

S Series Switches

Interoperation with Cisco PVST+

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About This Document

Purpose

This document describes how Huawei switches interoperate with Cisco switches running Per VLAN Spanning Tree Plus (PVST+) and provides detailed configuration procedures.






Intended Audience

This document is intended for:

- Network planning engineers
- Commissioning engineers
- Data configuration engineers
- Onsite maintenance engineers
- Network monitoring engineers
- System maintenance engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
 DANGER	Alerts you to a high risk hazard that could, if not avoided, result in serious injury or death.
 WARNING	Alerts you to a medium or low risk hazard that could, if not avoided, result in moderate or minor injury.
 CAUTION	Alerts you to a potentially hazardous situation that could, if not avoided, result in equipment damage, data loss, performance deterioration, or unanticipated results.
 TIP	Provides a tip that may help you solve a problem or save time.
 NOTE	Provides additional information to emphasize or supplement important points in the main text.

Change History

Changes between document issues are cumulative. The latest document issue contains all the changes made in earlier issues.

Issue 01 (2013-08-05)

This issue is the first official release.

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1 Overview

1.1 Cisco PVST+

Cisco switches support the following spanning tree protocols: Per VLAN Spanning Tree (PVST), Per VLAN Spanning Tree Plus (PVST+), Rapid PVST+, Multiple Instance Spanning Tree Protocol (MISTP), and Multiple Spanning Tree (MST). Cisco Catalyst series switches of IOS 12.2 and later versions support PVST+, Rapid PVST+, and MST. Some bridge protocol data units (BPDUs) of PVST+, Rapid PVST+, and MST use Cisco proprietary BPDU formats, which are different from the standard BPDU format defined by Institute of Electrical and Electronics Engineers (IEEE). Trunk ports on PVST+ or Rapid PVST+ capable Cisco switches send Cisco proprietary BPDUs in VLANs other than VLAN 1. The source MAC address of these BPDUs is the MAC address of the trunk port, and the destination MAC address is Cisco's reserved MAC address 01-00-0C-CC-CC-CD.

PVST can be considered a common STP running in each VLAN. Each VLAN has an independent STP status and a spanning tree calculated. Although PVST does not define instances like the Multiple Spanning Tree Protocol (MSTP), PVST can load balance traffic from different VLANs. PVST BPDUs carry VLAN information in data frames. The destination MAC address of PVST BPDUs is 01-00-0C-CC-CC-CD; therefore, PVST cannot interoperate with standard IEEE spanning tree protocols.

PVST+ is an enhancement to PVST. Like PVST, PVST+ does not support rapid transition, but it can work with the PortFast, UplinkFast, or BackboneFast feature to implement fast transition. PVST+ improves PVST by adding interoperability with standard spanning tree protocols. On an access port, PVST+ sends standard STP BPDUs in its native VLAN. On a trunk port, PVST+ sends standard STP BPDUs with the destination MAC address of 01-80-C2-00-00-00 only in VLAN 1, and sends Cisco proprietary BPDUs with the destination MAC address of 01-00-0C-CC-CC-CD in other VLANs allowed by the trunk port. Huawei switches transparently transmit Cisco proprietary BPDUs as common multicast frames.

Rapid PVST+ is an extension of PVST+. Compared with PVST+, Rapid PVST+ uses the Rapid Spanning Tree Protocol (RSTP) mechanism to implement rapid transition.

Cisco MST supports VLAN-instance mapping and defines the concept of domain; therefore, it can be considered as a standard MSTP protocol. MST BPDUs use the standard format defined by IEEE. Huawei and Cisco switches use different keys to generate MSTP digests in BPDUs. By default, MSTP and Cisco MST can implement only inter-domain interoperation because Huawei and Cisco switches generate different digests. To enable MSTP and Cisco MST to interoperate within an MPST domain, enable the digest snooping function on a Huawei switch's port connected to a Cisco switch.

1.1.1 Implementation

Cisco PVST+ state machine complies with IEEE 802.1D-2004 (RSTP). For details, see the IEEE 802.1D-2004 standard.

1.1.2 Working Mode

802.1D is backward compatible, so Cisco PVST+ is also backward compatible. PVST+ supports two working modes: STP and RSTP. You can configure the STP mode in a VLAN.

