AlliedWare Plus™ OS

How To | Configure interoperation between PVST+ and RSTP or MSTP

Introduction

Spanning trees that protect networks from loops can provide better traffic load balancing if traffic in different VLANs is sent over different spanning trees. Multiple Spanning Tree Protocol (MSTP), supported by Allied Telesis switches running AlliedWare Plus and AlliedWare, provides an IEEE standard protocol to serve this purpose. The proprietary Per-VLAN Spanning Tree Plus (PVST+) protocols serve this purpose on Cisco switches. The MSTP and PVST+ protocols can interoperate to provide network loop protection across networks that combine MSTP regions on Allied Telesis switches with PVST+ regions on Cisco switches.

This How To Note describes how RSTP and MSTP on Allied Telesis switches running AlliedWare Plus or AlliedWare interoperate with the proprietary PVST+ and rapid PVST+ protocols on Cisco switches, and provides configuration examples that demonstrate their compatibility.

List of terms:
STP
The Spanning Tree Protocol is an early standard for preventing network loops.
RSTP
The Rapid Spanning Tree Protocol recovers (converges to a new spanning tree) more quickly than STP after a network topology change. It is backwards-compatible with and STP.
MSTP
Multiple Spanning Tree Protocol: allows multiple spanning tree domains to be configured in a network and on a switch. It is based on RSTP, and is backwards-compatible with RSTP and STP.
PVST+
Per-VLAN Spanning Tree Plus is a Cisco proprietary spanning tree protocol based on STP.
Rapid PVST+
Rapid Per-VLAN Spanning Tree Plus is a Cisco proprietary spanning tree protocol, based on RSTP, which converges to a new spanning tree faster than PVST+.
SSTP
Shared Spanning Tree Protocol: the format of BPDUs used to communicate PVST+ and rapid PVST+ topology.

AlliedWare Plus™ OPERATING SYSTEM

Related How To Notes

You also may find the following How To Notes useful:

- AlliedWare Plus: *How To Configure Basic Switching Functionality* (Topics include RSTP and MSTP)
- AlliedWare: *How to configure Multiple Spanning Tree Protocol (MSTP)*

Which products and software version does it apply to?

This How To Note applies to the following Allied Telesis switches running operating system:

AlliedWare Plus software version 5.3.4 or later:

- SwitchBlade x8100
- SwitchBlade x908
- x600 Series (the examples use an x600)
- x610 Series
- x900-12 and x900-24 series

AlliedWare software version 2.9.1 or later:

- AT-8600 Series
- AT-8700 Series
- AT-8800 Series
- AT-8900 Series
- AT-9800 Series
- AT-9900 Series (the examples use an AT-9924T)
- AT-SB4000
- Rapier i Series
- Rapier w Series
- Rapier G6f
- x900-24 and x900-48 Series

AlliedWare software version 3.2.1 or later:

- AT-9924Ts

The examples described in this How To Note use Cisco 3750 switches. The same principles also apply to other Cisco switches supporting PVST+ and Rapid-PVST+.

Table of Contents

Overview of Spanning Trees

Allied Telesis switches running AlliedWare and AlliedWare Plus support IEEE standards-based spanning tree protocols for preventing network loops:

- **STP**
  The Spanning Tree Protocol (IEEE standard 802.1D) was the early standard for preventing network loops. STP is the default spanning tree protocol for Allied Telesis switches running AlliedWare.
- **RSTP**
  The Rapid Spanning Tree Protocol (IEEE standard 802.1w) is an enhancement of the original STP. It adds some optimizations that recover (converge to a new spanning tree) more quickly than STP after a network topology change. It is widely used and compatible with STP. RSTP is the default spanning tree protocol for Allied Telesis switches running AlliedWare Plus.
- **MSTP**
  The Multiple Spanning Tree Protocol (IEEE standard 802.1s and later merged into IEEE standard 802.1Q-2003) can be configured to support multiple independent instances of spanning trees overlaid on the same physical network. MSTP can interoperate with the earlier spanning trees (STP and RSTP) by dropping back to a compatibility mode on the links that connect to switches running the earlier spanning trees. MSTP maps one or more VLANs to each MST instance.

To communicate spanning tree topology between switches, these protocols send IEEE standard BPDUs to destination MAC address 01-80-C2-00-00-00. IEEE standard BPDUs are always untagged.

Cisco switches also use the proprietary spanning tree protocols PVST+ and rapid PVST+.

- **PVST+**
  Per-VLAN Spanning Tree Plus (PVST+) is a proprietary spanning tree protocol used by Cisco switches. Unlike IEEE standard spanning trees, PVST+ creates a separate spanning tree for each VLAN in the network. A VLAN trunk port may be forwarding for some VLANs, and blocking for other VLANs—the spanning tree topology for a VLAN may not follow the topology of the VLAN itself. PVST+ is the default spanning tree protocol on Cisco switches.
- **Rapid PVST+**
  Rapid PVST+ is Cisco's proprietary protocol based on IEEE standard 802.1w RSTP, and like RSTP, it converges more quickly than PVST+ to a new spanning tree after a topology change.

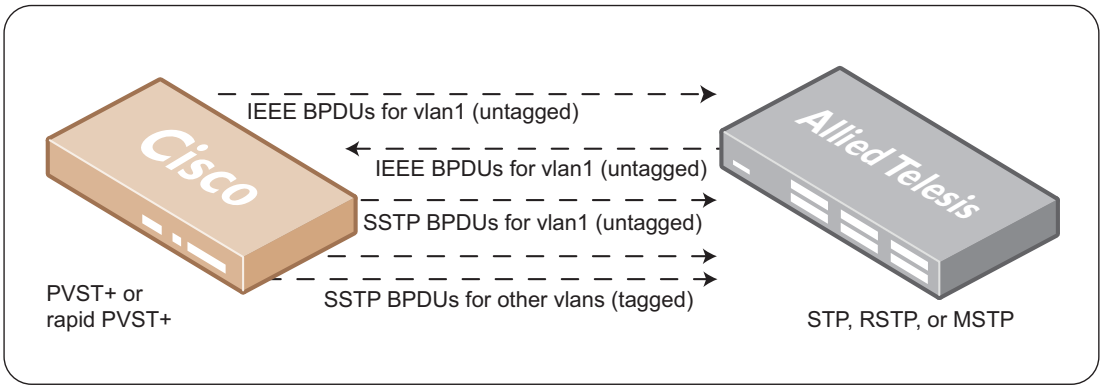
SSTP Cisco switches use special **Shared Spanning Tree Protocol (SSTP)** BPDUs to exchange PVST+ and rapid PVST+ spanning tree topology information. They transmit SSTP BPDUs to the Cisco **shared spanning tree MAC address** 01-00-0C-CC-CC-CD. These BPDUs have a format based on a proprietary enhancement of IEEE standard 802.1Q. On the native VLAN, these BPDUs are untagged. When a port is configured in trunk mode with multiple VLANs, then it transmits the SSTP BPDUs on that port tagged for those VLANs.

Interoperation between spanning tree protocols

There are two main aspects to the interoperation of IEEE standard MSTP (including RSTP and STP) with PVST+ (and rapid PVST+). The first involves forming a common spanning tree between switches and regions running MSTP and PVST+. The second involves tunnelling PVST+ spanning trees across MSTP regions.

When a Cisco switch configured with PVST+ receives IEEE standard RSTP BPDUs on a port (for instance from an Allied Telesis switch), it recognises them, and sends two versions of BPDUs on this port: **SSTP** format BPDUs and IEEE standard STP BPDUs. Similarly, a switch configured with rapid PVST+ recognises IEEE standard RSTP BPDUs, and on any port that receives RSTP BPDUs (such as one connected to an Allied Telesis switch), it sends two versions of BPDUs: SSTP format and IEEE standard RSTP format BPDUs.

Figure 1: SSTP and IEEE spanning tree BPDUs between PVST+ and MSTP switches



Common spanning tree

There are differences between the ways that MSTP and PVST+ map spanning tree instances to VLANs: we know that PVST+ creates a spanning tree instance for every VLAN, whereas MSTP maps one or more VLANs to each MST instance. At the point where a PVST+ region meets an MSTP region, the set of PVST+ instances does not generally match the set of MST instances. Therefore, the PVST+ region and the MSTP region need to communicate with each other on a single common spanning tree instance.

Interoperation between an MSTP region and a PVST+ region via the Common Spanning Tree is achieved as follows. For the MSTP region, the choice of which MSTP instance communicates to the PVST+ region is obvious—it is the CIST. For the PVST+ region, the choice is not so obvious, but Cisco switches use the vlan1 PVST+ instance as the common spanning tree. On the link between the PVST+ region and the MSTP region, the Cisco switch sends vlan1 BPDUs in IEEE standard format, so they can be interpreted by the peer switch in the MSTP region. Similarly, the Cisco switch processes the incoming MSTP BPDUs as though they were BPDUs for the vlan1 PVST+ instance.

If the ports via which the Cisco PVST+ switch connects to the MSTP switches are configured with a native VLAN (untagged), then the Cisco switches detect IEEE standard format BPDUs arriving from the peer switches, incorporate them into the common spanning tree that operates in the native VLAN (vlan1), and transmit untagged STP or RSTP packets to those peers, in addition to the SSTP format BPDUs.

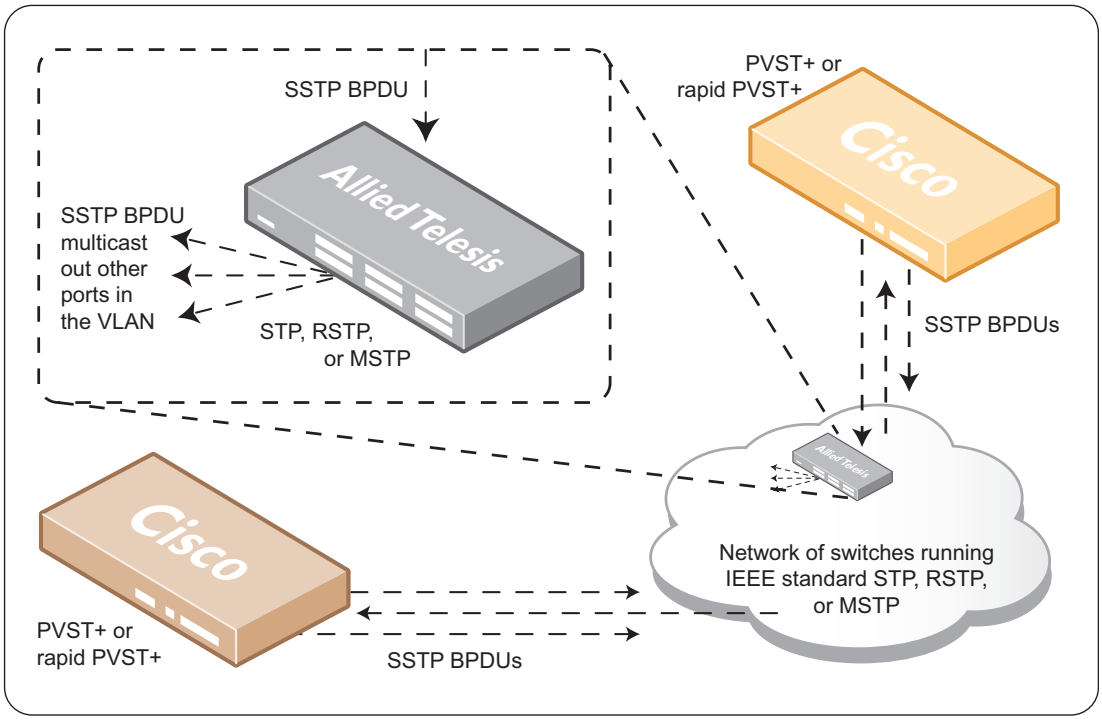
Tunnelling

In addition to the IEEE standard RSTP or STP BPDUs that the PVST+ switch sends on the link to the MSTP (or RSTP or STP) region, it also sends its usual SSTP format BPDUs for vlan1, untagged. When the MSTP switch receives these SSTP format BPDUs, it does not interpret them as standard BPDUs because they do not use the standard destination MAC address, so it makes no spanning tree decisions based on them. Instead, it multicasts them over all ports in the corresponding VLAN. These SSTP BPDUs may be multicast over the MSTP region to other PVST+ switches, which use them to maintain the vlan1 spanning tree topology across the MSTP (non-PVST+) switches.

The PVST+ switches also send SSTP format BPDUs for the other (non-vlan1) PVST+ instances into the MSTP region, tagged with the VID of their associated VLANs. These SSTP packets will also be multicast by the switches in the MSTP region, and so will reach any other PVST+ regions that may be connected to the MSTP region. In the case of these BPDUs, the switches in the PVST+ regions that receive them will recognise and process them as their normal PVST+ BPDUs. Thereby all the PVST+ instances are transparently expanded across the MSTP region, and their spanning trees span the MSTP region. As far as these spanning trees are concerned, the MSTP region is just treated as a single hub.

Figure 2 shows Shared Spanning Tree Protocol (SSTP) BPDUs tunnelled over a network of switches running IEEE standard spanning trees. Within the network, SSTP BPDUs are flooded to all ports in the corresponding VLANs.

Figure 2: SSTP BPDUs tunnelled over IEEE standard spanning tree network



Configuration To allow Cisco switches running rapid PVST+ or PVST+ to form a common spanning tree with Allied Telesis switches running RSTP, MSTP, or STP, vlan1 (the native VLAN) must be configured as untagged on the Cisco ports connected to the Allied Telesis switches.

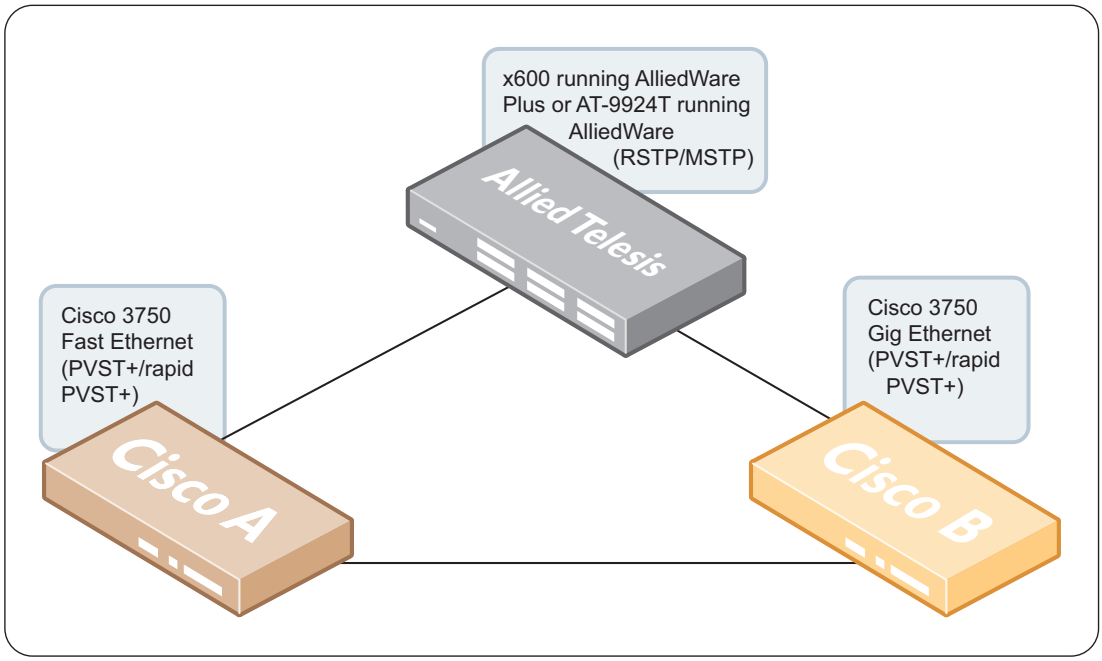
The examples in the rest of this How To Note demonstrate this interoperation.

Note: Although Cisco typically recommends not using vlan1 and not using the native VLAN that exists elsewhere on the switch, PVST+ interoperability requires using vlan1as the native VLAN on the link to the non-PVST+ switch, even though this goes against the usual recommendation.

Overview of Examples

The configuration examples in this How To Note demonstrate interoperation between various spanning tree configurations on Allied Telesis switches running AlliedWare Plus and AlliedWare, and PVST+ and rapid PVST+ on Cisco switches. In each example, an Allied Telesis switch and two Cisco switches are connected in a ring (Figure 3).

Figure 3: Network diagram overview



AlliedWare Plus and Cisco

- "AW+ Example A: PVST+ and RSTP—native VLAN only" on page 9

  RSTP is enabled on the x600 and the Cisco switches have PVST+ configured. Only the native VLAN is configured on all the ports in the ring.

