



Configuring Spanning Tree

CHAPTERS

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2. STP/RSTP Configurations
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This guide applies to:

T1500G-10PS v2 or above, T1500G-8T v2 or above, T1500G-10MPS v2 or above, T1500-28PCT v3 or above, T1600G-18TS v2 or above, T1600G-28TS v3 or above, T1600G-28PS v3 or above, T1600G-52TS v3 or above, T1600G-52PS v3 or above, T2600G-28TS v3 or above, T2600G-52TS v3 or above, T2600G-28MPS v3 or above, T2600G-28SQ v1 or above.

1 Spanning Tree

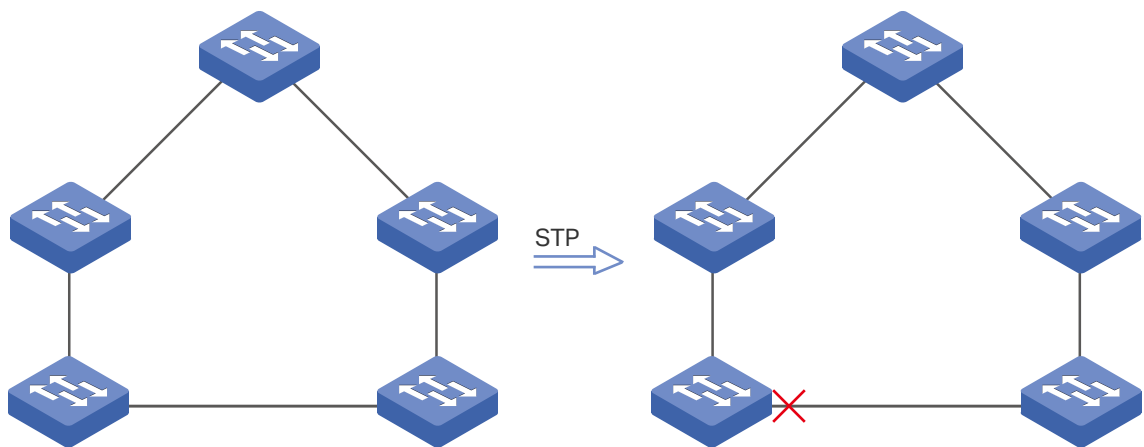
1.1 Overview

STP

STP (Spanning Tree Protocol) is a layer 2 Protocol that prevents loops in the network. As is shown in Figure 1-1, STP helps to:

- Block specific ports of the switches to build a loop-free topology.
- Detect topology changes and automatically generate a new loop-free topology.

Figure 1-1 STP Function



RSTP

RSTP (Rapid Spanning Tree Protocol) provides the same features as STP. Besides, RSTP can provide much faster spanning tree convergence.

MSTP

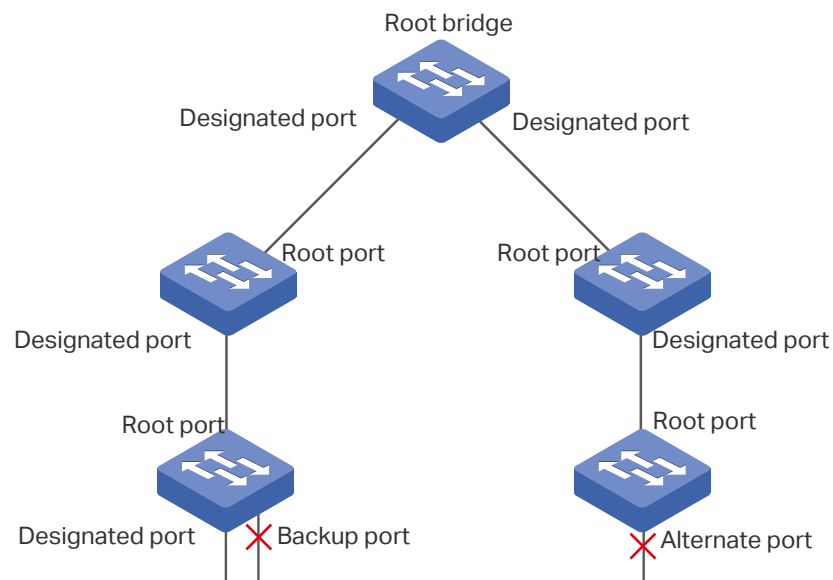
MSTP (Multiple Spanning Tree Protocol) also provides the fast spanning tree convergence as RSTP. In addition, MSTP enables VLANs to be mapped to different spanning trees (MST instances), and traffic in different VLANs will be transmitted along their respective paths, implementing load balancing.

1.2 Basic Concepts

1.2.1 STP/RSTP Concepts

Based on the networking topology below, this section will introduce some basic concepts in STP/RSTP.

Figure 1-2 STP/RSTP Topology



Root Bridge

The root bridge is the root of a spanning tree. The switch with the lowest bridge ID will be the root bridge, and there is only one root bridge in a spanning tree.

Bridge ID

Bridge ID is used to select the root bridge. It is composed of a 2-byte priority and a 6-byte MAC address. The priority is allowed to be configured manually on the switch, and the switch with the lowest priority value will be elected as the root bridge. If the priority of the switches are the same, the switch with the smallest MAC address will be selected as the root bridge.

Port Role

- Root Port

The root port is selected on non-root bridge that can provide the lowest root path cost. There is only one root port in each non-root bridge.

- Designated Port

The designated port is selected in each LAN segment that can provide the lowest root path cost from that LAN segment to the root bridge.

- **Alternate Port**

If a port is not selected as the designated port for it receives better BPDUs from another switch, it will become an alternate port.

In RSTP/MSTP, the alternate port is the backup for the root port. It is blocked when the root port works normally. Once the root port fails, the alternate port will become the new root port.

In STP, the alternate port is always blocked.

- **Backup Port**

If a port is not selected as the designated port for it receives better BPDUs from the switch it belongs to, it will become an backup port.

In RSTP/MSTP, the backup port is the backup for the designated port. It is blocked when the designated port works normally. Once the root port fails, the backup port will become the new designated port.

In STP, the backup port is always blocked.

- **Disable Port**

The disconnected port with spanning tree function enabled .

Port Status

Generally, in STP, the port status includes: Blocking, Listening, Learning, Forwarding and Disabled.

- **Blocking**

In this status, the port receives and sends BPDUs. The other packets are dropped.

- **Listening**

In this status, the port receives and sends BPDUs. The other packets are dropped.

- **Learning**

In this status, the port receives and sends BPDUs. It also receives the other user packets to update its MAC address table, but doesn't forward them.

- **Forwarding**

In this status, the port receives and sends BPDUs. It also receives the other user packets to update its MAC address table, and forwards them.

- **Disabled**

In this status, the port is not participating in the spanning tree, and drops all the packets it receives.

In RSTP/MSTP, the port status includes: Discarding, Learning and Forwarding. The Discarding status is the grouping of STP's Blocking, Listening and Disabled, and the Learning and Forwarding status correspond exactly to the Learning and Forwarding status specified in STP.

In TP-Link switches, the port status includes: Blocking, Learning, Forwarding and Disconnected.

- **Blocking**

In this status, the port receives and sends BPDUs. The other packets are dropped.

- **Learning**

In this status, the port receives and sends BPDUs. It also receives the other user packets to update its MAC address table, but doesn't forward them.

- **Forwarding**

In this status, the port receives and sends BPDUs. It also receives the other user packets to update its MAC address table, and forwards them.

- **Disconnected**

In this status, the port is enabled with spanning tree function but not connected to any device.

Path Cost

The path cost reflects the link speed of the port. The smaller the value, the higher link speed the port has.

The path cost can be manually configured on each port. If not, the path cost values are automatically calculated according to the link speed as shown below:

Table 1-1 The Default Path Cost Value

Link Speed	Path Cost Value
10Mb/s	2,000,000
100Mb/s	200,000
1Gb/s	20,000
10Gb/s	2,000

Root Path Cost

The root path cost is the accumulated path costs from the root bridge to the other switches. When root bridge sends its BPDU, the root path cost value is 0. When a switch receives this BPDU, the root path cost will be increased according to the path cost of the receive port. Then it create a new BPDU with the new root file cost and forwards it to the downstream switch. The value of the accumulated root path cost increases as the BPDU spreads further.

