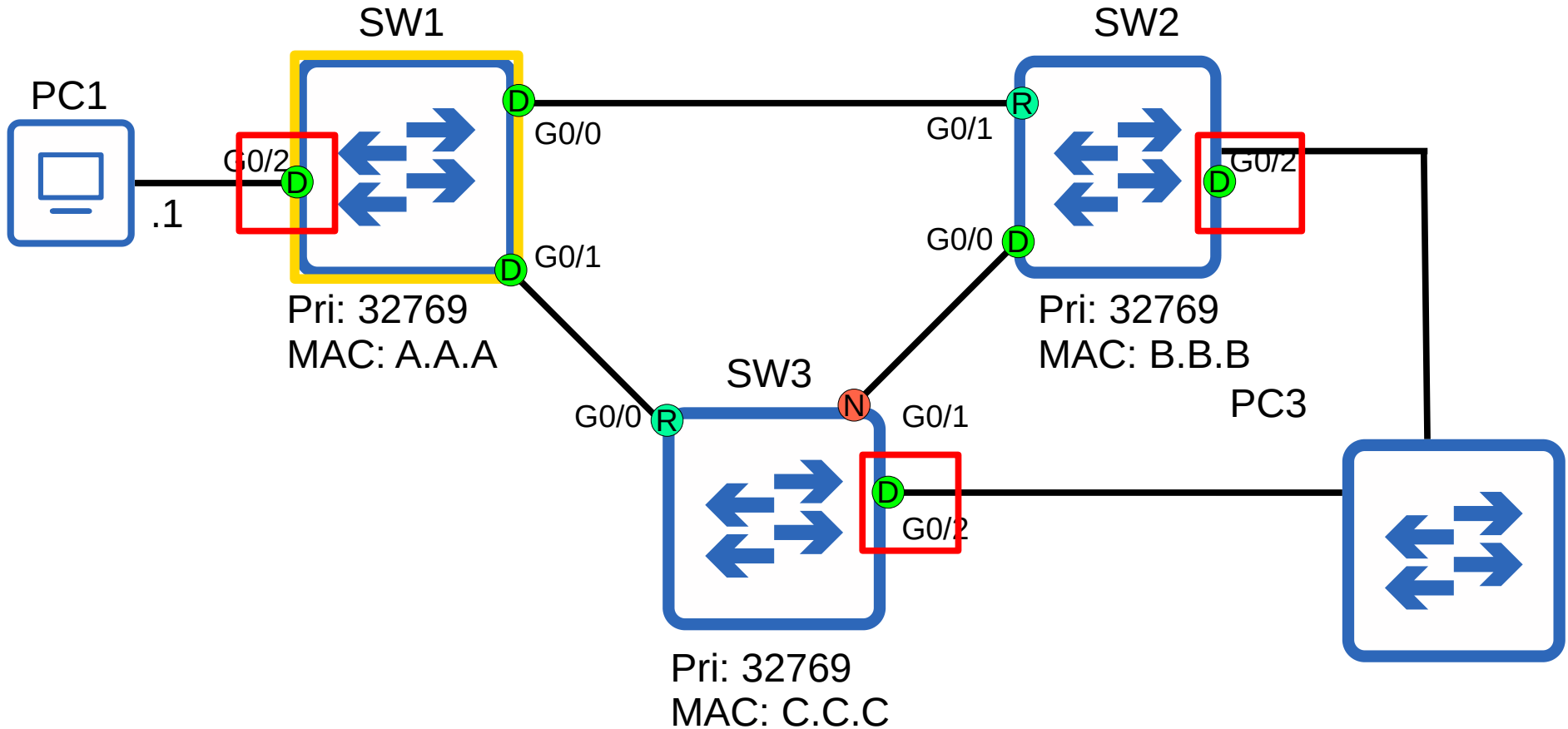
Spanning Tree Optional Features (STP Toolkit)

