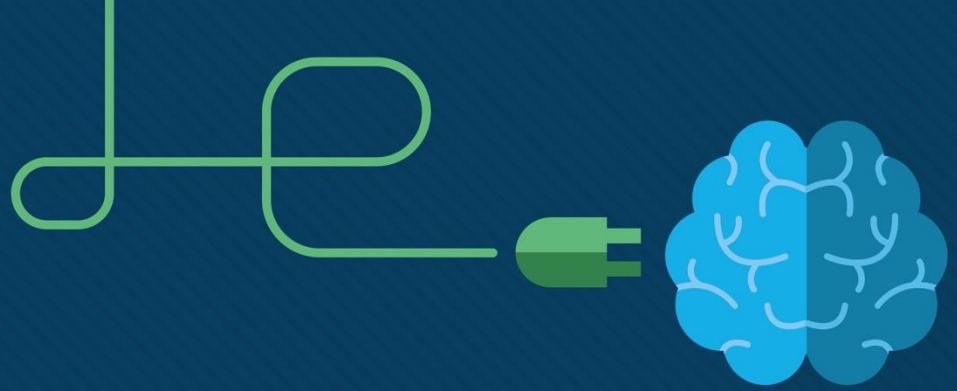

Chapter 4: Multiple Spanning Tree Protocol

Instructor Materials

CCNP Enterprise: Core Networking

Chapter 4 Content

This chapter covers the following content:

Multiple Spanning Tree Protocol - This section explains the advantages and operations of Multiple Spanning Tree Protocol (MST).

Multiple Spanning Tree Protocol

- The original 802.1D standard only supported one STP instance for an entire switch network. Which means that it was not possible to load share traffic across links by blocking for specific VLANs on one line and blocking for other VLANS on alternate links.
- Multiple Spanning Tree Protocol (MST) maps one or multiple VLANs to one STP instance.

CST Topology

The figure below shows a Common Spanning Tree (CST) topology. VLANs 1 - 4 share the same topology. Traffic from SW2 to SW3 must pass through SW1. If only SW2 and SW3 had end devices in VLAN 4, the topology could not be tuned to allow traffic to traverse directly between the two switches.

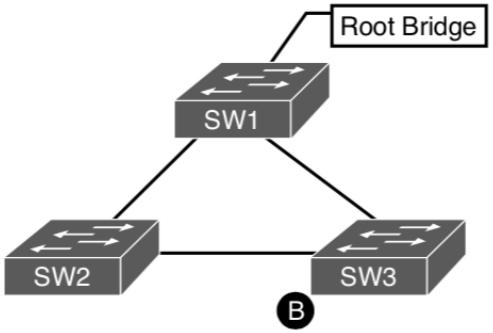

Figure 4-1 *Common Spanning Tree Instance (CST) Topology*

PVST Topologies

Per-VLAN Spanning Tree (PVST) provides a separate spanning tree instance for each VLAN configured on the network. The topologies below show how the switches maintain a different STP topology for each of the four VLANs. In environments with thousands of VLANs, maintaining an STP state for every VLAN can burden the switch's processor.