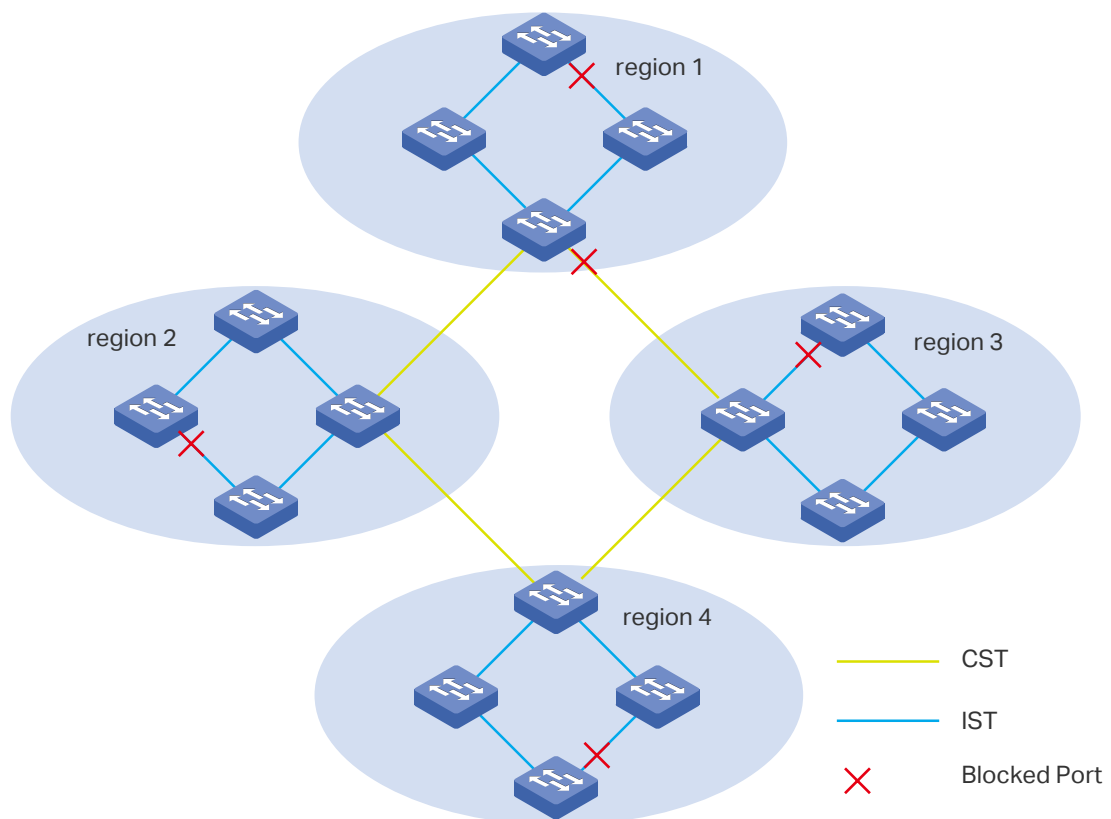
BPDU

BPDU is a kind of packet that is used to generate and maintain the spanning tree. The BPDUs (Bridge Protocol Data Unit) contain a lot of information, like bridge ID, root path cost, port priority and so on. Switches share these information to help determine the spanning tree topology.

1.2.2 MSTP Concepts

MSTP, compatible with STP and RSTP, has the same basic elements used in STP and RSTP. Based on the networking topology, this section will introduce some concepts only used in MSTP.

Figure 1-3 MSTP Topology



MST Region

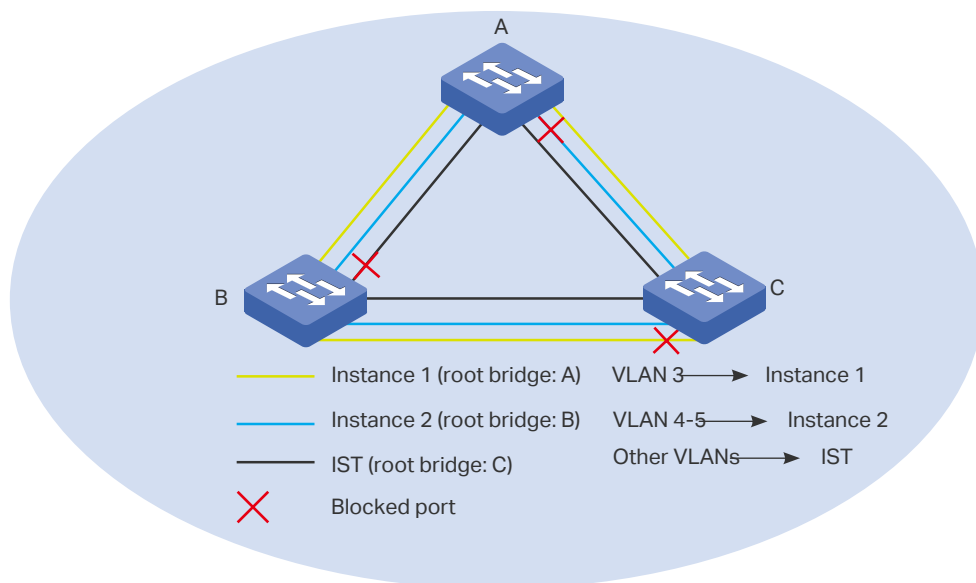
An MST region consists of multiple interconnected switches. The switches with the same following characteristics are considered as in the same region:

- Same region name
- Same revision level
- Same VLAN-Instance mapping

MST Instance

The MST instance is a spanning tree running in the MST region. Multiple MST instances can be established in one MST region and they are independent of each other. As is shown in Figure 1-4, there are three instances in a region, and each instance has its own root bridge.

Figure 1-4 MST Region



VLAN-Instance Mapping

VLAN-Instance Mapping describes the mapping relationship between VLANs and instances. Multiple VLANs can be mapped to a same instance, but one VLAN can be mapped to only one instance. As Figure 1-4 shows, VLAN 3 is mapped to instance 1, VLAN 4 and VLAN 5 are mapped to instance 2, the other VLANs are mapped to the IST.

IST

The Internal Spanning Tree (IST), which is a special MST instance with an instance ID 0. By default, all the VLANs are mapped to IST.

CST

The Common Spanning Tree (CST), that is the spanning tree connecting all MST regions. As is shown in Figure 1-3, region1-region 4 are connected by the CST.

CIST

The Common and Internal Spanning Tree (CIST), comprising IST and CST. CIST is the spanning tree that connects all the switches in the network.

1.3 STP Security

STP Security prevents the loops caused by wrong configurations or BPDU attacks. It contains Loop Protect, Root Protect, BPDU Protect, BPDU Filter and TC Protect functions.

» Loop Protect

Loop Protect function is used to prevent loops caused by link congestions or link failures. It is recommended to enable this function on root ports and alternate ports.

If the switch cannot receive BPDUs because of link congestions or link failures, the root port will become a designated port and the alternate port will transit to forwarding status, so loops will occur.

With Loop Protect function enabled, the port will temporarily transit to blocking state when the port does not receive BPDUs. After the link restores to normal, the port will transit to its normal state, so loops can be prevented.

» Root Protect

Root Protect function is used to ensure that the desired root bridge will not lose its position. It is recommended to enable this function on the designated ports of the root bridge.

Generally, the root bridge will lose its position once receiving higher-priority BPDUs caused by wrong configurations or malicious attacks. In this case, the spanning tree will be regenerated, and traffic needed to be forwarded along high-speed links may be lead to low-speed links.

With root protect function enabled, when the port receives higher-priority BPDUs, it will temporarily transit to blocking state. After two times of forward delay, if the port does not receive any higher-priority BPDUs, it will transit to its normal state.

» BPDU Protect

BPDU Protect function is used to prevent the port from receiving BPUDs. It is recommended to enable this function on edge ports.

Normally edge ports do not receive BPDUs, but if a user maliciously attacks the switch by sending BPDUs, the system automatically configures these ports as non-edge ports and regenerates the spanning tree.

With BPDU protect function enabled, the edge port will be shutdown when it receives BPDUs, and reports these cases to the administrator. Only the administrator can restore it.

» BPDU Filter

BPDU filter function is to prevent BPDU flooding in the network. It is recommended to enable this function on edge ports.

If a switch receives malicious BPDUs, it forwards these BPDUs to the other switches in the network, and the spanning tree will be continuously regenerated. In this case, the switch occupies too much CPU or the protocol status of BPDUs is wrong.

With BPDU filter function enabled, the port does not receive or forward BPDUs, but it sends out its own BPDUs, preventing the switch from being attacked by BPDUs.

» TC Protect

TC Protect function is used to prevent the switch from frequently removing MAC address entries. It is recommended to enable this function on the ports of non-root switches.

A switch removes MAC address entries upon receiving TC-BPDUs (the packets used to announce changes in the network topology). If a user maliciously sends a large number of TC-BPDUs to a switch in a short period, the switch will be busy with removing MAC address entries, which may decrease the performance and stability of the network.