Portfast



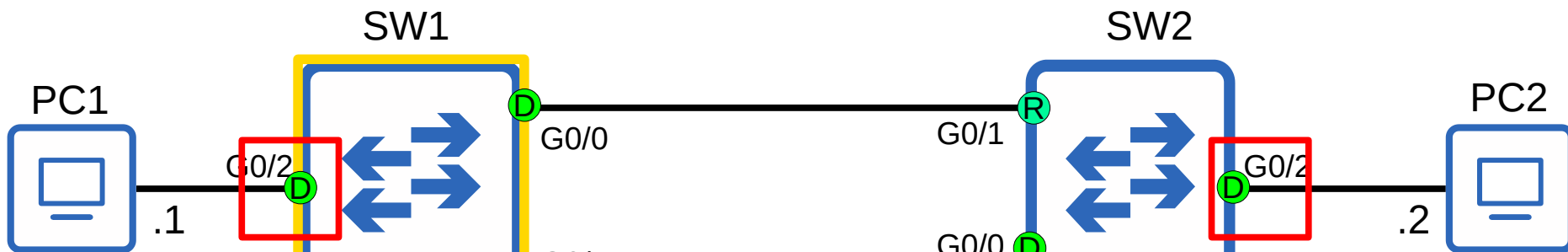
Spanning Tree Optional Features (STP Toolkit)

Portfast

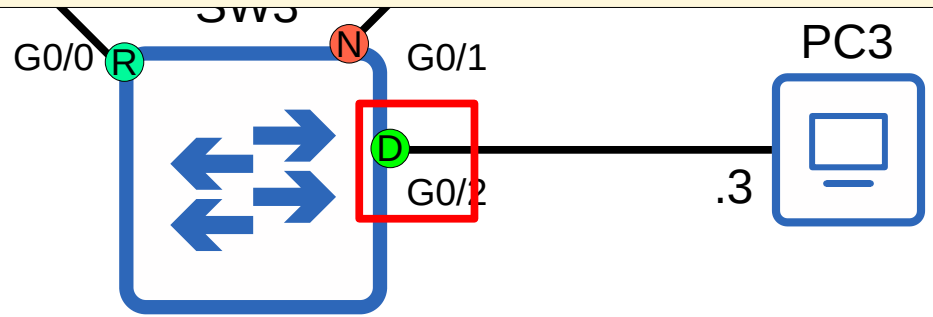


Spanning Tree Optional Features (STP Toolkit)

BPDUGuard



If an interface with BPDUGuard enabled receives a BPDU from another switch, the interface will be shut down to prevent a loop from forming.



Pri: 32769
MAC: C.C.C

BPDU Guard

```
SW1(config)#interface g0/2
SW1(config-if)#spanning-tree bpduguard enable
SW1(config-if)#
```

You can also enable BPDU Guard with the following command:

```
SW1(config)# spanning-tree portfast bpduguard default
```

This enables BPDU Guard on all Portfast-enabled interfaces.

BPDU Guard

```
%SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port FastEthernet0/1 with BPDU Guard enabled. Disabling port.  
  
%PM-4-ERR_DISABLE: bpduguard error detected on 0/1, putting 0/1 in err-disable state  
  
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down  
  
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
```

BPDU Guard

```
Switch(config-if)#shutdown
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
Switch(config-if)#no shutdown

Switch(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
%SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port FastEthernet0/1 with BPDU Guard enabled. Disabling port.

%PM-4-ERR_DISABLE: bpduguard error detected on 0/1, putting 0/1 in err-disable state

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
```

Spanning Tree Optional Features (STP Toolkit)

BPDU Guard

2.5 Describe the need for and basic operations of Rapid PVST+ Spanning Tree Protocol and identify

You probably don't have to know these STP optional features (or others such as UplinkFast, Backbone Fast, etc) for the CCNA. But make sure you know **Portfast** and **BPDU Guard**. If you want to read more about the others just in case, do a Google search.

Root Guard

If you enable **root guard** on an interface, even if it receives a superior BPDU (lower bridge ID) on that interface, the switch will not accept the new switch as the root bridge. The interface will be disabled.