- "AW+ Example B: Rapid PVST+ and RSTP—native VLAN only" on page 15

  RSTP is enabled on the x600 and the Cisco switches have rapid PVST+ configured. Only the native VLAN is configured on all the ports in the ring.

- "AW+ Example C: Rapid PVST+ and RSTP—trunked VLANs" on page 20

  RSTP is enabled on the x600, and the Cisco switches have rapid-PVST+ configured. All the ports in the ring are configured with a native VLAN and multiple trunked VLANs.

- "AW+ Example D: Rapid-PVST+ and MSTP—trunked VLANS" on page 32

  Multiple MSTP instances are configured on the x600, and the Cisco switches are configured for rapid PVST+. All the ports in the ring are configured with a native VLAN and multiple trunked VLANs.

AlliedWare and Cisco

- "AW Example E: Rapid PVST+ and RSTP—untagged VLAN only" on page 45

  RSTP is enabled on the AT-9924T and the Cisco switches have rapid PVST+ configured. Only the native (untagged) VLAN is configured on all the ports in the ring.

- "AW Example F: Rapid PVST+ and RSTP—tagged VLANs" on page 50

  RSTP is enabled on the AT-9924T and the Cisco switches have rapid-PVST+ configured. The ports in the ring are configured as VLAN trunk ports, with a native (untagged) VLAN and multiple tagged VLANs on each port.

- "AW Example G: Rapid PVST+ and MSTP— tagged VLANs" on page 64

  The AT-9924T is configured with multiple MSTP instances and the Cisco switches are configured for rapid PVST+. The ports in the ring are configured as VLAN trunk ports, with a native VLAN and multiple tagged VLANs on each port.

Summary of spanning tree interoperation

In each of the examples, the Allied Telesis switches and the Cisco switches form a spanning tree together on the native VLAN (vlan1). In the examples with trunked ports, the Cisco switches also form per-VLAN spanning trees with each other, with the Allied Telesis switch acting as a pass-through node in the ring. Because of the difference between PVST+, based on STP (IEEE 802.1D), and rapid PVST+, based on RSTP (IEEE 802.1w), the port states in the common spanning tree follow the conventions of the different IEEE standards.

The spanning tree interoperability demonstrated in these examples also applies to other x600 Series switches, Allied Telesis x900 Series and SwitchBlade x908 switches running AlliedWare plus, Allied Telesis switches running AlliedWare, and other Cisco switches supporting PVST+ and rapid-PVST+.

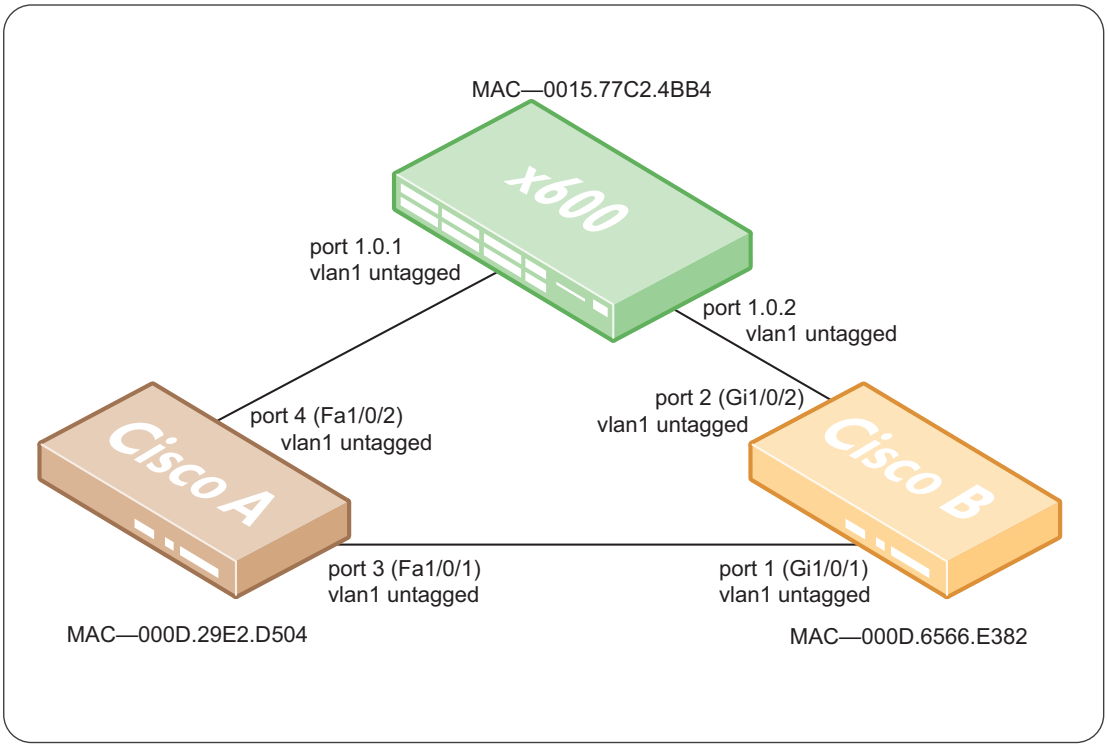
AW+ Example A: PVST+ and RSTP—native VLAN only

This example shows interoperation between an Allied Telesis switch running AlliedWare Plus with RSTP and Cisco switches running PVST+ over the default VLAN.

Configuration

The three switches are all connected via the default VLAN (vlan1), so no other VLAN configuration is required. The x600 has RSTP enabled by default, so no spanning tree configuration is needed. On both the Cisco-A and Cisco-B switches, the spanning tree mode is set to PVST+ (default).

Figure 4: Example A network configuration



x600 configuration

```
! No change to default spanning tree or VLAN configuration.
```

Cisco-A configuration

```
! No change to default spanning tree or VLAN configuration.
spanning-tree mode pvst
```

Cisco-B configuration

```
! No change to default spanning tree or VLAN configuration.
spanning-tree mode pvst
```

Results

In the output from the x600 (Figure 6), we can see that:

- Since the Cisco switches have been configured to use PVST+, the links between the Allied Telesis x600 switch and the Cisco switches reverted to exchanging STP BPDUs.
- The x600 is the root bridge for the spanning tree.

The output from the Cisco-A and Cisco-B switches shows that:

- Cisco-A (Figure 9) and Cisco-B (Figure 12) recognise that they received BPDUs from the x600.
- Cisco-A (Figure 8) and Cisco-B (Figure 11) agree that the x600 switch is the root bridge for the spanning tree.
- Cisco-A port 3 (interface Fa1/0/1), connecting it to Cisco-B, is blocking (Figure 8). This link is considered by the Cisco switches to be part of a common spanning tree with the x600 switch.
- Both Cisco-A (Figure 8) and Cisco-B (Figure 11) are configured to run PVST+, which is based on STP and sends messages which conform to IEEE standard 802.1D for STP:
  ```
  ... Spanning tree enabled protocol ieee ...
  ```
  Note that this output does not specifically indicate that the Cisco switch is using IEEE STP to interoperate with the Allied Telesis switch; it displays this string when it is configured to run PVST+ even if no Allied Telesis switch is connected to it. In later examples, when the spanning tree mode is set to rapid PVST+ (based on IEEE standard 802.1w for RSTP), the string displayed (e.g. Figure 16) is:
  ```
  ... Spanning tree enabled protocol rstp ...
  ```

Figure 5: Example A spanning tree topology

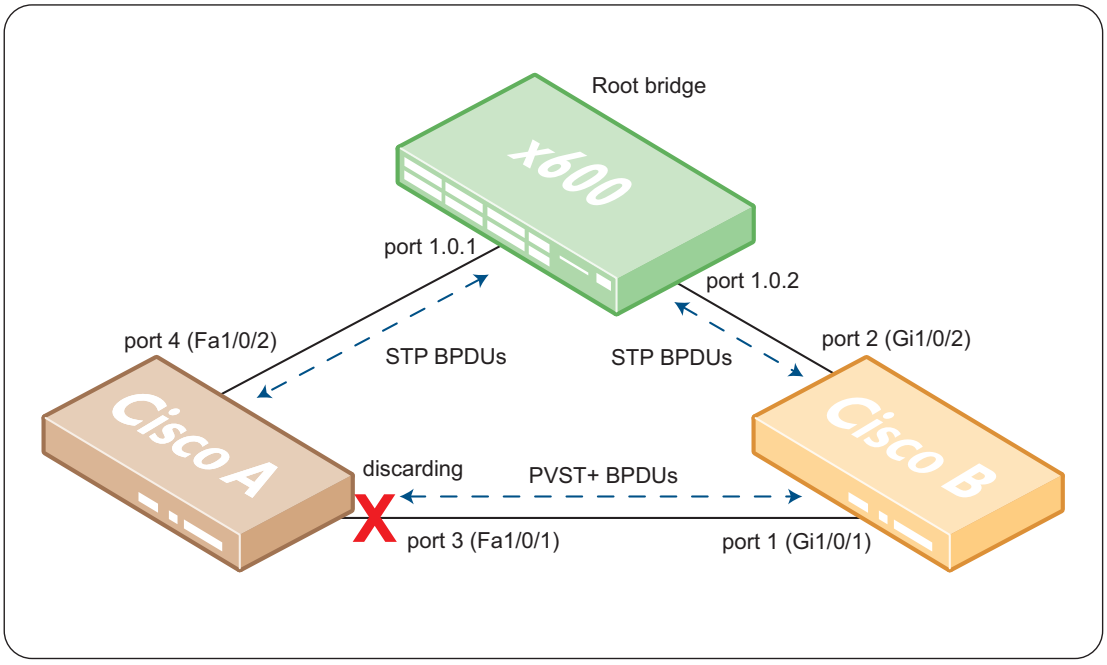


Figure 6: x600—output from the **show spanning-tree** command

```
awplus#sh spanning-tree
% Default: Bridge up - Spanning Tree Enabled
% Default: Root Path Cost 0 - Root Port 0 -  Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20
% Default: Root Id 8000001577c24bb4                          ← x600 sees itself as the root bridge.
% Default: Bridge Id 8000001577c24bb4
% Default: 4 topology change(s)  - last topology change Wed Sep  1 05:17:06 2010

% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec

%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Designated - State Forwarding
%   port1.0.1: Designated Path Cost 0
%   port1.0.1: Configured Path Cost 200000  - Add type Explicit ref count 1
%   port1.0.1: Designated Port Id 8389 - Priority 128  -
%   port1.0.1: Root 8000001577c24bb4                            ← x600 is the root bridge.
%   port1.0.1: Designated Bridge 8000001577c24bb4
%   port1.0.1: Message Age 0 - Max Age 20
%   port1.0.1: Hello Time 2 - Forward Delay 15
%   port1.0.1: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 1 - topo change timer 0
%   port1.0.1: forward-transitions 1
%   port1.0.1: Version Rapid Spanning Tree Protocol - Received STP - Send STP
                        This port received an STP BPDU, and so will send STP BPDUs. ↑
%   port1.0.1: No portfast configured - Current  portfast off
%   port1.0.1: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.1: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.1: no root guard configured - Current root guard off
%   port1.0.1: Configured Link Type point-to-point - Current point-to-point
%

%   port1.0.2: Ifindex 906 - Port Id 838a - Role Designated - State Forwarding
%   port1.0.2: Designated Path Cost 0
%   port1.0.2: Configured Path Cost 20000  - Add type Explicit ref count 1
%   port1.0.2: Designated Port Id 838a - Priority 128  -
%   port1.0.2: Root 8000001577c24bb4                            ← x600 switch is the root bridge.
%   port1.0.2: Designated Bridge 8000001577c24bb4
%   port1.0.2: Message Age 0 - Max Age 20
%   port1.0.2: Hello Time 2 - Forward Delay 15
%   port1.0.2: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 1 - topo change timer 0
%   port1.0.2: forward-transitions 1
%   port1.0.2: Version Rapid Spanning Tree Protocol - Received STP - Send STP
                        This port received an STP BPDU, and so will send STP BPDUs. ↑
%   port1.0.2: No portfast configured - Current  portfast off
%   port1.0.2: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.2: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.2: no root guard configured - Current root guard off
%   port1.0.2: Configured Link Type point-to-point - Current point-to-point
```

Figure 7: Cisco-A—output from the **show spanning-tree summary** command

```
Switch#sh spanning-tree summary
Switch is in pvst mode                          ← Cisco-A is running PVST+.
Root bridge for: none                           ← Cisco-A is not a root
Extended system ID           is enabled           bridge for any VLAN.
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      1         0        0          1          2
---------------------- -------- --------- -------- ---------- ----------
1 vlan                        1         0        0          1          2
                                ↑ One port is blocking; one port is forwarding.
```

Figure 8: Cisco-A—output from the **show spanning-tree** command

```
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32768
              Address     0015.77c2.4bb4          ← Cisco-A agrees that
              Cost        19                        x600 is the root bridge.
              Port        4 (FastEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     000d.29e2.d500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Altn BLK 19        128.3    P2p
Fa1/0/2             Root FWD 19        128.4    P2p   ← Port connected to
                                                       Cisco-B is blocking.
```

Figure 9: Cisco-A—output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail

 VLAN0001 is executing the ieee compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15
  Current root has priority 32768, address 0015.77c2.4bb4
                    Cisco-A agrees that x600 is the root bridge.↑
  Root port is 4 (FastEthernet1/0/2), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 2 last change occurred 1d00h ago
      from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
      hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0001 is alternate blocking
                    Port connected to Cisco-B is blocking. ↑
    Port path cost 19, Port priority 128, Port Identifier 128.3.
    Designated root has priority 32768, address 0015.77c2.4bb4
    Designated bridge has priority 32769, address 000d.6566.e380
    Designated port id is 128.1, designated path cost 4
    Timers: message age 3, forward delay 0, hold 0
    Number of transitions to forwarding state: 1
    Link type is point-to-point by default
    BPDU: sent 52, received 43470

 Port 4 (FastEthernet1/0/2) of VLAN0001 is root forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.4.
    Designated root has priority 32768, address 0015.77c2.4bb4
    Designated bridge has priority 32768, address 0015.77c2.4bb4
    Designated port id is 128.905, designated path cost 0
    Timers: message age 2, forward delay 0, hold 0
    Number of transitions to forwarding state: 1
    BPDU: sent 19, received 43411
                    ← Cisco-A is receiving BPDUs from x600.
```

Figure 10: Cisco-B—output from the **show spanning-tree summary** command

```
Switch#sh spanning-tree summary

Switch is in pvst mode
Root bridge for: none                    ← Cisco-B is not a root
Extended system ID           is enabled    bridge for any VLAN.
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                     0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
1 vlan                       0         0        0          2          2
                                  Both ports are forwarding. ↑
```

Figure 11: Cisco-B—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32768
              Address     0015.77c2.4bb4
              Cost        4
              Port        2 (GigabitEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     000d.6566.e380
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Desg FWD 19        128.1    P2p
Gi1/0/2             Root FWD 4         128.2    P2p
```

← Cisco-B agrees that x600 is the root bridge.

← Both ports are forwarding.

Figure 12: Cisco-B—output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail

 VLAN0001 is executing the ieee compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15
  Current root has priority 32768, address 0015.77c2.4bb4
```

↑ Cisco-B agrees that x600 is the root bridge.

