CCNA 200-301

Spanning-Tree Protocol

Historical view

STP & RSTP Basics

- What is STP function?
- How STP works?
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- Electing Root port
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Historical view

The IEEE first standardized STP as part of the IEEE 802.1D standard back in 1990. Over time, the industry and IEEE improved STP, with the eventual replacement of STP with an improved protocol: Rapid Spanning Tree Protocol (RSTP).

The IEEE first released RSTP as amendment 802.1w and, in 2004, integrated RSTP into the 802.1D standard. An argument could be made to ignore STP today and instead focus solely on RSTP. Most modern networks use RSTP instead of STP. The most recent models and IOS versions of Cisco switches default to use RSTP instead of STP.

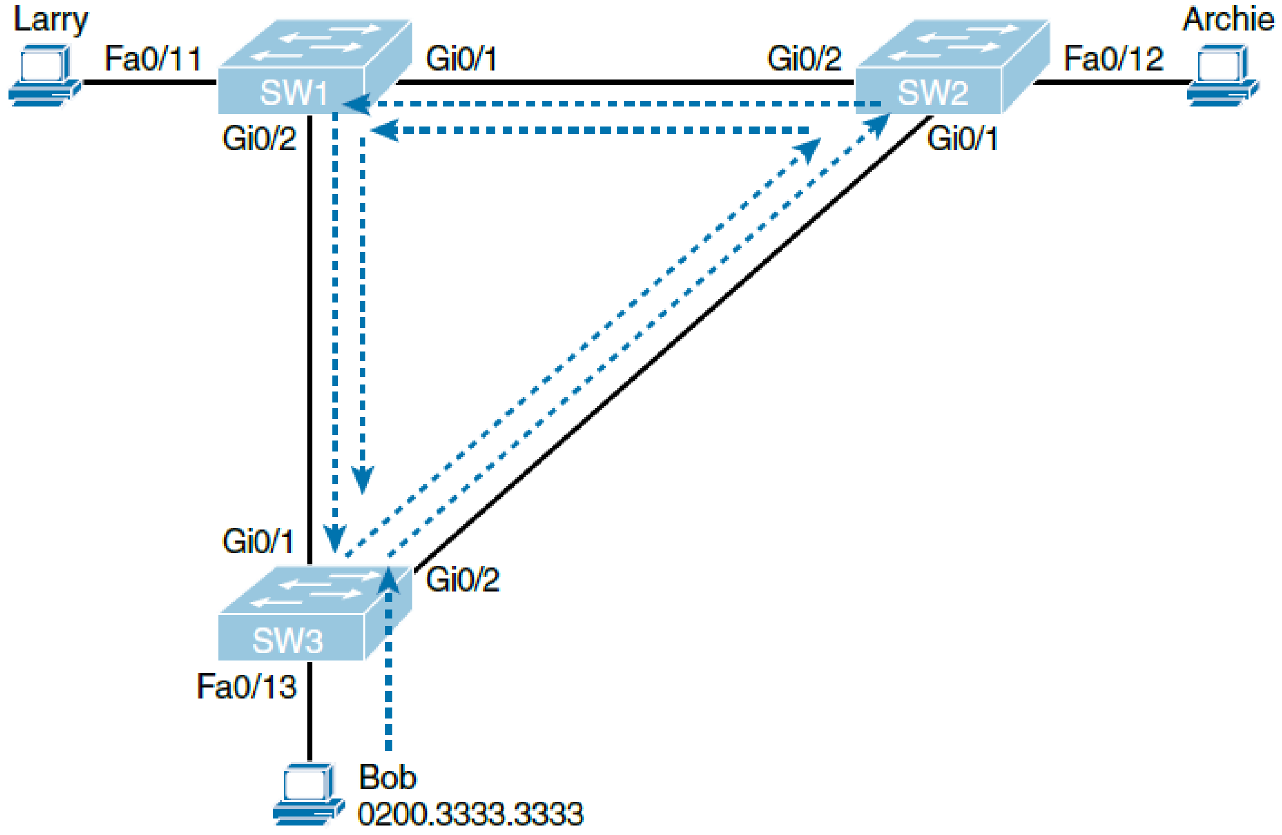
However, STP and RSTP share many of the same mechanisms, and RSTP's improvements can be best understood in comparison to STP.

