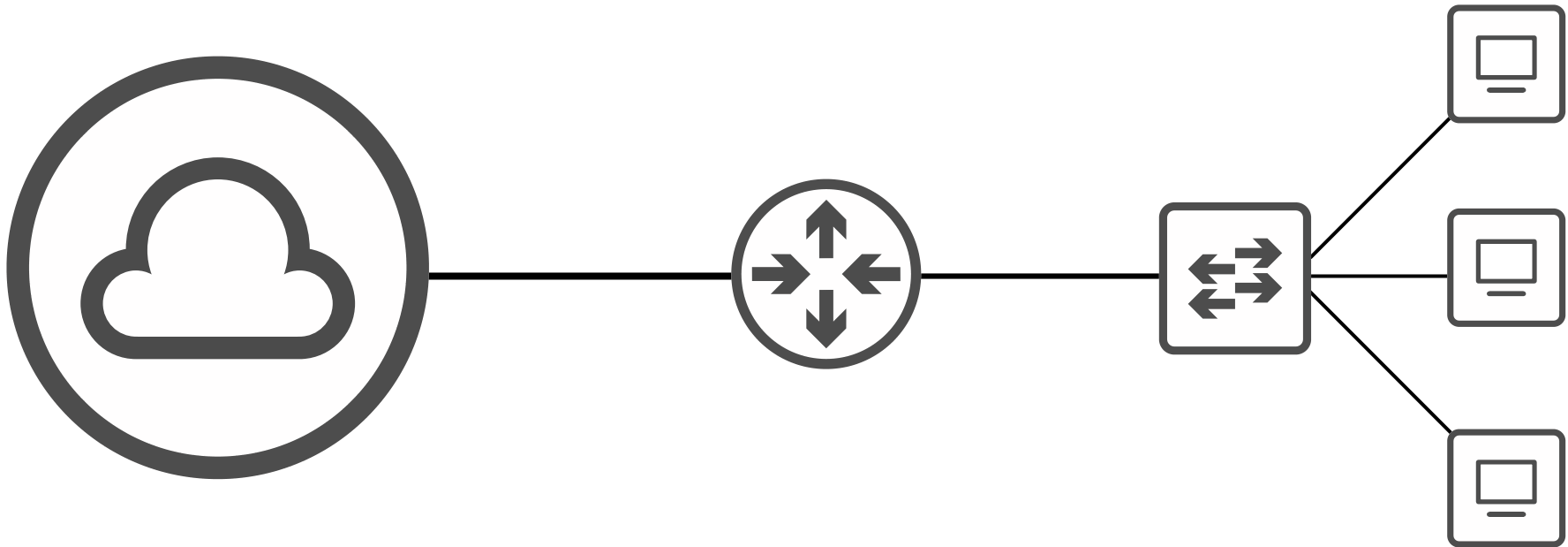


CCNA 200-301 Day 22

Rapid Spanning Tree Protocol



Things we'll cover

- Comparison of STP versions (standard vs Cisco)
- Rapid PVST+

Spanning Tree Versions

Industry standards (IEEE)

Spanning Tree Protocol (802.1D)

- The original STP
- All VLANs share one STP instance.
- Therefore, cannot load balance.

Rapid Spanning Tree Protocol (802.1w)

- Much faster at converging/adapating to network changes than 802.1D
- All VLANs share one STP instance.
- Therefore, cannot load balance.

Multiple Spanning Tree Protocol (802.1s)

- Uses modified RSTP mechanics.
- Can group multiple VLANs into different instances (ie. VLANs 1-5 in instance 1, VLANs 6-10 in instance 2) to perform load balancing.

Cisco versions

Per-VLAN Spanning Tree Plus (PVST+)

- Cisco's upgrade to 802.1D
- Each VLAN has its own STP instance.
- Can load balance by blocking different ports in each VLAN.

Rapid Per-VLAN Spanning Tree Plus (Rapid PVST+)

- Cisco's upgrade to 802.1w
- Each VLAN has its own STP instance.
- Can load balance by blocking different ports in each VLAN.

Rapid Spanning Tree Protocol

Cisco's summary:

“RSTP is not a timer-based spanning tree algorithm like 802.1D. Therefore, RSTP offers an improvement over the 30 seconds or more that 802.1D takes to move a link to forwarding. The heart of the protocol is a new bridge-bridge handshake mechanism, which allows ports to move directly to forwarding.”

Similarities between STP and RSTP:

- RSTP serves the same purpose as STP, blocking specific ports to prevent Layer 2 loops.
- RSTP elects a root bridge with the same rules as STP.
- RSTP elects root ports with the same rules as STP.
- RSTP elects designated ports with the same rules as STP.