```
  Root port is 2 (GigabitEthernet1/0/2), cost of root path is 4
  Topology change flag not set, detected flag not set
  Number of topology changes 5 last change occurred 1d00h ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 32768, address 0015.77c2.4bb4
   Designated bridge has priority 32769, address 000d.6566.e380
   Designated port id is 128.1, designated path cost 4
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 43642, received 51

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is root forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 32768, address 0015.77c2.4bb4
   Designated bridge has priority 32768, address 0015.77c2.4bb4
   Designated port id is 128.906, designated path cost 0
   Timers: message age 1, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 7, received 43590
```

← Cisco-B is receiving BPDUs from x600.

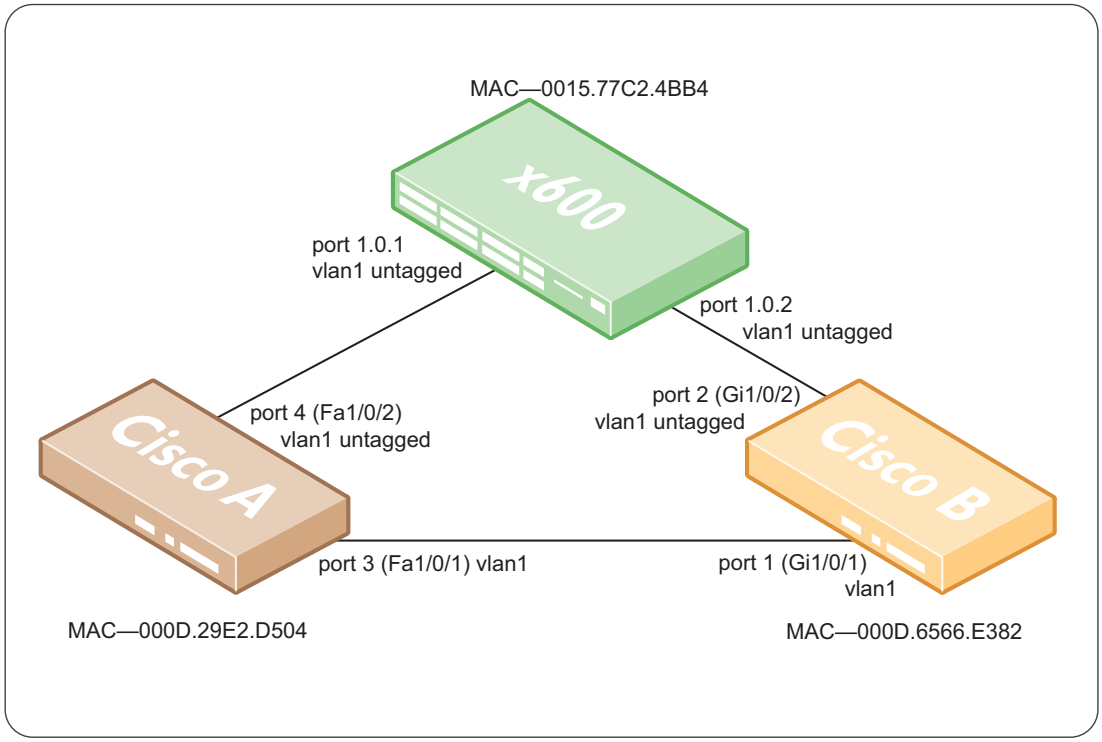
AW+ Example B: Rapid PVST+ and RSTP—native VLAN only

In this example, we have changed the configuration on both the Cisco switches to use rapid PVST+. As in the previous example, RSTP is enabled on the x600, and only the default native VLAN is configured on all the ports in the ring. For a similar example using AlliedWare, see "AW Example E: Rapid PVST+ and RSTP—untagged VLAN only" on page 45.

Configuration

As in the previous example, the three switches are all connected via the default VLAN (vlan1). On the x600, RSTP is enabled by default; on both the Cisco-A and Cisco-B switches, the spanning tree mode is set to rapid PVST+.

Figure 13: Example B network configuration



x600 configuration

```
! No change to default spanning tree or VLAN configuration.
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
```

Results

In the output from the x600 (Figure 15), we can see that:

- The x600 switch sees itself as the root bridge.
- The x600 switch is receiving RSTP BPDUs.

The output from Cisco-A and Cisco-B shows that:

- Once again, they both agree that the x600 is the root bridge for this spanning tree instance (Figure 16, Figure 18).
- Once again, Cisco-A's port 3 (Fa1/0/1) is discarding (blocking) in this spanning tree instance (Figure 16).
- Rapid PVST+ running on these switches is based on RSTP (Figure 16, Figure 18).

Figure 14: Example B spanning tree topology

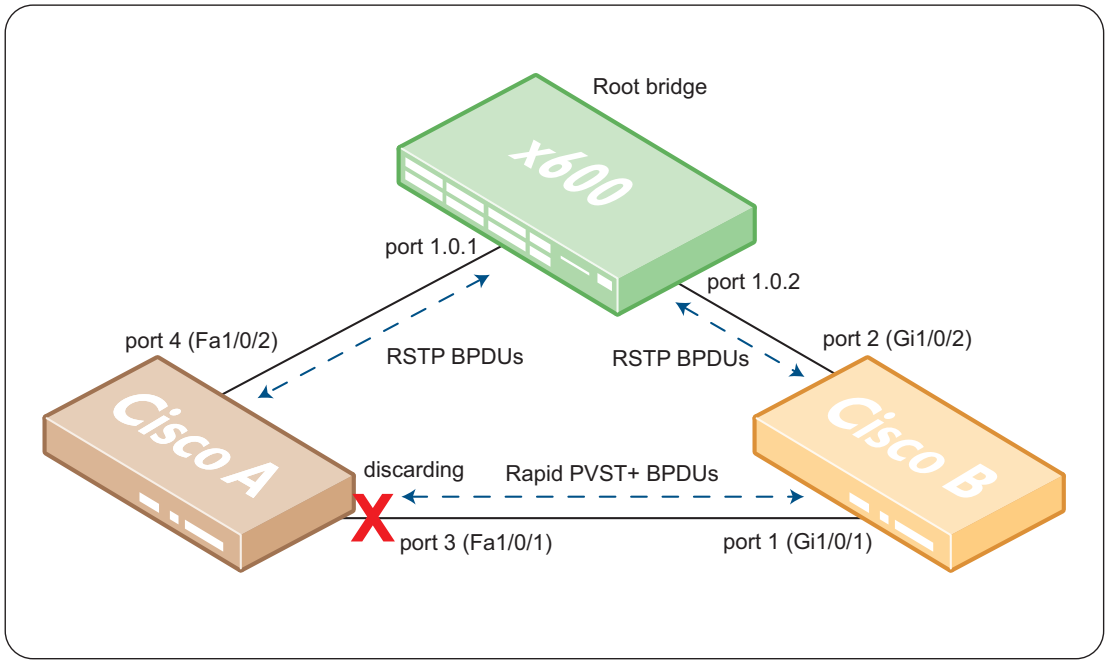


Figure 15: x600—output from the **show spanning-tree** command

```
awplus#sh spanning-tree
% Default: Bridge up - Spanning Tree Enabled
% Default: Root Path Cost 0 - Root Port 0 -  Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20
% Default: Root Id 8000001577c24bb4                    ← x600 sees itself as the root bridge.
% Default: Bridge Id 8000001577c24bb4
% Default: 28 topology change(s)  - last topology change Tue Aug 10 20:18:35 2010
% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec
%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Designated - State Forwarding
                                        Port connected to Cisco-A is forwarding. ↑
%   port1.0.1: Designated Path Cost 0
%   port1.0.1: Configured Path Cost 20000  - Add type Explicit ref count 1
%   port1.0.1: Designated Port Id 8389 - Priority 128  -
%   port1.0.1: Root 8000001577c24bb4
%   port1.0.1: Designated Bridge 8000001577c24bb4
%   port1.0.1: Message Age 0 - Max Age 20
%   port1.0.1: Hello Time 2 - Forward Delay 15
%   port1.0.1: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 1 - topo change timer 0
%   port1.0.1: forward-transitions 1
%   port1.0.1: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
        Port connected to Cisco-A is now receiving RSTP BPDUs, so will send RSTP BPDUs. ↑
%   port1.0.1: No portfast configured - Current  portfast off
%   port1.0.1: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.1: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.1: no root guard configured - Current root guard off
%   port1.0.1: Configured Link Type point-to-point - Current point-to-point
%

%   port1.0.2: Ifindex 906 - Port Id 838a - Role Designated - State Forwarding
                                        Port connected to Cisco-B is forwarding. ↑
%   port1.0.2: Designated Path Cost 0
%   port1.0.2: Configured Path Cost 200000  - Add type Explicit ref count 1
%   port1.0.2: Designated Port Id 838a - Priority 128  -
%   port1.0.2: Root 8000001577c24bb4
%   port1.0.2: Designated Bridge 8000001577c24bb4
%   port1.0.2: Message Age 0 - Max Age 20
%   port1.0.2: Hello Time 2 - Forward Delay 15
%   port1.0.2: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 0 - topo change timer 0
%   port1.0.2: forward-transitions 1
%   port1.0.2: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
                        This port is now receiving RSTP BPDUs, so will send RSTP BPDUs. ↑
%   port1.0.2: No portfast configured - Current  portfast off
%   port1.0.2: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.2: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.2: no root guard configured - Current root guard off
%   port1.0.2: Configured Link Type point-to-point - Current point-to-point
```

Figure 16: Cisco-A—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32768
              Address     0015.77c2.4bb4
              Cost        19
              Port        4 (FastEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     000d.29e2.d500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Altn BLK 19        128.3    P2p
Fa1/0/2             Root FWD 19        128.4    P2p
```

← Rapid PVST is based on RSTP.

← Cisco-A agrees that x600 is the root bridge.

← Port connected to Cisco-B is blocking.

Figure 17: Cisco-A—output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32768, address 0015.77c2.4bb4
  Root port is 4 (FastEthernet1/0/2), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 4 last change occurred 00:21:23 ago
          from FastEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0001 is alternate blocking
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 32768, address 0015.77c2.4bb4
   Designated bridge has priority 32769, address 000d.6566.e380
   Designated port id is 128.1, designated path cost 4
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 0
   Link type is point-to-point by default
   BPDU: sent 1, received 654

 Port 4 (FastEthernet1/0/2) of VLAN0001 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 32768, address 0015.77c2.4bb4
   Designated bridge has priority 32768, address 0015.77c2.4bb4
   Designated port id is 128.906, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 7, received 34138
```

← x600 is the root bridge.

← Port connected to Cisco-B is blocking.

← Cisco-A is receiving BPDUs from x600.

Figure 18: Cisco-B—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp                    ← Rapid PVST is based on RSTP.
  Root ID     Priority    32768
              Address     0015.77c2.4bb4                 ← Cisco-B agrees that
              Cost        4                                x600 is the root bridge.
              Port        2 (GigabitEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     000d.6566.e380
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Desg FWD 19        128.1    P2p
Gi1/0/2             Root FWD 4         128.2    P2p        ← Both ports are
                                                             forwarding.
```

Figure 19: Cisco-B—output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32768, address 0015.77c2.4bb4
  Root port is 2 (GigabitEthernet1/0/2), cost of root path is 4
  Topology change flag not set, detected flag not set
  Number of topology changes 3 last change occurred 01:08:33 ago
          from GigabitEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0001 is designated forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.1.
    Designated root has priority 32768, address 0015.77c2.4bb4
    Designated bridge has priority 32769, address 000d.6566.e380
    Designated port id is 128.1, designated path cost 4
    Timers: message age 0, forward delay 0, hold 0
    Number of transitions to forwarding state: 2
    Link type is point-to-point by default
    BPDU: sent 2064, received 2

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is root forwarding
    Port path cost 4, Port priority 128, Port Identifier 128.2.
    Designated root has priority 32768, address 0015.77c2.4bb4
    Designated bridge has priority 32768, address 0015.77c2.4bb4
    Designated port id is 128.905, designated path cost 0
    Timers: message age 16, forward delay 0, hold 0
    Number of transitions to forwarding state: 1
    Link type is point-to-point by default
    BPDU: sent 8, received 2071
                                                  ← Cisco-B is receiving BPDUs from x600.
```

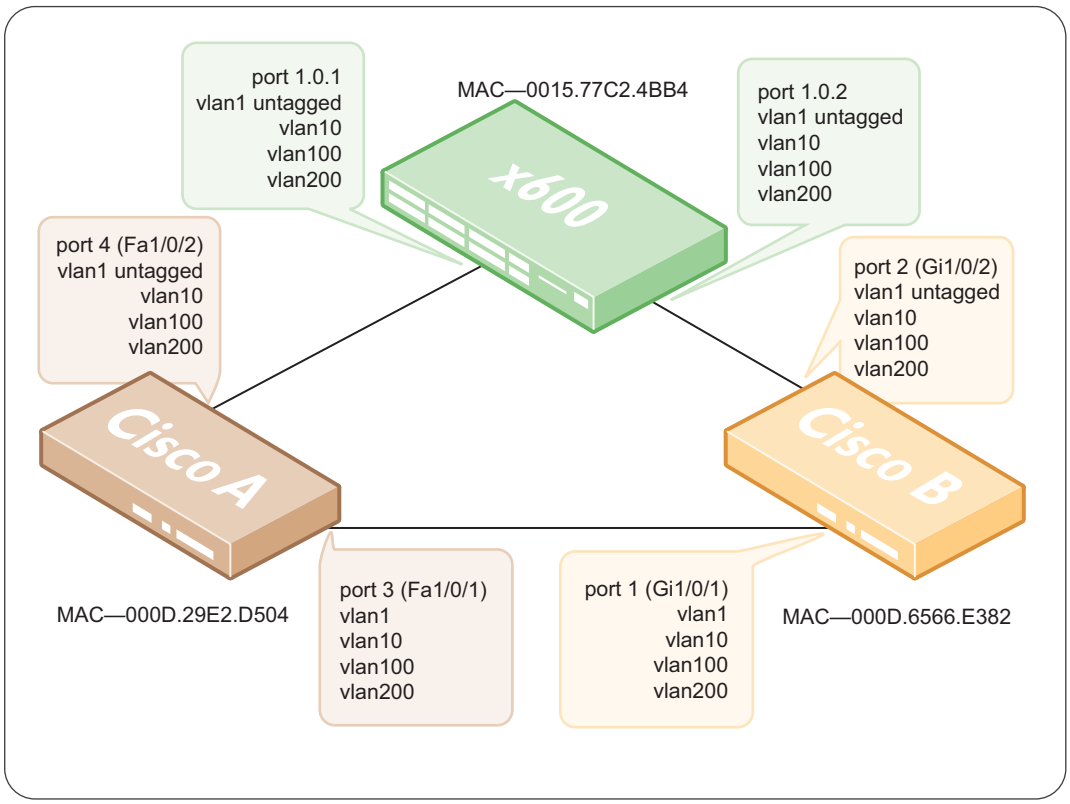
AW+ Example C: Rapid PVST+ and RSTP—trunked VLANs

This example demonstrates compatibility between RSTP on an AlliedWare Plus switch and rapid PVST+ on the Cisco switches over trunk ports (ports with tagged VLANs). For a similar example using AlliedWare, see "AW Example F: Rapid PVST+ and RSTP—tagged VLANs" on page 50.

Configuration

Three VLANs are configured on each switch in the network, in addition to the default native vlan1. The x600 has RSTP enabled by default, and both the Cisco switches have rapid PVST+ configured. The priority values on Cisco-A and Cisco-B are modified so that they each become root bridges for some of their per-VLAN spanning trees, with Cisco-A becoming the root bridge for vlan1.

Figure 20: Example C network configuration



x600 configuration

```
spanning-tree mode rstp
!
vlan database
 vlan 10 name vlan10
 vlan 100 name vlan100
 vlan 200 name vlan200
 vlan 10,100,200 state enable
!
interface port1.0.1-1.0.2
 switchport mode trunk
 switchport trunk allowed vlan add 10,100,200
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 4096
spanning-tree vlan 10 priority 61440
!
vlan 10,100,200
!
interface FastEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface FastEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1,10 priority 4096
!
vlan 10,100,200
!
interface GigabitEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface GigabitEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Results

The output from the x600 (Figure 22) shows that in this example:

- Both the ring ports on x600 are now transmitting and receiving RSTP BPDUs.
- x600 sees Cisco-A as the root bridge. (It does not distinguish spanning trees by VLAN.)
- As the identity of the root bridge has changed, the location of the blocking port in the ring has also changed—port1.0.1 on the x600 is now discarding (blocking). This blocks traffic for all VLANs.

The output from Cisco-A and Cisco-B shows that, unlike in the previous examples:

- Cisco-A is the root bridge for vlan1, vlan100, and vlan200 (Figure 23, Figure 24, Figure 25).
- Cisco-B is the root bridge for vlan10 (Figure 23, Figure 24, Figure 25).
- Both the ring ports on Cisco-A are in the forwarding state (Figure 23, Figure 24).
- Both the ring ports on Cisco-B are in the forwarding state (Figure 25, Figure 26).