Loop Guard

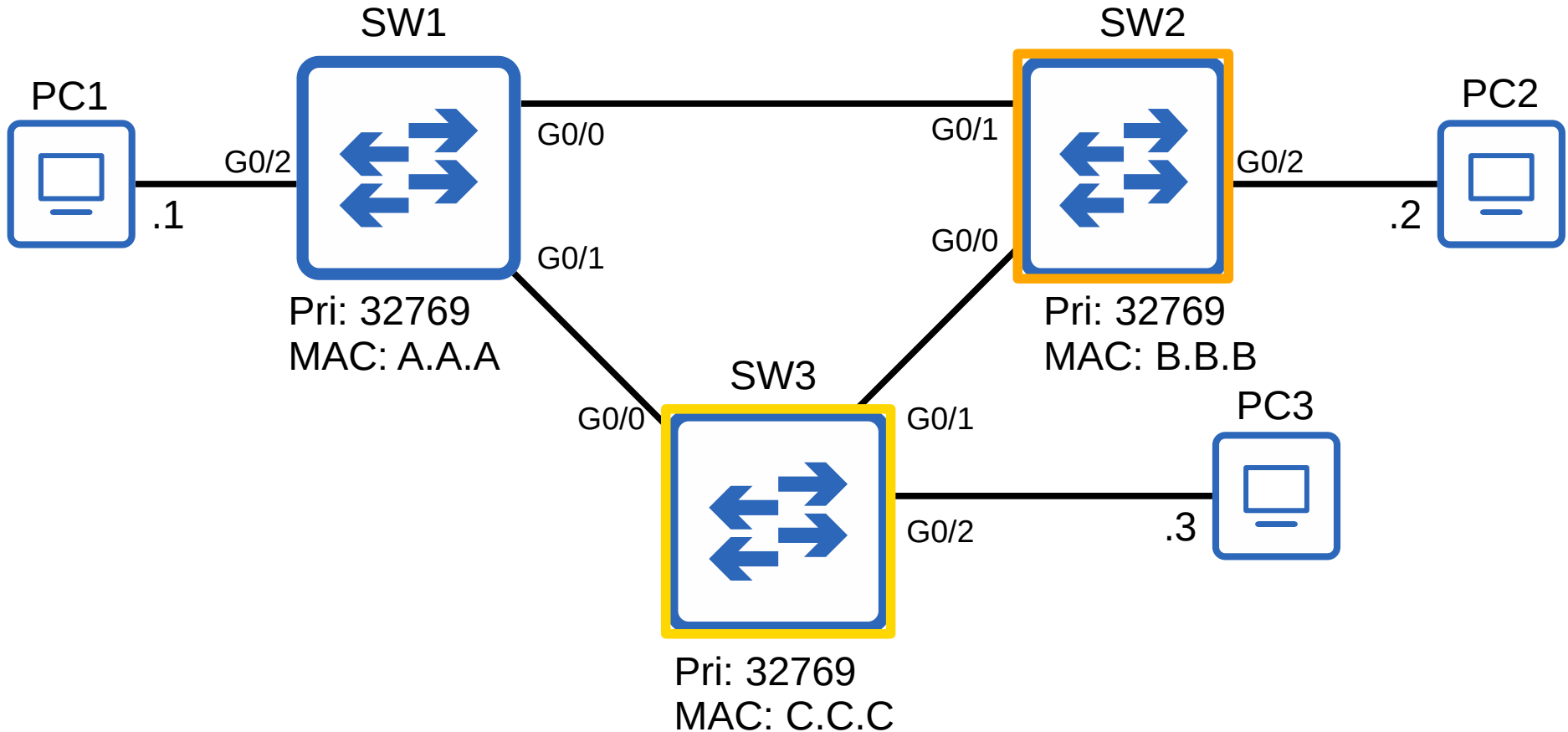
If you enable **loop guard** on an interface, even if the interface stops receiving BPDUs, it will not start forwarding. The interface will be disabled.

Configure the Spanning Tree mode

```
SW1(config)#spanning-tree mode ?  
mst          Multiple spanning tree mode  
pvst         Per-Vlan spanning tree mode  
rapid-pvst  Per-Vlan rapid spanning tree mode
```

```
SW1(config)#spanning-tree mode pvst
```

Configure the Primary Root Bridge



Configure the Primary Root Bridge

```

SW3(config)#spanning-tree vlan 1 root primary
SW3(config)#do show spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    24577
             Address    cccc.cccc.cccc
             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    cccc.cccc.cccc
             Hello Time  2 sec    Max Age 20 sec    Forward Delay 15 sec
             Aging Time  15 sec
  
```

```

!
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 24576
!
  
