

Layer 2 redundancy – Spanning Tree Protocol

Lecture 4

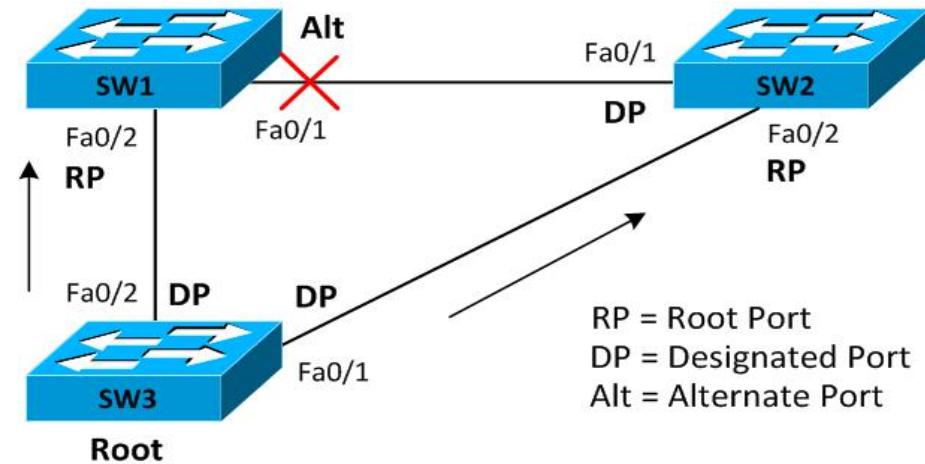


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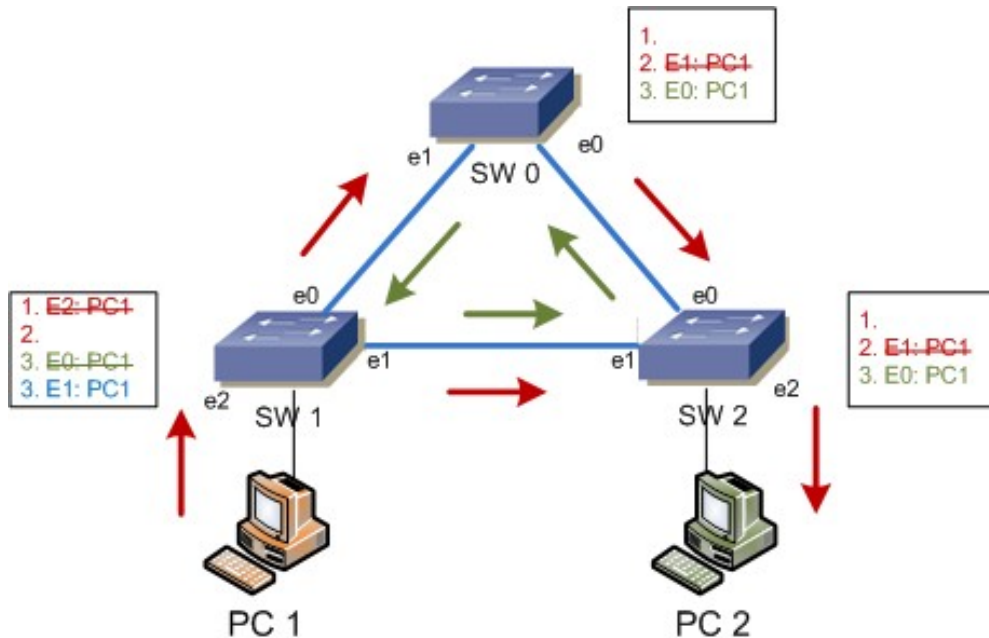
1. Spanning tree protocol (STP)
2. Rapid STP (RSTP)
3. Per-VLAN STP plus (PVST+)