Figure 21: Example C spanning tree topology

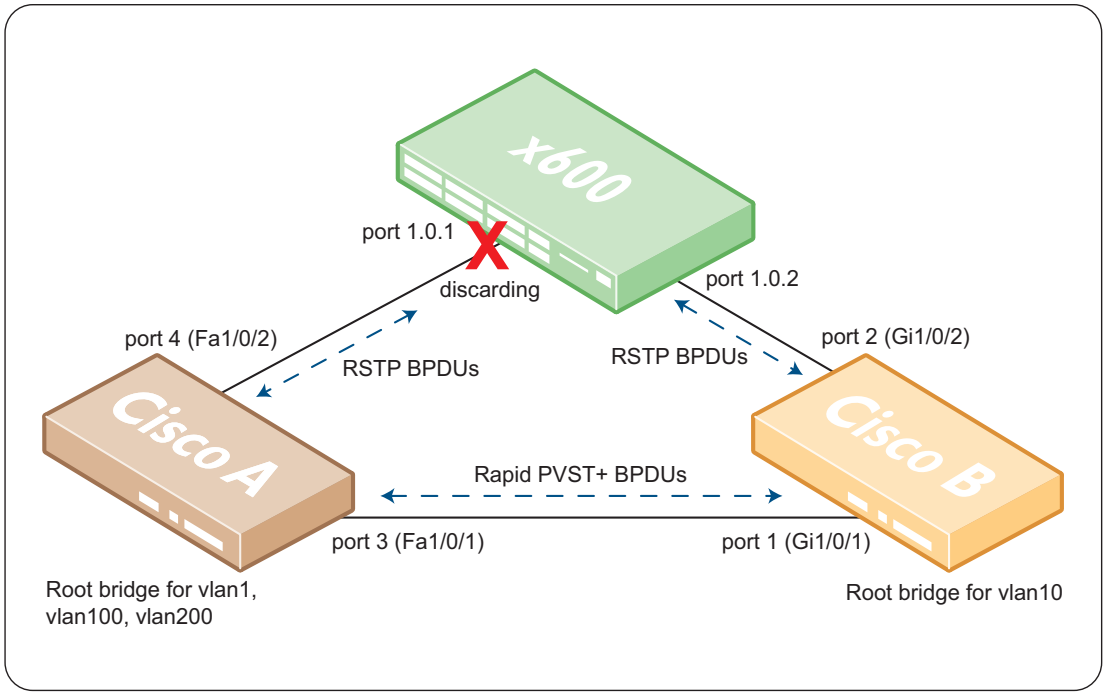


Figure 22: x600—output from the **show spanning-tree** command

```
awplus#sh spanning-tree
% Default: Bridge up - Spanning Tree Enabled
% Default: Root Path Cost 20019 - Root Port 5002 -  Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20
% Default: Root Id 1001000d29e2d500                    ← x600 sees Cisco-A as the root bridge.
% Default: Bridge Id 8000001577c24bb4
% Default: 7 topology change(s)  - last topology change Thu Sep 23 05:31:30 2010

% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec
%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Alternate - State Discarding
                                  ↑Port connected to Cisco-A is blocking for all VLANs.
%   port1.0.1: Designated Path Cost 0
%   port1.0.1: Configured Path Cost 200000  - Add type Explicit ref count 1
%   port1.0.1: Designated Port Id 8003 - Priority 128  -
%   port1.0.1: Root 1001000d29e2d500                  ← Cisco-A is the root bridge.
%   port1.0.1: Designated Bridge 1001000d29e2d500
%   port1.0.1: Message Age 0 - Max Age 20
%   port1.0.1: Hello Time 2 - Forward Delay 15
%   port1.0.1: Forward Timer 0 - Msg Age Timer 4 - Hello Timer 1 - topo change timer 0
%   port1.0.1: forward-transitions 0
%   port1.0.1: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
                          This port is receiving RSTP BPDUs, so will send RSTP BPDUs. ↑
%   port1.0.1: No portfast configured - Current  portfast off
%   port1.0.1: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.1: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.1: no root guard configured - Current root guard off
%   port1.0.1: Configured Link Type point-to-point - Current point-to-point
%

%   port1.0.2: Ifindex 906 - Port Id 838a - Role Rootport - State Forwarding
                          The port connected to Cisco-B is forwarding for all VLANs. ↑
%   port1.0.2: Designated Path Cost 19
%   port1.0.2: Configured Path Cost 20000  - Add type Explicit ref count 1
%   port1.0.2: Designated Port Id 8002 - Priority 128  -
%   port1.0.2: Root 1001000d29e2d500                  ← Cisco-A is the root bridge.
%   port1.0.2: Designated Bridge 1001000d6566e380
%   port1.0.2: Message Age 1 - Max Age 20
%   port1.0.2: Hello Time 2 - Forward Delay 15
%   port1.0.2: Forward Timer 0 - Msg Age Timer 5 - Hello Timer 1 - topo change timer 0
%   port1.0.2: forward-transitions 1
%   port1.0.2: Version Rapid Spanning Tree Protocol - Received RSTP - Send RSTP
                          This port is receiving RSTP BPDUs, so will send RSTP BPDUs. ↑
%   port1.0.2: No portfast configured - Current  portfast off
%   port1.0.2: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.2: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.2: no root guard configured - Current root guard off
%   port1.0.2: Configured Link Type point-to-point - Current point-to-point
```

Figure 23: Cisco-A—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    4097
              Address     000d.29e2.d500
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    4097   (priority 4096 sys-id-ext 1)
             Address     000d.29e2.d500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- ------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p

VLAN0010
  Spanning tree enabled protocol rstp
  Root ID     Priority    4106
              Address     000d.6566.e380
              Cost        19
              Port        4 (FastEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec  Bridge ID  Priority    61450  (priority 61440 sys-
id-ext 10)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- ------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Root FWD 19        128.4    P2p

VLAN0100
  Spanning tree enabled protocol rstp
  Root ID     Priority    32868
              Address     000d.29e2.d500
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32868  (priority 32768 sys-id-ext 100)
             Address     000d.29e2.d500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- ------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p
```

← Cisco-A is the root bridge for vlan1.

↑ Both ports on Cisco-A are forwarding for vlan1.

← Cisco-B is the root bridge for vlan10.

↑ Both ports on Cisco-A are forwarding for vlan10.

← Cisco-A is the root bridge for vlan100.

↑ Both ports on Cisco-A are forwarding for vlan100.

Figure 23: Cisco-A—output from the **show spanning-tree** command (continued)

```
VLAN0200
  Spanning tree enabled protocol rstp
  Root ID     Priority    32968
              Address     000d.29e2.d500
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec
Forward Delay 15 sec

  Bridge ID  Priority    32968  (priority 32768 sys-id-ext 200)
             Address     000d.29e2.d500
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p
```

← Cisco-A is the root bridge for vlan200.

↑ Both ports on Cisco-A are forwarding for vlan200.

Figure 24: Cisco-A—output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 15 last change occurred 01:33:15 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 2795, received 16

Port 4 (FastEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 4097, address 000d.29e2.d500

   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 78324, received 22
```

← Cisco-A sees itself as root bridge for vlan1.

← Cisco-A is root bridge for vlan1.

← Cisco-A is root bridge for vlan1.

Figure 24: Cisco-A—output from the **show spanning-tree detail** command (continued)

```
VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 61440, sysid 10, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 4106, address 000d.6566.e380
  Root port is 4 (FastEthernet1/0/2), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 11 last change occurred 01:33:17 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0010 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 61450, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 3008, received 0

 Port 4 (FastEthernet1/0/2) of VLAN0010 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 4106, address 000d.6566.e380
   Designated port id is 128.1, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 25, received 78539

VLAN0100 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 100, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 11 last change occurred 01:46:06 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0100 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 3180, received 0
```

← Cisco-A sees Cisco-B as root bridge for vlan10.

← Cisco-B is root bridge for vlan10.

← Cisco-B is root bridge for vlan10.

← Cisco-A sees itself as root bridge for vlan100.

← Cisco-A is root bridge for vlan100.

Figure 24: Cisco-A—output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0100 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 78706, received 26

 VLAN0200 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 200, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 11 last change occurred 01:46:09 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0200 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 32968, address 000d.29e2.d500
   Designated bridge has priority 32968, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 3181, received 0

 Port 4 (FastEthernet1/0/2) of VLAN0200 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 32968, address 000d.29e2.d500
   Designated bridge has priority 32968, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 78707, received 26
```

← Cisco-A is root bridge for vlan100.

← Cisco-A sees itself as root bridge for vlan200.

← Cisco-A is root bridge for vlan200.

← Cisco-A is root bridge for vlan200.

Figure 25: Cisco-B—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    4097
              Address     000d.29e2.d500
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
  Bridge ID   Priority    4097   (priority 4096 sys-id-ext 1)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300
Interface           Role   Sts Cost      Prio.Nbr Type
------------------- ------ --------- -------- --------------------------------
Gi1/0/1             Root   FWD 19        128.1    P2p
Gi1/0/2             Desg   FWD 4         128.2    P2p

VLAN0010
  Spanning tree enabled protocol rstp
  Root ID     Priority    4106
              Address     000d.6566.e380
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
  Bridge ID   Priority    4106   (priority 4096 sys-id-ext 10)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300
Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Gi1/0/1             Desg FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p

VLAN0100
  Spanning tree enabled protocol rstp
  Root ID     Priority    32868
              Address     000d.29e2.d500
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
  Bridge ID   Priority    32868  (priority 32768 sys-id-ext 100)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300
Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p
```

← Cisco-B sees Cisco-A as root bridge for vlan1.

↑ Both ports on Cisco-B are forwarding for vlan1.

← Cisco-B sees Cisco-A as root bridge for vlan10.

↑ Both ports on Cisco-B are forwarding for vlan10.

← Cisco-B sees itself as root bridge for vlan100.

↑ Both ports on Cisco-B are forwarding for vlan100.

Figure 25: Cisco-B—output from the **show spanning-tree** command (continued)

```
VLAN0200
  Spanning tree enabled protocol rstp
  Root ID     Priority    32968
              Address     000d.29e2.d500
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32968  (priority 32768 sys-id-ext 200)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p
```

← Cisco-B sees Cisco-A as root bridge for vlan200.

↑ Both ports on Cisco-B are forwarding for vlan200.

Figure 26: Cisco-B—output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 4097, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 23 last change occurred 00:08:02 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0001 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 25, received 79562

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 242, received 3
```

← Cisco-B sees Cisco-A as root bridge for vlan1.

Figure 26: Cisco-B—output from the **show spanning-tree detail** command (continued)

```
VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 10, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
  Topology change flag not set, detected flag not set
  Number of topology changes 21 last change occurred 00:07:34 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0010 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 4106, address 000d.6566.e380
   Designated port id is 128.1, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 79566, received 28

 Port 2 (GigabitEthernet1/0/2) of VLAN0010 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 4106, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 245, received 0

VLAN0100 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 100, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32868, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 19 last change occurred 00:07:37 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0100 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 29, received 79563
```

← Cisco-B sees itself as root bridge for vlan10.

← Cisco-B sees Cisco-A as root bridge for vlan100.

Figure 26: Cisco-B—output from the **show spanning-tree detail** command (continued)

```
 Port 2 (GigabitEthernet1/0/2) of VLAN0100 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 245, received 0

VLAN0200 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 200, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32968, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 19 last change occurred 00:07:38 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0200 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 32968, address 000d.29e2.d500
   Designated bridge has priority 32968, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 29, received 79564

 Port 2 (GigabitEthernet1/0/2) of VLAN0200 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 32968, address 000d.29e2.d500
   Designated bridge has priority 32968, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 247, received 0
```

← Cisco-B sees Cisco-A as root bridge for vlan200.

AW+ Example D: Rapid-PVST+ and MSTP—trunked VLANS

As in the previous example, all the switches and ports are configured with multiple VLANs. Unlike the previous examples, however, on the x600 switch these VLANs are mapped to multiple MSTP instances.

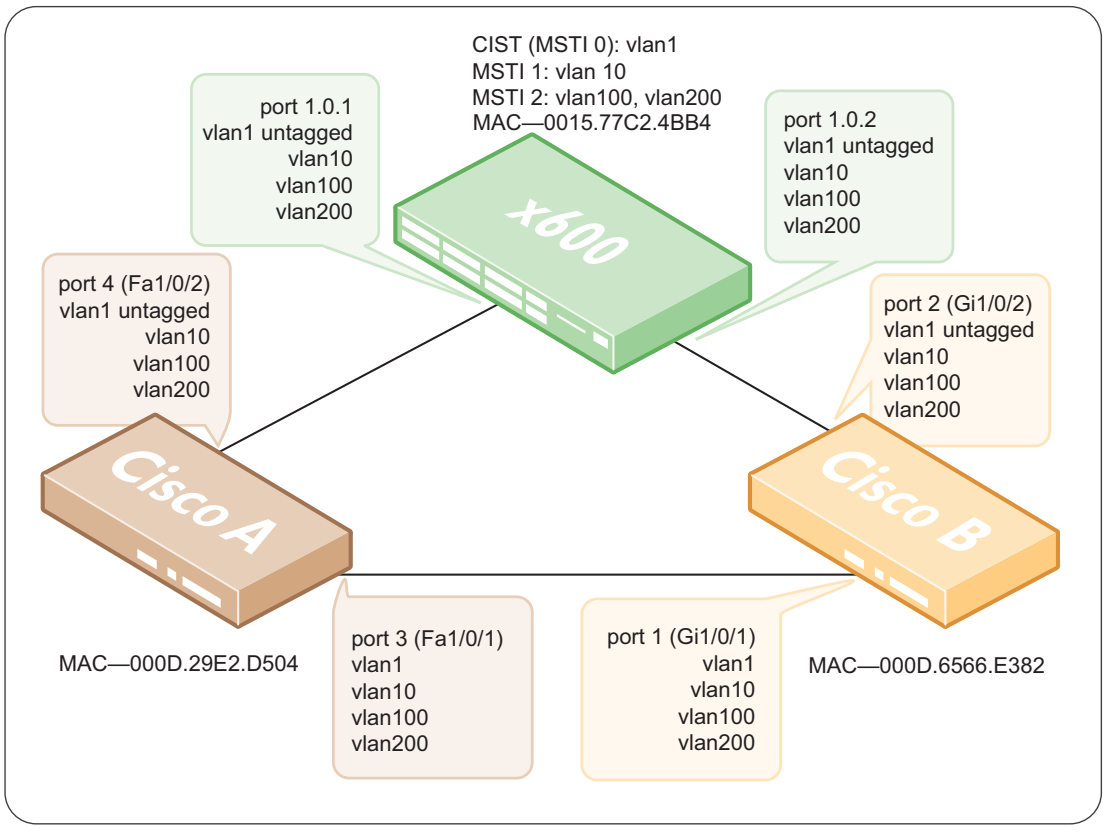
For a similar example on AlliedWare, see "AW Example G: Rapid PVST+ and MSTP— tagged VLANs" on page 64.

Configuration

On the x600, vlan1 belongs to the CIST (Common and Internal Spanning Tree), vlan10 belongs to MSTI1, and vlan100 and vlan200 belong to MSTI2.

To allow the rapid PVST+ switches to interoperate with the MSTP switch, it is important to ensure that vlan1 is untagged on the Cisco ports connected to the x600 MSTP switch. This allows the switches to form a common spanning tree using vlan1. For a description of how MSTP and rapid PVST+ (and PVST+) interact, see "Interoperation between spanning tree protocols" on page 5.

Figure 27: Example D network configuration



x600 configuration

```
spanning-tree mode mstp
!
spanning-tree mst configuration
 instance 1 vlan 10
 instance 2 vlan 100
 instance 2 vlan 200
 region awplus
 revision 1
!
vlan database
 vlan 10 name vlan10
 vlan 100 name vlan100
 vlan 200 name vlan200
 vlan 10,100,200 state enable
!
interface port1.0.1-1.0.2
 switchport mode trunk
 switchport trunk allowed vlan add 10,100,200
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 4096
spanning-tree vlan 10 priority 61440
!
vlan 10,100,200
!
interface FastEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface FastEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1,10 priority 4096
!
vlan 10,100,200
!
interface GigabitEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface GigabitEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Results

The x600 (which is basically acting as a bridge) is the root bridge for vlan1(CIST)—it receives IEEE standard BPDUs from the Cisco switches for vlan1so that they can form a common spanning tree. Cisco A is the root bridge for vlan100 and vlan200, and Cisco B is the root bridge for vlan10. The x600 does not know about vlan10, vlan100, and vlan200; when it receives the rapid PVST+ SSTP format BPDUs from Cisco-A, it ignores their content and transparently floods them on the Cisco-B ports, and vice versa.

In the output from the x600, we can see that:

- The x600 sees Cisco-A as the root bridge of the CIST (Figure 29, Figure 32).
- The x600 output does not mention the Cisco switches as root bridges or designated bridges for MSTI 1 (Figure 30) or MSTI 2 (Figure 31), because the Cisco switches only participate in the CIST, and not the other MST instances.
- The x600 receives only RSTP BPDUs from the Cisco switches, and transmits MSTP BPDUs (Figure 32).
- Port 1.0.2 is discarding (blocking) for the CIST (Figure 30), MSTI 1 (Figure 31), and MSTI 2 (Figure 32), that is, for all the VLANs.