```

The **spanning-tree vlan *vlan-number* root primary** command sets the STP priority to 24576. If another switch already has a priority lower than 24576, it sets this switch's priority to 4096 less than the other switch's priority.

Configure the Secondary Root Bridge

```
SW2(config)#spanning-tree vlan 1 root secondary
SW2(config)#do show spanning-tree
```

```
VLAN0001
Spanning tree enabled protocol ieee
Root ID    Priority    24577
Address    cccc.cccc.cccc
```

```
!
spanning-tree mode pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 28672
!
```

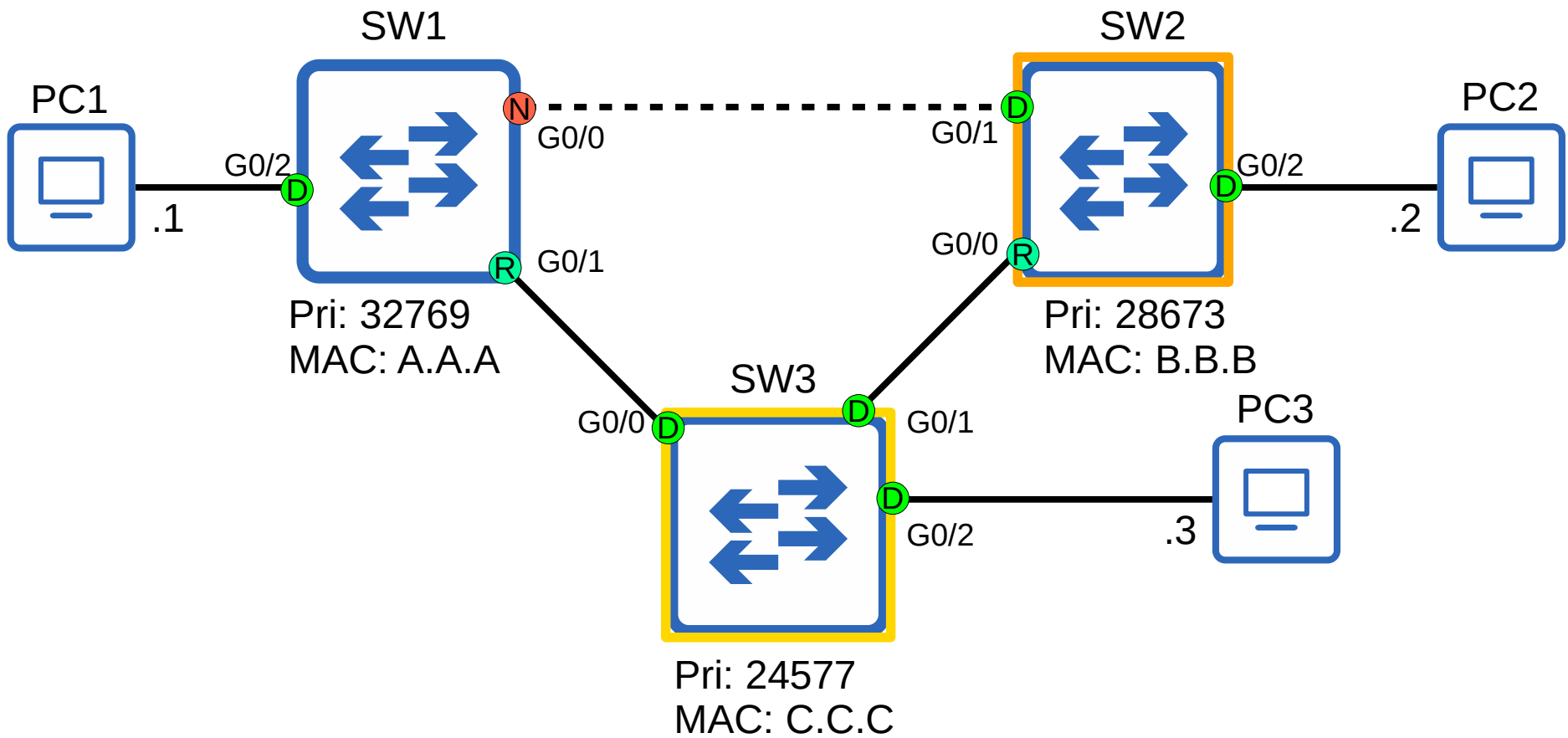
```
SW2(config)#spanning-tree vlan 1 priority ?
Priority    <0-61440>  bridge priority in increments of 4096
```

```
Bridge ID  Priority    28673 (priority 28672 sys-id-ext 1)
Address    bbbb.bbbb.bbbb
Hello Time  2 sec     Max Age 20 sec   Forward Delay 15 sec
Aging Time  300 sec
```