With TC protect function enabled, if the number of the received TC-BPDUs exceeds the maximum number you set in the TC threshold, the switch will not remove MAC address entries in the TC protect cycle.

Follow these steps to configure STP/RSTP parameters on ports:

- 1) In the **Port Config** section, configure STP/RSTP parameters on ports.

UNIT	Select the desired unit or LAGs.
Status	Enable or disable spanning tree function on the desired port.
Priority	<p>Specify the Priority for the desired port. The value should be an integral multiple of 16, ranging from 0 to 240.</p> <p>The port with lower value has the higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities between these port and select a root port with the highest priority.</p>
Ext-Path Cost	<p>Enter the value of the external path cost. The valid values are from 0 to 2000000. The default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed.</p> <p>For STP/RSTP, external path cost indicates the path cost of the port in spanning tree. The port with the lowest root path cost will be elected as the root port of the switch.</p> <p>For MSTP, external path cost indicates the path cost of the port in CST.</p>
Int-Path Cost	<p>Enter the value of the internal path cost. The default setting is Auto, which means the port calculates the internal path cost automatically according to the port's link speed. This parameter is only used in MSTP and you need not to configure it if the spanning tree mode is STP/RSTP.</p> <p>For MSTP, internal path cost is used to calculate the path cost in IST. The port with the lowest root path cost will be elected as the root port of the switch in IST.</p>
Edge Port	<p>Select Enable to set the port as an edge port.</p> <p>When the topology is changed, the edge port can transit its state from blocking to forwarding directly. For the quick generation of the spanning tree, it is recommended to set the ports that are connected to the end devices as edge ports.</p>
P2P Link	<p>Select the status of the P2P (Point-to-Point) link to which the ports are connected. During the regeneration of the spanning tree, if the port of P2P link is elected as the root port or the designated port, it can transit its state to forwarding directly.</p> <p>Three options are supported: Auto, Open(Force) and Closed(Force). By default, it is Auto.</p> <p>Auto: The switch automatically checks if the port is connected to a P2P link, then sets the status as Open or Closed.</p> <p>Open(Force): A port is set as the one that is connected to a P2P link. You should check the link first.</p> <p>Close(Force): A port is set as the one that is not connected to a P2P link. You should check the link first.</p>

MCheck	<p>Select whether to perform MCheck operations on the port. If a port on an RSTP-enabled/MSTP-enabled device is connected to an STP-enabled device, the port will switch to STP compatible mode and send packets in STP format. MCheck is used to switch the mode of the port back to RSTP/MSTP after the port is disconnected from the STP-enabled device. The MCheck configuration can take effect only once, after that the MCheck status of the port will switch to Disabled.</p>
Port Mode	<p>Displays the spanning tree mode of the port.</p> <p>STP: The spanning tree mode of the port is STP.</p> <p>RSTP: The spanning tree mode of the port is RSTP.</p> <p>MSTP: The spanning tree mode of the port is MSTP.</p>
Port Role	<p>Displays the role that the port plays in the spanning tree.</p> <p>Root Port: Indicates that the port is the root port in the spanning tree. It has the lowest path cost from the root bridge to this switch and is used to communicate with the root bridge.</p> <p>Designated Port: Indicates that the port is the designated port in the spanning tree. It has the lowest path cost from the root bridge to this physical network segment and is used to forward data for the corresponding network segment.</p> <p>Alternate Port: Indicates that the port is the alternate port in the spanning tree. It is the backup of the root port or master port.</p> <p>Backup Port: Indicates that the port is the backup port in the spanning tree. It is the backup of the designated port.</p> <p>Disabled: Indicates that the port is not participating in the spanning tree.</p>
Port Status	<p>Displays the port status.</p> <p>Forwarding: The port receives and sends BPDUs, and forwards user data.</p> <p>Learning: The port receives and sends BPDUs. It also receives user traffic, but doesn't forward the traffic.</p> <p>Blocking: The port only receives and sends BPDUs.</p> <p>Disconnected: The port has the spanning tree function enabled but is not connected to any device.</p>
LAG	<p>Displays the LAG the port belongs to.</p>

2) Click **Apply**.

2.1.2 Configuring STP/RSTP Globally

Choose the menu **L2 FEATURES > Spanning Tree > STP Config > STP Config** to load the following page.

Figure 2-2 Configuring STP/RSTP Globally

Global Config

Spanning Tree: Enable

Mode:

[Apply](#)

Parameters Config

CIST Priority: (0-61440, in increments of 4096)

Hello Time: seconds (1-10)

Max Age: seconds (6-40)

Forward Delay: seconds (4-30)

Tx Hold Count: pps (1-20)

Max Hops: hop (1-40)

[Apply](#)

Follow these steps to configure STP/RSTP globally:

- 1) In the **Parameters Config** section, configure the global parameters of STP/RSTP and click **Apply**.

CIST Priority	<p>Specify the CIST priority for the switch. CIST priority is a parameter used to determine the root bridge for spanning tree. The switch with the lower value has the higher priority.</p> <p>In STP/RSTP, CIST priority is the priority of the switch in spanning tree. The switch with the highest priority will be elected as the root bridge.</p> <p>In MSTP, CISP priority is the priority of the switch in CIST. The switch with the higher priority will be elected as the root bridge in CIST.</p>
Hello Time	Specify the interval between BPDUs' sending. The default value is 2. The root bridge sends configuration BPDUs at an interval of Hello Time. It works with the MAX Age to test the link failures and maintain the spanning tree.
Max Age	Specify the maximum time that the switch can wait without receiving a BPDU before attempting to regenerate a new spanning tree. The default value is 2.
Forward Delay	Specify the interval between the port state transition from listening to learning. The default value is 15. It is used to prevent the network from causing temporary loops during the regeneration of spanning tree. The interval between the port state transition from learning to forwarding is also the Forward Delay.
Tx Hold Count	Specify the maximum number of BPDU that can be sent in a second. The default value is 5.

Max Hops

Specify the maximum BPDU counts that can be forwarded in a MST region. The default value is 20. A switch receives BPDU, then decrements the hop count by one and generates BPDUs with the new value. When the hop reaches zero, the switch will discard the BPDU. This value can control the scale of the spanning tree in the MST region.

Note: Max Hops is a parameter configured in MSTP. You need not configure it if the spanning tree mode is STP/RSTP.

 **Note:**

To prevent frequent network flapping, make sure that Hello Time, Forward Delay, and Max Age conform to the following formulas:

- $2 * (\text{Hello Time} + 1) \leq \text{Max Age}$
- $2 * (\text{Forward Delay} - 1) \geq \text{Max Age}$

-
- 2) In the **Global Config** section, enable spanning tree function, choose the STP mode as STP/RSTP, and click **Apply**.

Spanning Tree

Check the box to enable the spanning tree function globally.

Mode

Select the desired spanning tree mode as STP/RSTP on the switch. By default, it's STP.

STP: Specify the spanning tree mode as STP.

RSTP: Specify the spanning tree mode as RSTP.

MSTP: Specify the spanning tree mode as MSTP.

2.1.3 Verifying the STP/RSTP Configurations

Verify the STP/RSTP information of your switch after all the configurations are finished.

Choose the menu **L2 FEATURES > Spanning Tree > STP Config > STP Summary** to load the following page.

Figure 2-3 Verifying the STP/RSTP Configurations

STP Summary

Spanning Tree: Enable

Spanning Tree Mode: STP

Local Bridge: 32768---00-0a-eb-13-a2-02

Root Bridge: 32768---00-0a-eb-13-a2-02

External Path Cost: 0

Regional Root Bridge: ---

Internal Path Cost: ---

Designated Bridge: 32768---00-0a-eb-13-a2-02

Root Port: ---

Latest TC Time: 2006-01-01 08:00:45

TC Count: 0

MSTP Instance Summary

Instance ID:

Instance Status: Disable

Local Bridge: ---

Regional Root Bridge: ---

Internal Path Cost: ---

Designated Bridge: ---

Root Port: ---

Latest TC Time: ---

TC Count: ---

[Refresh](#)

The **STP Summary** section shows the summary information of spanning tree :

Spanning Tree	Displays the status of the spanning tree function.
Spanning Tree Mode	Displays the spanning tree mode.
Local Bridge	Displays the bridge ID of the local bridge. The local bridge is the current switch.
Root Bridge	Displays the bridge ID of the root bridge.
External Path Cost	Displays the root path cost from the switch to the root bridge.
Regional Root Bridge	It is the root bridge of IST. It is not displayed when you choose the spanning tree mode as STP/RSTP.
Internal Path Cost	The internal path cost is the root path cost from the switch to the root bridge of IST. It is not displayed when you choose the spanning tree mode as STP/RSTP.