STP & RSTP Basics

Without STP or RSTP, an ethernet frame will circulating in LAN for indefinite period. With STP or RSTP enabled, ethernet switch will block some switch port and those port won’t forward frames and will get rid of Layer 2 loops.

We have the topology with three switches: without STP/RSTP switches will flood frames according to forwarding logic.

As a result, **broadcast storm** will be created.



STP & RSTP Basics

The problems with absence of STP/RSTP

Problem	Description
Broadcast storms	The forwarding of a frame repeatedly on the same links, consuming significant parts of the links' capacities
MAC table instability	The continual updating of a switch's MAC address table with incorrect entries, in reaction to looping frames, resulting in frames being sent to the wrong locations
Multiple frame transmission	A side effect of looping frames in which multiple copies of one frame are delivered to the intended host, confusing the host

MAC-address instability

St1. SW3 learns Bob PC mac-address from Fa0/13 interface.

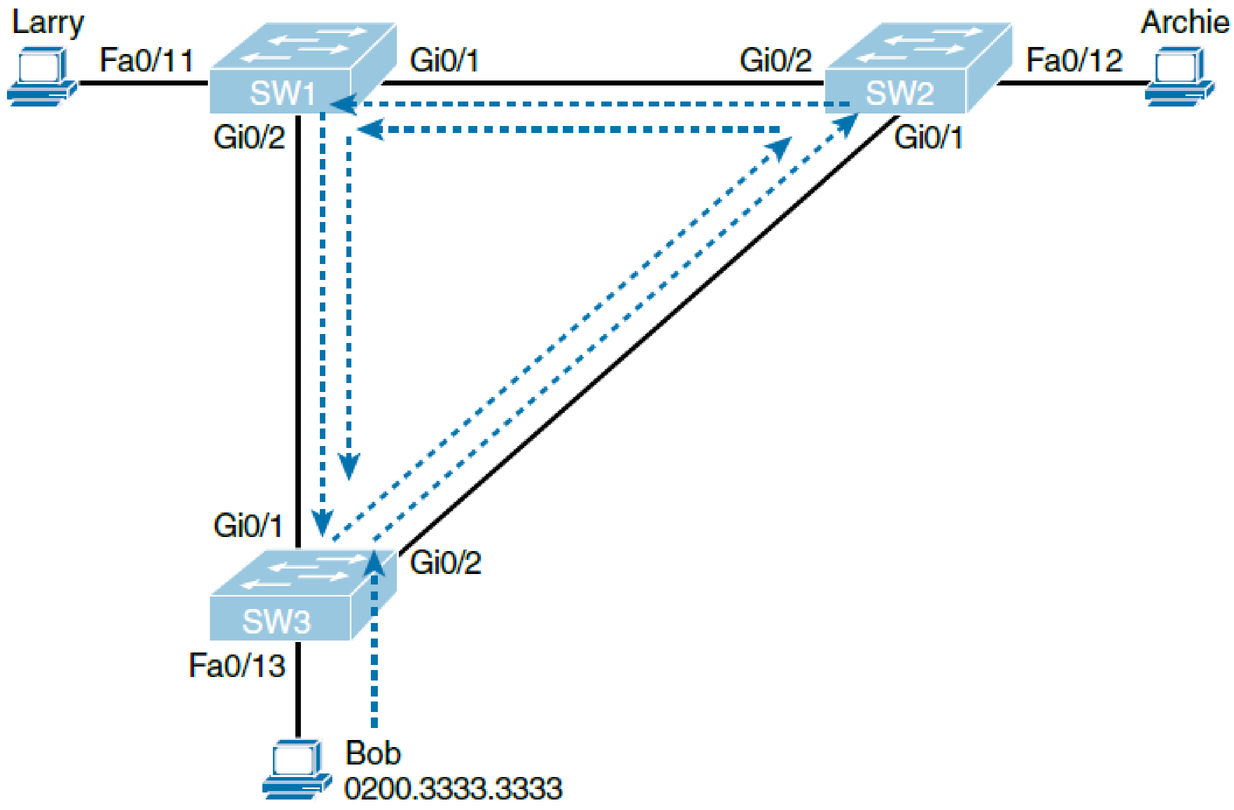
St2. SW3 forwards the same mac-address to SW2.