The `spanning-tree vlan vLan-number root secondary` command sets the STP priority to 28672.

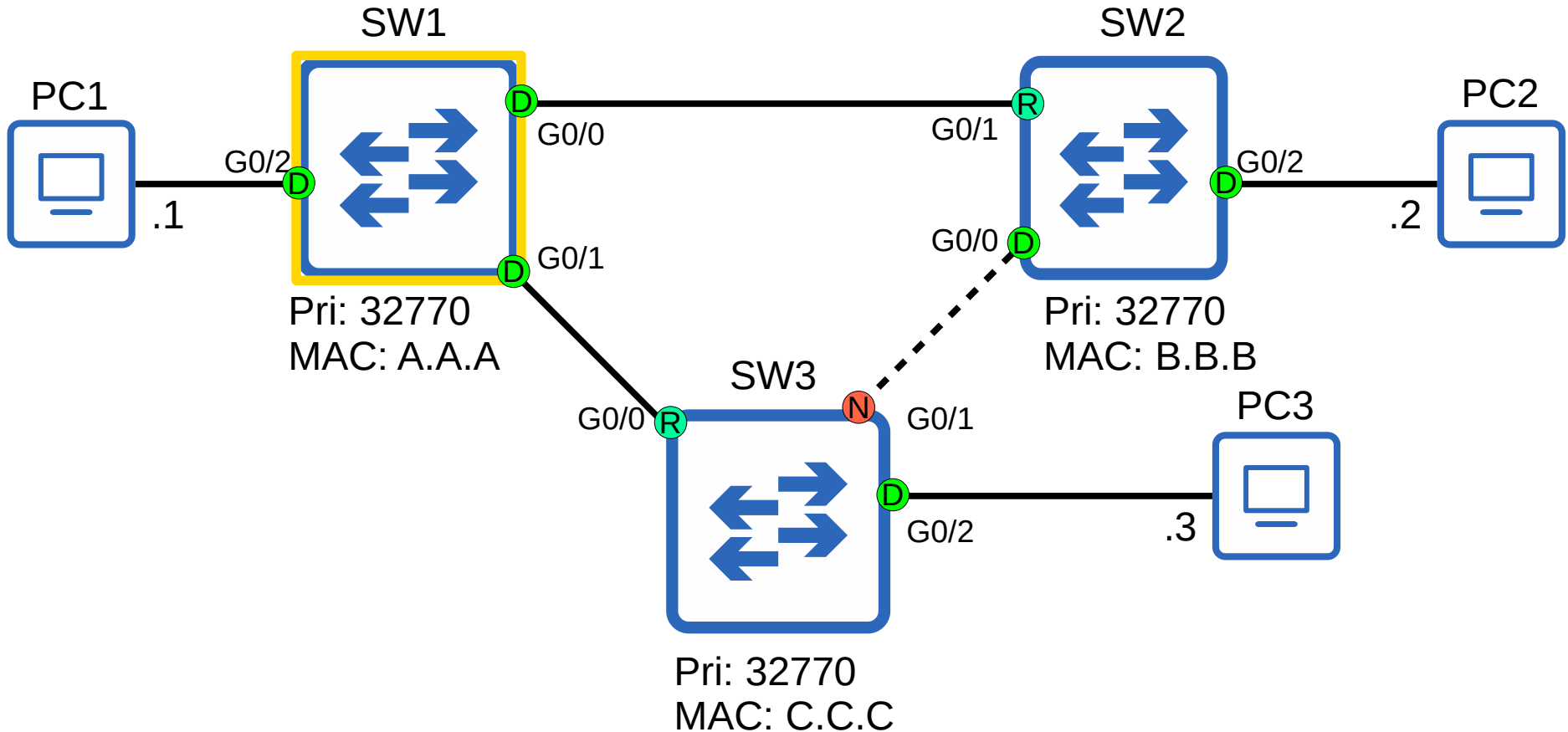
STP Load-Balancing

VLAN 1 Topology



STP Load-Balancing