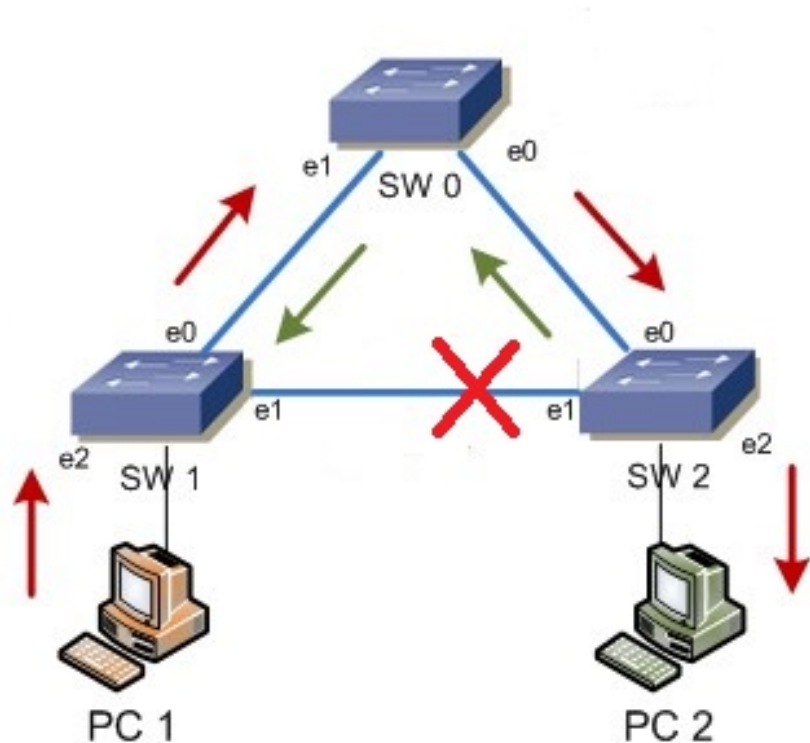
Spanning tree protocol (STP)

What is the Spanning Tree Protocol?



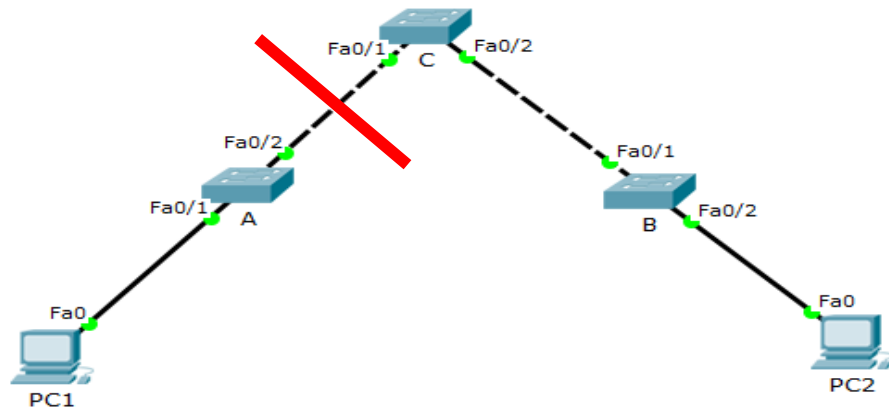
- It addresses a problem which switches can not handle alone: the **broadcast storms**
- Without STP, a L2 loop will:
 - Overload the links
 - Affect the end devices
 - Cause MAC table instability
 - ...never stop

What is the Spanning Tree Protocol? (2)



- All STP enabled switches “talk” to each other
- The management information that they exchange is in the form of **BPDUs** (**B**ridge **P**rotocol **D**ata **U**nits)
- The goal is to **logically** block one or more ports to prevent from loops

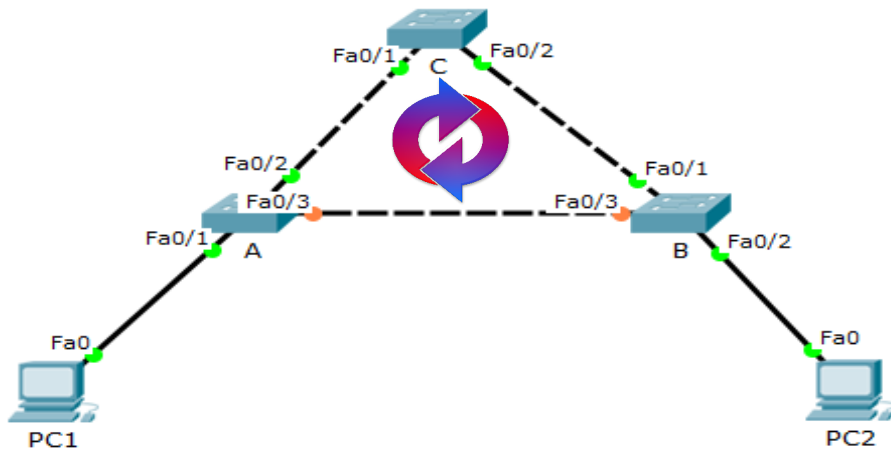
Why STP is needed?



- In this topology STP is NOT needed
- ...but there is no redundancy

Why STP is needed? (2)

- Now there is a redundancy
- ...but there is also the loop problem!