1.2 MSTP

MSTP is a new spanning tree protocol defined in IEEE 802.1s. Compared with STP and RSTP, MSTP has the following advantages:

- Divides a switching network into multiple domains. Each domain has multiple spanning trees, which are independent of each other. MSTP uses a Common and Internal Spanning Tree (CIST) to prevent loops in the entire network topology.
- Maps multiple VLANs to one instance, reducing communication costs and conserving resources. The topology of each multiple spanning tree instance (MSTI) is calculated independently (each instance has an independent spanning tree). Traffic from different VLAN is load balanced among the instances.
- MSTP provides a rapid port state transition mechanism similar to RSTP.
- MSTP is compatible with STP and RSTP.

1.2.1 Implementation

The MSTP state machine complies with IEEE 802.1s-2002 (MSTP). For details, see the IEEE 802.1s-2002 standard.

1.2.2 Working Mode

MSTP and RSTP are compatible and can recognize BPDUs of each other. STP, however, cannot identify MSTP BPDUs. For compatibility with STP, MSTP supports three working modes: STP-compatible mode, RSTP mode, and MSTP mode.

- In STP-compatible mode, each port sends STP BPDUs.
- In RSTP mode, each port sends RSTP BPDUs. When a port is connected to a device running STP, the port transitions to the STP-compatible mode.
- In MSTP mode, each port sends MSTP BPDUs. When a port is connected to a device running STP, the port transitions to the STP-compatible mode.

A device working in RSTP or MSTP mode can transition to the STP-compatible mode, but a device working in STP-compatible mode cannot transition to the RSTP or MSTP mode. To change the working mode from STP-compatible to RSTP or MSTP, perform an mCheck operation. On a switching network, if a port on an MSTP- or RSTP-capable device is connected to an STP-capable device, the port automatically transitions to the STP-compatible mode. When the STP-capable device is removed, the port cannot automatically restore the MSTP or RSTP mode, and still works in STP-compatible mode. To switch the port to the MSTP or RSTP mode, perform an mCheck operation. In STP-compatible or RSTP mode, multiple instances can be configured and the port states in MSTIs are the same as those in the

CIST. To reduce loads on the CPU, you are advised not to configure multiple instances in STP-compatible or RSTP mode.

2 Interoperability Analysis

2.1 Interoperation Networking Design

PVST+ is a Cisco proprietary protocol that uses a Cisco reserved multicast MAC address. Huawei switches do not support Cisco PVST+. The following methods can implement interoperation between Cisco PVST+ switches and Huawei switches:

- On a trunk port, Cisco PVST+ sends two types of BPDUs in VLAN 1: untagged Cisco PVST+ proprietary BPDUs and standard RSTP BPDUs. Huawei switches can identify RSTP BPDUs. When a Huawei switch connects to a trunk port of a Cisco PVST+ switch, enable RSTP or MSTP on the Huawei switch so that it can work with the Cisco PVST+ switch.
- On an access port, Cisco PVST+ sends standard BPDUs. When a Huawei switch connects to an access port of a Cisco PVST+ switch, enable RSTP or MSTP on the Huawei switch.
- (Not recommended) Huawei switches forward Cisco PVST+ BPDUs as service packets to access the Cisco PVST+ network. In this mode, the blocked ports are located on Cisco switches.

2.2 Comparison Between MSTP and Cisco PVST+

Table 2-1 lists differences between MSTP and Cisco PVST+.

Table 2-1 Differences between MSTP and Cisco PVST+

Protocol	Cisco PVST+	MSTP
Interoperability	Proprietary protocol	Standard protocol
State machine	Compatible with IEEE 802.1D-2004.	Compatible with IEEE 802.1s-2002 and IEEE 802.1D-2004.
Fast transition	In seconds	In seconds
Path cost standard	802.1D-1998 and 802.1T	802.1D-1998, 802.1T, and Legacy
BPDU protection	bpdu guard	bpdu-protection

Protocol	Cisco PVST+	MSTP
Loop protection	loop guard	loop-protection
Edge port	portfast	edged-port