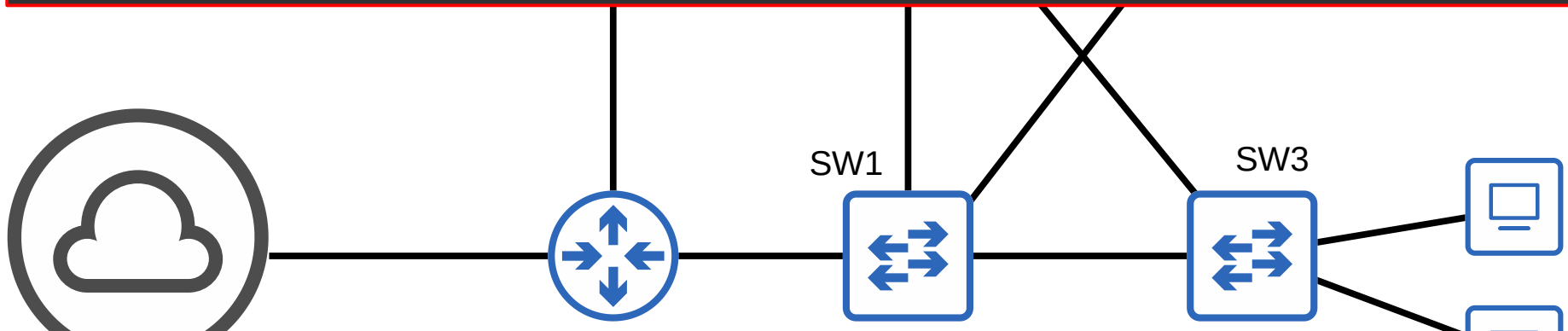
VLAN 2 Topology



Spanning Tree Quiz 7

```
SW1(config)# spanning-tree vlan 10 root primary
SW1(config)# spanning-tree vlan 20 root secondary
```