Designated Bridge	Displays the bridge ID of the designated bridge. The designated bridge is the switch that has designated ports.
Root Port	Displays the root port of the current switch.
Latest TC Time	Displays the latest time when the topology is changed.
TC Count	Displays how many times the topology has changed.

2.2 Using the CLI

2.2.1 Configuring STP/RSTP Parameters on Ports

Follow these steps to configure STP/RSTP parameters on ports:

Step 1	configure Enter global configuration mode.
Step 2	interface {fastEthernet <i>port</i> range fastEthernet <i>port-list</i> gigabitEthernet <i>port</i> range gigabitEthernet <i>port-list</i> ten-gigabitEthernet <i>port</i> range ten-gigabitEthernet <i>port-list</i> port-channel <i>port-channel-id</i> range port-channel <i>port-channel-list</i>} Enter interface configuration mode.
Step 3	spanning-tree Enable spanning tree function for desired ports.

Step 4 **spanning-tree common-config [port-priority *pri*] [ext-cost *ext-cost*] [portfast { enable | disable }] [point-to-point { auto | open | close }]**

Configure STP/RSTP parameters on the desired port .

pri: Specify the Priority for the desired port. The value should be an integral multiple of 16, ranging from 0 to 240. The default value is 128. Ports with lower values have higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities and select a root port with the highest priority.

ext-cost: Specify the value of the external path cost. The valid values are from 0 to 2000000 and the default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed.

For STP/RSTP, external path cost indicates the path cost of the port in spanning tree. The Port with the lowest root path cost will be elected as the root port of the switch.

For MSTP, external path cost indicates the path cost of the port in CST.

portfast { enable | disable }: Enable to set the port as an edge port. By default, it is disabled. When the topology is changed, the edge port can transit its state from blocking to forwarding directly. For the quick generation of the spanning tree, it is recommended to set the ports that are connected to the end devices as edge ports.

point-to-point { auto | open | close }: Select the status of the P2P (Point-to-Point) link to which the ports are connected. During the regeneration of the spanning tree, if the port of P2P link is elected as the root port or the designated port, it can transit its state to forwarding directly. Auto indicates that the switch automatically checks if the port is connected to a P2P link, then sets the status as Open or Closed. Open is used to set the port as the one that is connected to a P2P link. Close is used to set the port as the one that is not connected to a P2P link.

Step 5 **spanning-tree mcheck**

(Optional) Perform MCheck operations on the port.

If a port on an RSTP-enabled/MSTP-enabled device is connected to an STP-enabled device, the port will switch to STP compatible mode and send packets in STP format. MCheck is used to switch the mode of the port back to RSTP/MSTP after the port is disconnected from the STP-enabled device. The MCheck configuration can take effect only once, after that the MCheck status of the port will switch to Disabled.

Step 6 **show spanning-tree interface [fastEthernet *port* | gigabitEthernet *port* | ten-gigabitEthernet *port* | port-channel *lagid*] [edge | ext-cost | int-cost | mode | p2p | priority | role | state | status]**

(Optional) View the information of all ports or a specified port.

port: Specify the port number.

lagid: Specify the ID of the LAG.

ext-cost | int-cost | mode | p2p | priority | role | state | status: Display the specified information.

Step 7 **end**

Return to privileged EXEC mode.

Step 8 **copy running-config startup-config**

Save the settings in the configuration file.

The following example shows how to enable spanning tree function on port 1/0/3 and configure the port priority as 32 :

```
Switch#configure
```

```
Switch(config)#interface gigabitEthernet 1/0/3
```

```
Switch(config-if)#spanning-tree
```

```
Switch(config-if)#spanning-tree common-config port-priority 32
```

```
Switch(config-if)#show spanning-tree interface gigabitEthernet 1/0/3
```

Interface	State	Prio	Ext-Cost	Int-Cost	Edge	P2p	Mode
-----	-----	----	-----	-----	----	-----	-----
Gi1/0/3	Enable	32	Auto	Auto	No	No(auto)	N/A
Role	Status	LAG					
-----	-----	-----					
N/A	LnkDwn	N/A					

```
Switch(config-if)#end
```

```
Switch#copy running-config startup-config
```

2.2.2 Configuring Global STP/RSTP Parameters

Follow these steps to configure global STP/RSTP parameters of the switch:

Step 1 **configure**
Enter global configuration mode.

Step 2 **spanning-tree priority *pri***
Configure the priority of the switch.

pri: Specify the priority for the switch. The valid value is from 0 to 61440, which are divisible by 4096. The priority is a parameter used to determine the root bridge for spanning tree. The switch with the lower value has the higher priority.

In STP/RSTP, the value is the priority of the switch in spanning tree. The switch with the highest priority will be elected as the root bridge.

In MSTP, the value is the priority of the switch in CIST. The switch with the higher priority will be elected as the root bridge in CIST.

Step 3 **spanning-tree timer** [[**forward-time** *forward-time*] [**hello-time** *hello-time*] [**max-age** *max-age*]]

(Optional) Configure the Forward Delay, Hello Time and Max Age.

forward-time: Specify the value of Forward Delay. It is the interval between the port state transition from listening to learning. The valid values are from 4 to 30 in seconds, and the default value is 15. Forward Delay is used to prevent the network from causing temporary loops during the regeneration of spanning tree. The interval between the port state transition from learning to forwarding is also the Forward Delay.

hello-time: Specify the value of Hello Time. It is the interval between BPDUs' sending. The valid values are from 1 to 10 in seconds, and the default value is 2. The root bridge sends configuration BPDUs at an interval of Hello Time. It works with the MAX Age to test the link failures and maintain the spanning tree.

max-age: Specify the value of Max Age. It is the maximum time that the switch can wait without receiving a BPDU before attempting to regenerate a new spanning tree. The valid values are from 6 to 40 in seconds, and the default value is 20.

Step 4 **spanning-tree hold-count** *value*

Specify the maximum number of BPDU that can be sent in a second.

value: Specify the maximum number of BPDU packets that can be sent in a second. The valid values are from 1 to 20 pps, and the default value is 5.

Step 5 **show spanning-tree bridge**

(Optional) View the global STP/RSTP parameters of the switch.

Step 6 **end**

Return to privileged EXEC mode.

Step 7 **copy running-config startup-config**

Save the settings in the configuration file.

 **Note:**

To prevent frequent network flapping, make sure that Hello Time, Forward Delay, and Max Age conform to the following formulas:

- $2 * (\text{Hello Time} + 1) \leq \text{Max Age}$
- $2 * (\text{Forward Delay} - 1) \geq \text{Max Age}$

This example shows how to configure the priority of the switch as 36864, the Forward Delay as 12 seconds:

Switch#configure

Switch(config)#spanning-tree priority 36864

Switch(config)#spanning-tree timer forward-time 12

Switch(config)#show spanning-tree bridge

State	Mode	Priority	Hello-Time	Fwd-Time	Max-Age	Hold-Count	Max-Hops
-----	-----	-----	-----	-----	-----	-----	-----
Enable	Rstp	36864	2	12	20	5	20

```
Switch(config)#end
```

```
Switch#copy running-config startup-config
```

2.2.3 Enabling STP/RSTP Globally

Follow these steps to configure the spanning tree mode as STP/RSTP, and enable spanning tree function globally:

Step 1 **configure**

Enter global configuration mode.

Step 2 **spanning-tree mode { stp | rstp }**

Configure the spanning tree mode as STP/RSTP.

stp: Specify the spanning tree mode as STP .

rstp: Specify the spanning tree mode as RSTP .

Step 3 **spanning-tree**

Enable spanning tree function globally.

Step 4 **show spanning-tree active**

(Optional) View the active information of STP/RSTP.

Step 5 **end**

Return to privileged EXEC mode.

Step 6 **copy running-config startup-config**

Save the settings in the configuration file.