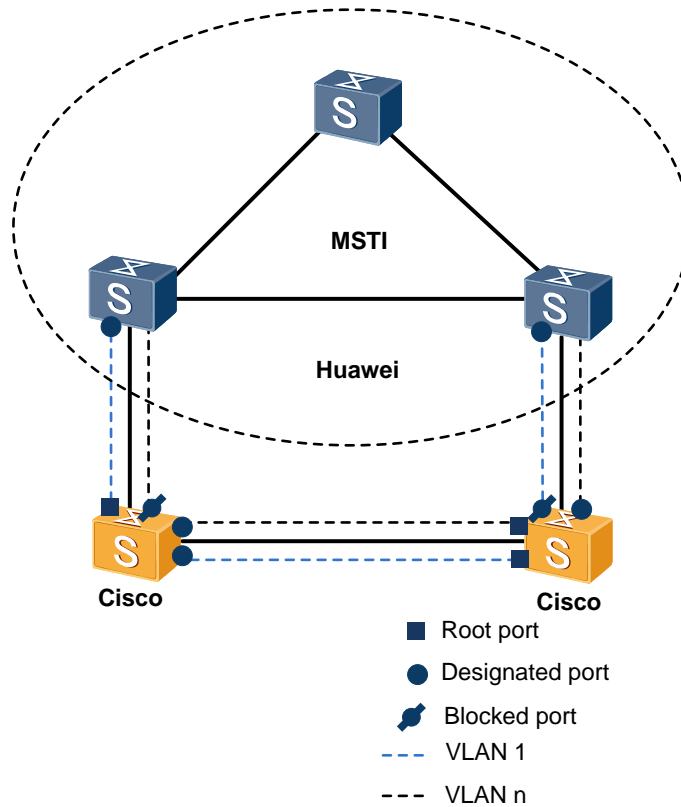
2.3 Interoperation Scenarios

Huawei switches do not support Cisco PVST+ and they run MSTP or RSTP to interoperate with Cisco switches. When Huawei switches run MSTP, their ports transition to RSTP mode after receiving RSTP BPDUs. Therefore, ports on Huawei switches work in RSTP mode when connecting to Cisco switches, regardless of whether Huawei switches are running MSTP or RSTP.

2.3.1 Root Bridge on an MSTP-Capable Huawei Switch

Set an appropriate bridge priority for VLAN 1 to ensure that the root bridge of VLAN 1 is located in the MSTI and the blocked ports are located on Cisco PVST+ switches. As shown in Figure 2-1, trunk ports of Cisco PVST+ send standard RSTP BPDUs only in VLAN 1. The common spanning tree (CST) for VLAN 1 of MSTP can communicate with the spanning tree for VLAN 1 of Cisco PVST+ (blue dashed line). After a port on a Huawei switch receives PVST+ BPDUs from a VLAN other than VLAN 1, the switch broadcasts the PVST+ BPDUs to all the other ports. Upon receiving the PVST+ BPDUs, Cisco PVST+ switches block the receiving ports (black dashed line). Because blocked ports for the VLANs are different, traffic can still be load balanced in the VLANs.