The STP algorithm

1. Elect the **Root** switch (Root bridge)
 - This is the switch with the lowest BID (Bridge ID)
 - BID = Switch Priority and MAC
2. Select the **root ports**
 - They have the best cost (lowest) to the Root
 - Selected per switch
3. Select the **designated ports**
 - They have the best cost (lowest) to the Root
 - Selected per segment (connection)
4. All other ports go to **blocking** state

STP tie-breakers

- If there is a tie situation - the same path cost via different paths, use the following tie-breakers:
 - When selecting Root port or Designated port, choose the neighboring switch which has the lowest Bridge ID
 - If the Bridge ID is the same, select the lowest Port ID (PID)
- Port ID = Port priority and port number

Link costs (path cost)

Data rate	STP Cost (802.1D-1998)	RSTP Cost (802.1W-2001)
4 Mbit/s	250	5,000,000
10 Mbit/s	100	2,000,000
16 Mbit/s	62	1,250,000
100 Mbit/s	19	200,000
1 Gbit/s	4	20,000
2 Gbit/s	3	10,000
10 Gbit/s	2	2,000

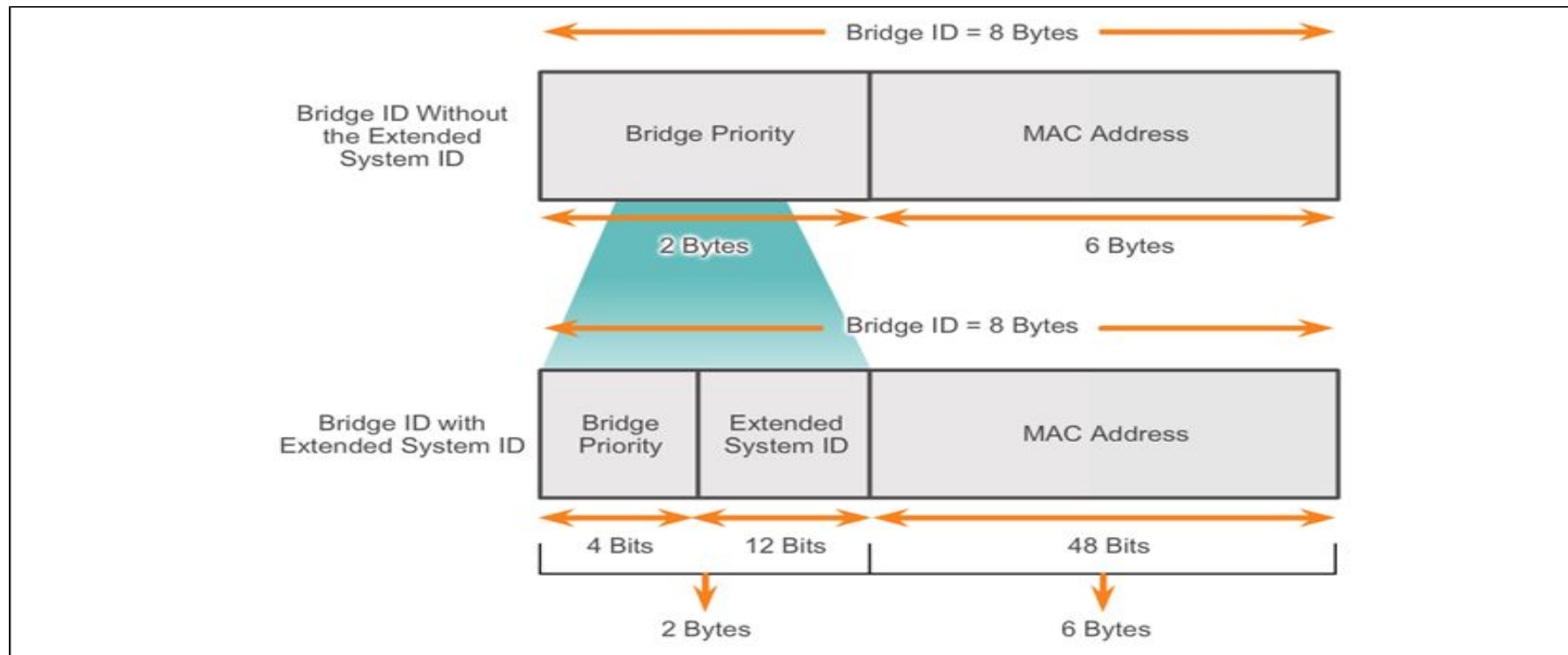
- Higher port speed -> lower cost
- The values can be changed by administrator

STP Priority

- A number between 0 and 61440
- Must be configured in increments of 4096
- Default is 32768 (+ the VLAN ID)
- The switch with the lowest priority will become the Root
- If equal values -> lowest MAC address wins
(BID = Priority and MAC)