This example shows how to enable spanning tree function, configure the spanning tree mode as RSTP and verify the configurations:

```
Switch#configure
```

```
Switch(config)#spanning-tree mode rstp
```

```
Switch(config)#spanning-tree
```

```
Switch(config)#show spanning-tree active
```

```
Spanning tree is enabled
```

```
Spanning-tree's mode: RSTP (802.1w Rapid Spanning Tree Protocol)
```

```
Latest topology change time: 2006-01-02 10:04:02
```

Root Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Local bridge is the root bridge

Designated Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Local Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Interface	State	Prio	Ext-Cost	Int-Cost	Edge	P2p	Mode
-----	-----	----	-----	-----	----	-----	-----
Gi1/0/16	Enable	128	200000	200000	No	Yes(auto)	Rstp
Gi1/0/18	Enable	128	200000	200000	No	Yes(auto)	Rstp
Gi1/0/20	Enable	128	200000	200000	No	Yes(auto)	Rstp

Role	Status	LAG
-----	-----	-----
Desg	Fwd	N/A
Desg	Fwd	N/A
Desg	Fwd	N/A

Switch(config)#end

Switch#copy running-config startup-config

3 MSTP Configurations

To complete the MSTP configuration, follow these steps:

- 1) Configure parameters on ports in CIST.
- 2) Configure the MSTP region.
- 3) Configure the MSTP globally.
- 4) Verify the MSTP configurations.

Configuration Guidelines

- Before configuring the spanning tree, it's necessary to make clear the role that each switch plays in a spanning tree.
- To avoid any possible network flapping caused by MSTP parameter changes, it is recommended to enable MSTP function globally after configuring the relevant parameter.

3.1 Using the GUI

3.1.1 Configuring Parameters on Ports in CIST

Choose the menu **L2 FEATURES > Spanning Tree > Port Config** to load the following page.

Figure 3-1 Configuring the Parameters of the Ports

Port Config												
UNIT1												LAGS
<input type="checkbox"/>	Port	Status	Priority	Ext-Path Cost	Int-Path Cost	Edge Port	P2P Link	MCheck	Port Mode	Port Role	Port Status	LAG
<input checked="" type="checkbox"/>	1/0/1	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/2	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/3	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/4	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/5	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/6	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/7	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/8	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/9	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---
<input type="checkbox"/>	1/0/10	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--	--	---

Total: 28 1 entry selected. Cancel Apply

Follow these steps to configure parameters on ports in CIST:

- 1) In the **Port Config** section, configure the parameters on ports.

UNIT	Select the desired unit or LAGs.
Status	Enable or disable spanning tree function on the desired port.
Priority	<p>Specify the Priority for the desired port. The value should be an integral multiple of 16, ranging from 0 to 240.</p> <p>The port with lower value has the higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities between these port and select a root port with the highest priority.</p>
Ext-Path Cost	<p>Enter the value of the external path cost. The default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed.</p> <p>For STP/RSTP, external path cost indicates the path cost of the port in spanning tree. The port with the lowest root path cost will be elected as the root port of the switch.</p> <p>For MSTP, external path cost indicates the path cost of the port in CST.</p>
Int-Path Cost	<p>Enter the value of the internal path cost. The valid values are from 0 to 2000000. The default setting is Auto, which means the port calculates the internal path cost automatically according to the port's link speed. This parameter is only used in MSTP and you need not to configure it if the spanning tree mode is STP/RSTP.</p> <p>For MSTP, internal path cost is used to calculate the path cost in IST. The port with the lowest root path cost will be elected as the root port of the switch in IST.</p>
Edge Port	<p>Select Enable to set the port as an edge port.</p> <p>When the topology is changed, the edge port can transit its state from blocking to forwarding directly. For the quick generation of the spanning tree, it is recommended to set the ports that are connected to the end devices as edge ports.</p>

P2P Link	<p>Select the status of the P2P (Point-to-Point) link to which the ports are connected. During the regeneration of the spanning tree, if the port of P2P link is elected as the root port or the designated port, it can transit its state to forwarding directly.</p> <p>Three options are supported: Auto, Open(Force) and Closed(Force). By default, it is Auto.</p> <p>Auto: The switch automatically checks if the port is connected to a P2P link, then sets the status as Open or Closed.</p> <p>Open(Force): A port is set as the one that is connected to a P2P link. You should check the link first.</p> <p>Close(Force): A port is set as the one that is not connected to a P2P link. You should check the link first.</p>
MCheck	<p>Select whether to perform MCheck operations on the port. If a port on an RSTP-enabled/MSTP-enabled device is connected to an STP-enabled device, the port will switch to STP compatible mode and send packets in STP format. MCheck is used to switch the mode of the port back to RSTP/MSTP after the port is disconnected from the STP-enabled device. The MCheck configuration can take effect only once, after that the MCheck status of the port will switch to Disabled.</p>
Port Mode	<p>Displays the spanning tree mode of the port.</p> <p>STP: The spanning tree mode of the port is STP.</p> <p>RSTP: The spanning tree mode of the port is RSTP.</p> <p>MSTP: The spanning tree mode of the port is MSTP.</p>
Port Role	<p>Displays the role that the port plays in the spanning tree.</p> <p>Root Port: Indicates that the port is the root port in the spanning tree. It has the lowest path cost from the root bridge to this switch and is used to communicate with the root bridge.</p> <p>Designated Port: Indicates that the port is the designated port in the spanning tree. It has the lowest path cost from the root bridge to this physical network segment and is used to forward data for the corresponding network segment.</p> <p>Master Port: Indicates the port provides the lowest root path cost from the region to the root bridge in CIST. In CIST, each region is regarded as a switch, and the master port is the root port of the corresponding region.</p> <p>Alternate Port: Indicates that the port is the alternate port in the spanning tree. It is the backup of the root port or master port.</p> <p>Backup Port: Indicates that the port is the backup port in the spanning tree. It is the backup of the designated port.</p> <p>Disabled: Indicates that the port is not participating in the spanning tree.</p>

Port Status	<p>Displays the port status.</p> <p>Forwarding: The port receives and sends BPDUs, and forwards user data.</p> <p>Learning: The port receives and sends BPDUs. It also receives user traffic, but doesn't forward the traffic.</p> <p>Blocking: The port only receives and sends BPDUs.</p> <p>Disconnected: The port has the spanning tree function enabled but is not connected to any device.</p>
LAG	Displays the LAG the port belongs to.

2) Click **Apply**.

3.1.2 Configuring the MSTP Region

Configure the region name, revision level, VLAN-Instance mapping of the switch. The switches with the same region name, the same revision level and the same VLAN-Instance mapping are considered as in the same region.

Besides, configure the priority of the switch, the priority and path cost of ports in the desired instance.

■ Configuring the Region Name and Revision Level

Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Region Config** to load the following page.

Figure 3-2 Configuring the Region

Follow these steps to create an MST region:

1) In the **Region Config** section, set the name and revision level to specify an MSTP region.

Region Name	Configure the name for an MST region using up to 32 characters. By default, it is the MAC address of the switch.
Revision	Enter the revision level. By default, it is 0.

2) Click **Apply**.

- **Configuring the VLAN-Instance Mapping and Switch Priority**

Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Config** to load the following page.

Figure 3-3 Configuring the VLAN-Instance Mapping

Instance Config					
				+ Add	- Delete
<input type="checkbox"/>	Instance ID	Priority	VLAN ID	Operation	
<input type="checkbox"/>	CIST	36864	1-4094,		
Total: 1					

Follow these steps to map VLANs to the corresponding instance, and configure the priority of the switch in the desired instance:

- 1) In the **Instance Config** section, click **Add** and enter the instance ID, Priority and corresponding VLAN ID.

Figure 3-4 Configuring the Instance

Instance Config

Instance ID: (1-8)

Priority: (0-61440, in increments of 4096)

VLAN ID: Add Delete

(1-4094, format:1,3,4-7,11-30)

Instance ID Enter the corresponding instance ID.

Priority Specify the priority for the switch in the corresponding instance. The value should be an integral multiple of 4096, ranging from 0 to 61440. It is used to determine the root bridge for the instance. Switches with a lower value have higher priority, and the switch with the highest priority will be elected as the root bridge in the corresponding instance.

VLAN ID Enter the VLAN ID to map the VLAN to the desired instance or unbind the VLAN-instance mapping.

- 2) Click **Create**.

- **Configuring Parameters on Ports in the Instance**

Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Port Config** to load the following page.

Figure 3-5 Configuring Port Parameters in the Instance

Instance Port Config

Instance ID:

UNIT1 | LAGS

<input type="checkbox"/>	Port	Priority	Path Cost	Port Role	Port Status	LAG
<input checked="" type="checkbox"/>	1/0/1	128	Auto	--	--	---
<input type="checkbox"/>	1/0/2	128	Auto	--	--	---
<input type="checkbox"/>	1/0/3	128	Auto	Disable	Disconnected	---
<input type="checkbox"/>	1/0/4	128	Auto	--	--	---
<input type="checkbox"/>	1/0/5	128	Auto	--	--	---
<input type="checkbox"/>	1/0/6	128	Auto	--	--	---
<input type="checkbox"/>	1/0/7	128	Auto	--	--	---
<input type="checkbox"/>	1/0/8	128	Auto	--	--	---
<input type="checkbox"/>	1/0/9	128	Auto	--	--	---
<input type="checkbox"/>	1/0/10	128	Auto	--	--	---

Total: 28 | 1 entry selected. |

Follow these steps to configure port parameters in the instance:

- 1) In the **Instance Port Config** section, select the desired instance ID.