Spanning Tree Protocol

Speed	STP Cost	RSTP Cost
10 Mbps	100	2,000,000
100 Mbps	19	200,000
1 Gbps	4	20,000
10 Gbps	2	2000
100 Gbps	X	200
1 Tbps	X	20

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

Rapid Spanning Tree Port States

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

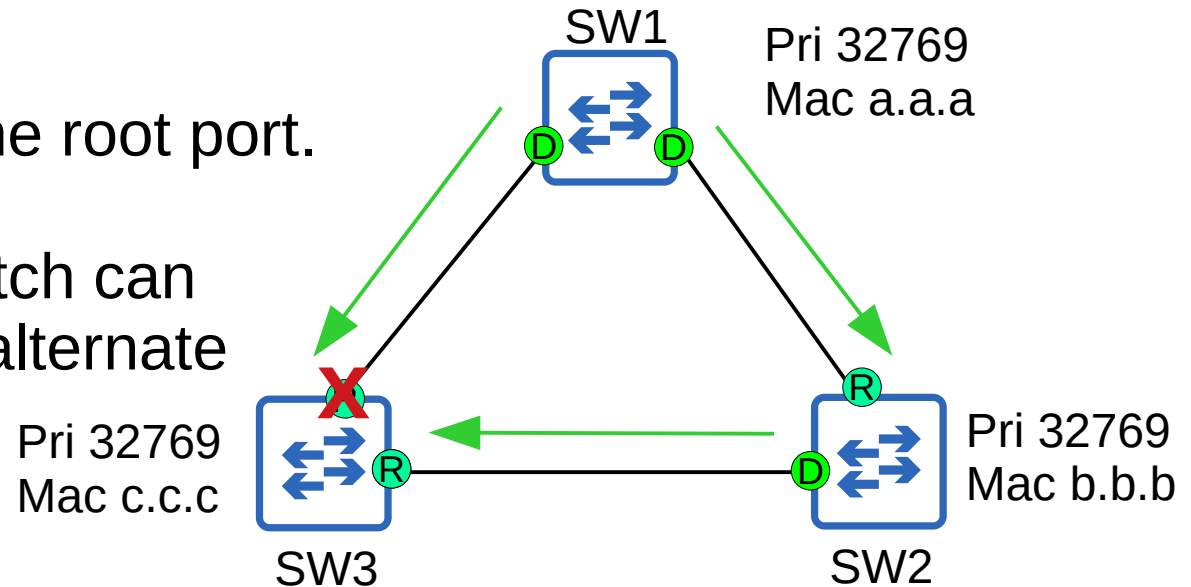
- If a port is administratively disabled (**shutdown** command) = discarding state
- If a port is enabled but blocking traffic to prevent Layer 2 loops = discarding state

Rapid Spanning Tree Port Roles

- The **root port** role remains unchanged in RSTP.
 - The port that is closest to the root bridge becomes the root port for the switch.
 - The root bridge is the only switch that doesn't have a root port.
- The **designated port** role remains unchanged in RSTP.
 - The port on a segment (collision domain) that sends the best BPDU is that segment's designated port (only one per segment)
- The **non-designated port** role is split into two separate roles in RSTP:
 - the **alternate port** role
 - the **backup port** role

RSTP: Alternate port role

- The RSTP **alternate** port role is a discarding port that receives a superior BPDUs from another switch.
- This is the same as what you've learned about **blocking** ports in classic STP.
- Functions as a backup to the root port.
- If the root port fails, the switch can immediately move its best alternate port to forwarding.



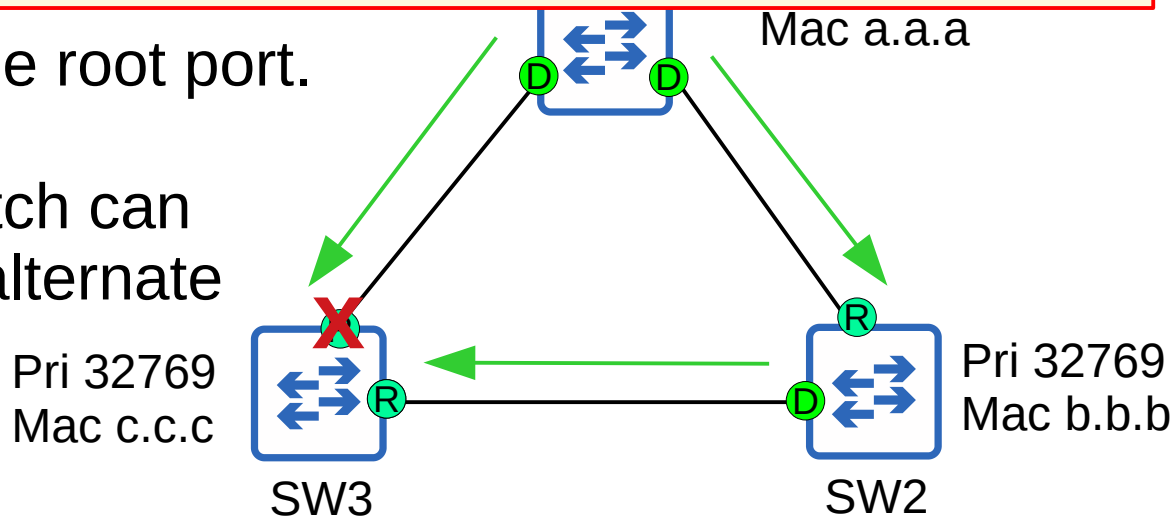
RSTP: Alternate port role

- The RSTP **alternate** port role is a discarding port that receives a superior BPDUs from another switch.

- This immediate move to forwarding state functions like a classic STP optional feature called UplinkFast. Because it is built into RSTP, you do not need to activate UplinkFast when using RSTP/Rapid PVST+.

- Functions as a backup to the root port.

- If the root port fails, the switch can immediately move its best alternate port to forwarding.