The output from Cisco-A (Figure 33, Figure 34) and Cisco-B (Figure 35, Figure 36) shows that:

- Cisco-A is the root bridge for vlan1, vlan100, and vlan200; Cisco-B is the root bridge for vlan10.
- Both Cisco-A and Cisco-B have all ports in the forwarding state. (As we have seen from the previous x600 output, port1.0.2 on the x600 is the blocking port in the ring.)
- The **show spanning-tree summary** command (Figure 33, Figure 35) summarises the spanning tree configuration and shows whether any other spanning tree features are enabled.

Figure 28: Example D spanning tree topology

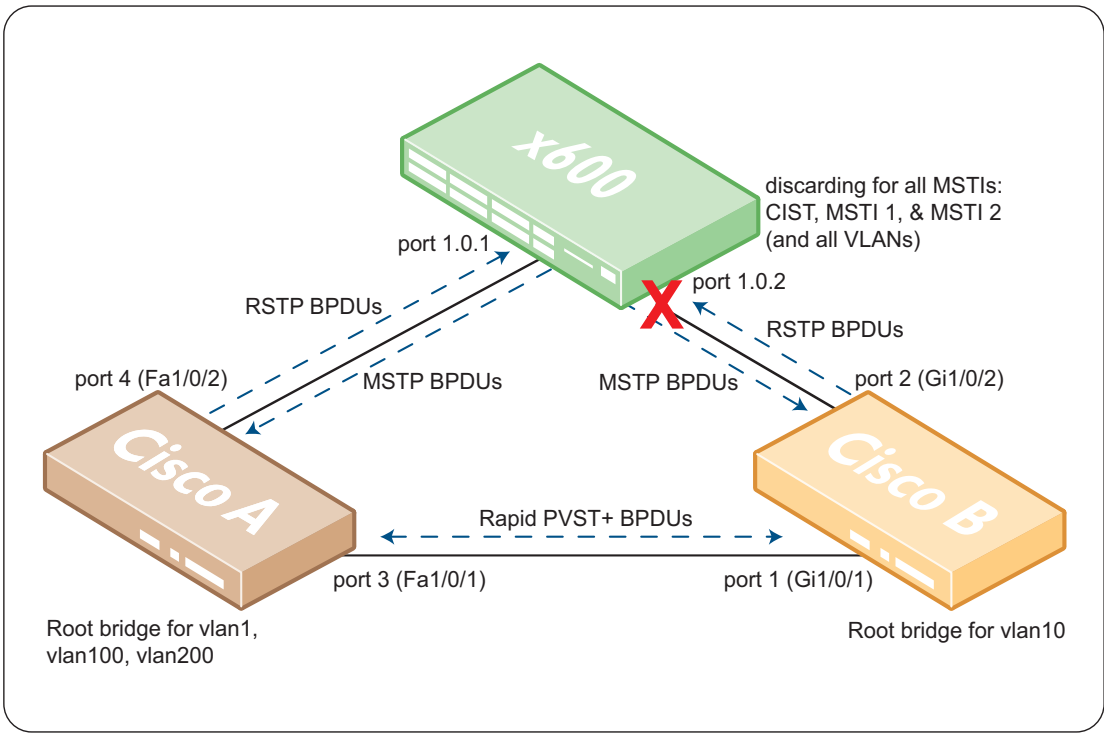


Figure 29: x600—output from the **show spanning-tree mst** command

```
awplus#sh spanning-tree mst

% Default: Bridge up - Spanning Tree Enabled
% Default: CIST Root Path Cost 20019 - CIST Root Port 5001 - CIST Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20 - Max-hops 20
% Default: CIST Root Id 1001000d29e2d500
% Default: CIST Reg Root Id 8000001577c24bb4
% Default: CIST Bridge Id 8000001577c24bb4
% Default: CIST 26 topology change(s)  - last topology change Tue Sep 21 11:16:36 2010

% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec
%
%   Instance        VLAN
%   0:              1
%   1:              10  (port1.0.1)
%   1:              10  (port1.0.2)
%   2:              100, 200  (port1.0.1)
%   2:              100, 200  (port1.0.2)
```

← x600 sees Cisco-A as the root bridge of CIST.

←On x600:

- the CIST (MSTI 0) includes vlan1 (default VLAN)
- MSTI 1 includes ports 1.0.1-1.0.2 in vlan10
- MSTI 2 includes ports 1.0.1-1.0.2 in vlan100 & vlan200.

Figure 30: x600—output from the **show spanning-tree mst instance 1** command

```
awplus#sh spanning-tree mst instance 1

% 0: MSTI Root Path Cost 0 - MSTI Root Port 0 - MSTI Bridge Priority 32768
% 0: MSTI Root Id 8001001577c24bb4                ← x600 sees itself as the root bridge of MSTI 1.
% 0: MSTI Bridge Id 8001001577c24bb4
% 0: 26 topology changes - last topology change Tue Sep 21 11:16:36 2010
%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Masterport - State Forwarding
%   port1.0.1: Designated Internal Path Cost 0  - Designated Port Id 8389
%   port1.0.1: Configured Internal Path Cost 20000
%   port1.0.1: Configured CST External Path cost 20000
%   port1.0.1: CST Priority 128  - MSTI Priority 128
%   port1.0.1: Designated Root 8001001577c24bb4
%   port1.0.1: Designated Bridge 8001001577c24bb4
%   port1.0.1: Message Age 0 - Max Age 0
%   port1.0.1: Hello Time 2 - Forward Delay 15
%   port1.0.1: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 1

%   port1.0.2: Ifindex 906 - Port Id 838a - Role Alternate - State Discarding
                              Port 1.0.2 connected to Cisco-B is blocking for MSTI 1. ↑
%   port1.0.2: Designated Internal Path Cost 0  - Designated Port Id 838a
%   port1.0.2: Configured Internal Path Cost 200000
%   port1.0.2: Configured CST External Path cost 200000
%   port1.0.2: CST Priority 128  - MSTI Priority 128
%   port1.0.2: Designated Root 8001001577c24bb4
%   port1.0.2: Designated Bridge 8001001577c24bb4
%   port1.0.2: Message Age 0 - Max Age 0
%   port1.0.2: Hello Time 2 - Forward Delay 15
%   port1.0.2: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 0
```

Figure 31: x600—output from the **show spanning-tree mst instance 2** command

```
awplus#sh spanning-tree mst instance 2
% 0: MSTI Root Path Cost 0 - MSTI Root Port 0 - MSTI Bridge Priority 32768
% 0: MSTI Root Id 8002001577c24bb4                ← x600 sees itself as the root bridge of MSTI 2.
% 0: MSTI Bridge Id 8002001577c24bb4
% 0: 26 topology changes - last topology change Tue Sep 21 11:16:36 2010
%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Masterport - State Forwarding
%   port1.0.1: Designated Internal Path Cost 0  - Designated Port Id 8389
%   port1.0.1: Configured Internal Path Cost 20000
%   port1.0.1: Configured CST External Path cost 20000
%   port1.0.1: CST Priority 128  - MSTI Priority 128
%   port1.0.1: Designated Root 8002001577c24bb4
%   port1.0.1: Designated Bridge 8002001577c24bb4
%   port1.0.1: Message Age 0 - Max Age 0
%   port1.0.1: Hello Time 2 - Forward Delay 15
%   port1.0.1: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 1
```

Figure 31: x600—output from the **show spanning-tree mst instance 2** command (continued)

```
%   port1.0.2: Ifindex 906 - Port Id 838a - Role Alternate - State Discarding
                                  Port 1.0.2 connected to Cisco-B is blocking for MSTI 2. ↑
%   port1.0.2: Designated Internal Path Cost 0  - Designated Port Id 838a
%   port1.0.2: Configured Internal Path Cost 200000
%   port1.0.2: Configured CST External Path cost 200000
%   port1.0.2: CST Priority 128  - MSTI Priority 128
%   port1.0.2: Designated Root 8002001577c24bb4
%   port1.0.2: Designated Bridge 8002001577c24bb4
%   port1.0.2: Message Age 0 - Max Age 0
%   port1.0.2: Hello Time 2 - Forward Delay 15
%   port1.0.2: Forward Timer 0 - Msg Age Timer 0 - Hello Timer 0
```

Figure 32: x600—output from the **show spanning-tree** command

```
awplus#sh spanning-tree
% Default: Bridge up - Spanning Tree Enabled
% Default: CIST Root Path Cost 20019 - CIST Root Port 5001 - CIST Bridge Priority 32768
% Default: Forward Delay 15 - Hello Time 2 - Max Age 20 - Max-hops 20
% Default: CIST Root Id 1001000d29e2d500                ← x600 sees Cisco-A as the root
% Default: CIST Reg Root Id 8000001577c24bb4                    bridge of the CIST.
% Default: CIST Bridge Id 8000001577c24bb4
% Default: CIST 26 topology change(s)  - last topology
change Tue Sep 21 11:16:36 2010
% Default: portfast bpdu-filter disabled
% Default: portfast bpdu-guard disabled
% Default: portfast errdisable timeout disabled
% Default: portfast errdisable timeout interval 300 sec

%   port1.0.1: Ifindex 905 - Port Id 8389 - Role Rootport - State Forwarding
%   port1.0.1: Designated External Path Cost 19 -Internal Path Cost 0
%   port1.0.1: Configured Path Cost 20000  - Add type Explicit ref count 3
%   port1.0.1: Designated Port Id 8002 - CIST Priority 128  -
%   port1.0.1: CIST Root 1001000d29e2d500          ← Cisco-A is root bridge of CIST.
%   port1.0.1: Regional Root 8000001577c24bb4
%   port1.0.1: Designated Bridge 1001000d6566e380
%   port1.0.1: Message Age 1 - Max Age 20
%   port1.0.1: CIST Hello Time 2 - Forward Delay 15
%   port1.0.1: CIST Forward Timer 0 - Msg Age Timer 5 -Hello Timer 1 -topo change timer 0
%   port1.0.1: forward-transitions 3
%   port1.0.1: Version Multiple Spanning Tree Protocol - Received RSTP - Send MSTP
                        This port is receiving RSTP BPDUs and sending MSTP BPDUs. ↑
%   port1.0.1: No portfast configured - Current  portfast off
%   port1.0.1: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.1: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.1: no root guard configured - Current root guard off
%   port1.0.1: Configured Link Type point-to-point - Current point-to-point
%
```

Figure 32: x600—output from the **show spanning-tree** command (continued)

```
%   port1.0.2: Ifindex 906 - Port Id 838a - Role Alternate - State Discarding
                Port 1.0.2 connected to Cisco-B is blocking for CIST, i.e., for all VLANs. ↑
%   port1.0.2: Designated External Path Cost 0 -Internal Path Cost 0
%   port1.0.2: Configured Path Cost 200000  - Add type Explicit ref count 3
%   port1.0.2: Designated Port Id 8003 - CIST Priority 128  -
%   port1.0.2: CIST Root 1001000d29e2d500
%   port1.0.2: Regional Root 8000001577c24bb4
%   port1.0.2: Designated Bridge 1001000d29e2d500
%   port1.0.2: Message Age 0 - Max Age 20
%   port1.0.2: CIST Hello Time 2 - Forward Delay 15
%   port1.0.2: CIST Forward Timer 0 - Msg Age Timer 5 - Hello Timer 1 - topo change
timer 0
%   port1.0.2: forward-transitions 5
%   port1.0.2: Version Multiple Spanning Tree Protocol - Received RSTP - Send MSTP
                This port is receiving RSTP BPDUs and transmitting MSTP BPDUs. ↑
%   port1.0.2: No portfast configured - Current  portfast off
%   port1.0.2: portfast bpdu-guard  default  - Current portfast bpdu-guard off
%   port1.0.2: portfast bpdu-filter default  - Current portfast bpdu-filter off
%   port1.0.2: no root guard configured - Current root guard off
%   port1.0.2: Configured Link Type point-to-point - Current point-to-point
```

Figure 33: Cisco-A—output from the **show spanning-tree summary** command

```
Switch#show spanning-tree summary

Switch is in rapid-pvst mode
Root bridge for: VLAN0001, VLAN0100, VLAN0200
                                                  ← Cisco-A sees itself as
                                                    root bridge for vlan1,
                                                    vlan100, vlan200.
Extended system ID           is enabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
                Both ports on Cisco-A are forwarding for all VLANs. ↑
```

Figure 34: Cisco-A—output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail
 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree                    ← Cisco-A sees itself as the
  Topology change flag not set, detected flag not set       root bridge for vlan1.
  Number of topology changes 3 last change occurred 00:12:51
ago
          from FastEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0001 is designated forwarding Port path cost 19, Port
priority 128, Port Identifier 128.3.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 388, received 3

 Port 4 (FastEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 386, received 4

VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 61440, sysid 10, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 4106, address 000d.6566.e380  ← Cisco-A sees Cisco-B as the
  Root port is 4 (FastEthernet1/0/2), cost of root path is 19   root bridge for vlan10.
  Topology change flag not set, detected flag not set
  Number of topology changes 3 last change occurred 00:17:11
ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0010 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 61450, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   BPDU: sent 534, received 2
```

Figure 34: Cisco-A—output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0010 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 4106, address 000d.6566.e380
  Designated bridge has priority 4106, address 000d.6566.e380
  Designated port id is 128.1, designated path cost 0
  Timers: message age 16, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 7, received 533

VLAN0100 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 100, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-A sees itself as
 Topology change flag not set, detected flag not set       root bridge for vlan100.
 Number of topology changes 3 last change occurred 00:17:46 ago
     from FastEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
     hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 538, received 3

Port 4 (FastEthernet1/0/2) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 535, received 8

VLAN0200 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 200, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-A sees itself as
 Topology change flag not set, detected flag not set       root bridge for vlan200.
 Number of topology changes 3 last change occurred 00:17:48 ago
         from FastEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 539, received 3
```

Figure 34: Cisco-A—output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 537, received 8
```

Figure 35: Cisco-B—output from the **show spanning-tree summary** command

```
Switch#show spanning-tree summary

Switch is in rapid-pvst mode
Root bridge for: VLAN0010                          ← Cisco-B sees itself as the
Extended system ID           is enabled                root bridge for vlan10.
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
                                  Both ports on Cisco-B are forwarding for all VLANs. ↑
```

Figure 36: Cisco-B—output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 4097, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 7 last change occurred 00:36:38 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0001 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 16, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 4, received 1094

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   BPDU: sent 1756, received 9

VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 10, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree
    Topology change flag not set, detected flag not set
  Number of topology changes 9 last change occurred 00:36:04 ago
          from GigabitEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0010 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 4106, address 000d.6566.e380
   Designated port id is 128.1, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 1096, received 7
```

← Cisco-B sees Cisco-A as root bridge for vlan1.

← Cisco-B sees itself as root bridge for vlan10.

Figure 36: Cisco-B—output from the **show spanning-tree detail** command (continued)

```
 Port 2 (GigabitEthernet1/0/2) of VLAN0010 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 4106, address 000d.6566.e380
   Designated bridge has priority 4106, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   BPDU: sent 170836, received 477

 VLAN0100 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 100, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32868, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
 Number of topology changes 7 last change occurred 00:36:09 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0100 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 8, received 1097

 Port 2 (GigabitEthernet1/0/2) of VLAN0100 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 32868, address 000d.29e2.d500
   Designated bridge has priority 32868, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 3
   Link type is point-to-point by default
   BPDU: sent 45016, received 126289

VLAN0200 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 200, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32968, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 7 last change occurred 00:36:10 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300
```

← Cisco-B sees Cisco-A as root bridge for vlan100.

← Cisco-B sees Cisco-A as root bridge for vlan200.