Instance ID Select the ID number of the instance that you want to configure.

- 2) Configure port parameters in the desired instance.

UNIT Select the desired unit or LAGs for configuration.

Priority Specify the Priority for the port in the corresponding instance. The value should be an integral multiple of 16, ranging from 0 to 240.

The port with lower value has the higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities between these ports and select a root port with the highest priority.

Path Cost Enter the value of the path cost in the corresponding instance. The valid values are from 0 to 2000000. The default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed. The port with the lowest root path cost will be elected as the root port of the switch.

Port Role	<p>Displays the role that the port plays in the desired instance.</p> <p>Root Port: Indicates that the port is the root port in the desired instance. It has the lowest path cost from the root bridge to this switch and is used to communicate with the root bridge.</p> <p>Designated Port: Indicates that the port is the designated port in the desired instance. It has the lowest path cost from the root bridge to this physical network segment and is used to forward data for the corresponding network segment.</p> <p>Alternate Port: Indicates that the port is the alternate port in the desired instance. It is the backup of the root port or master port.</p> <p>Backup Port: Indicates that the port is the backup port in the desired instance. It is the backup of the designated port.</p> <p>Master Port: Indicates the port provides the lowest root path cost from the region to the root bridge in CIST. In CIST, each region is regarded as a switch, and the master port is the root port of the corresponding region.</p> <p>Disabled: Indicates that the port is not participating in the spanning tree.</p>
Port Status	<p>Displays the port status.</p> <p>Forwarding: The port receives and sends BPDUs, and forwards user traffic.</p> <p>Learning: The port receives and sends BPDUs. It also receives user traffic, but doesn't forward the traffic.</p> <p>Blocking: The port only receives and sends BPDUs.</p> <p>Disconnected: The port has the spanning tree function enabled but is not connected to any device.</p>
LAG	<p>Displays the LAG which the port belongs to.</p>

3.1.3 Configuring MSTP Globally

Choose the menu **L2 FEATURES > Spanning Tree > STP Config > STP Config** to load the following page.

Figure 3-6 Configure MSTP Function Globally

Global Config

Spanning Tree: Enable

Mode: MSTP

Apply

Parameters Config

CIST Priority: 36864 (0-61440, in increments of 4096)

Hello Time: 2 seconds (1-10)

Max Age: 20 seconds (6-40)

Forward Delay: 12 seconds (4-30)

Tx Hold Count: 5 pps (1-20)

Max Hops: 20 hop (1-40)

Apply

Follow these steps to configure MSTP globally:

- 1) In the **Parameters Config** section, Configure the global parameters of MSTP and click **Apply**.

CIST Priority	<p>Specify the CIST priority for the switch. CIST priority is a parameter used to determine the root bridge for spanning tree. The switch with the lower value has the higher priority.</p> <p>In STP/RSTP, CIST priority is the priority of the switch in spanning tree. The switch with the highest priority will be elected as the root bridge.</p> <p>In MSTP, CISP priority is the priority of the switch in CIST. The switch with the higher priority will be elected as the root bridge in CIST.</p>
Hello Time	<p>Specify the interval between BPDUs' sending. The default value is 2. The root bridge sends configuration BPDUs at an interval of Hello Time. It works with the MAX Age to test the link failures and maintain the spanning tree.</p>
Max Age	<p>Specify the maximum time that the switch can wait without receiving a BPDU before attempting to regenerate a new spanning tree. The default value is 20.</p>

Forward Delay	Specify the interval between the port state transition from listening to learning. The default value is 15. It is used to prevent the network from causing temporary loops during the regeneration of spanning tree. The interval between the port state transition from learning to forwarding is also the Forward Delay.
Tx Hold Count	Specify the maximum number of BPDU that can be sent in a second. The default value is 5.
Max Hops	Specify the maximum BPDU hop counts that can be forwarded in a MST region. The default value is 20. A switch receives BPDU, then decrements the hop count by one and generates BPDUs with the new value. When the hop reaches zero, the switch will discard the BPDU. This value can control the scale of the spanning tree in the MST region. Note: Max Hops is a parameter configured in MSTP. You need not configure it if the spanning tree mode is STP/RSTP.

 **Note:**

To prevent frequent network flapping, make sure that Hello Time, Forward Delay, and Max Age conform to the following formulas:

- $2 * (\text{Hello Time} + 1) \leq \text{Max Age}$
- $2 * (\text{Forward Delay} - 1) \geq \text{Max Age}$

2) In the **Global Config** section, enable Spanning-Tree function and choose the STP mode as MSTP and click **Apply**.

Spanning-Tree	Check the box to enable the spanning tree function globally.
Mode	Select the desired spanning tree mode as STP/RSTP on the switch. By default, it's STP. STP: Specify the spanning tree mode as STP. RSTP: Specify the spanning tree mode as RSTP. MSTP: Specify the spanning tree mode as MSTP.

3.1.4 Verifying the MSTP Configurations

Choose the menu **Spanning Tree > STP Config > STP Summary** to load the following page.

Figure 3-7 Verifying the MSTP Configurations

STP Summary

Spanning Tree:	Enable
Spanning Tree Mode:	MSTP
Local Bridge:	36864--00-0a-eb-13-a2-02
Root Bridge:	36864--00-0a-eb-13-a2-02
External Path Cost:	0
Regional Root Bridge:	36864--00-0a-eb-13-a2-02
Internal Path Cost:	0
Designated Bridge:	36864--00-0a-eb-13-a2-02
Root Port:	---
Latest TC Time:	2006-01-01 08:00:45
TC Count:	0

MSTP Instance Summary

Instance ID:	<input type="text" value=""/>
Instance Status:	Disable
Local Bridge:	---
Regional Root Bridge:	---
Internal Path Cost:	---
Designated Bridge:	---
Root Port:	---
Latest TC Time:	---
TC Count:	---

The **STP Summary** section shows the summary information of CIST:

Spanning Tree	Displays the status of the spanning tree function.
Spanning-Tree Mode	Displays the spanning tree mode.
Local Bridge	Displays the bridge ID of the local switch. The local bridge is the current switch.
Root Bridge	Displays the bridge ID of the root bridge in CIST.
External Path Cost	Displays the external path cost. It is the root path cost from the switch to the root bridge in CIST.

Regional Root Bridge	Displays the bridge ID of the root bridge in IST.
Internal Path Cost	Displays the internal path cost. It is the root path cost from the current switch to the root bridge in IST.
Designated Bridge	Displays the bridge ID of the designated bridge in CIST.
Root Port	Displays the root port of in CIST.
Latest TC Time	Displays the latest time when the topology is changed.
TC Count	Displays how many times the topology has changed.

The **MSTP Instance Summary** section shows the information in MST instances:

Instance ID	Select the desired instance.
Instance Status	Displays the status of the desired instance.
Local Bridge	Displays the bridge ID of the local switch. The local bridge is the current switch.
Regional Root Bridge	Displays the bridge ID of the root bridge in the desired instance.
Internal Path Cost	Displays the internal path cost. It is the root path cost from the current switch to the regional root bridge.
Designated Bridge	Displays the bridge ID of the designated bridge in the desired instance.
Root Port	Displays the root port of the desired instance.
Latest TC Time	Displays the latest time when the topology is changed.
TC Count	Displays how many times the topology has changed.

3.2 Using the CLI

3.2.1 Configuring Parameters on Ports in CIST

Follow these steps to configure the parameters of the port in CIST:

Step 1	configure Enter global configuration mode.
Step 2	interface {fastEthernet <i>port</i> range fastEthernet <i>port-list</i> gigabitEthernet <i>port</i> range gigabitEthernet <i>port-list</i> ten-gigabitEthernet <i>port</i> range ten-gigabitEthernet <i>port-list</i> port-channel <i>port-channel-id</i> range port-channel <i>port-channel-list</i>} Enter interface configuration mode.

Step 3 **spanning-tree**

Enable spanning tree function for the desired port.

Step 4 **spanning-tree common-config [port-priority *pri*] [ext-cost *ext-cost*] [int-cost *int-cost*] [portfast { enable | disable }] [point-to-point { auto | open | close }]**

Configure the parameters on ports in CIST.

pri: Specify the Priority for the desired port. The value should be an integral multiple of 16, ranging from 0 to 240. The default value is 128. Ports with lower values have higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities and select a root port with the highest priority.

ext-cost: Specify the value of the external path cost. The valid values are from 0 to 2000000 and the default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed.