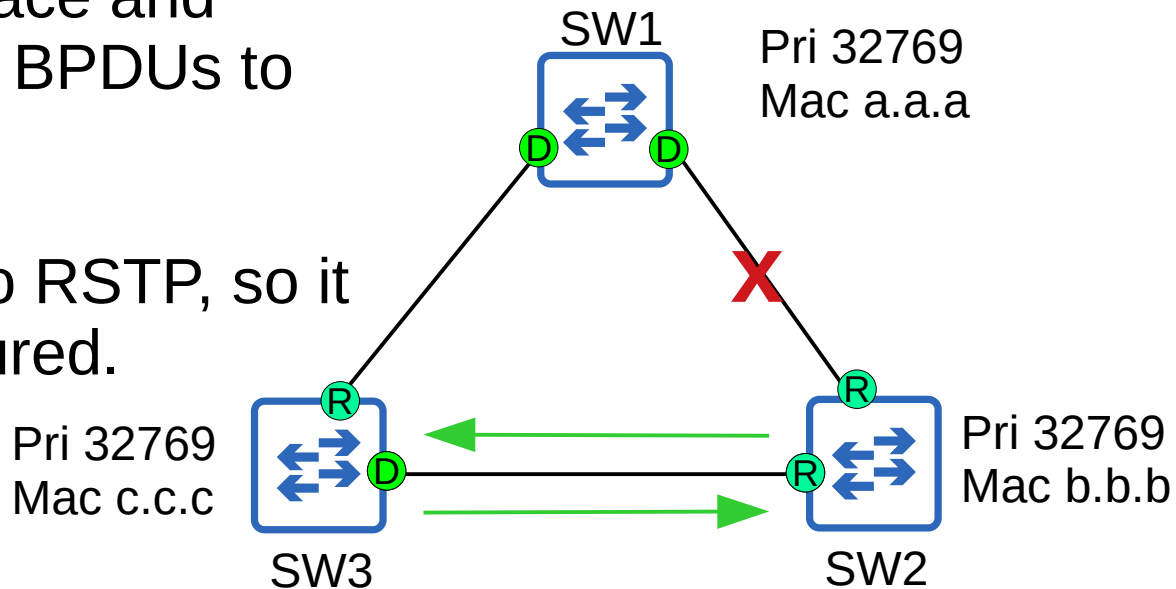


RSTP: BackboneFast functionality

- One more STP optional feature that was built into RSTP is **BackboneFast**.

- BackboneFast allows SW3 to expire the max age timers on its interface and rapidly forward the superior BPDUs to SW2.

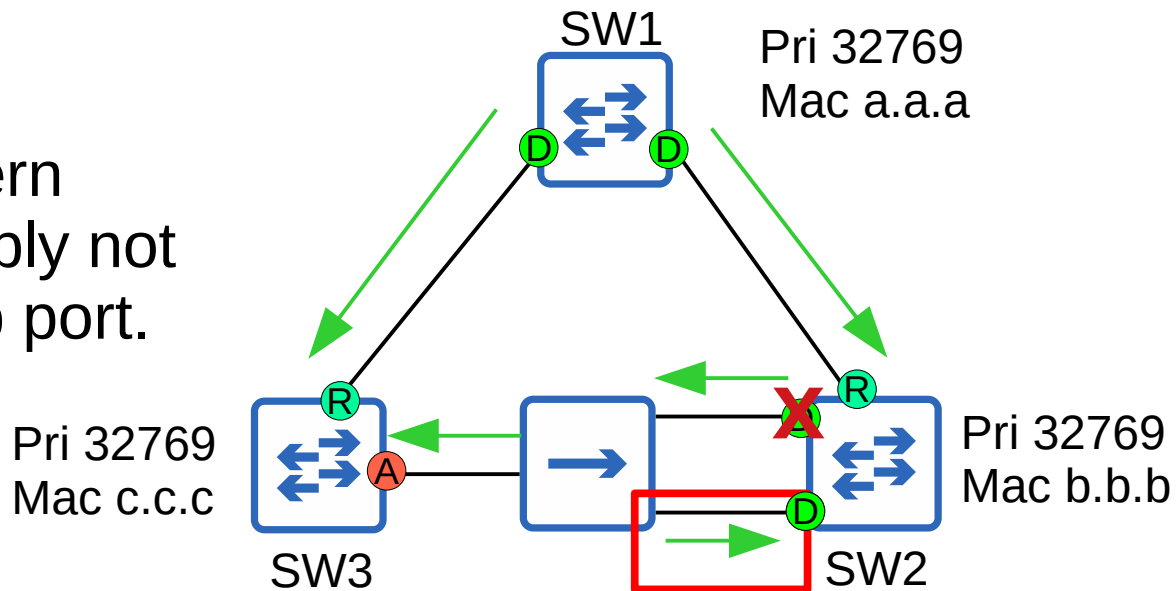
- This functionality is built into RSTP, so it does not need to be configured.



- **UplinkFast** and **BackboneFast** are two optional features in classic STP. They must be configured to operate on the switch (not necessary to know for CCNA).
- Both features are built into RSTP, so you do not have to configure them. They operate by default.
- You do not need to have a detailed understanding of them for the CCNA. Know their names and their basic purpose (to help blocking/discarding ports rapidly move to forwarding).
- If you want to learn more, do a Google search for 'spanning tree uplinkfast' or 'spanning tree backbonefast'.