St3. SW2 forwards the same mac-address to SW1.

St4. SW1 forward Bob PC mac-address to SW3.

As we see, in the 4th step SW3 learns Bob PC's mac-address again and from different port(Gi0/1).

This process happens again and again and called **MAC-address instability**.



What is STP function?

STP/RSTP prevents loops by placing each switch port in either a forwarding state or a blocking state. Interfaces in the forwarding state act as normal, forwarding and receiving frames. However, interfaces in a blocking state do not process any frames except STP/RSTP messages (and some other overhead messages). Interfaces that block do not forward user frames, do not learn MAC addresses of received frames, and do not process received user frames.

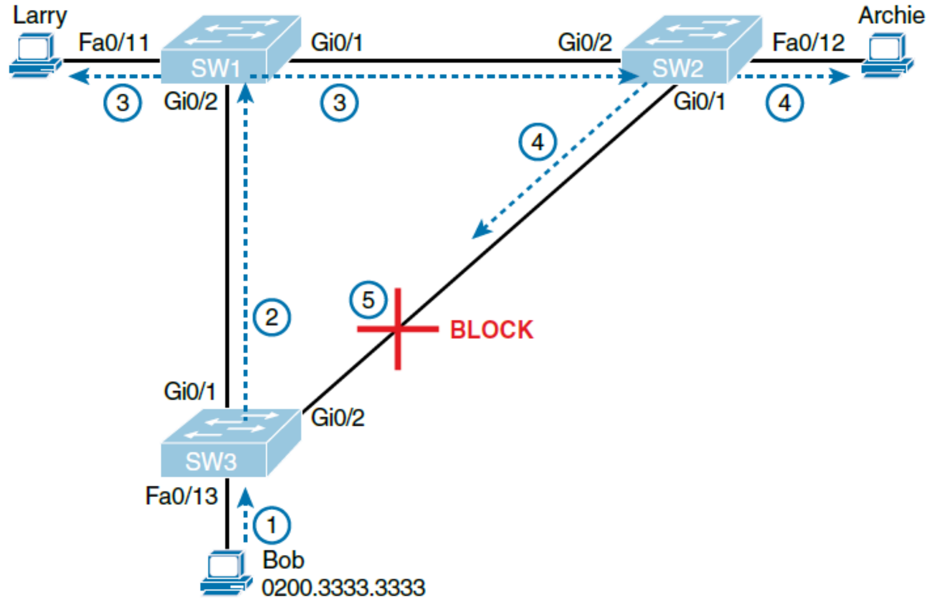
Step 1. Bob sends the frame to SW3.

Step 2. SW3 forwards the frame only to SW1, but not out Gi0/2 to SW2, becauseSW3's Gi0/2 interface is in a blocking state.

Step 3. SW1 floods the frame out both Fa0/11 and Gi0/1.

Step 4. SW2 floods the frame out Fa0/12 and Gi0/1.

Step 5. SW3 physically receives the frame, but it ignores the frame received from SW2 because SW3's Gi0/2 interface is in a blocking state.



How STP works?

Spanning-tree uses Spanning Tree Algorithm (STA) that selects interfaces to put whether forwarding or blocking states. STP elects root-bridge (master-switch) in ethernet LAN segment. STP/RSTP defines messages called bridge protocol data units (BPDU), also called configuration BPDUs, which switches use to exchange information with each other. We have two types of BPDU.

- Configuration BPDU (used for election of root bridge)
- Topology-Change BPDU

Configuration BPDU is also called Hello BPDU and consists of the following parts with Bridge-ID.

- The STP/RSTP *bridge ID* (BID) is an 8-byte value unique to each switch. The bridge ID consists of a 2-byte priority field and a 6-byte system ID, with the system ID being based on universal (burned-in) MAC address in each switch.