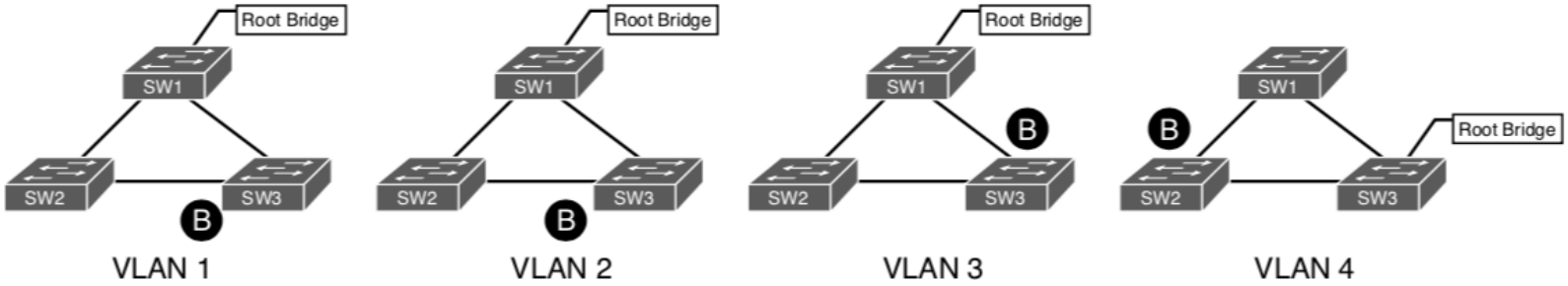

Figure 4-2 *Per-VLAN Spanning Tree (PVST) Topologies*

MST Topology

MST maps one or multiple VLANs into one STP tree, called an MST instance (MSTI). The figure shows how the switches maintain STP topologies for four VLANs. If more VLANs were added to the environment, the switches would maintain three STP topologies if the VLANs aligned to one of the existing MSTIs.

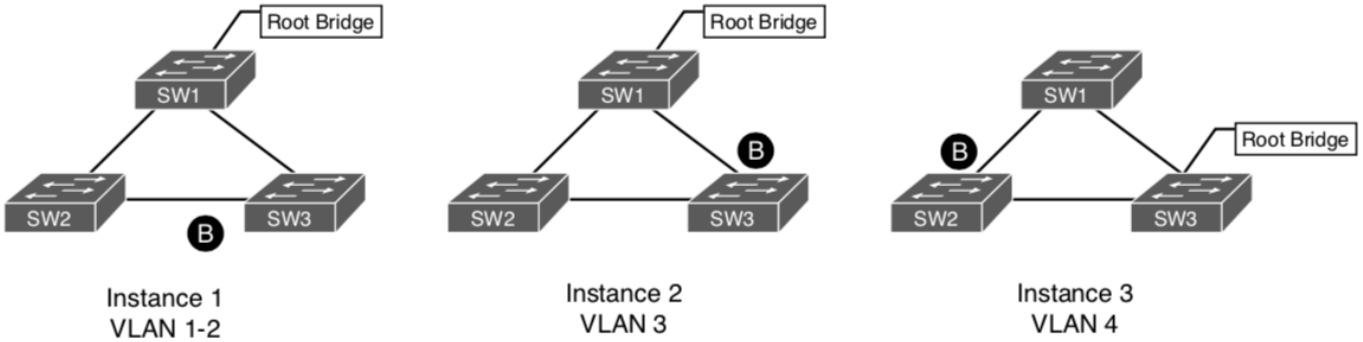

Figure 4-3 *MST Topologies*

MST Region

A group of MST switches with the same high-level configuration is known as an MST region. MST incorporates mechanisms that make an MST region appear as a single virtual switch to external switches.