RSTP: Backup port role

- The RSTP **backup** port role is a discarding port that receives a superior BPDUs from another interface on the same switch.
- This only happens when two interfaces are connected to the same collision domain (via a hub)
- Hubs are not used in modern networks, so you will probably not encounter an RSTP backup port.
- Function as a backup for a designated port.



RSTP: Backup port role

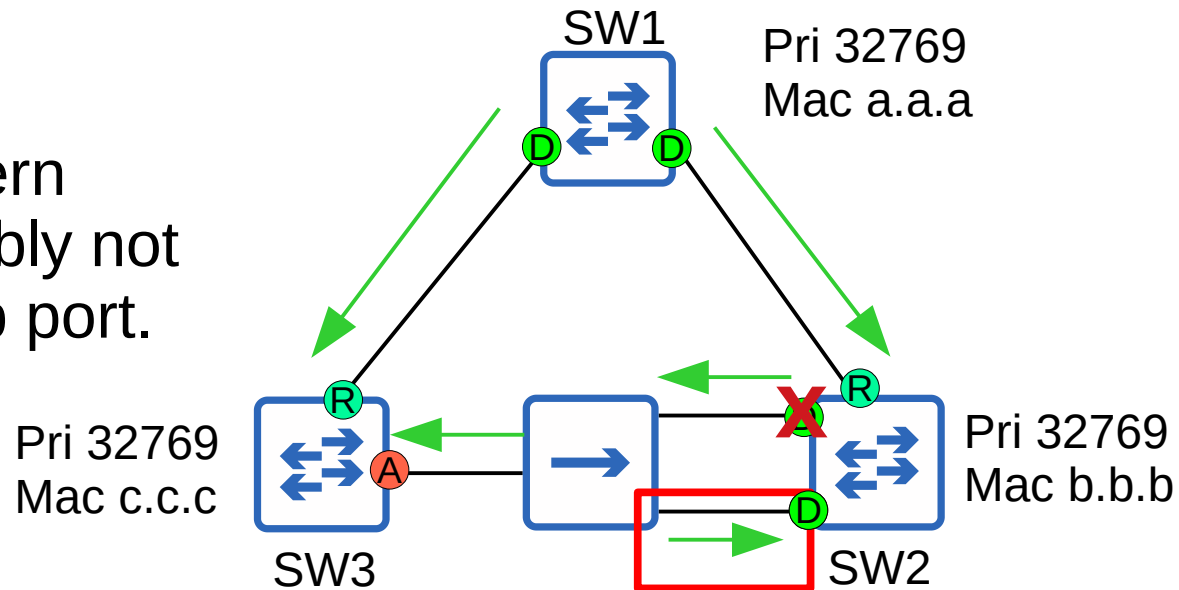
- The RSTP **backup** port role is a discarding port that receives a superior BPDU from another interface on the same switch.

The interface with the lowest port ID will be selected as the

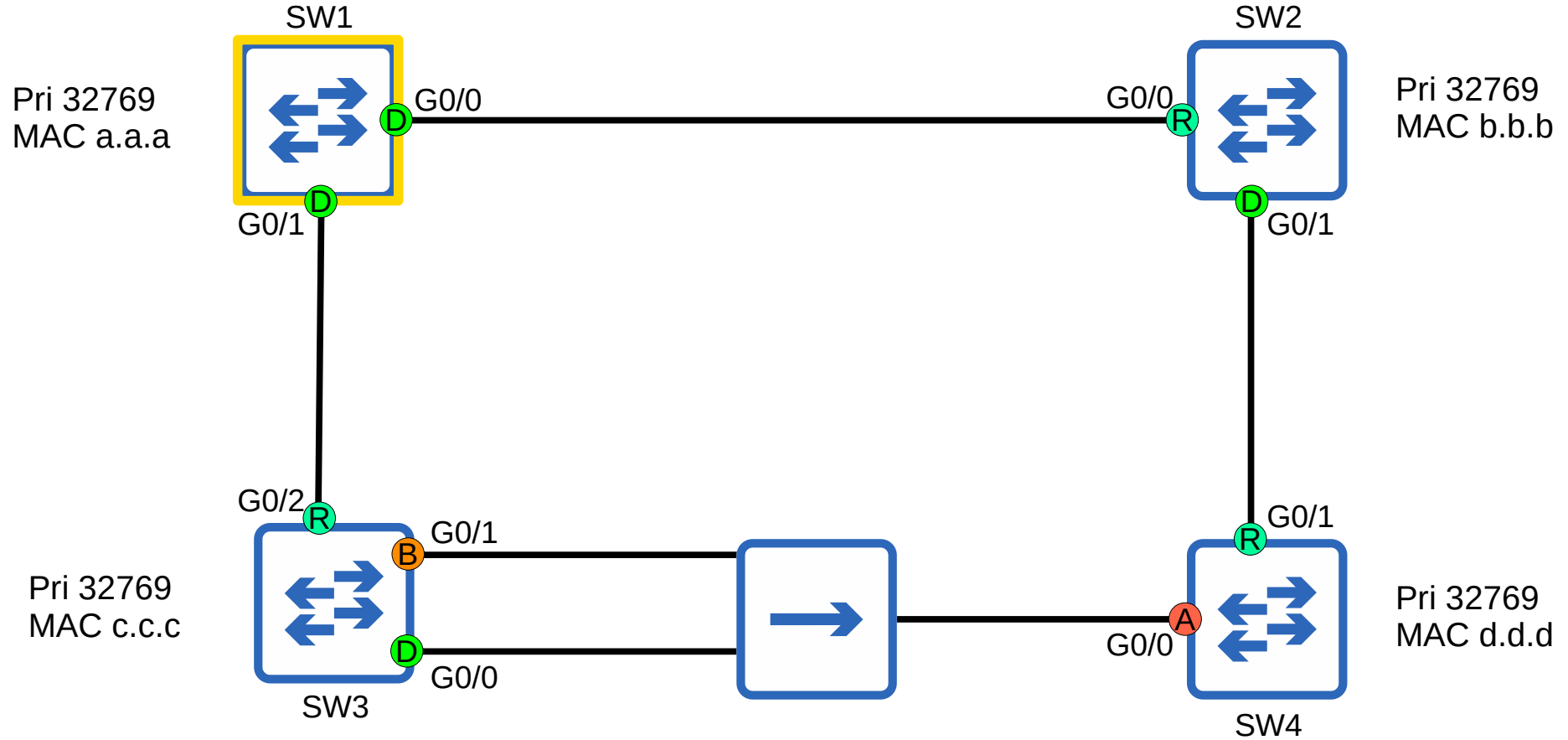
- This designated port, and the other will be the backup port. e
- collision domain (via a hub)