For STP/RSTP, external path cost indicates the path cost of the port in spanning tree. The Port with the lowest root path cost will be elected as the root port of the switch.

For MSTP, external path cost indicates the path cost of the port in CST.

int-cost: Specify the value of the internal path cost. The valid values are from 0 to 2000000. The default setting is Auto, which means the port calculates the internal path cost automatically according to the port's link speed. This parameter is only used in MSTP.

For MSTP, internal path cost is used to calculate the path cost in IST. The port with the lowest root path cost will be elected as the root port of the switch in IST.

portfast { enable | disable }: Enable to set the port as an edge port. By default, it is disabled. When the topology is changed, the edge port can transit its state from blocking to forwarding directly. For the quick generation of the spanning tree, it is recommended to set the ports that are connected to the end devices as edge ports.

point-to-point { auto | open | close }: Select the status of the P2P (Point-to-Point) link to which the ports are connected. During the regeneration of the spanning tree, if the port of P2P link is elected as the root port or the designated port, it can transit its state to forwarding directly. Auto indicates that the switch automatically checks if the port is connected to a P2P link, then sets the status as Open or Closed. Open is used to set the port as the one that is connected to a P2P link. Close is used to set the port as the one that is not connected to a P2P link.

Step 5 **spanning-tree mcheck**

(Optional) Perform MCheck operations on the port.

If a port on an RSTP-enabled/MSTP-enabled device is connected to an STP-enabled device, the port will switch to STP compatible mode and send packets in STP format. MCheck is used to switch the mode of the port back to RSTP/MSTP after the port is disconnected from the STP-enabled device. The MCheck configuration can take effect only once, after that the MCheck status of the port will switch to Disabled.

Step 6 **show spanning-tree interface** [**fastEthernet** *port* | **gigabitEthernet** *port* | **ten-gigabitEthernet** *port* | **port-channel** *lagid*] [**edge** | **ext-cost** | **int-cost** | **mode** | **p2p** | **priority** | **role** | **state** | **status**]

(Optional) View the information of all ports or a specified port.

port: Specify the port number.

lagid: Specify the ID of the LAG.

ext-cost | **int-cost** | **mode** | **p2p** | **priority** | **role** | **state** | **status**: Display the specified information.

Step 7 **end**

Return to privileged EXEC mode.

Step 8 **copy running-config startup-config**

Save the settings in the configuration file.

This example shows how to enable spanning tree function for port 1/0/3 and configure the port priority as 32 :

Switch#configure

Switch(config)#interface gigabitEthernet 1/0/3

Switch(config-if)#spanning-tree

Switch(config-if)#spanning-tree common-config port-priority 32

Switch(config-if)#show spanning-tree interface gigabitEthernet 1/0/3

MST-Instance 0 (CIST)

Interface	State	Prio	Ext-Cost	Int-Cost	Edge	P2p	Mode	Role	Status
Gi1/0/3	Enable	32	Auto	Auto	No	No(auto)	N/A	N/A	LnkDwn

MST-Instance 5

Interface	Prio	Cost	Role	Status
Gi1/0/3	144	200	N/A	LnkDwn

Switch(config-if)#end

Switch#copy running-config startup-config

3.2.2 Configuring the MSTP Region

■ Configuring the MST Region

Follow these steps to configure the MST region and the priority of the switch in the instance:

Step 1	configure Enter global configuration mode.
Step 2	spanning-tree mst instance <i>instance-id</i> priority <i>pri</i> Configure the priority of the switch in the instance. <i>instance-id</i> : Specify the instance ID, the valid values ranges from 1 to 8. <i>pri</i> : Specify the priority for the switch in the corresponding instance. The value should be an integral multiple of 4096, ranging from 0 to 61440. The default value is 32768. It is used to determine the root bridge for the instance. Switches with a lower value have higher priority, and the switch with the highest priority will be elected as the root bridge in the corresponding instance.
Step 3	spanning-tree mst configuration Enter MST configuration mode, as to configure the VLAN-Instance mapping, region name and revision level.
Step 4	name <i>name</i> Configure the region name of the region. <i>name</i> : Specify the region name, used to identify an MST region. The valid values are from 1 to 32 characters.
Step 5	revision <i>revision</i> Configure the revision level of the region. <i>revision</i> : Specify the revision level of the region. The valid values are from 0 to 65535.
Step 6	instance <i>instance-id</i> vlan <i>vlan-id</i> Configure the VLAN-Instance mapping. <i>instance-id</i> : Specify the Instance ID. The valid values are from 1 to 8. <i>vlan-id</i> : Specify the VLAN mapped to the corresponding instance.
Step 7	show spanning-tree mst { configuration [digest] instance <i>instance-id</i> [interface [fastEthernet <i>port</i> gigabitEthernet <i>port</i> port-channel <i>lagid</i> ten-gigabitEthernet <i>port</i>]] } (Optional) View the related information of MSTP Instance. <i>digest</i> : Specify to display the digest calculated by instance-vlan map. <i>instance-id</i> : Specify the Instance ID desired to view, ranging from 1 to 8. <i>port</i> : Specify the port number. <i>lagid</i> : Specify the ID of the LAG.

Step 8 **end**
Return to privileged EXEC mode.

Step 9 **copy running-config startup-config**
Save the settings in the configuration file.

This example shows how to create an MST region, of which the region name is R1, the revision level is 100 and VLAN 2-VLAN 6 are mapped to instance 5:

Switch#configure

Switch(config)#spanning-tree mst configuration

Switch(config-mst)#name R1

Switch(config-mst)#revision 100

Switch(config-mst)#instance 5 vlan 2-6

Switch(config-mst)#show spanning-tree mst configuration

Region-Name : R1

Revision : 100

MST-Instance	Vlans-Mapped
--------------	--------------

0	1,7-4094
---	----------

5	2-6,
---	------

Switch(config-mst)#end

Switch#copy running-config startup-config

- **Configuring the Parameters on Ports in Instance**

Follow these steps to configure the priority and path cost of ports in the specified instance:

Step 1 **configure**
Enter global configuration mode.

Step 2 **interface {fastEthernet *port* | range fastEthernet *port-list* | gigabitEthernet *port* | range gigabitEthernet *port-list* | ten-gigabitEthernet *port* | range ten-gigabitEthernet *port-list* | port-channel *port-channel-id* | range port-channel *port-channel-list*}**
Enter interface configuration mode.

-
- Step 3 **spanning-tree mst instance** *instance-id* **[[port-priority *pri*] | [cost *cost*]]**
- Configure the priority and path cost of ports in the specified instance.
- instance-id*: Specify the instance ID, the valid values ranges from 1 to 8.
- pri*: Specify the Priority for the port in the corresponding instance. The value should be an integral multiple of 16, ranging from 0 to 240. The default value is 128. The port with lower value has the higher priority. When the root path of the port is the same as other ports', the switch will compare the port priorities between these ports and select a root port with the highest priority.
- cost*: Enter the value of the path cost in the corresponding instance. The valid values are from 0 to 2000000. The default setting is Auto, which means the port calculates the external path cost automatically according to the port's link speed. The port with the lowest root path cost will be elected as the root port of the switch.
-
- Step 4 **show spanning-tree mst** **{ configuration [digest] | instance** *instance-id* **[interface [fastEthernet** *port* **| gigabitEthernet** *port* **| port-channel** *lagid* **| ten-gigabitEthernet** *port* **]]}**
- (Optional) View the related information of MSTP Instance.
- digest*: Specify to display the digest calculated by instance-vlan map.
- instance-id*: Specify the Instance ID desired to view, ranging from 1 to 8.
- port*: Specify the port number.
- lagid*: Specify the ID of the LAG.
-
- Step 5 **end**
- Return to privileged EXEC mode.
-
- Step 6 **copy running-config startup-config**
- Save the settings in the configuration file.
-

This example shows how to configure the priority as 144, the path cost as 200 of port 1/0/3 in instance 5:

Switch#configure

Switch(config)#interface gigabitEthernet 1/0/3

Switch(config-if)#spanning-tree mst instance 5 port-priority 144 cost 200

Switch(config-if)#show spanning-tree interface gigabitEthernet 1/0/3

MST-Instance 0 (CIST)

Interface	State	Prio	Ext-Cost	Int-Cost	Edge	P2p	Mode	Role	Status	LAG
-----	-----	----	-----	-----	----	-----	-----	----	-----	----
Gi1/0/3	Enable	32	Auto	Auto	No	No(auto)	N/A	N/A	LnkDwn	N/A

MST-Instance 5

Interface	Prio	Cost	Role	Status	LAG
-----	-----	-----	-----	-----	-----
Gi1/0/3	144	200	N/A	LnkDwn	N/A

```
Switch(config-if)#end
```

```
Switch#copy running-config startup-config
```

3.2.3 Configuring Global MSTP Parameters

Follow these steps to configure the global MSTP parameters of the switch:

Step 1 **configure**

Enter global configuration mode.