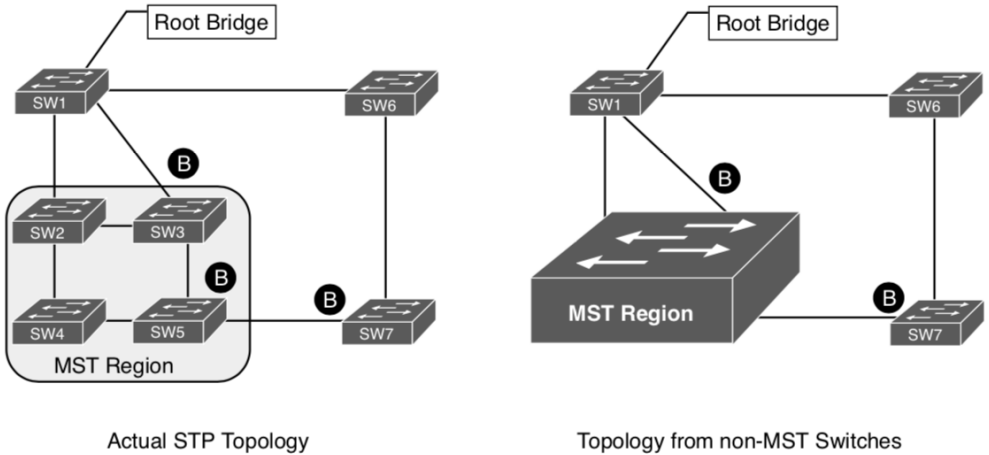

Figure 4-4 *Operating Functions Within an MST Region*

MST Instances

MST uses a special instance, instance 0, called the internal spanning tree (IST). It is always the first instance and runs on all switch port interfaces in the MST region regardless of the VLANs associated with the ports. Additional information about other MSTIs is nested in the IST BPDU that is transmitted throughout the MST region. This allows MST to advertise only one set of BPDUs, which minimizes STP traffic.

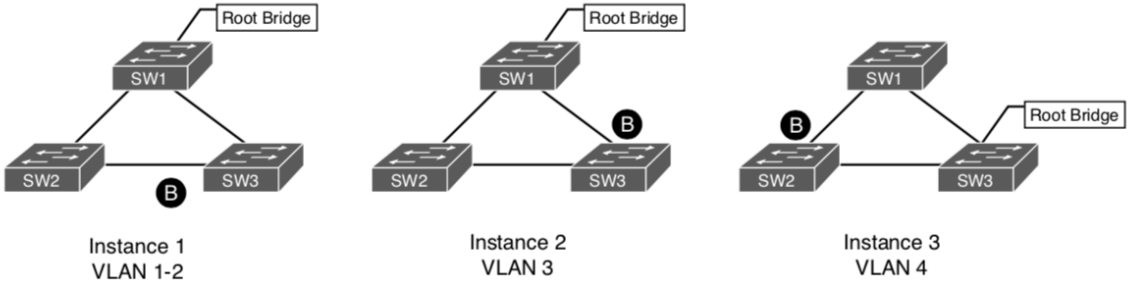

Figure 4-3 *MST Topologies*

Note: Up to 16 MST instances are supported by default.

MST Configuration

The following steps are used to configure MST:

Step 1. Define MST as the spanning tree protocol with the command **spanning-tree mode mst**

Step 2. (Optional) Define MST instance priority, using one of two methods:

- **spanning-tree mode mst** *instance-number* **priority** *priority*
- **spanning-tree mode mst** *instance-number* **root {primary | secondary} [diameter** *diameter***]**

(**Note**: Priority is a value between 0 and 61,440 in increments of 4096. The primary keyword sets the priority to 24,576 and the secondary keyword sets the priority to 28,672.)

Step 3. Associate VLANs to an MST instance. By default, all VLANs are associated to the MST 0 instance. The MST configuration sub-mode must be entered with the command **spanning-tree mst configuration**. Then the VLANs are assigned to a different MST instance with the command **instance** instance-number **vlan** vlan-id.

MST Configuration (Cont.)

Step 4. Specify the MST version number. The MST version number must match for all switches in the same MST region. The MST version number is configured with the sub-mode configuration command **revision** *version*.

Step 5. (Optional) Define the MST region name. MST regions are recognized by switches that share a common name. By default, a region name is an empty string. The MST region name is set with the command **name** *mst-region-name*.