- Hubs are not used in modern networks, so you will probably not encounter an RSTP backup port.

- Function as a backup for a designated port.



RSTP Quiz 1



Rapid Spanning Tree Protocol

```
SW3(config)#spanning-tree mode ?
mst      Multiple spanning tree mode
pvst     Per-Vlan spanning tree mode
rapid-pvst Per-Vlan rapid spanning tree mode
```

```
SW3(config)#spanning-tree mode rapid-pvst
```

```
SW3(config)#do show spanning-tree
```

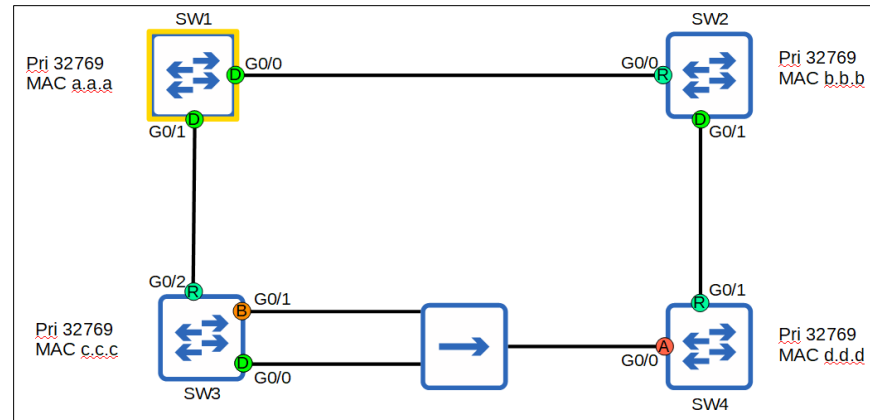
```
VLAN0001
```

```
Spanning tree enabled protocol rstp
```

```
Root ID    Priority    32769
Address    aaaa.aaaa.aaaa
Cost       4
Port       3 (GigabitEthernet0/2)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
```

```
Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
Address    cccc.cccc.cccc
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
-----	-----	-----	-----	-----	-----
Gi0/0	Desg	FWD	4	128.1	Shr
Gi0/1	Back	BLK	4	128.2	Shr
Gi0/2	Root	FWD	4	128.3	P2p



Rapid Spanning Tree Protocol

```
SW4#show spanning-tree
```

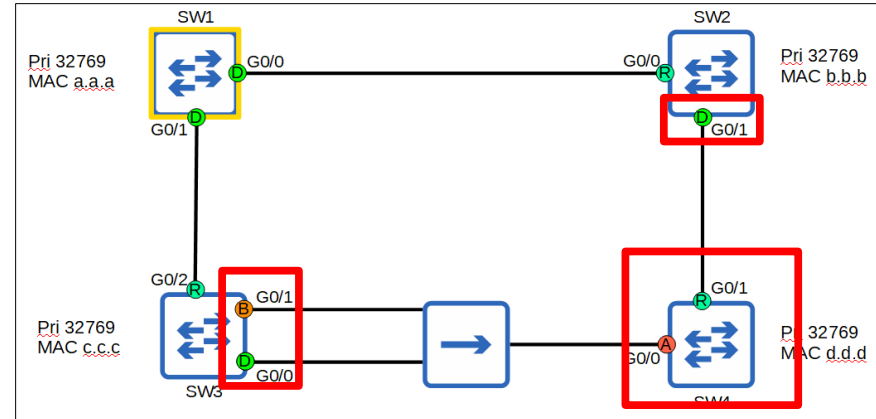
```
VLAN0001
```