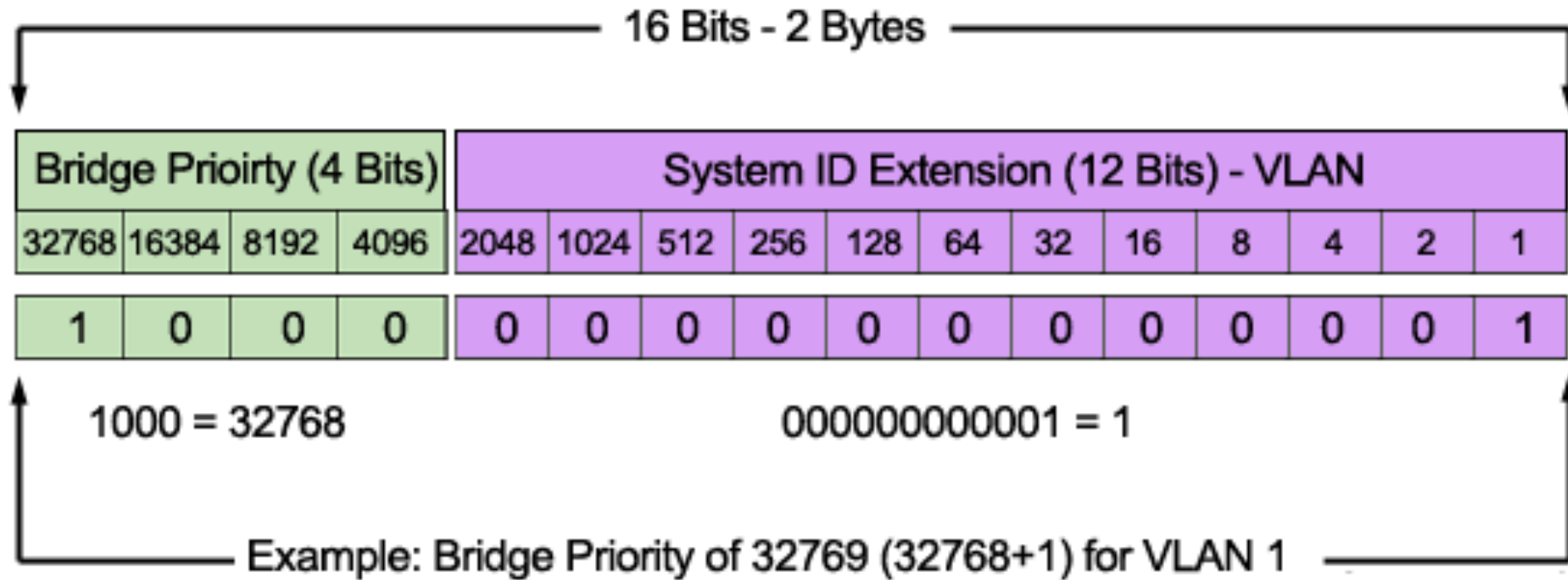
STP Priority (2)

- 16 bits reserved for bridge priority initially
- Only the first 4 are now used for priority and the other 12 are for VLAN