Field	Description
Root bridge ID	The bridge ID of the switch the sender of this Hello currently believes to be the root switch
Sender's bridge ID	The bridge ID of the switch sending this Hello BPDU
Sender's root cost	The STP/RSTP cost between this switch and the current root
Timer values on the root switch	Includes the Hello timer, MaxAge timer, and forward delay timer

Root-Bridge Election Process

- Switches elect a root switch based on the BIDs in the BPDUs. The root switch is the switch with the lowest numeric value for the BID. Because the two-part BID starts with the priority value, essentially the switch with the lowest priority becomes the root. For example, if one switch has priority 4096, and another switch has priority 8192, the switch with priority 4096 wins, regardless of what MAC address was used to create the BID for each switch.
- If a tie occurs based on the priority portion of the BID, the switch with the lowest MAC address portion of the BID is the root.
- The process begins with all switches claiming to be the root by sending Hello BPDUs listing their own BID as the root BID. If a switch hears a Hello that lists a better (lower) BID, that switch stops advertising itself as root and starts forwarding the superior Hello. The Hello sent by the better switch lists the better switch's BID as the root.

Bridge-ID = 6 byte (MAC_Address) + 2 byte (System_Priority)

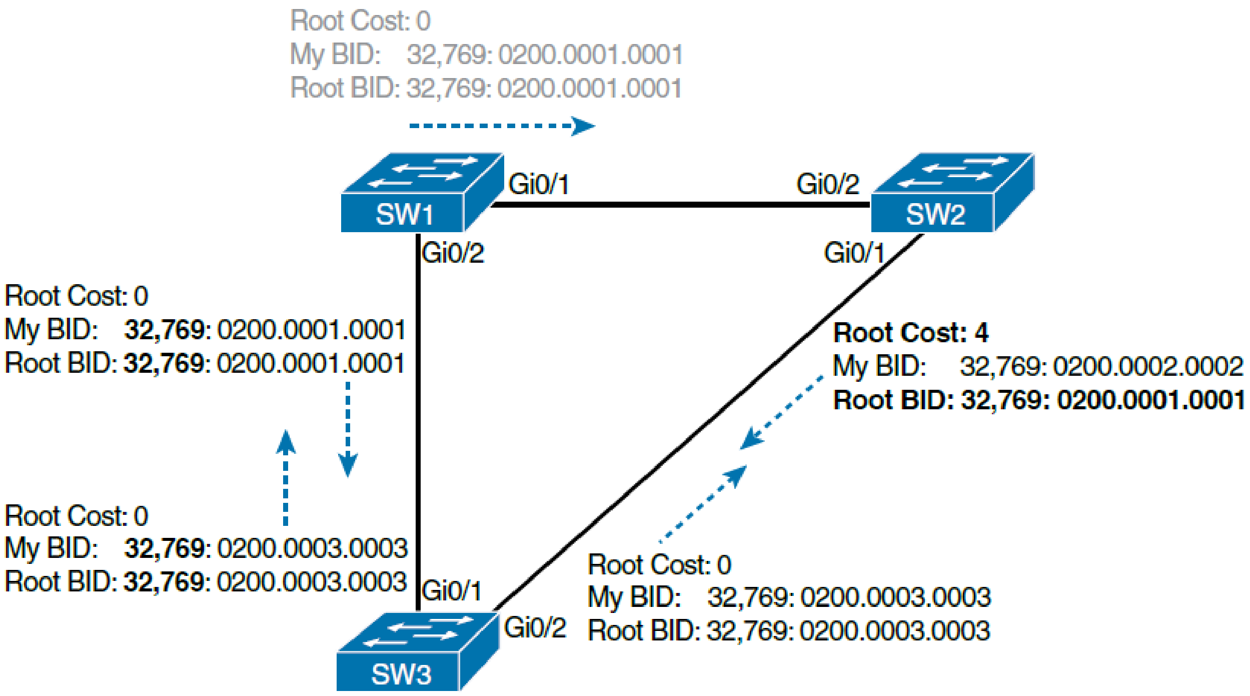
Root-Bridge Election Process cont

Default system priority = 32768 + 1 (default VLAN) = 32769.