```
Spanning tree enabled protocol rstp
```

```
Root ID    Priority    32769
Address    aaaa.aaaa.aaaa
Cost       8
Port       2 (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    dddd.ddd.ddd
Hello Time 2 sec    Max Age 20 sec    Forward Delay 15 sec
Aging Time 300 sec
```

Interface	Role	Sts	Cost	Prio.Nbr	Type
Gi0/0	Altn	BLK	4	128.1	P2p
Gi0/1	Root	FWD	4	128.2	P2p



Rapid STP is compatible with Classic STP. The interface(s) on the Rapid STP-enabled switch connected to the Classic STP-enabled switch will operate in Classic STP mode (timers, blocking → listening → learning → forwarding process, etc).

Rapid 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+
> 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: 1
    Message Age: 1
    Max Age: 20
    Hello Time: 2
    Forward Delay: 15
    Version 1 Length: 0
  
```

```

> Frame 71: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
> IEEE 802.3 Ethernet
> Logical-Link Control
< Spanning Tree Protocol
  Protocol Identifier: Spanning Tree Protocol (0x0000)
  Protocol Version Identifier: Rapid Spanning Tree (2)
  BPDU Type: Rapid/Multiple Spanning Tree (0x02)
  < BPDU flags: 0x3c, Forwarding, Learning, Port Role: Designated
    0... .. = Topology Change Acknowledgment: No
    .0.. .. = Agreement: No
    ..1. .... = Forwarding: Yes
    ...1 .... = Learning: Yes
    .... 11.. = Port Role: Designated (3)
    .... ..0. = Proposal: No
    .... ...0 = Topology Change: No
  < Root Identifier: 32768 / 1 / aa:aa:aa:aa:aa:aa
    Root Bridge Priority: 32768
  
```

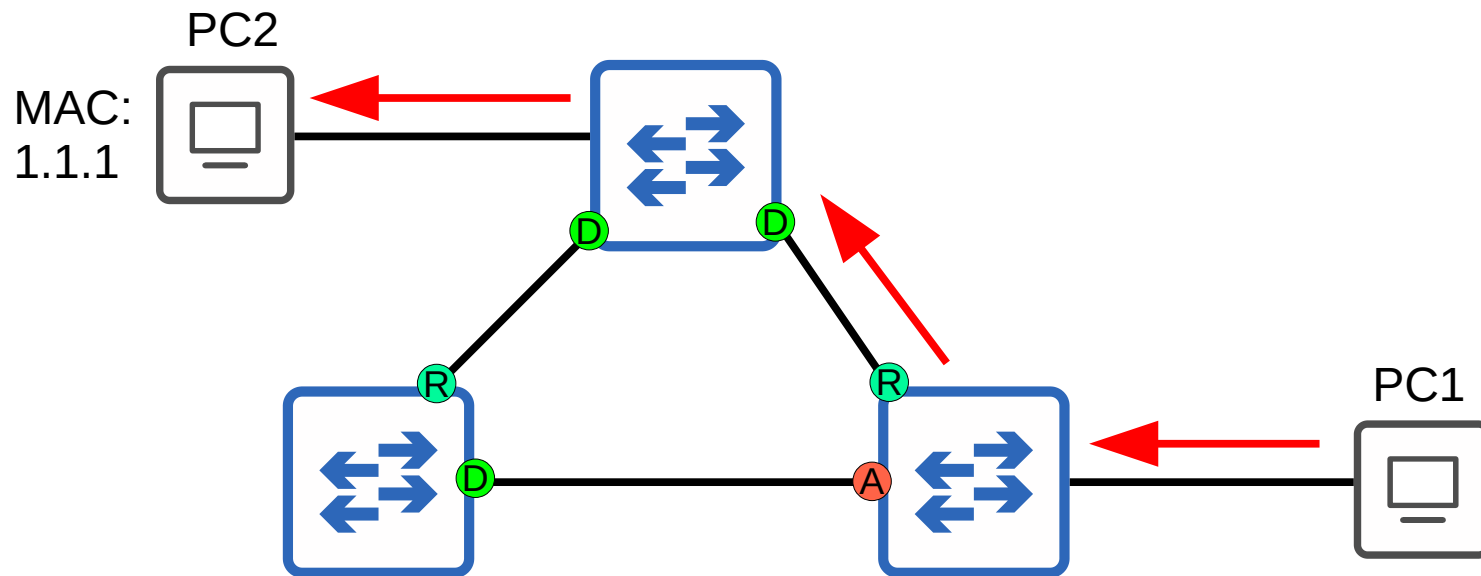
In classic STP, only the root bridge originated BPDUs, and other switches just forwarded the BPDUs they received.
In rapid STP, ALL switches originate and send their own BPDUs from their designated ports.

```

Message Age: 1
Max Age: 20
Hello Time: 2
Forward Delay: 15
Version 1 Length: 0
  