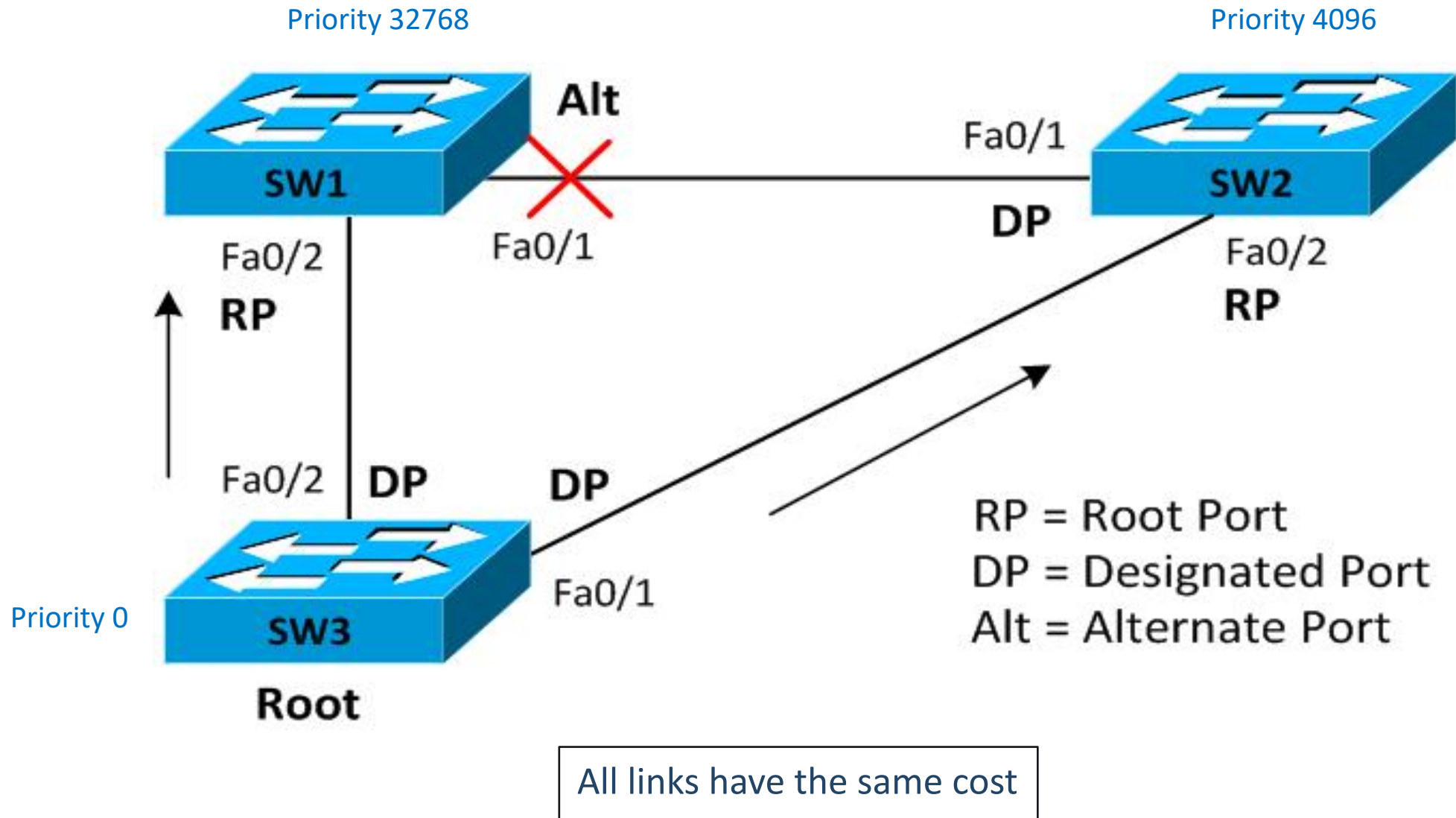


STP Priority (3)