Figure 36: Cisco-B—output from the **show spanning-tree detail** command (continued)

```
Port 1 (GigabitEthernet1/0/1) of VLAN0200 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 15, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 8, received 1098

Port 2 (GigabitEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 3
  Link type is point-to-point by default
  BPDU: sent 45017, received 126289
```

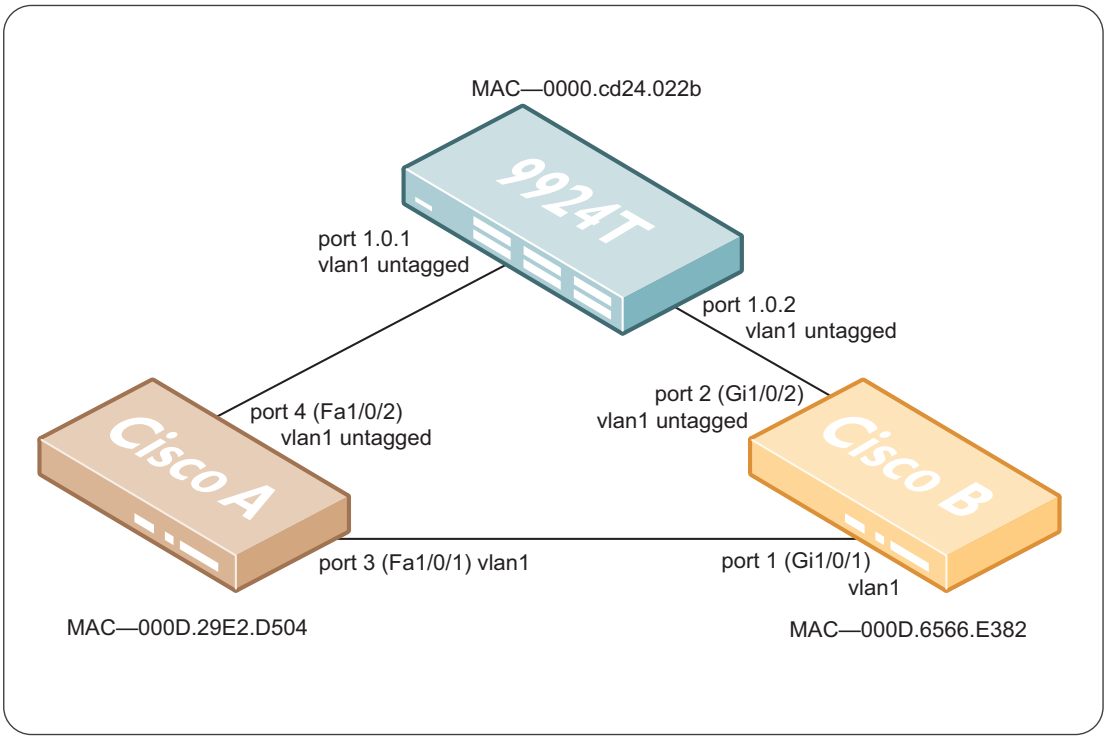
AW Example E: Rapid PVST+ and RSTP—untagged VLAN only

This example demonstrates interoperation between RSTP on an Allied Telesis switch running AlliedWare and rapid PVST+ on the Cisco switches. For a similar example using AlliedWare Plus, see "AW+ Example B: Rapid PVST+ and RSTP—native VLAN only" on page 15.

Configuration

The three switches are all connected via the default VLAN (vlan1). On the AT-9924T, RSTP is enabled; on both the Cisco-A and Cisco-B switches, the spanning tree mode is set to rapid PVST+.

Figure 37: Example E network configuration



AT-9924T configuration

```
# STP general configuration
enable stp=default
set stp=default mode=rapid
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
```

Results

The output from the AT-9924T shows that:

- The AT-9924T sees itself as the root bridge (Figure 39, Figure 40).
- Ports 1.0.1 and 1.0.2 are both sending RSTP BPDUs (Figure 40).
- Ports 1.0.1 and 1.0.2 are both forwarding (Figure 40).

The output from Cisco-A shows that:

- It sees the AT-9924T as the root bridge (Figure 41, Figure 43).
- FastEthernet1 (port 3) is in the blocking state, which indicates that the Cisco switches consider this link to be part of the common spanning tree with the AlliedWare switch (Figure 41, Figure 42).
- It is running an RSTP compatible protocol for vlan1 on FastEthernet1/0/2 (port 4). RSTP compatible Rapid PVST+ running on these switches is based on RSTP (Figure 41, Figure 43).

Figure 38: Example E spanning tree topology

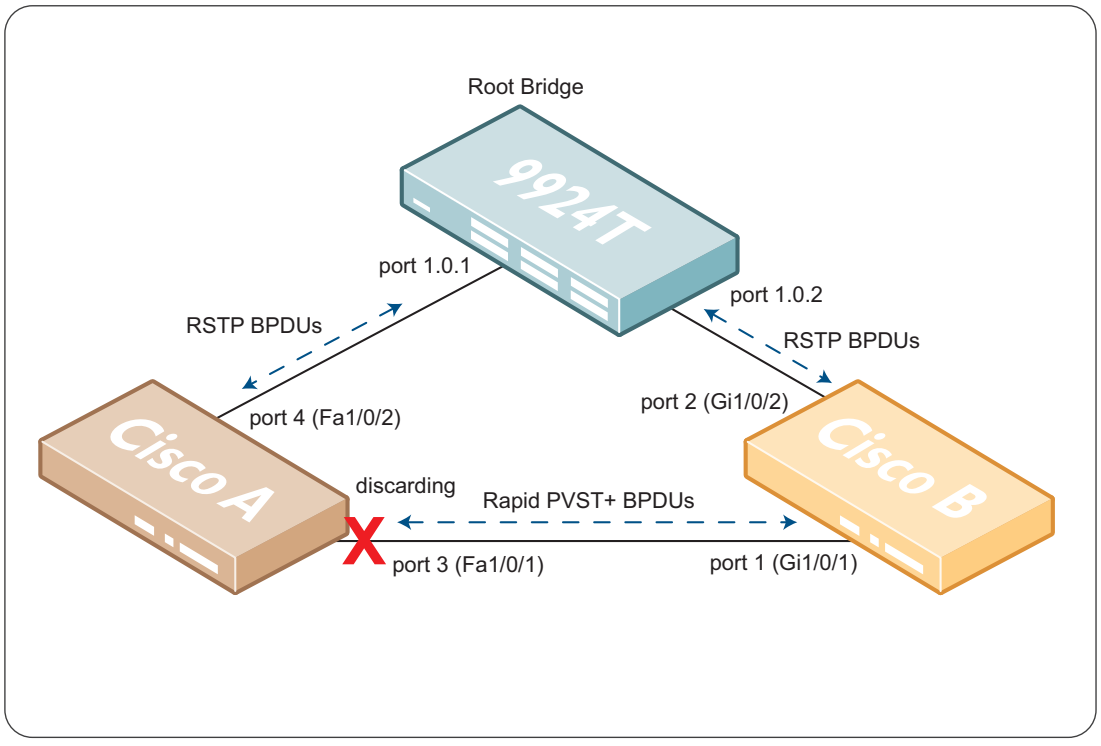


Figure 39: AT-9924T—output from the **show stp** command

```
Manager > sh stp

 STP Information
--------------------------------------------------------------------------
 Name ................. default
 Mode ................. Rapid
 RSTP Type ............ Normal
 VLAN members ......... default (1)
 Status ............... ON
 Number of Ports ...... 24
   Number Enabled ..... 2
   Number Disabled .... 22
 Bridge Identifier .... 32768 : 00-00-cd-24-02-2b
 Bridge Priority ...... 32768
 Root Bridge .......... 32768 : 00-00-cd-24-02-2b   ← AT-9924T sees itself
 Designated Bridge .... 32768 : 00-00-cd-24-02-2b     as  root bridge.
 Root Port ............ (n/a)
 Root Path Cost ....... 0
 Max Age .............. 20
 Hello Time ........... 2
 Forward Delay ........ 15
 Switch Max Age ....... 20
 Switch Hello Time .... 2
 Switch Forward Delay .. 15
 Transmission Limit .... 3
 Number of TC ......... 11
 Time since last TC .... 949
--------------------------------------------------------------------------
```

Figure 40: AT-9924T: output from the **show stp port** command

```
Manager > show stp port=1-2

 STP Port Information
------------------------------------------------------------------------
 STP ..................... default
   STP Status ............ ON

   Port .................. 1
     RSTP Port Role ...... Designated
     State ............... Forwarding          ← Port 1 is forwarding.
     Point To Point ...... Yes (Auto)
     Port Priority ....... 128
     Port Identifier ..... 8001
     Pathcost ............ 20000 (auto configured)
     Designated Root ..... 32768 : 00-00-cd-24-02-2b
     Designated Cost ..... 0
     Designated Bridge ... 32768 : 00-00-cd-24-02-2b
     Designated Port ..... 8001
     EdgePort ............ No
     VLAN membership ..... 1
     Send RSTP BPDU ...... TRUE          ← Port 1 is sending RSTP BPDUs.
     Counters:
       Loopback Disabled            0

   Port .................. 2
     RSTP Port Role ...... Designated
     State ............... Forwarding          ← Port 2 is forwarding.
     Point To Point ...... Yes (Auto)
     Port Priority ....... 128
     Port Identifier ..... 8002
     Pathcost ............ 200000 (auto configured)
     Designated Root ..... 32768 : 00-00-cd-24-02-2b
     Designated Cost ..... 0
     Designated Bridge ... 32768 : 00-00-cd-24-02-2b
     Designated Port ..... 8002
     EdgePort ............ No
     VLAN membership ..... 1
     Send RSTP BPDU ...... TRUE          ← Port 2 is sending RSTP BPDUs.

     Counters:
       Loopback Disabled            0
```

Figure 41: Cisco-A—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp          ← Cisco-A is running an RSTP compatible protocol

  Root ID     Priority    32768
              Address     0000.cd24.022b       ← Cisco-A sees AT-9924T as  the root bridge.
              Cost        19
              Port        4 (FastEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------------
Fa1/0/1             Altn BLK 19        128.3    P2p   ← FastEthernet1/Port 3 is blocking.
Fa1/0/2             Root FWD 19        128.4    P2p
```

Figure 42: Cisco-A—output from the **show spanning-tree blockedports** command

```
Switch#show spanning-tree blockedports

Name                 Blocked Interfaces List
-------------------- ---------------------------------------
VLAN0001             Fa1/0/1                  ← FastEthernet1/Port 3 is blocking.

Number of blocked ports (segments) in
the system : 1
```

Figure 43: Cisco-A—output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree          ← Cisco-A is running
protocol                                                           RSTP-compatible protocol

  Bridge Identifier has priority 32768, sysid 1, address
000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32768, address 0000.cd24.022b          ← Cisco-A sees AT-9924T
  Root port is 4 (FastEthernet1/0/2), cost of root path is 19        as  the root bridge.
  Topology change flag not set, detected flag not set
  Number of topology changes 29 last change occurred 00:25:52 ago
          from FastEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300
```

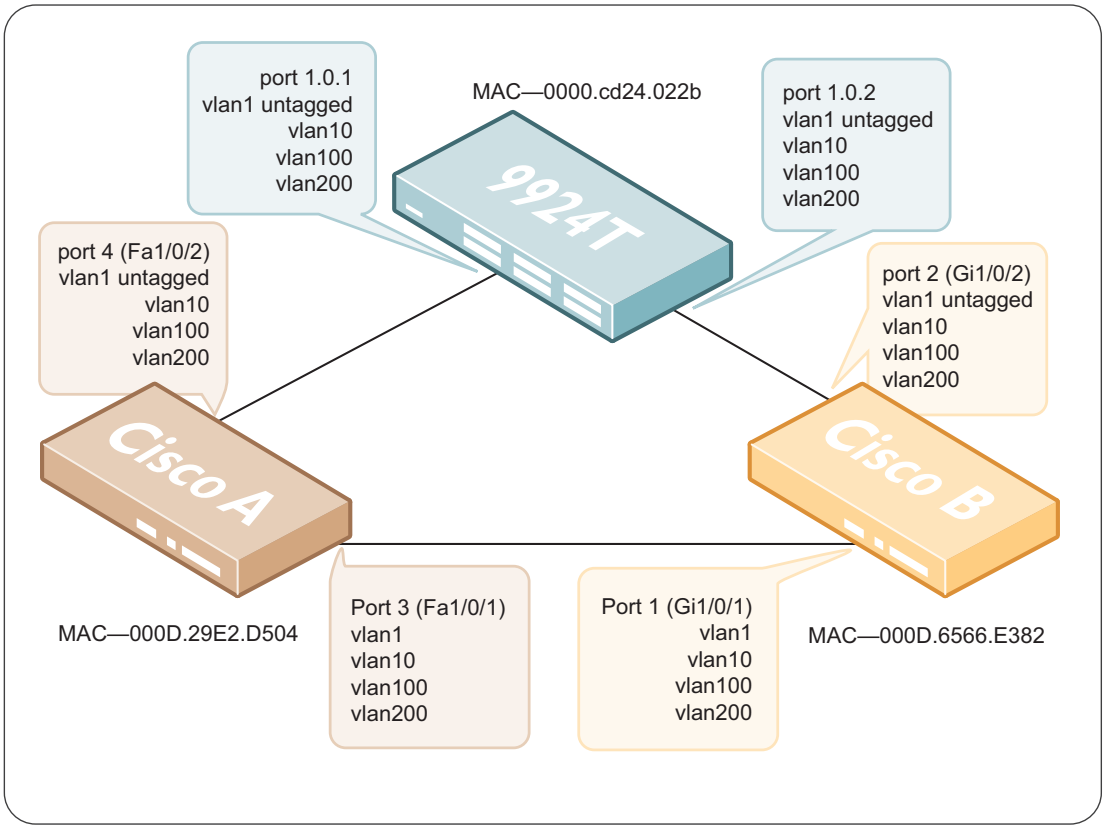
AW Example F: Rapid PVST+ and RSTP—tagged VLANs

This example demonstrates compatibility between RSTP on and AlliedWare switch and rapid PVST+ on the Cisco switches over trunk ports (ports with tagged VLANs). For a similar example using AlliedWare Plus, see "AW+ Example C: Rapid PVST+ and RSTP—trunked VLANs" on page 20.

Configuration

In this example we have three VLANs configured on each switch in the network in addition to the default VLAN. The AT-9924T has RSTP enabled and both of the Cisco switches have rapid PVST+ configured. The AT-9924T has a higher priority value than the other switches, so it does not become the root bridge.

Figure 44: Example F network configuration



AT-9924T configuration

```
# STP general configuration
enable stp=default
set stp=default mode=rapid priority=61440
# VLAN configuration
create vlan=vlan10 vid= 10
create vlan=vlan100 vid= 100
create vlan=vlan200 vid= 200
add vlan10 port=1, 2 frame=tagged
add vlan100 port=1, 2 frame=tagged
add vlan200 port=1, 2 frame=tagged
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority  32768
spanning-tree vlan 10,100,200 priority 0

!
vlan 10,100,200
!
interface FastEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface FastEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
!
vlan 10,100,200
!
interface GigabitEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface GigabitEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Results

The output from the AT-9924T (Figure 46, Figure 47) shows that:

- Since the priorities have changed, the Cisco-A is the root bridge for this common spanning tree (CST), and Cisco-B is the designated bridge (Figure 46, Figure 47).
- Port 1 on the AT-9924T is blocking for the CIST, and port 2 is forwarding (Figure 46).
- It is in RSTP mode, and sending RSTP BPDUs (Figure 46, Figure 47).
- The counters on the AT-9924T are incrementing on both transmit and receive, so we can see that the AT-9924T is participating in the STP instance (Figure 48).

The output from the Cisco switches (Figure 49, Figure 50, Figure 51, Figure 52, Figure 53, Figure 54) show that:

- Cisco-A is the root bridge for all four VLANs.
- Both ring ports on both Cisco-A (Figure 50) and Cisco-B (Figure 49) are forwarding for all the VLANs (the default native vlan1 and the configured VLANs vlan10, vlan100, vlan200).

Figure 45: Example F spanning tree topology

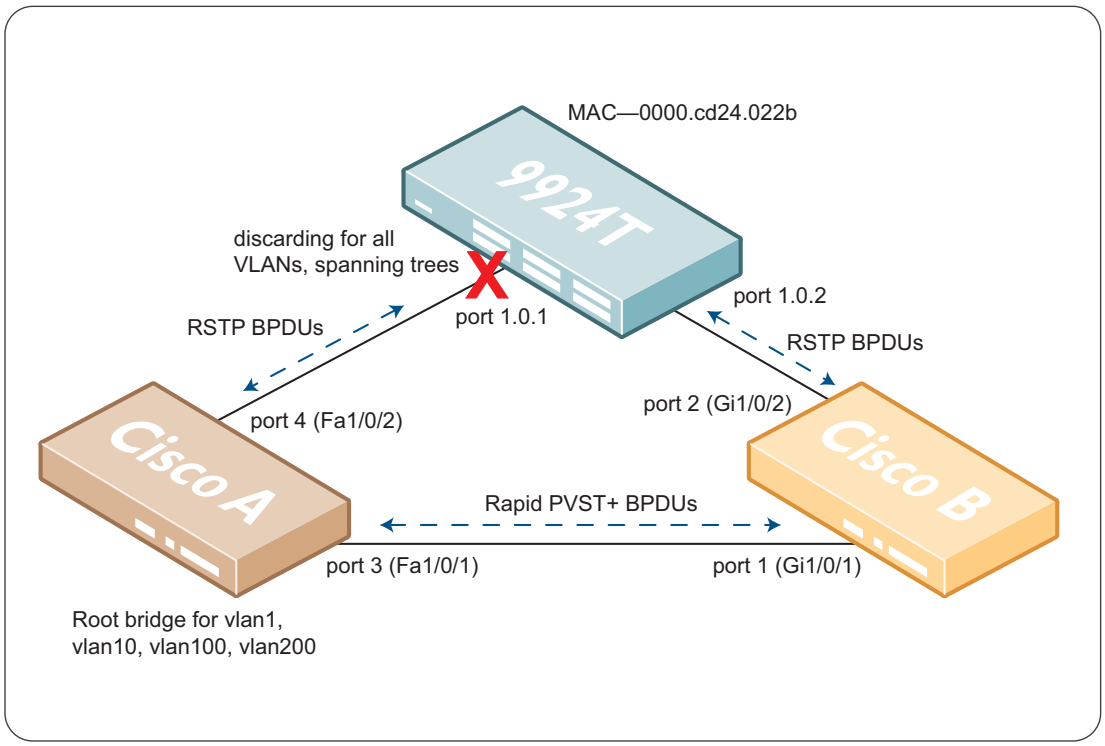


Figure 46: AT-9924T—output from the **show stp port** command