```

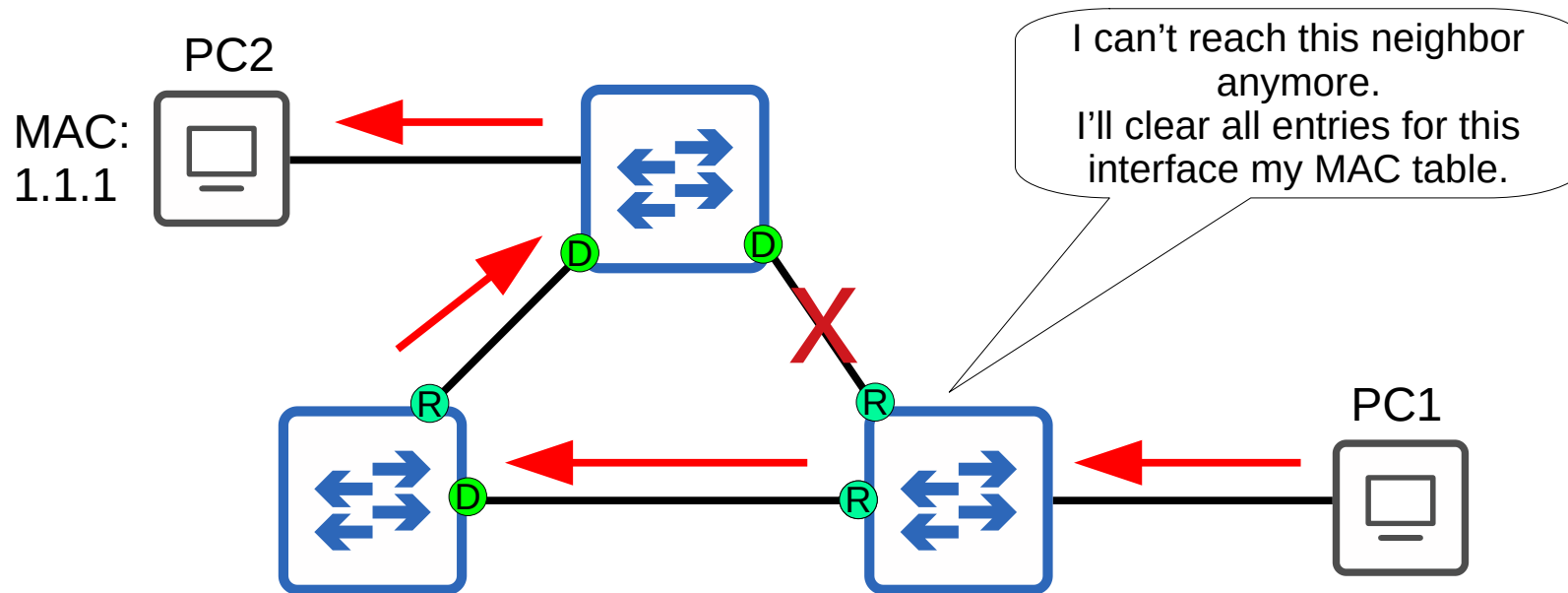
Rapid Spanning Tree Protocol

- All switches running Rapid STP send their own BPDUs every hello time (2 seconds).
- Switches 'age' the BPDU information much more quickly. In classic STP, a switch waits 10 hello intervals (20 seconds). In rapid STP, a switch considers a neighbor lost if it misses 3 BPDUs (6 seconds). It will then 'flush' all MAC addresses learned on that interface.



Rapid Spanning Tree Protocol

- All switches running Rapid STP send their own BPDUs every hello time (2 seconds).
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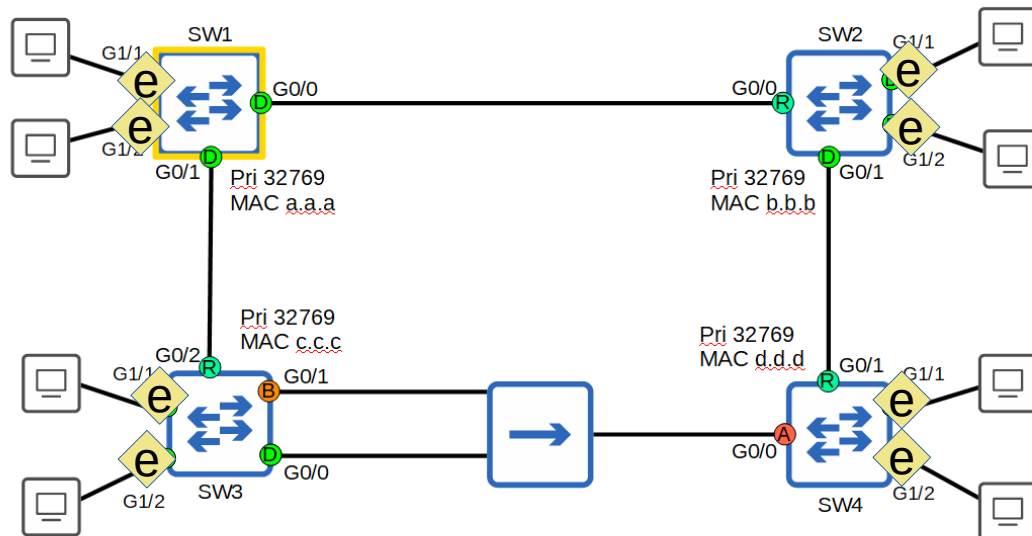
RSTP Link Types

- RSTP distinguishes between three different 'link types'.
- **Edge**: a port that is connected to an end host. Moves directly to forwarding, without negotiation.
- **Point-to-point**: a direct connection between two switches.
- **Shared**: a connection to a hub. Must operate in half-duplex mode.

RSTP Link Types: Edge

- Edge ports are connected to end hosts.
- Because there is no risk of creating a loop, they can move straight to the forwarding state without the negotiation process.
- They function like a classic STP port with PortFast enabled.