- Extended system ID is the reason for the 4096 increments

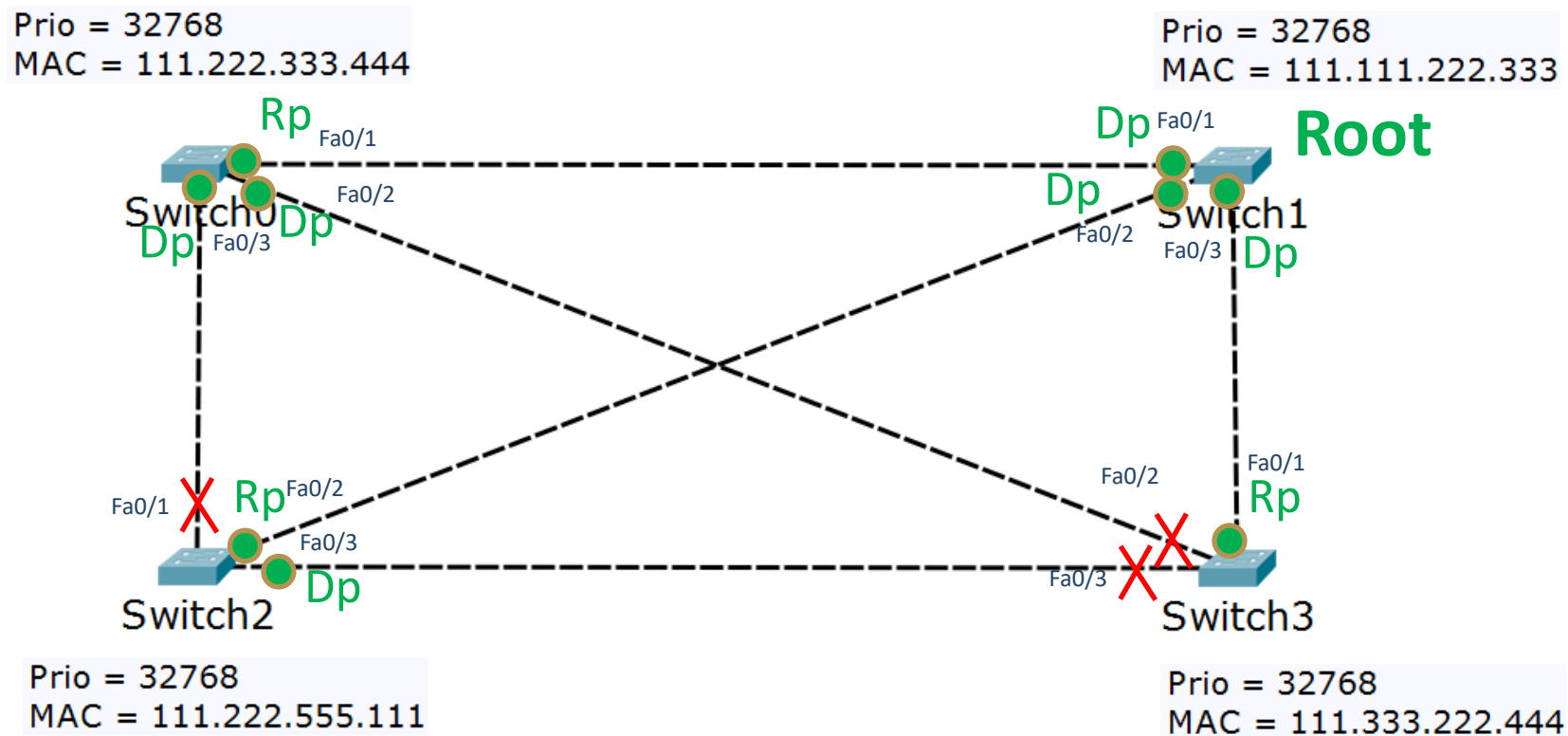


STP Example 1



STP Example 2

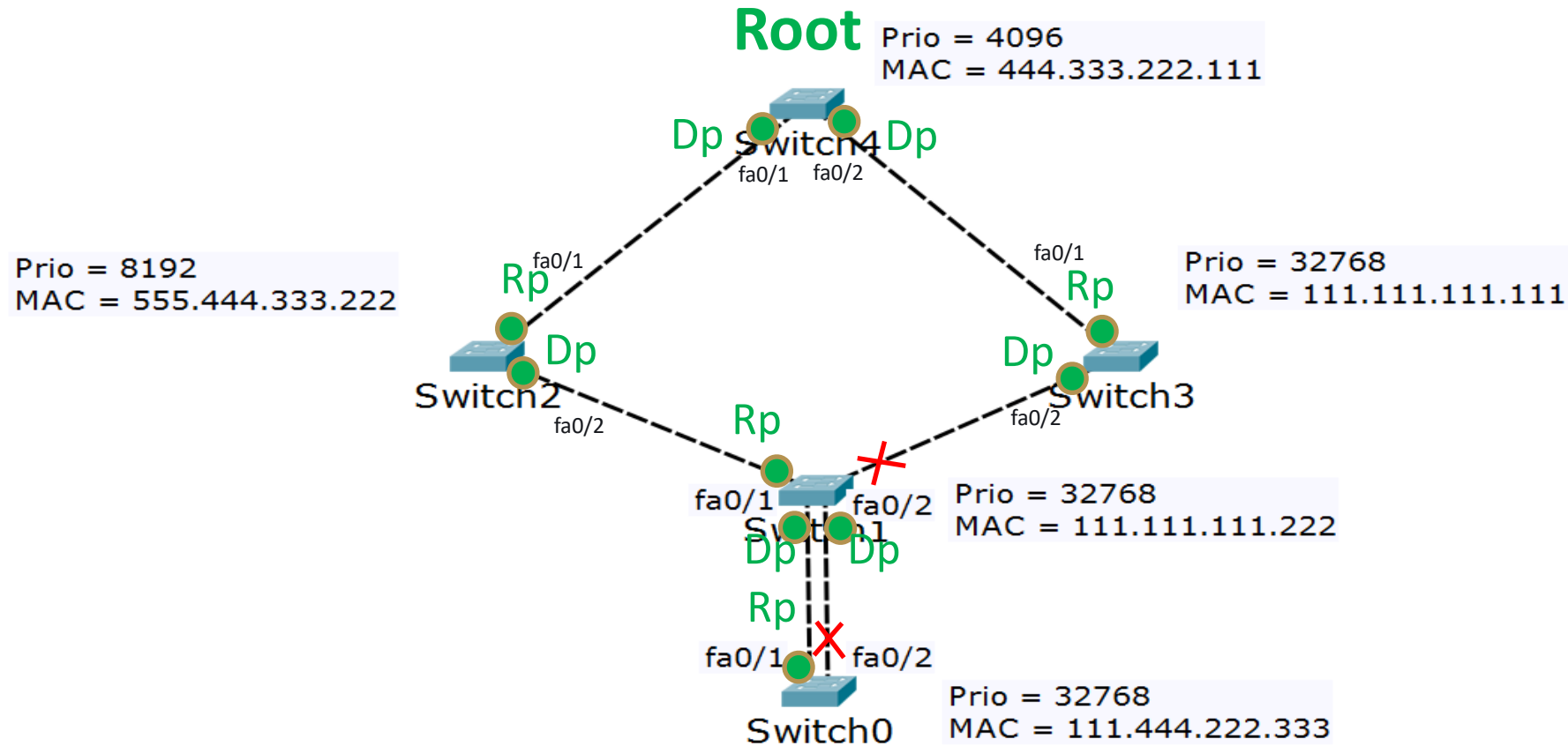
Find the Root, the RP, the DP and the Blocking ports