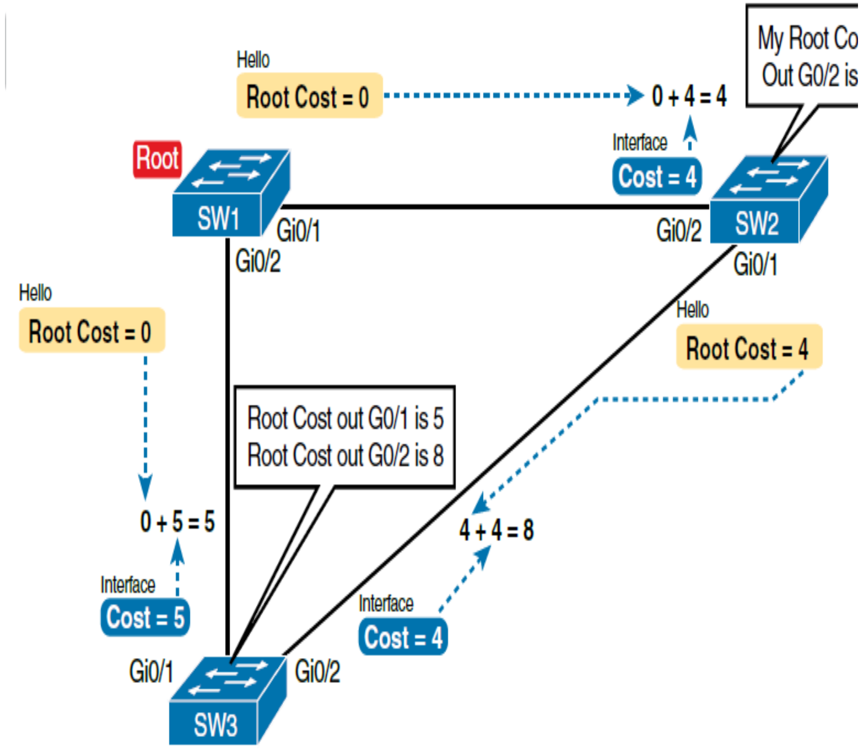
Let’s look at the next topology

In the topology we see that all switche’s system priority is the same. We look at the mac-address.

From the topology wee see that SW1 wins the election process because of its lowest mac-address.



Choosing the Root port



The second part of the STP/RSTP process occurs when each nonroot switch chooses its one and only *root port*. A switch's RP is its interface through which it has the least STP/RSTP cost to reach the root switch (least root cost).

The Root port is in forwarding state.

SW3 has a root cost to SW1 – 5 (on G0/1).

SW2 has a root cost to SW1 – 4 (on G0/2)

Switches need a tiebreaker to use in case the best root cost ties for two or more paths. If a tie occurs, the switch applies these three tiebreakers to the paths that tie, in order, as follows:

1. Choose based on the lowest neighbor bridge ID.

2. Choose based on the lowest neighbor port priority.

3. Choose based on the lowest neighbor internal port number.

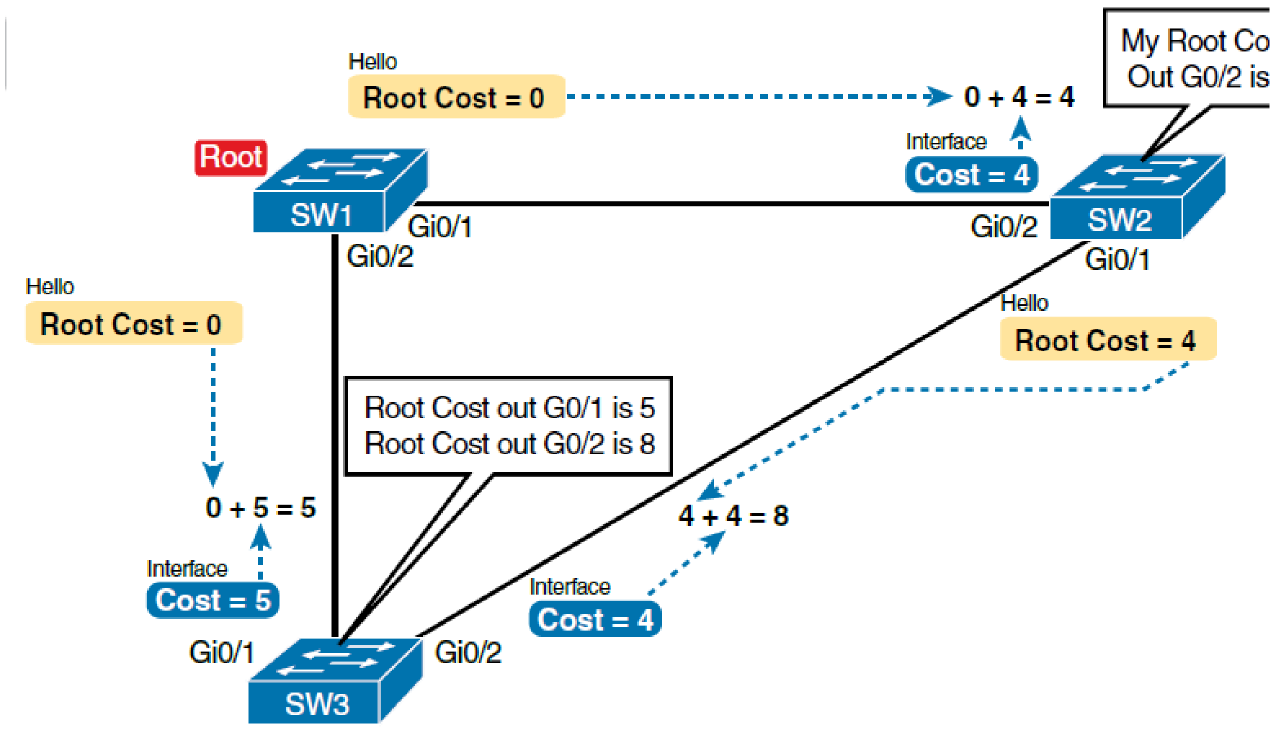
Choosing the Designated Port

STP/RSTP's final step to choose the STP/RSTP topology is to choose the designated port on each LAN segment. The designated port (DP) on each LAN segment is the switch port that advertises the lowest-cost Hello onto a LAN segment.

According to the topology SW3 G0/2 port advertises cost 5 to reach root switch. But SW2 G0/1 interfaces advertises cost 4 to reach root switch.

As a result, SW2 Gi0/1 interfaces wins election of DP.

DP is in forwarding states.



Special rules

All Root Switche’s interfaces are Designated Ports and in forwarding states.

All noonroot switche’s port that are connected to root switch is called Root port and is in forwarding states.

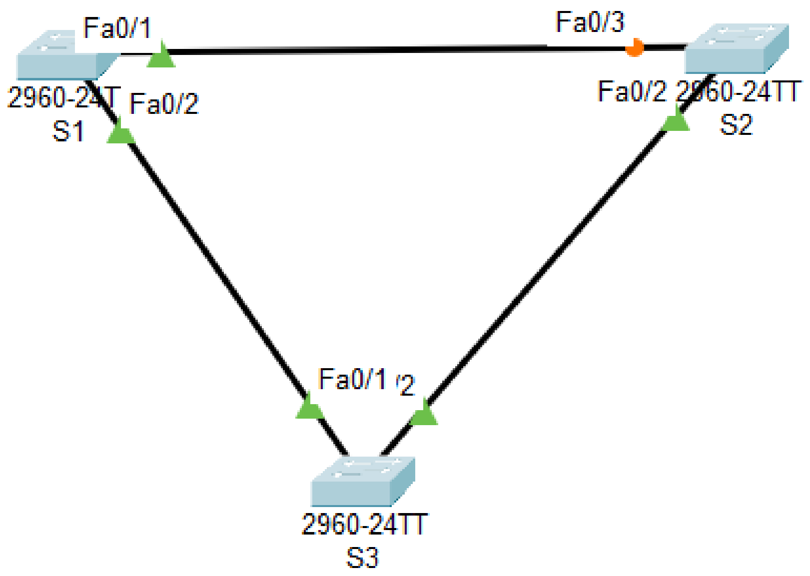
Ethernet Speed	IEEE Cost: 1998 (and Before)	IEEE Cost: 2004 (and After)
10 Mbps	100	2,000,000
100 Mbps	19	200,000
1 Gbps	4	20,000
10 Gbps	2	2000
100 Gbps	N/A	200
1 Tbps	N/A	20

Practical view

In the topology we have three switches:

Using #show spanning-tree command we analyze existing spanning-tree case.

In practice we see Root Ports, DPs,Alternate Ports and their states.



That is all for Lesson 11

The key is :

Learn

Repeat

Practice

You will be able to reach your goals.

GOOD LUCK !!!!!...