Figure 2-1 Root bridge on an MSTP-capable Huawei switch

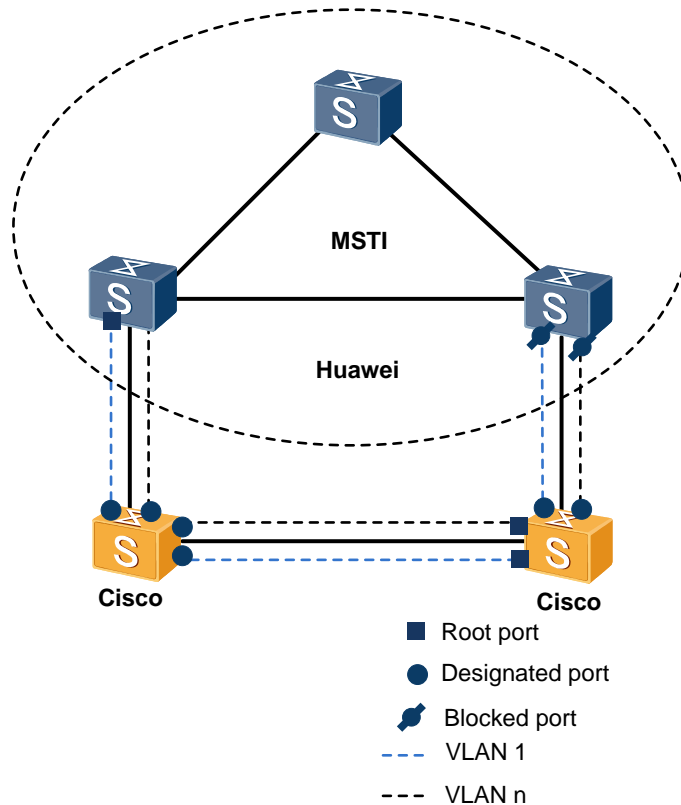


2.3.2 Root Bridge on a Cisco PVST+ Switch

Set bridge priorities of all Cisco PVST+ VLANs to ensure that the root bridge is located on a Cisco PVST+ switch and the blocked ports are located in the MSTI. The MSTI maintains the same forwarding state as all the instances; therefore, Huawei switches block service packets from VLANs other than VLAN 1. In addition, Huawei switches also block Cisco PVST+ BPDUs from VLANs other than VLAN 1. Therefore, Cisco PVST+ switches do not receive broadcast Cisco PVST+ BPDUs, ensuring forwarding of service packets from these VLANs.

Figure 2-2 shows the root bridge on a Cisco PVST+ switch and blocked ports on Huawei switches.

Figure 2-2 Root bridge on a Cisco PVST+ switch



2.4 Precautions

Regardless of the MSTP or RSTP mode, interworking ports work in RSTP mode. When interworking ports on Huawei switches are blocked, all VLANs matching instances are blocked and load balancing cannot be implemented. Therefore, it is recommended that the root bridge be deployed in the MSTI.

2.5 Product and Version Support

2.5.1 Huawei Version

Applicable to Huawei switches of all versions.

2.5.2 Cisco Version

Cisco Catalyst series switches of IOS 12.2 and later versions that support PVST+, Rapid PVST+, and MST can interoperate with Huawei switches working in STP, RSTP, or MSTP mode.

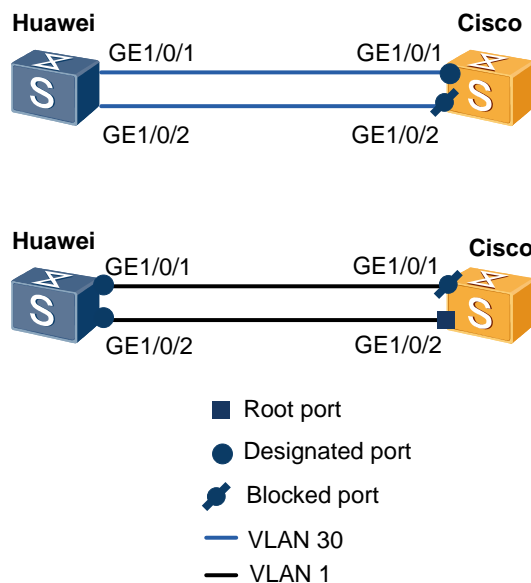
When Cisco switches of versions earlier than IOS 12.2 work in RPVST or PVST mode, they cannot interoperate with MSTP-capable Huawei switches. Huawei switches can only transparently forward BPDUs.

3 Configuration Examples

3.1 Example 1: Interoperation Between Huawei Switches (Root Bridge) and Cisco PVST+ Switches

3.1.1 Network Topology

Figure 3-1 Interoperation between Huawei switches (root bridge) and Cisco PVST+ switches



3.1.2 Configuration

Configuration Requirements

Huawei switches do not support Cisco PVST+ and they run MSTP or RSTP to interoperate with Cisco switches. Load balancing is required, so a Huawei switch must be configured as the root bridge. When Huawei switches run MSTP, their ports connected to Cisco switches automatically switch to the RSTP mode, so the MSTP and RSTP modes have the same effect on Cisco PVST+ switches. As shown in Figure 3-1, Huawei S5700SI switches

run MSTP and connect to Cisco switches through GE1/0/1 and GE1/0/2, which automatically switch to the RSTP mode. The blocked port of VLAN 1 is GE1/0/1 on the Cisco switch, and the blocked port of VLAN 30 is GE1/0/2 on the Cisco switch.