Example 4-1 *Sample MST Configuration on SW1*

```
SW1(config)# spanning-tree mode mst
SW1(config)# spanning-tree mst 0 root primary
SW1(config)# spanning-tree mst 1 root primary
SW1(config)# spanning-tree mst 2 root primary
SW1(config)# spanning-tree mst configuration
SW1(config-mst)# name ENTERPRISE_CORE
SW1(config-mst)# revision 2
SW1(config-mst)# instance 1 vlan 10,20
SW1(config-mst)# instance 2 vlan 99
```

MST Verification

- To verify MST use the command **show spanning-tree mst configuration**.
- Relevant spanning tree information can be obtained with the command **show spanning- tree**.
- A consolidated view of the MST topology table is displayed with the command **show spanning-tree mst** [*instance-number*].
- Specific MST settings are viewed for a specific interface with the command **show spanning-tree mst interface** *interface-id.*

Example 4-2 *Verifying the MST Configuration*

```
SW2# show spanning-tree mst configuration
Name      [ENTERPRISE_CORE]
Revision  2     Instances configured 3

Instance  Vlans mapped
--------  ----------------------------------------------------------------------
0         1-9,11-19,21-98,100-4094
1         10,20
2         99
```

Example 4-4 *Granular View of MST Topology*

```
SW1# show spanning-tree mst
! Output omitted for brevity

##### MST0    vlans mapped:   1-9,11-19,21-98,100-4094
Bridge        address 0062.ec9d.c500  priority      0     (0 sysid 0)
Root          this switch for the CIST
Operational   hello time 2 , forward delay 15, max age 20, txholdcount 6
Configured    hello time 2 , forward delay 15, max age 20, max hops    20
```

Example 4-5 *Viewing Interface-Specific MST Settings*

```
SW2# show spanning-tree mst interface gigabitEthernet 1/0/1

GigabitEthernet1/0/1 of MST0 is root forwarding
Edge port: no            (default)        port guard : none        (default)
Link type: point-to-point (auto)          bpdu filter: disable     (default)
Boundary : internal                       bpdu guard : disable     (default)
Bpdus sent 17, received 217

Instance Role Sts Cost      Prio.Nbr Vlans mapped
-------- ---- --- --------- -------- --------------------------------
0        Root FWD 20000     128.1    1-9,11-19,21-98,100-4094
1        Root FWD 20000     128.1    10,20
2        Root FWD 20000     128.1    99
```

MST Tuning

MST supports the tuning of port cost and port priority.

The interface config command **spanning-tree mst** *instance-number* **cost** *cost* sets the interface cost.

Example 4-6 *Changing the MST Interface Cost*

```
SW3# show spanning-tree mst 0
! Output omitted for brevity
Interface                Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------
Gi1/0/1                  Root FWD 20000     128.1    P2p
Gi1/0/2                  Altn BLK 20000     128.2    P2p
Gi1/0/5                  Desg FWD 20000     128.5    P2p

SW3# configure term
Enter configuration commands, one per line. End with CNTL/Z.
SW3(config)# interface gi1/0/1
SW3(config-if)# spanning-tree mst 0 cost 1

SW3# show spanning-tree mst 0
! Output omitted for brevity
Interface                Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------
Gi1/0/1                  Root FWD 1         128.1    P2p
Gi1/0/2                  Desg FWD 20000     128.2    P2p
Gi1/0/5                  Desg FWD 20000     128.5    P2p
```

MST Tuning (Cont.)

The interface config command **spanning-tree mst** *instance-number* **port-priority** *priority* sets the interface priority.

Example 4-7 *Changing the MST Interface Priority*

```
SW4# show spanning-tree mst 0
! Output omitted for brevity
##### MST0    vlans mapped:   1-9,11-19,21-98,100-4094
Interface                Role Sts Cost      Prio.Nbr Type
---------------          ---- --- --------- -------- --------------------
Gi1/0/2                  Root FWD 20000     128.2    P2p
Gi1/0/5                  Desg FWD 20000     128.5    P2p
Gi1/0/6                  Desg FWD 20000     128.6    P2p

SW4# configure term
Enter configuration commands, one per line. End with CNTL/Z.
SW4(config)# interface gi1/0/5

##### MST0    vlans mapped:   1-9,11-19,21-98,100-4094
Interface                Role Sts Cost      Prio.Nbr Type
---------------          ---- --- --------- -------- --------------------
Gi1/0/2                  Root FWD 20000     128.2    P2p
Gi1/0/5                  Desg FWD 20000      64.5    P2p
Gi1/0/6                  Desg FWD 20000     128.6    P2p
```