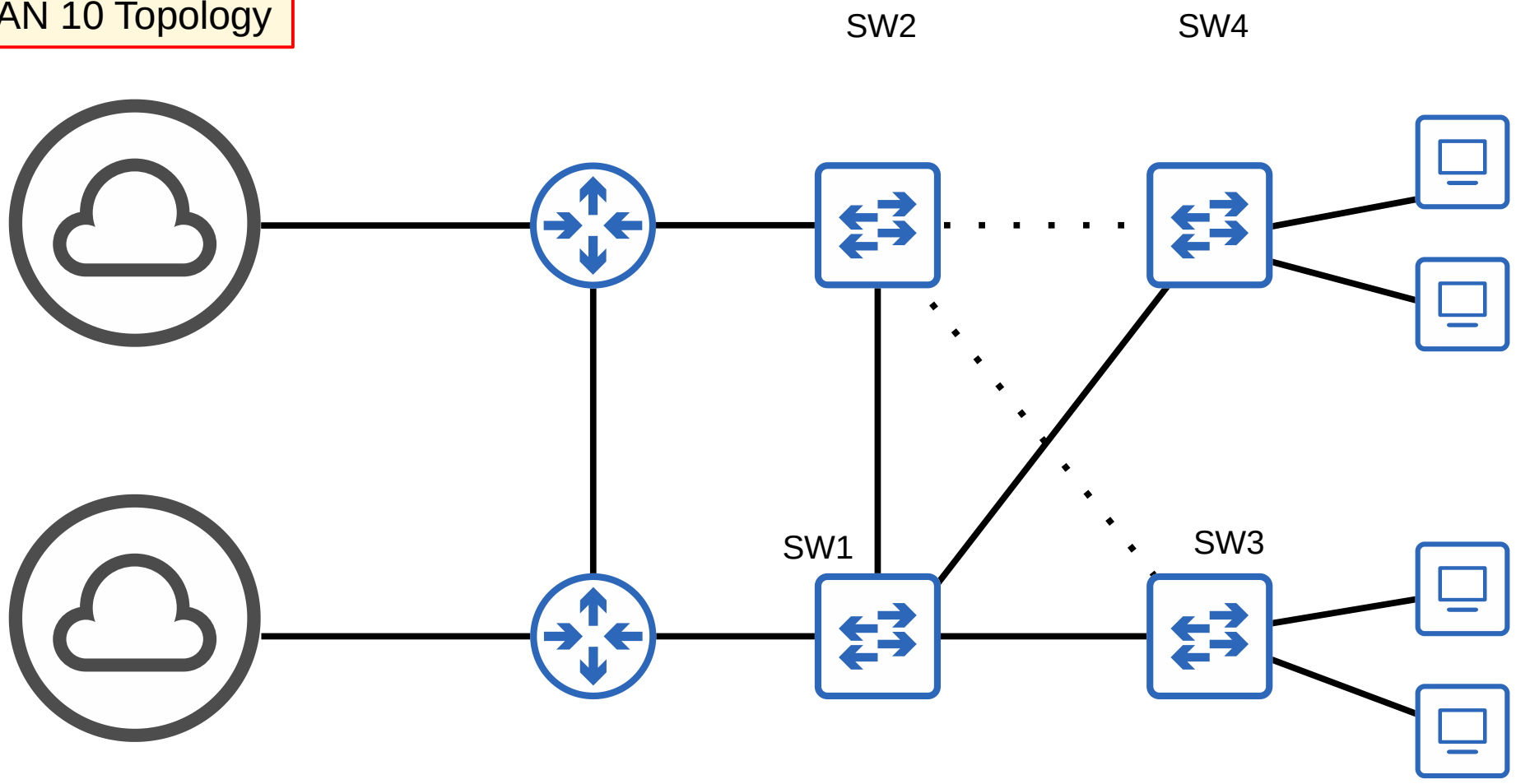
```
SW2(config)# spanning-tree vlan 20 root primary
SW2(config)# spanning-tree vlan 10 root secondary
```



Two VLANs are active in this network, 10 and 20. By default, SW3 is the root bridge for both VLANs. Configure SW1 as the primary root for VLAN10 and the secondary root for VLAN20. Configure SW2 as the primary root for VLAN20 and the secondary root for VLAN10. Which two commands should you issue on SW1, and which two commands should you issue on SW2?