Configuration Methods

- On Cisco switches: Configure the same path cost algorithm on all Cisco switches. Set an appropriate bridge priority for VLAN 1 to ensure that it is lower than the bridge priority of Huawei CST, and set bridge priorities for other VLANs based on the site requirements.
- On Huawei switches: Configure the same path cost algorithm on all Huawei switches. Ensure that the bridge priority of Huawei CST is higher than that of Cisco VLAN 1.

Configuration Files

- Cisco switches

```
spanning-tree mode rapid-pvst
spanning-tree logging
spanning-tree extend system-id
spanning-tree vlan 1 priority 4096
spanning-tree pathcost method long
!
interface GigabitEthernet1/0/1
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 1,30
  switchport mode trunk
  spanning-tree vlan 30 port-priority 48
end
!
interface GigabitEthernet1/0/2
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 1,30
  switchport mode trunk
end
```

- Huawei switches

```
stp root primary
#
interface GigabitEthernet1/0/1
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 30
#
interface GigabitEthernet1/0/2
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 30
#
```

3.1.3 Configuration Notes

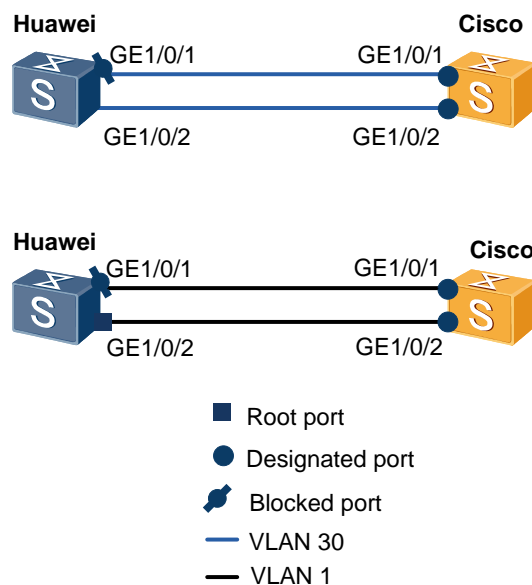
- Ensure that spanning trees in all VLANs use a Huawei switch as the root bridge.
- Configure Huawei switches to work in MSTP or RSTP mode, and do not use the STP-compatible mode.

- Cisco native VLAN traffic is untagged, so the PVID on Huawei switches must be the same as the native VLAN ID on Cisco switches.

3.2 Example 2: Interoperation Between Huawei Switches and Cisco PVST+ Switches (Root Bridge)

3.2.1 Network Topology

Figure 3-2 Interoperation between Huawei switches and Cisco PVST+ switches (root bridge)



3.2.2 Configuration

Configuration Requirements

Huawei switches do not support Cisco PVST+ and they run MSTP or RSTP to interoperate with Cisco switches. Load balancing is not required, so a Cisco PVST+ switch can be configured as the root bridge. As shown in Figure 3-2, Huawei S5700SI switches run MSTP and connect to Cisco switches through GE1/0/1 and GE1/0/2, which automatically switch to the RSTP mode. The blocked port of VLAN 1 is GE1/0/1 on Huawei S5700SI. Service packets of VLAN 30 are also blocked, and therefore Cisco PVST+ BPDUs cannot be broadcast in VLAN 30. As a result, both the two Cisco PVST+ ports (GE1/0/1 and GE1/0/2) connected to the Huawei switch in VLAN 30 become designated ports. Fast convergence cannot be implemented in VLAN 30 because GE1/0/2 on the Cisco switch cannot receive packets from VLAN 30.

Configuration Methods

- On Cisco switches: Configure a Cisco switch as the PVST+ root bridge. Configure the same path cost algorithm on all Cisco switches. Set an appropriate bridge priority for VLAN 1 to ensure that it is higher than the bridge priority of Huawei CST.

- On Huawei switches: Configure the same path cost algorithm on all Huawei switches. Ensure that the bridge priority of Huawei CST is lower than that of Cisco VLAN 1.