Common MST Misconfigurations

There are two common misconfigurations within the MST region:

- VLAN assignment to the IST
- Trunk link pruning

VLAN Assignment to IST

- The IST topology may not correlate to the access layer and might introduce a blocking port that was not intentional.
- In the example, it appears as if traffic between PC-A and PC-B would flow across the Gi1/0/2 interface, as it is an access port assigned to VLAN 10. However, all interfaces belong to the IST instance.
- SW2 must block either Gi1/0/1 or Gi1/0/2. Since SW1 is the root bridge, SW2 blocks Gi1/0/2 based on the port identifier from SW1. Therefore, blocking the IST instance.
- There are two solutions for this scenario:
  - Move VLAN 10 to an MSTI instance other than the IST. If you do this, the switches will build a topology based on the links in use by that MSTI.
  - Allow the VLANs associated with the IST on all interswitch (trunk) links.

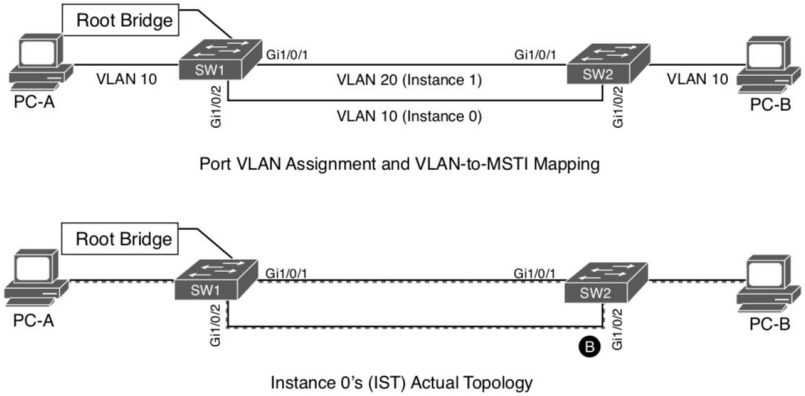

Figure 4-5 *Understanding the IST Topology*

Trunk Link Pruning

Pruning of VLANs on a trunk link is a common practice for load balancing. However, it is important that pruning of VLANs does not occur for VLANs in the same MST on different network links.

- Links between SW1 to SW2 and SW1 to SW3 have been pruned to help with load balancing traffic.
- After implementing the changes, users attached to SW1 and SW3 can no longer communicate with the servers on SW1.
- This is due to the VLANs on the trunk links changing but not the MSTI topology.

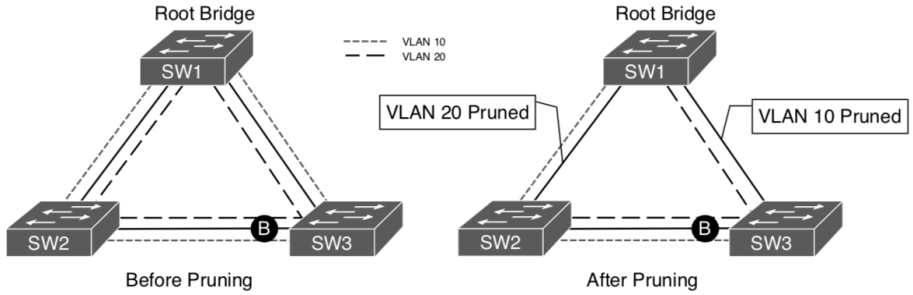

Figure 4-6 *Trunk Link Pruning*

A simple rule to follow is to only prune all the VLANs in the same MSTI for a trunk link.