```
Manager > sh stp port=1-2

 STP Port Information
--------------------------------------------------------------------------------
 STP ..................... default
   STP Status ............ ON
   Port .................. 1
     RSTP Port Role ...... Alternate
     State ............... Discarding          ← Port 1 is discarding for the CST (all VLANs).
     Point To Point ...... Yes (Auto)
     Port Priority ....... 128
     Port Identifier ..... 8001
     Pathcost ............ 200000 (auto configured)
     Designated Root ..... 32769 : 00-0d-29-e2-d5-00   ← Port 1 sees Cisco-A as root bridge.
     Designated Cost ..... 0
     Designated Bridge ... 32769 : 00-0d-29-e2-d5-00   ← Port 1 sees Cisco-B as designated bridge.
     Designated Port ..... 8004
     EdgePort ............ No
     VLAN membership ..... 4
     Send RSTP BPDU ...... TRUE                ← Port 1 is sending RSTP BPDUs

     Counters:
      Loopback Disabled            0

   Port .................. 2
     RSTP Port Role ...... Root
     State ............... Forwarding          ← Port 2 is forwarding for the CST (all VLANs).
     Point To Point ...... Yes (Auto)
     Port Priority ....... 128
     Port Identifier ..... 8002
     Pathcost ............ 20000 (auto configured)
     Designated Root ..... 32769 : 00-0d-29-e2-d5-00   ← Port 2 sees Cisco-A as root bridge.
     Designated Cost ..... 19
     Designated Bridge ... 32769 : 00-0d-65-66-e3-80   ← Port 2 sees Cisco-B as designated bridge.
     Designated Port ..... 8002
     EdgePort ............ No
     VLAN membership ..... 4
     Send RSTP BPDU ...... TRUE                ← Port 2 is sending RSTP BPDUs
     Counters:
       Loopback Disabled            0
--------------------------------------------------------------------------------
```

Figure 47: AT-9924T: output from the **show stp** command

```
Manager > sh stp

 STP Information
--------------------------------------------------------------------------
 Name ................. default
 Mode ................. Rapid                          ← In RSTP mode.
 RSTP Type ............ Normal
 VLAN members ......... default (1)
                        vlan10 (10)
                        vlan100 (100)
                        vlan200 (200)
 Status ............... ON
 Number of Ports ...... 24
   Number Enabled ..... 2
   Number Disabled .... 22
 Bridge Identifier .... 61440 : 00-00-cd-24-02-2b
 Bridge Priority ...... 61440
 Root Bridge .......... 32769 : 00-0d-29-e2-d5-00   ← Sees Cisco-A
 Designated Bridge .... 32769 : 00-0d-65-66-e3-80     as root bridge.
 Root Port ............ 2
 Root Path Cost ....... 20019
 Max Age .............. 20
 Hello Time ........... 2
 Forward Delay ........ 15
 Switch Max Age ....... 20
 Switch Hello Time .... 2
 Switch Forward Delay .. 15
 Transmission Limit .... 3
 Number of TC ......... 2
 Time since last TC .... 2367
```

Figure 48: AT-9924T: output from the **show stp count** command

```
Manager > show stp count

 STP Counters
--------------------------------------------------------------------------
 STP Name: default                  ↓   Counters incrementing.   ↓

  Receive:                                Transmit:
  Total STP Packets          7179         Total STP Packets          177
  Configuration BPDU            0         Configuration BPDU           0
  TCN BPDU                      0         TCN BPDU                     0
  RSTP TC-Flag                 21         RSTP TC-Flag                10
  RST BPDU                   7179         RST BPDU                   177
  Invalid BPDU                  0

  Discarded:
  Port Disabled                 0
  Invalid Protocol              0
  Invalid Type                  0
  Invalid Message Age           0
  Config BPDU length            0
  TCN BPDU length               0
  RST BPDU length               0

--------------------------------------------------------------------------
```

Figure 49: Cisco-A: output from the **show spanning-tree summary** command

```
Switch#sh spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: VLAN0001, VLAN0010, VLAN0100, VLAN0200
Extended system ID           is enabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
```

← Cisco-A is root bridge for all 4 VLANs

All VLANs are forwarding. ↓

Figure 50: Cisco-A—output from the **show spanning-tree** command

```
Switch#sh spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32769
              Address     000d.29e2.d500
              This bridge is the root

              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p
```

← Cisco-A is root bridge for vlan1.

← Both ports forwarding.

Figure 50: Cisco-A—output from the **show spanning-tree** command (continued)

```
VLAN0010
  Spanning tree enabled protocol rstp
  Root ID     Priority    10
              Address     000d.29e2.d500
              This bridge is the root          ← Cisco-A is root bridge for vlan10.

              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    10     (priority 0 sys-id-ext 10)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p          ← Both ports forwarding.

VLAN0100
  Spanning tree enabled protocol rstp
  Root ID     Priority    100
              Address     000d.29e2.d500
              This bridge is the root          ← Cisco-A is root bridge for vlan100.

              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    100    (priority 0 sys-id-ext 100)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p          ← Both ports forwarding.

VLAN0200
  Spanning tree enabled protocol rstp
  Root ID     Priority    200
              Address     000d.29e2.d500
              This bridge is the root          ← Cisco-A is root bridge for vlan200.

              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    200    (priority 0 sys-id-ext 200)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p          ← Both ports forwarding.
```

Figure 51: Cisco-A: output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree                    ←Cisco-A is the root bridge for vlan1.
  Topology change flag not set, detected flag not set
  Number of topology changes 10 last change occurred 02:59:02 ago
          from FastEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 32769, address 000d.29e2.d500
   Designated bridge has priority 32769, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 3
   Link type is point-to-point by default
   BPDU: sent 211406, received 1997

 Port 4 (FastEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.4.
   Designated root has priority 32769, address 000d.29e2.d500
   Designated bridge has priority 32769, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   BPDU: sent 5359, received 83

 VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 0, sysid 10, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree                    ← Cisco-A is root bridge for vlan10.
  Topology change flag not set, detected flag not set
  Number of topology changes 7 last change occurred 02:59:29 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0010 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 10, address 000d.29e2.d500
   Designated bridge has priority 10, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 213374, received 13
```

Figure 51: Cisco-A: output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0010 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 10, address 000d.29e2.d500
  Designated bridge has priority 10, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 5437, received 4

VLAN0100 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 0, sysid 100, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-A is root bridge for vlan100.
 Topology change flag not set, detected flag not set
 Number of topology changes 8 last change occurred 02:59:33 ago
         from FastEthernet1/0/1
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 100, address 000d.29e2.d500
  Designated bridge has priority 100, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 213376, received 15

Port 4 (FastEthernet1/0/2) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 100, address 000d.29e2.d500
  Designated bridge has priority 100, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 5439, received 4

VLAN0200 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 0, sysid 200, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-A is root bridge for vlan200.
 Topology change flag not set, detected flag not set
 Number of topology changes 7 last change occurred 02:59:35 ago
         from FastEthernet1/0/1
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 200, address 000d.29e2.d500
  Designated bridge has priority 200, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 213380, received 14
```

Figure 51: Cisco-A: output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 200, address 000d.29e2.d500
  Designated bridge has priority 200, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 5443, received 4
```

Figure 52: Cisco-B: output from the **show spanning-tree summary** command

```
Switch#sh spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: none
Extended system ID           is enabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short
                                    All VLANs are forwarding. ↓

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
```

Figure 53: Cisco-B: output from the **show spanning-tree** command

```
Switch#show spanning-tree

VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    32769
              Address     000d.29e2.d500      ← Cisco-A is root bridge for vlan1.
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p      ← Both ports forwarding.
```

Figure 53: Cisco-B: output from the **show spanning-tree** command (continued)

```
VLAN0010
  Spanning tree enabled protocol rstp
  Root ID     Priority    10
              Address     000d.29e2.d500          ← Cisco-A is root bridge for vlan01.
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32778  (priority 32768 sys-id-ext 10)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p          ← Both ports forwarding.

VLAN0100
  Spanning tree enabled protocol rstp
  Root ID     Priority    100
              Address     000d.29e2.d500          ← Cisco-A is root bridge for vlan100.
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32868  (priority 32768 sys-id-ext 100)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p          ← Both ports forwarding.

VLAN0200
  Spanning tree enabled protocol rstp
  Root ID     Priority    200
              Address     000d.29e2.d500          ← Cisco-A is root bridge for vlan200.
              Cost        19
              Port        1 (GigabitEthernet1/0/1)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32968  (priority 32768 sys-id-ext 200)
              Address     000d.6566.e380
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Gi1/0/1             Root FWD 19        128.1    P2p
Gi1/0/2             Desg FWD 4         128.2    P2p          ← Both ports forwarding.
```

Figure 54: Cisco-B: output from the **show spanning-tree detail** command

```
Switch#sh spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 32769, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 10 last change occurred 03:23:16 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0001 is root forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.1.
    Designated root has priority 32769, address 000d.29e2.d500
    Designated bridge has priority 32769, address 000d.29e2.d500
    Designated port id is 128.3, designated path cost 0
    Timers: message age 15, forward delay 0, hold 0
    Number of transitions to forwarding state: 4
    Link type is point-to-point by default
    BPDU: sent 1007, received 212112

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is designated forwarding
    Port path cost 4, Port priority 128, Port Identifier 128.2.
    Designated root has priority 32769, address 000d.29e2.d500
    Designated bridge has priority 32769, address 000d.6566.e380
    Designated port id is 128.2, designated path cost 19
    Timers: message age 0, forward delay 0, hold 0
    Number of transitions to forwarding state: 2
    Link type is point-to-point by default
    BPDU: sent 6069, received 87

 VLAN0010 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 32768, sysid 10, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 10, address 000d.29e2.d500
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
  Topology change flag not set, detected flag not set
  Number of topology changes 6 last change occurred 03:22:46 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0010 is root forwarding
    Port path cost 19, Port priority 128, Port Identifier 128.1.
    Designated root has priority 10, address 000d.29e2.d500
    Designated bridge has priority 10, address 000d.29e2.d500
    Designated port id is 128.3, designated path cost 0
    Timers: message age 15, forward delay 0, hold 0
    Number of transitions to forwarding state: 2
    Link type is point-to-point by default
    BPDU: sent 13, received 213011
```

Figure 54: Cisco-B: output from the **show spanning-tree detail** command (continued)

```
Port 2 (GigabitEthernet1/0/2) of VLAN0010 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 10, address 000d.29e2.d500
  Designated bridge has priority 32778, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 2
  Link type is point-to-point by default
  BPDU: sent 6067, received 81

VLAN0100 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 100, address 000d.6566.e380
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 Current root has priority 100, address 000d.29e2.d500
 Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
 Topology change flag not set, detected flag not set
 Number of topology changes 7 last change occurred 03:22:47 ago
         from GigabitEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0100 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 100, address 000d.29e2.d500
  Designated bridge has priority 100, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 16, forward delay 0, hold 0
  Number of transitions to forwarding state: 3
  Link type is point-to-point by default
  BPDU: sent 14, received 213097

Port 2 (GigabitEthernet1/0/2) of VLAN0100 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 100, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 2
  Link type is point-to-point by default
  BPDU: sent 6069, received 81

VLAN0200 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 200, address 000d.6566.e380
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 Current root has priority 200, address 000d.29e2.d500
 Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
 Topology change flag not set, detected flag not set
 Number of topology changes 6 last change occurred 03:22:49 ago
         from GigabitEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300
```

Figure 54: Cisco-B: output from the **show spanning-tree detail** command (continued)

```
Port 1 (GigabitEthernet1/0/1) of VLAN0200 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 200, address 000d.29e2.d500
  Designated bridge has priority 200, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 15, forward delay 0, hold 0
  Number of transitions to forwarding state: 2
  Link type is point-to-point by default
  BPDU: sent 14, received 213010

Port 2 (GigabitEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 200, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 2
  Link type is point-to-point by default
  BPDU: sent 6070, received 81
```

AW Example G: Rapid PVST+ and MSTP— tagged VLANs

This example demonstrates compatibility between MSTP on an Allied Telesis switch running AlliedWare and rapid PVST+ on the Cisco switches, over trunk ports (ports with tagged VLANs). For a similar example using AlliedWare Plus, see "AW+ Example D: Rapid-PVST+ and MSTP—trunked VLANS" on page 32.

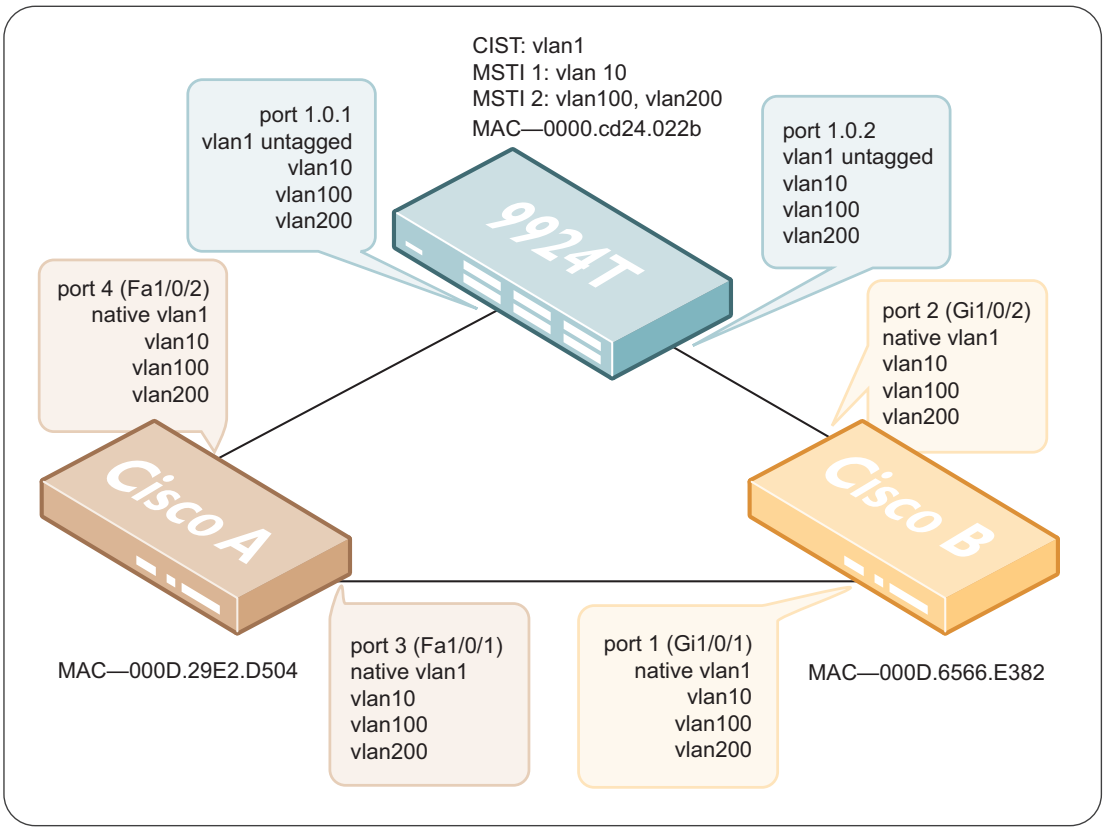
The same VLANs are configured on the switches as in the previous test, but in this example MSTP (with multiple spanning tree instances) is configured on the AT-9924T.

For a description of how MSTP and rapid PVST+ (and PVST+) interact, see "Interoperation between spanning tree protocols" on page 5.