Note: All links are with the same cost

STP Example 3

Find the Root, the RP, the DP and the Blocking ports



Note: All links are with the same cost



Rapid STP (RSTP)

Spanning Tree Protocol – Main Flavors

- **STP** - Spanning Tree Protocol, IEEE 802.1D
- **RSTP** - Rapid STP, IEEE 802.1W
- **MSTP** - Multiple STP, IEEE 802.1S (802.1Q-2005)
- **PVST+** - Per-VLAN STP, Cisco proprietary

STP (the good old Spanning Tree)

- Spanning Tree Protocol
- The industry standard name is IEEE 802.1D
- Slow convergence
- Port states:
 - Disabled
 - Blocking (up to 20 sec)
 - Listening (up to 15 sec)
 - Learning (up to 15 sec)
 - Forwarding

RSTP (the faster STP)

- Rapid STP
- The industry standard name is IEEE 802.1W
- Much faster convergence than STP
- Introducing **Edge port** – a port which is connected to an end device
- RSTP uses the same algorithm as STP
- Port states:
 - Discarding
 - Learning
 - Forwarding

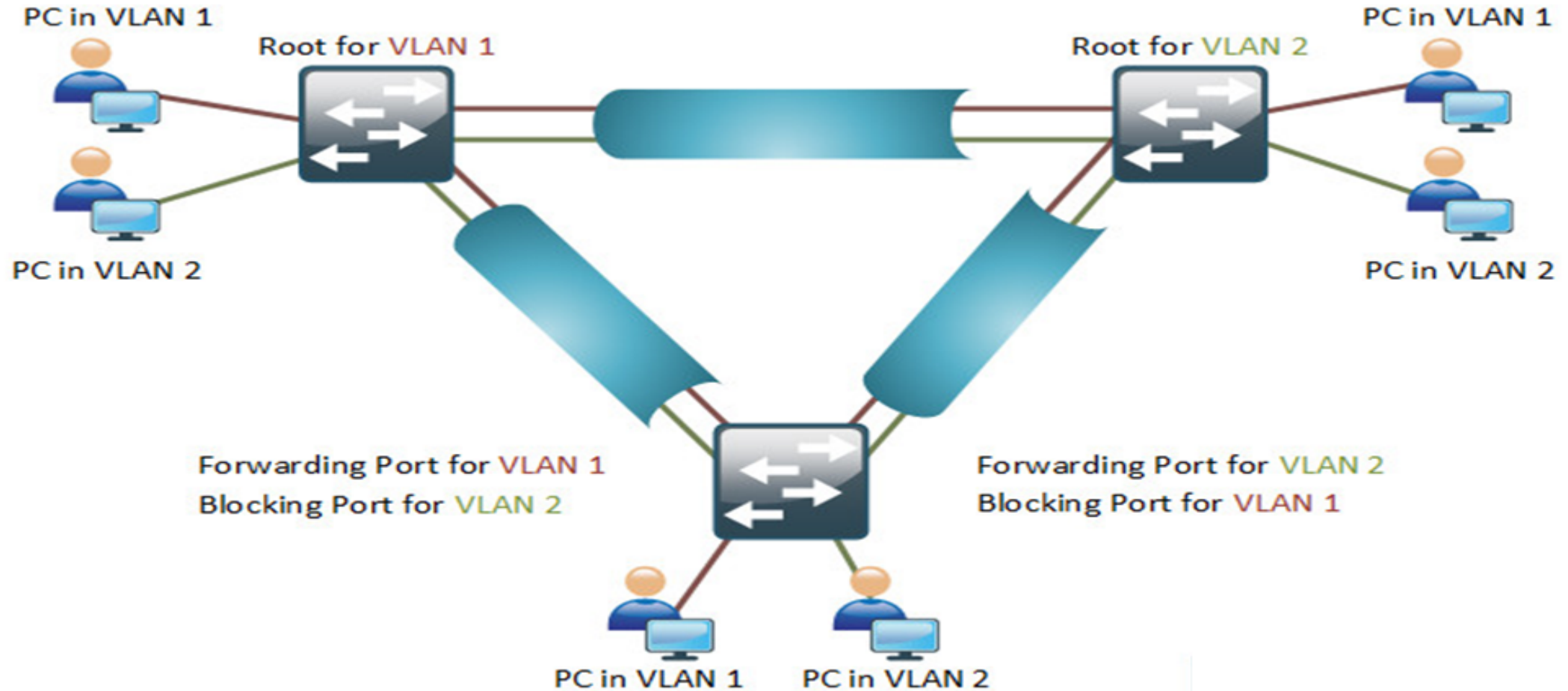


Per-VLAN STP plus (PVST+)