MST Region Boundary

- An MST region boundary is any port that connects to a switch that is in a different MST region or that connects to 802.1D or 802.1W BPDUs.
- MSTI's never interact outside of the region and MST switches can detect PVST+ neighbors at MST region boundaries.
- Propagating CST at the MST region boundary involves a feature called PVST simulation mechanism. It sends out PVST+ & RSTP BPDUs, one for each VLAN.
- The PVST simulation mechanism is required because PVST+/RSTP topologies do not understand the structure of IST BPDUs.
- When the MST boundary receives the PVST+ BPDU it doesn't map the VLAN to the MSTI. Instead the MST boundary maps the PVST+ BPDU from VLAN 1 to the instance. It only does this when it receives a PVST BPDU on a port.

MST Region Design Considerations

There are two design considerations when integrating an MST region with a PVST+/RSTP environment:

- MST region as the root bridge
- MST region is not a root bridge for any VLAN

MST Region as the Root Bridge

The MST region as the root bridge ensures that all region boundary ports flood the same IST instance BPDU to all the VLANs in the PVST topology. This makes the IST instance preferred over any other switch in the PVST+ topology. The MST region appears as a single device and the PVST+ switches detect and place the alternative link into a blocking state.

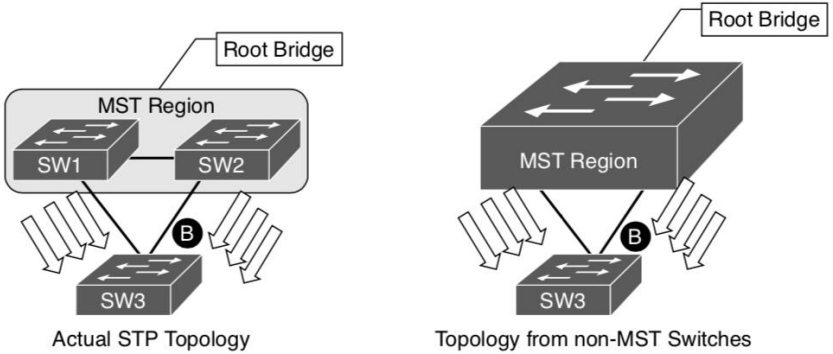

Figure 4-7 *MST Region as the Root*

MST Region Not a Root Bridge for Any VLAN

- In the situation that the MST region is not a root bridge for any VLAN, the MST region boundary ports can only block or forward for all VLANs.
- There is not an option to load balance traffic because the IST instance must remain constant.
- If the MST switch detects a better BPDU for a specific VLAN on a boundary port, the switch will use BPDU guard to block the port. This is called PVST simulation check and it done to ensure a loop-free topology.

Prepare for the Exam

Prepare for the Exam

Key Topics for Chapter 4

Description
Multiple Spanning Tree Protocol
MST instance
MST region
Internal Spanning Tree (IST)
MST region boundary

Key Terms for Chapter 4

Terms
Common Spanning Tree (CST)
Internal spanning tree (IST)
MST instance (MSTI)
MST region
MST region boundary
PVST simulation check

Prepare for the Exam

Command Reference for Chapter 4

Task	Command Syntax
Configure the switch for a basic MST region that includes all VLANS and the version number 1	**spanning-tree mode mst** **spanning-tree mst configuration** **instance** 0 **vlan** *1-4094* **revision 1**
Modify a switch's MSTI priority or make it the root bridge for the MSTI	**spanning-tree mst** *instance-number* **priority** *priority* OR **spanning-tree mst** *instance-number* **root** {**primary** | **secondary**}[**diameter** *diameter*]
Specify additional VLANs to an MSTI	**spanning-tree mst configuration instance** *instance-number* **vlan** *vlan-id*
Change the MST version number	**spanning-tree mst configuration revision** *version*
Change the port cost for a specific MSTI	**spanning-tree mst** *instance-number* **cost** *cost*
Change the port priority for a specific MSTI	**spanning-tree mst** *instance-number* **port- priority** *priority*
Display the MST configuration	**show spanning-tree mst configuration**
Verify the MST switch status	**show spanning-tree mst** [*instance-number*]
View the STP topology for the MST	**show spanning-tree mst interface** *interface-id*


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