Configuration Files

- Cisco switches

```
spanning-tree mode rapid-pvst
spanning-tree logging
spanning-tree extend system-id
spanning-tree vlan 1 priority 0
spanning-tree pathcost method long
!
interface GigabitEthernet1/0/1
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 1,30
  switchport mode trunk
end
!
interface GigabitEthernet1/0/2
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 1,30
  switchport mode trunk
end
```

- Huawei switches

```
#
interface GigabitEthernet1/0/1
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 30
#
interface GigabitEthernet1/0/2
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 30
#
```

3.2.3 Configuration Notes

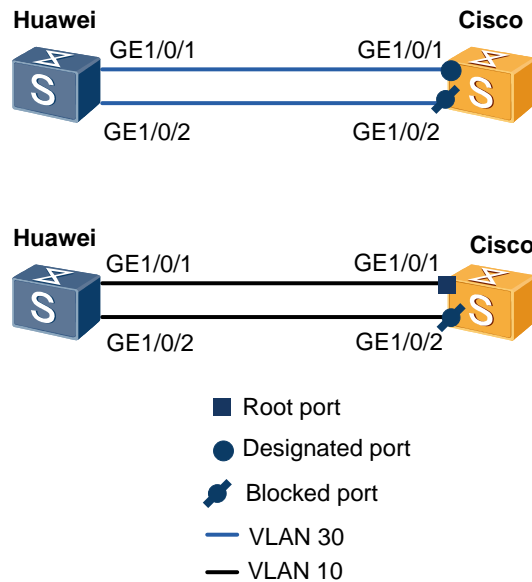
This plan implements fast convergence only in VLAN 1. Other VLANs cannot implement fast convergence or load balancing. Therefore, this plan is not recommended.

3.3 Example 3: Interoperation with Cisco PVST+ Switches by Forwarding PVST+ BPDUs

Cisco switches do not process BPDUs of VLAN 1 forwarded by Huawei switches. Therefore, this plan applies only to VLANs other than VLAN 1.

3.3.1 Network Topology

Figure 3-3 Huawei switches forwarding PVST+ BPDUs from Cisco PVST+ switches



3.3.2 Configuration

Configuration Requirements

Huawei switches do not support Cisco PVST+ and can forward PVST+ BPDUs as service packets to access the Cisco network. As shown in Figure 3-3, ports GE1/0/1 and GE1/0/2 on Huawei S5700SI switches forward PVST+ BPDUs.

Configuration Methods

- On Cisco switches: Configure a Cisco switch as the PVST+ root bridge. Configure the same path cost algorithm on all Cisco switches.
- On Huawei switches: Add ports connected to Cisco switches to the corresponding Cisco PVST VLANs. The ports do not participate in STP calculation.

Configuration Files

- Cisco switches

```
spanning-tree mode pvst
spanning-tree logging
spanning-tree extend system-id
spanning-tree pathcost method long
!
interface GigabitEthernet1/0/1
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 10,30
  switchport mode trunk
end
!
```

```
interface GigabitEthernet1/0/2
  switchport trunk encapsulation dot1q
  switchport trunk allowed vlan 10,30
  switchport mode trunk
end
```

- Huawei switches

```
#
interface GigabitEthernet1/0/1
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 10 30
  stp disable
#
interface GigabitEthernet1/0/2
  undo shutdown
  port link-type trunk
  port trunk allow-pass vlan 10 30
  stp disable
#
```

3.3.3 Configuration Notes

- Do not enable STP on Huawei switch ports that transparently transmit Cisco PVST+ BPDUs. Otherwise, these ports cannot forward PVST+ BPDUs but still send BPDUs, which interfere with PVST+ calculation on Cisco switches.
- Cisco native VLAN traffic is untagged, so the PVID on Huawei switches must be the same as the native VLAN ID on Cisco switches.

4 References

- IEEE 802.1D-1998: <http://www.ieee.org>
- IEEE 802.1W-2001: <http://www.ieee.org>
- IEEE 802.1s-2002: <http://www.ieee.org>
- IEEE 802.1D-2004: <http://www.ieee.org>
- IEEE 802.1Q-2005: <http://www.ieee.org>
- IEEE 802.1Q-2011: <http://www.ieee.org>