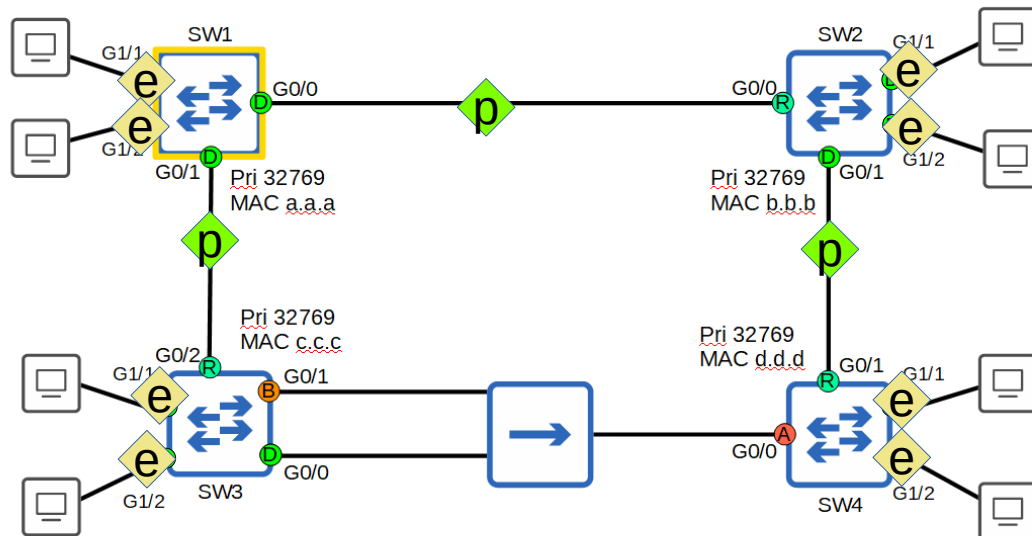
```
SW1(config-if)# spanning-tree portfast
```



RSTP Link Types: Point-to-Point

- Point-to-point ports connect directly to another switch.
- They function in full-duplex.
- You don't need to configure the interface as point-to-point (it should be detected).

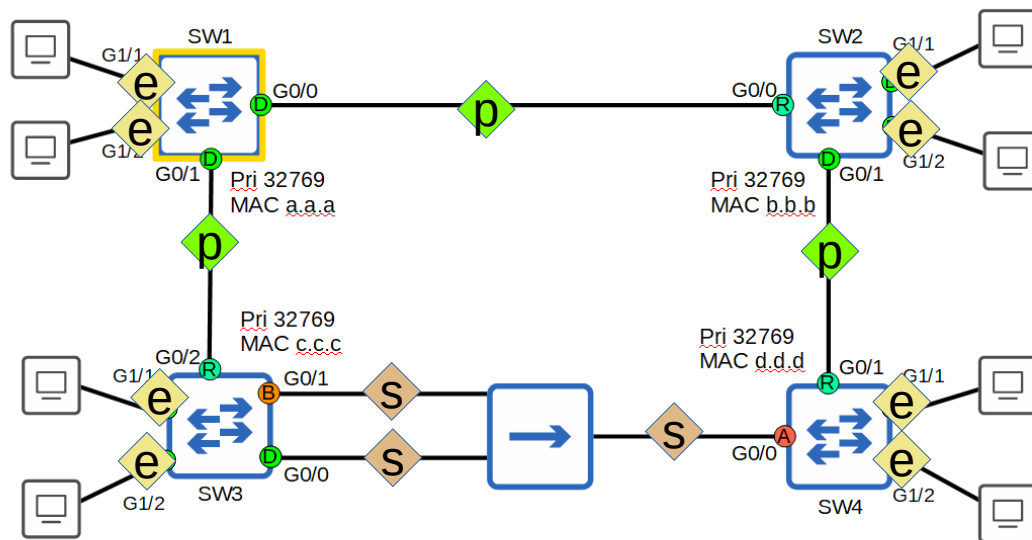
```
SW1(config-if)# spanning-tree link-type point-to-point
```



RSTP Link Types: Shared

- Shared ports connect to another switch (or switches) via a hub.
- They function in half-duplex.
- You don't need to configure the interface as shared (it should be detected).

```
SW1(config-if)# spanning-tree link-type shared
```



Things we'll cover

- Comparison of STP versions (standard vs Cisco)
- Rapid PVST+
 - RSTP port states (discarding, learning, forwarding)
 - RSTP port roles (root, designated, alternate, backup)
 - STP optional features built into in RSTP (UplinkFast, BackboneFast, PortFast)
 - RSTP BPDU (sent by all switches, not just the root bridge)
 - RSTP link types (edge, point-to-point, shared)

QUIZ

Which IEEE 802.1D optional features were built in to the IEEE 802.1w standard, and allow ports to move rapidly to the forwarding state?
(select three)

- a) Root Guard
- b) PortFast
- c) BPDU Guard
- d) UplinkFast
- e) BackboneFast
- f) Loop Guard
- g) RootFast

RSTP Quiz 3

You want to configure an 802.1w edge port, so that hosts connected to the interface can begin sending traffic over the network immediately. Which command should you use?

- a) SW1(config-if)# spanning-tree link-type edge
- b) SW1(config-if)# spanning-tree mode edge
- c) SW1(config-if)# spanning-tree link-type portfast
- d) SW1(config-if)# spanning-tree portfast

RSTP Quiz 4

Identify the root bridge in this network. What is the RSTP port role of each switch port? What is the appropriate RSTP link type of each connection between devices?