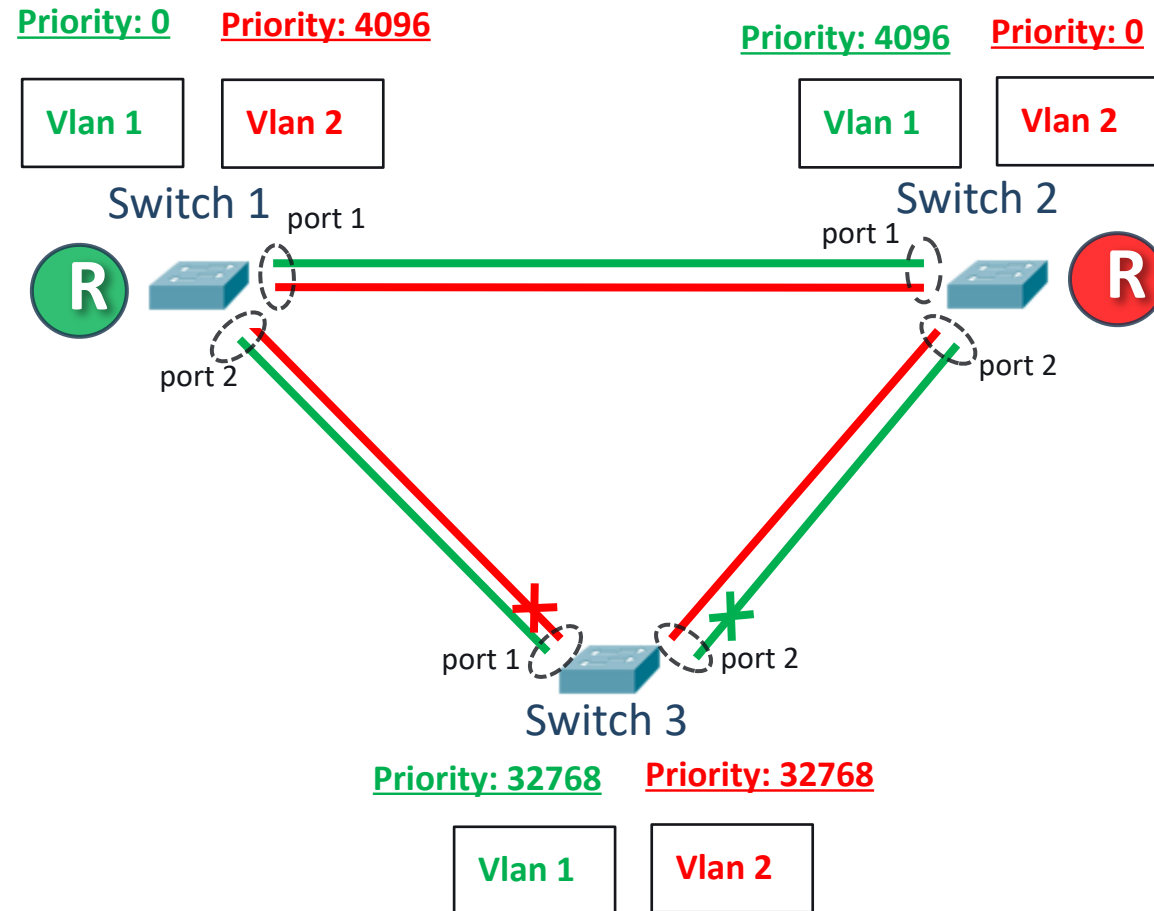
PVST+

- Per-VLAN Spanning Tree is Cisco protocol
- Why? It has a similar idea as MSTP - to distribute the load
- Creates a spanning tree topology for each VLAN separately
- PortFast in PVST+ is like Edge port in STP/RSTP

PVST+ (2)



PVST+ (3)



The good and the bad about PVST+

- PVST+ advantages:
 - triggers STP calculation **only if** there is a potential loop in a **particular VLAN**
 - detailed “look” of the network – does not block ports when there is no loop on the trunks for a given VLAN
- PVST+ disadvantages
 - generates **a lot of overhead** in the network
 - proprietary protocol



Demonstration

Summary

1. Spanning tree protocol (STP)
2. Rapid STP (RSTP)
3. Per-VLAN STP plus (PVST+)