Configuration

All three switches and their connecting ports have three VLANs configured in addition to the default VLAN. On the AT-9924T, the default vlan1 is left in the default CIST, vlan10 is associated with MSTI 1, and vlan100 and vlan200 with MSTI 2. On Cisco-A and Cisco-B, rapid-PVST+ automatically associates each VLAN with its own spanning tree.

Figure 55: Example G network configuration



AT-9924T configuration

AT-9924T configuration:

```
# VLAN general configuration
create vlan="vlan10" vid=10
create vlan="vlan100" vid=100
create vlan="vlan200" vid=200

# VLAN port configuration
add vlan="10" port=1-2 frame=tagged
add vlan="100" port=1-2 frame=tagged
add vlan="200" port=1-2 frame=tagged

# MSTP configuration
create mstp msti=1
add mstp msti=1 vlan=10
create mstp msti=2
add mstp msti=2 vlan=100,200
set mstp configname=atr revisionlevel=1
enable mstp
```

Cisco-A configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1 priority 4096
spanning-tree vlan 10 priority 61440
!
vlan 10,100,200
!
interface FastEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface FastEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Cisco-B configuration

```
spanning-tree mode rapid-pvst
spanning-tree extend system-id
spanning-tree vlan 1,10 priority 4096
!
vlan 10,100,200
!
interface GigabitEthernet1/0/1
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
!
interface GigabitEthernet1/0/2
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 1,10,100,200
 switchport mode trunk
```

Results

The output from the AT-9924T (Figure 57, Figure 58, Figure 59) shows that:

- The VLANs are associated with the correct MSTIs: the default vlan is in the CIST, vlan10 is in MSTI 1, and vlan100 and vlan200 are in MSTI 2 (Figure 57).
- Port 1 is forwarding and port 2 is discarding for both MSTI1 and MSTI 2 (Figure 58).
- It sees itself as the designated bridge for both MSTI 1 (Figure 58) and MSTI 2 (Figure 59).

The output from Cisco-A (Figure 60, Figure 61, Figure 62) and Cisco-B (Figure 63, Figure 64) shows that:

- Cisco-A is the root bridge for vlan1 (the CIST) and vlan100 and vlan 200.
- Cisco-B is the root bridge for vlan10.
- All the ports participating in the four per-VLAN spanning trees are forwarding.

Figure 56: Example G spanning tree topology

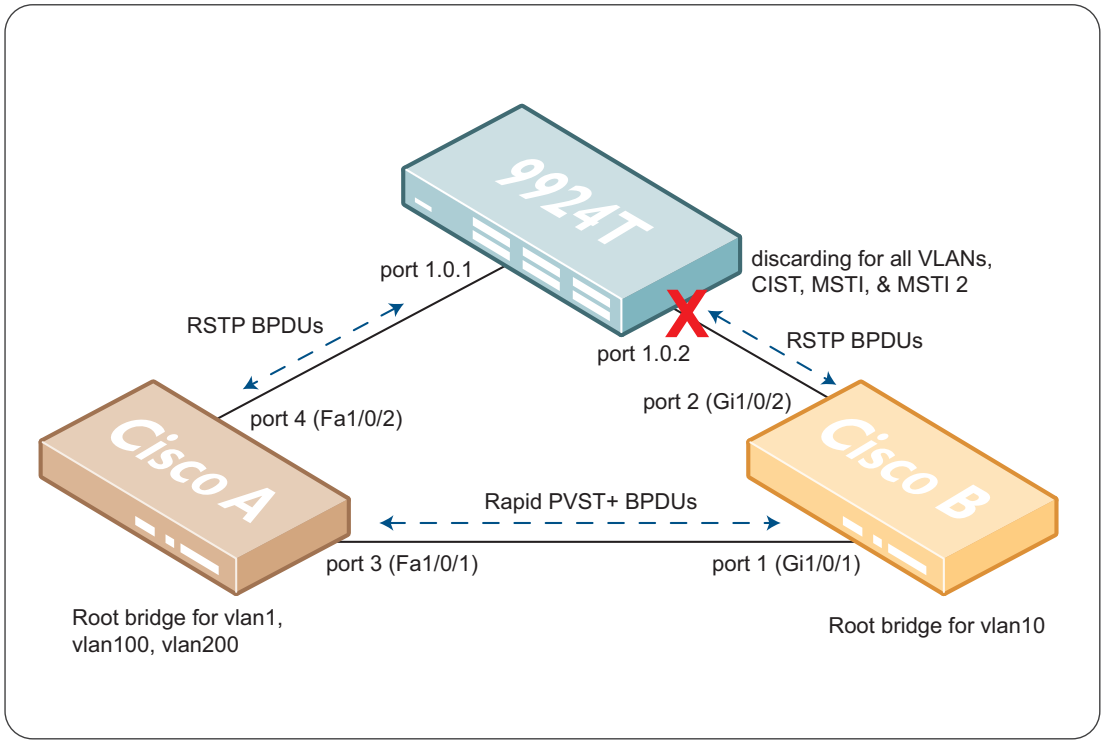


Figure 57: AT-9924T output from the **show mstp table** command

```
MST Configuration Table
--------------------------------------------------------------------------
Multiple Spanning Tree Instance    VLAN Members
--------------------------------------------------------------------------
CIST                               1-9,11-99,101-199,201-4094
MSTI 1                             10
MSTI 2                             100,200
--------------------------------------------------------------------------
```

Figure 58: AT-9924T output from the **show mstp msti** command for MSTI 1

```
Manager > sh mstp msti=1 port=1-2

MSTI 1 Port Information
------------------------------------------------------------------------
Port Number ............................ 1
  Port Identifier ...................... 128:1
  Port Role ............................ Master Port
  Port State ........................... Forwarding      ← Port 1 is forwarding for MSTI 1.

  Switch Port State .................... Enabled
  Link Status .......................... Up
  Port Path Cost ....................... 20000
  Designated Bridge .................... 32768 : 00-00-cd-24-02-2b
  Designated Port ...................... 128:1           ↑ Sees itself as designated bridge for MSTI 1.

  Regional Root Path Cost .............. 0

Port Number ............................ 2
  Port Identifier ...................... 128:2
  Port Role ............................ Alternate Port
  Port State ........................... Discarding      ← Port 2 is discarding.
  Switch Port State .................... Enabled
  Link Status .......................... Up
  Port Path Cost ....................... 200000
  Designated Bridge .................... 32768 : 00-00-cd-24-02-2b
  Designated Port ...................... 128:2           ↑ Sees itself as designated bridge for MSTI 1
  Regional Root Path Cost .............. 0
------------------------------------------------
```

Figure 59: AT-9924T output from the **show mstp msti** command for MSTI 2

```
Manager > sh mstp msti=2 port=1-2

MSTI 2 Port Information
------------------------------------------------------------------------
Port Number ............................ 1
  Port Identifier ...................... 128:1
  Port Role ............................ Master Port
  Port State ........................... Forwarding      ← Port 1 is forwarding for MSTI 2.
  Switch Port State .................... Enabled
  Link Status .......................... Up
  Port Path Cost ....................... 20000
  Designated Bridge .................... 32768 : 00-00-cd-24-02-2b
  Designated Port ...................... 128:1           ↑ Sees itself as designated bridge for MSTI 2
  Regional Root Path Cost .............. 0

Port Number ............................ 2
  Port Identifier ...................... 128:2
  Port Role ............................ Alternate Port
  Port State ........................... Discarding      ← Port 2 is discarding for MSTI 2.
  Switch Port State .................... Enabled
  Link Status .......................... Up
  Port Path Cost ....................... 200000
  Designated Bridge .................... 32768 : 00-00-cd-24-02-2b
  Designated Port ...................... 128:2           ↑ Sees itself as designated bridge for MSTI 2
  Regional Root Path Cost .............. 0
------------------------------------------------
```

Figure 60: Cisco-A: output from the **show spanning-tree summary** command

```
Switch#show spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: VLAN0001, VLAN0100, VLAN0200

Extended system ID           is enabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
```

← Cisco-A is the root bridge for vlan1, vlan100, vlan200.

All ports are forwarding ↓ for all VLANs.

Figure 61: Cisco-A: output from the **show spanning-tree active** command

```
VLAN0001
  Spanning tree enabled protocol rstp
  Root ID     Priority    4097
              Address     000d.29e2.d500
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    4097   (priority 4096 sys-id-ext 1)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p

VLAN0010
  Spanning tree enabled protocol rstp
  Root ID     Priority    4106
              Address     000d.6566.e380
              Cost        19
              Port        4 (FastEthernet1/0/2)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    61450  (priority 61440 sys-id-ext 10)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Root FWD 19        128.4    P2p
```

← Cisco-A is root bridge for vlan1.

← Cisco-B is root bridge for vlan10.

Figure 61: Cisco-A: output from the **show spanning-tree active** command (continued)

```
VLAN0100
  Spanning tree enabled protocol rstp
  Root ID     Priority    32868
              Address     000d.29e2.d500      ← Cisco-A is root bridge for vlan100.
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32868  (priority 32768 sys-id-ext 100)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p

VLAN0200
  Spanning tree enabled protocol rstp
  Root ID     Priority    32968
              Address     000d.29e2.d500      ← Cisco-A is root bridge for vlan200.
              This bridge is the root
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32968  (priority 32768 sys-id-ext 200)
              Address     000d.29e2.d500
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300

Interface           Role Sts Cost      Prio.Nbr Type
------------------- ---- --- --------- -------- --------------------------
Fa1/0/1             Desg FWD 19        128.3    P2p
Fa1/0/2             Desg FWD 19        128.4    P2p
```

Figure 62: Cisco-A: output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.29e2.d500
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  We are the root of the spanning tree                    ← Cisco-A is root bridge for vlan1.
  Topology change flag not set, detected flag not set
  Number of topology changes 13 last change occurred 01:13:22 ago
          from FastEthernet1/0/1
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 3 (FastEthernet1/0/1) of VLAN0001 is designated forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.3.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.3, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 2189, received 1
```

Figure 62: Cisco-A: output from the **show spanning-tree detail** command (continued)

```
Port 4 (FastEthernet1/0/2) of VLAN0001 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 4097, address 000d.29e2.d500
  Designated bridge has priority 4097, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 35357, received 19

VLAN0010 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 61440, sysid 10, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 Current root has priority 4106, address 000d.6566.e380
 Root port is 4 (FastEthernet1/0/2), cost of root path is 19
 Topology change flag not set, detected flag not set
 Number of topology changes 9 last change occurred 01:12:54 ago
         from FastEthernet1/0/1
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0010 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 4106, address 000d.6566.e380
  Designated bridge has priority 61450, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2191, received 0

Port 4 (FastEthernet1/0/2) of VLAN0010 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 4106, address 000d.6566.e380
  Designated bridge has priority 4106, address 000d.6566.e380
  Designated port id is 128.1, designated path cost 0
  Timers: message age 15, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 22, received 35359

VLAN0100 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 100, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree
 Topology change flag not set, detected flag not set
 Number of topology changes 9 last change occurred 01:12:56 ago
         from FastEthernet1/0/1
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300
```

← Cisco-B is root bridge for vlan10.

← Cisco-A is root bridge for vlan100.

Figure 62: Cisco-A: output from the **show spanning-tree detail** command (continued)

```
Port 3 (FastEthernet1/0/1) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2191, received 0

Port 4 (FastEthernet1/0/2) of VLAN0100 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 35358, received 23

VLAN0200 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 200, address 000d.29e2.d500
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-A is root bridge for vlan200.
 Topology change flag not set, detected flag not set
 Number of topology changes 9 last change occurred 01:12:58 ago
         from FastEthernet1/0/1
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 3 (FastEthernet1/0/1) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.3.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.3, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2193, received 0

Port 4 (FastEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.4.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 35359, received 23
```

Figure 63: Cisco-B—output from the **show spanning-tree summary** command

```
Switch#sh spanning-tree summary
Switch is in rapid-pvst mode
Root bridge for: VLAN0010                          ← Cisco-B is root bridge for vlan10.
Extended system ID           is enabled
Portfast Default             is disabled
PortFast BPDU Guard Default  is disabled
Portfast BPDU Filter Default is disabled
Loopguard Default            is disabled
EtherChannel misconfig guard is enabled
UplinkFast                   is disabled
BackboneFast                 is disabled
Configured Pathcost method used is short

Name                   Blocking Listening Learning Forwarding STP Active
---------------------- -------- --------- -------- ---------- ----------
VLAN0001                      0         0        0          2          2
VLAN0010                      0         0        0          2          2
VLAN0100                      0         0        0          2          2
VLAN0200                      0         0        0          2          2
---------------------- -------- --------- -------- ---------- ----------
4 vlans                       0         0        0          8          8
```

Figure 64: Cisco-B: output from the **show spanning-tree detail** command

```
Switch#show spanning-tree detail

 VLAN0001 is executing the rstp compatible Spanning Tree protocol
  Bridge Identifier has priority 4096, sysid 1, address 000d.6566.e380
  Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
  Current root has priority 4097, address 000d.29e2.d500          ← Cisco-A is root
  Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19    bridge for vlan1.
  Topology change flag not set, detected flag not set
  Number of topology changes 18 last change occurred 01:27:10 ago
          from GigabitEthernet1/0/2
  Times:  hold 1, topology change 35, notification 2
          hello 2, max age 20, forward delay 15
  Timers: hello 0, topology change 0, notification 0, aging 300

 Port 1 (GigabitEthernet1/0/1) of VLAN0001 is root forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.29e2.d500
   Designated port id is 128.4, designated path cost 0
   Timers: message age 15, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 19, received 35768

 Port 2 (GigabitEthernet1/0/2) of VLAN0001 is designated forwarding
   Port path cost 4, Port priority 128, Port Identifier 128.2.
   Designated root has priority 4097, address 000d.29e2.d500
   Designated bridge has priority 4097, address 000d.6566.e380
   Designated port id is 128.2, designated path cost 19
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   Link type is point-to-point by default
   BPDU: sent 2600, received 3
```

Figure 64: Cisco-B: output from the **show spanning-tree detail** command (continued)

```
VLAN0010 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 4096, sysid 10, address 000d.6566.e380
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 We are the root of the spanning tree                    ← Cisco-B is root bridge for vlan10.
 Topology change flag not set, detected flag not set
 Number of topology changes 18 last change occurred 01:26:42 ago
         from GigabitEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0010 is designated forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 4106, address 000d.6566.e380
  Designated bridge has priority 4106, address 000d.6566.e380
  Designated port id is 128.1, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 35770, received 22

 Port 2 (GigabitEthernet1/0/2) of VLAN0010 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 4106, address 000d.6566.e380
  Designated bridge has priority 4106, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 0
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2602, received 0

VLAN0100 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 100, address 000d.6566.e380
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 Current root has priority 32868, address 000d.29e2.d500
 Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19   ← Cisco-A is root
 Topology change flag not set, detected flag not set                bridge for vlan100.
 Number of topology changes 16 last change occurred 01:26:44 ago
         from GigabitEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0100 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 15, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 23, received 35770
```

Figure 64: Cisco-B: output from the **show spanning-tree detail** command (continued)

```
Port 2 (GigabitEthernet1/0/2) of VLAN0100 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 32868, address 000d.29e2.d500
  Designated bridge has priority 32868, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2603, received 0

VLAN0200 is executing the rstp compatible Spanning Tree protocol
 Bridge Identifier has priority 32768, sysid 200, address 000d.6566.e380
 Configured hello time 2, max age 20, forward delay 15, transmit hold-count 6
 Current root has priority 32968, address 000d.29e2.d500
 Root port is 1 (GigabitEthernet1/0/1), cost of root path is 19
 Topology change flag not set, detected flag not set
 Number of topology changes 16 last change occurred 01:26:47 ago
         from GigabitEthernet1/0/2
 Times:  hold 1, topology change 35, notification 2
         hello 2, max age 20, forward delay 15
 Timers: hello 0, topology change 0, notification 0, aging 300

Port 1 (GigabitEthernet1/0/1) of VLAN0200 is root forwarding
  Port path cost 19, Port priority 128, Port Identifier 128.1.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.29e2.d500
  Designated port id is 128.4, designated path cost 0
  Timers: message age 15, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 23, received 35771

Port 2 (GigabitEthernet1/0/2) of VLAN0200 is designated forwarding
  Port path cost 4, Port priority 128, Port Identifier 128.2.
  Designated root has priority 32968, address 000d.29e2.d500
  Designated bridge has priority 32968, address 000d.6566.e380
  Designated port id is 128.2, designated path cost 19
  Timers: message age 0, forward delay 0, hold 0
  Number of transitions to forwarding state: 1
  Link type is point-to-point by default
  BPDU: sent 2605, received 0
```

← Cisco-A is root bridge for vlan200.