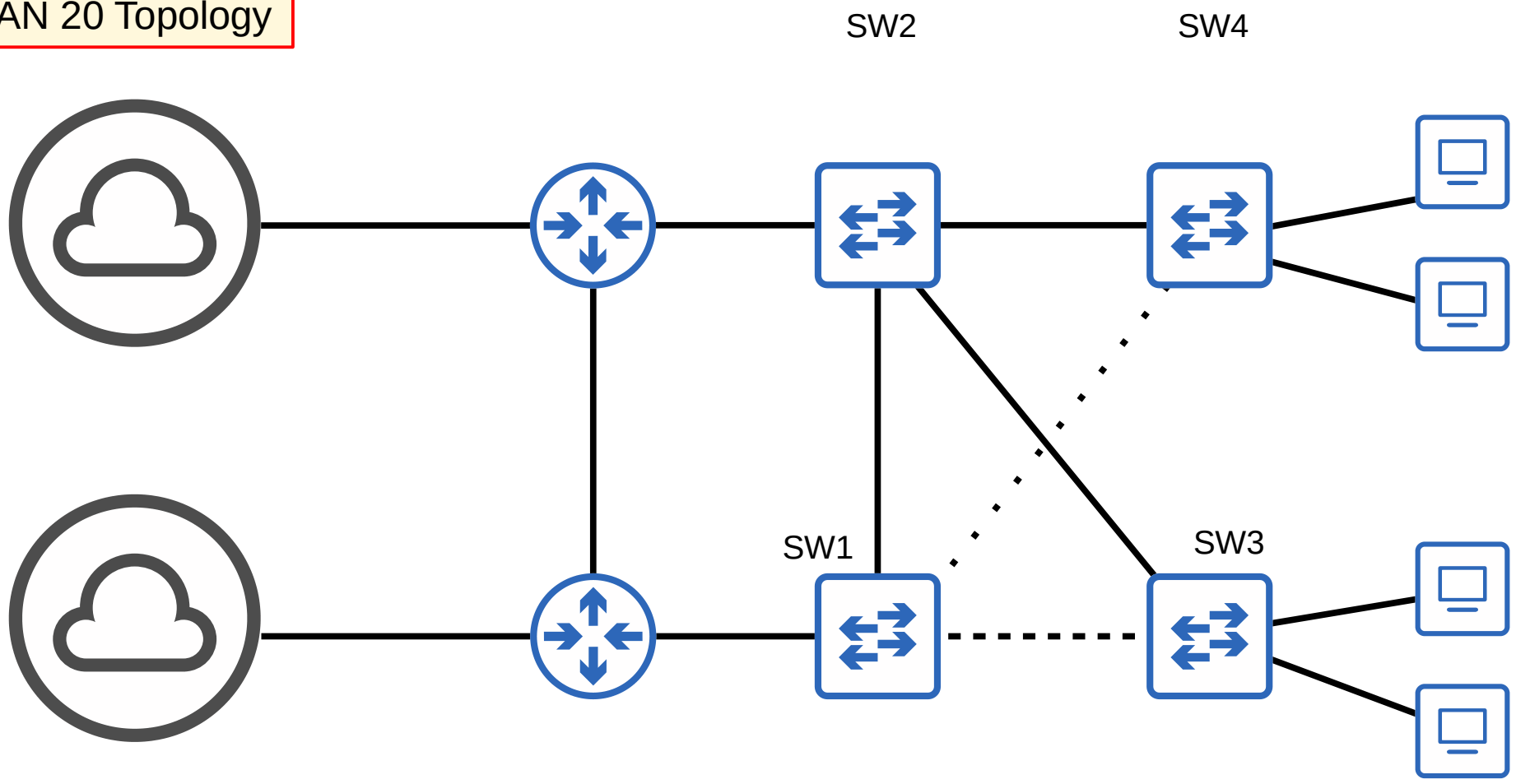
Spanning Tree Quiz 7

VLAN 10 Topology



Spanning Tree Quiz 7

VLAN 20 Topology



Configure STP Port Settings

```
SW2(config-if)#spanning-tree vlan 1 ?
  cost          Change an interface's per VLAN spanning tree path cost
  port-priority Change an interface's spanning tree port priority

SW2(config-if)#spanning-tree vlan 1 █
```

```
SW2(config-if)#spanning-tree vlan 1 cost ?
  <1-200000000> Change an interface's per VLAN spanning tree path cost

SW2(config-if)#spanning-tree vlan 1 cost 200
SW2(config-if)#spanning-tree vlan 1 port-priority ?
  <0-224> port priority in increments of 32

SW2(config-if)#spanning-tree vlan 1 port-priority 32
SW2(config-if)# █
```

- STP states/timers
- STP BPDU
- STP optional features
- STP configuration

QUIZ

Spanning Tree Quiz 8

You connect a PC to a switch, however for about half a minute you are unable to connect to the network. Which two options could fix this issue and allow you to access the network more quickly? (Choose two. Each answer is a complete solution.)

- a) Enable PortFast on the switch port you connect the PC to.
- b) Reduce the STP hello timer.
- c) Reduce the STP forward delay timer.
- d) Reduce the STP max age timer.

A packet capture indicates that a switch port has an STP port ID of 0x8002. What is the STP port priority of this port?

- a) 80
- b) 32
- c) 128
- d) 224

You want to make sure that a Layer 2 loop will not be caused if a user connects a switch to a switch port. Which spanning tree optional feature achieves this?

- a) PortFast
- b) Loop Guard
- c) Root Guard
- d) BPDU Guard