Step 2 **spanning-tree priority *pri***

Configure the priority of the switch for comparison in CIST.

pri: Specify the priority for the switch. The valid value is from 0 to 61440, which are divisible by 4096. The priority is a parameter used to determine the root bridge for spanning tree. The switch with the lower value has the higher priority.

In STP/RSTP, the value is the priority of the switch in spanning tree. The switch with the highest priority will be elected as the root bridge.

In MSTP, the value is the priority of the switch in CIST. The switch with the higher priority will be elected as the root bridge in CIST.

Step 3 **spanning-tree timer [[*forward-time forward-time*] [*hello-time hello-time*] [*max-age max-age*]]**

(Optional) Configure the Forward Delay, Hello Time and Max Age.

forward-time: Specify the value of Forward Delay. It is the interval between the port state transition from listening to learning. The valid values are from 4 to 30 in seconds, and the default value is 15. Forward Delay is used to prevent the network from causing temporary loops during the regeneration of spanning tree. The interval between the port state transition from learning to forwarding is also the Forward Delay.

hello-time: Specify the value of Hello Time. It is the interval between BPDUs' sending. The valid values are from 1 to 10 in seconds, and the default value is 2. The root bridge sends configuration BPDUs at an interval of Hello Time. It works with the MAX Age to test the link failures and maintain the spanning tree.

max-age: Specify the value of Max Age. It is the maximum time that the switch can wait without receiving a BPDU before attempting to regenerate a new spanning tree. The valid values are from 6 to 40 in seconds, and the default value is 20.

Step 4 **spanning-tree hold-count *value***

(Optional) Specify the maximum number of BPDU that can be sent in a second.

value: Specify the maximum number of BPDU packets that can be sent in a second. The valid values are from 1 to 20 pps, and the default value is 5.

Step 5 `spanning-tree max-hops value`

(Optional) Specify the maximum BPDU hop counts that can be forwarded in a MST region. A switch receives BPDU, then decrements the hop count by one and generates BPDUs with the new value. When the hop reaches zero, the switch will discard the BPDU. This value can control the scale of the spanning tree in the MST region.

value: Specify the maximum number of hops that occur in a specific region before the BPDU is discarded. The valid values are from 1 to 40 in hop, and the default value is 20.

Step 6 `show spanning-tree bridge`

(Optional) View the global parameters of the switch.

Step 7 `end`

Return to privileged EXEC mode.

Step 8 `copy running-config startup-config`

Save the settings in the configuration file.

 **Note:**

To prevent frequent network flapping, make sure that Hello Time, Forward Delay, and Max Age conform to the following formulas:

- $2 * (\text{Hello Time} + 1) \leq \text{Max Age}$
- $2 * (\text{Forward Delay} - 1) \geq \text{Max Age}$

This example shows how to configure the CIST priority as 36864, the Forward Delay as 12 seconds, the Hold Count as 8 and the Max Hop as 25:

Switch#configure

```
Switch(config)#spanning-tree priority 36864
```

```
Switch(config-if)#spanning-tree timer forward-time 12
```

```
Switch(config-if)#spanning-tree hold-count 8
```

```
Switch(config-if)#spanning-tree max-hops 25
```

```
Switch(config-if)#show spanning-tree bridge
```

State	Mode	Priority	Hello-Time	Fwd-Time	Max-Age	Hold-Count	Max-Hops
Enable	Mstp	36864	2	12	20	8	25

```
Switch(config-if)#end
```

```
Switch#copy running-config startup-config
```

3.2.4 Enabling Spanning Tree Globally

Follow these steps to configure the spanning tree mode as MSTP and enable spanning tree function globally:

Step 1	configure Enter global configuration mode.
Step 2	spanning-tree mode mstp Configure the spanning tree mode as MSTP. <i>mstp</i> : Specify the spanning tree mode as MSTP.
Step 3	spanning-tree Enable spanning tree function globally.
Step 4	show spanning-tree active (Optional) View the active information of MSTP.
Step 5	end Return to privileged EXEC mode.
Step 6	copy running-config startup-config Save the settings in the configuration file.

This example shows how to configure the spanning tree mode as MSTP and enable spanning tree function globally :

Switch#configure

Switch(config)#spanning-tree mode mstp

Switch(config)#spanning-tree

Switch(config)#show spanning-tree active

Spanning tree is enabled

Spanning-tree's mode: MSTP (802.1s Multiple Spanning Tree Protocol)

Latest topology change time: 2006-01-04 10:47:42

MST-Instance 0 (CIST)

Root Bridge

Priority : 32768

Address : 00-0a-eb-13-23-97

External Cost : 200000

Root Port : Gi/0/20

Designated Bridge

Priority : 32768

Address : 00-0a-eb-13-23-97

Regional Root Bridge

Priority : 36864

Address : 00-0a-eb-13-12-ba

Local bridge is the regional root bridge

Local Bridge

Priority : 36864

Address : 00-0a-eb-13-12-ba

Interface	State	Prio	Ext-Cost	Int-Cost	Edge	P2p	Mode	Role	Status
Gi/0/16	Enable	128	200000	200000	No	Yes(auto)	Mstp	Altn	Blk
Gi/0/20	Enable	128	200000	200000	No	Yes(auto)	Mstp	Root	Fwd

MST-Instance 1

Root Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Local bridge is the root bridge

Designated Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Local Bridge

Priority : 32768

Address : 00-0a-eb-13-12-ba

Interface	Prio	Cost	Role	Status
Gi/0/16	128	200000	Altn	Blk
Gi/0/20	128	200000	Mstr	Fwd

Switch(config)#end

Switch#copy running-config startup-config

4 STP Security Configurations

4.1 Using the GUI

Choose the menu **L2 FEATURES > Spanning Tree > STP Security** to load the following page.

Figure 4-1 Configuring the Port Protect

Port Protect

UNIT1
LAGS

<input type="checkbox"/>	Port	Loop Protect	Root Protect	TC Guard	BPDU Protect	BPDU Filter	BPDU Forward	LAG
<input checked="" type="checkbox"/>	1/0/1	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/2	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/3	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/4	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/5	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/6	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/7	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/8	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/9	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---
<input type="checkbox"/>	1/0/10	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	---

Total: 28
1 entry selected.

Cancel
Apply

Configure the Port Protect features for the selected ports, and click **Apply**.

UNIT

Select the desired unit or LAGs for configuration.

Loop Protect

Enable or disable Loop Protect. It is recommended to enable this function on root ports and alternate ports.

When there are link congestions or link failures in the network, the switch will not receive BPDUs from the upstream device in time. Loop Protect is used to avoid loop caused by the recalculation in this situation. With Loop Protect function enabled, the port will temporarily transit to a blocking state after it does not receive BPDUs in time.

Root Protect	<p>Enable or disable Root Protect. It is recommended to enable this function on the designated ports of the root bridge.</p> <p>Switches with faulty configurations may produce a higher-priority BPDUs than the root bridge's, and this situation will cause recalculation of the spanning tree. Root Protect is used to ensure that the desired root bridge will not lose its position in the scenario above. With root protect enabled, the port will temporarily transit to blocking state when it receives higher-priority BPDUs. After two forward delays, if the port does not receive any other higher-priority BPDUs, it will transit to its normal state.</p>
TC Guard	<p>Enable or disable the TC Guard function. It is recommended to enable this function on the ports of non-root switches.</p> <p>TC Guard function is used to prevent the switch from frequently changing the MAC address table. With TC Guard function enabled, when the switch receives TC-BPDUs, it will not process the TC-BPDUs at once. The switch will wait for a fixed time and process the TC-BPDUs together after receiving the first TC-BPDU, then it will restart timing.</p>
BPDU Protect	<p>Enable or disable the BPDU Protect function. It is recommended to enable this function on edge ports.</p> <p>Edge ports in spanning tree are used to connect to the end devices and it doesn't receive BPDUs in the normal situation. If edge ports receive BPDUs, it may be an attack. BPDU Protect is used to protect the switch from the attack talked above. With BPDU protect function enabled, the edge ports will be shutdown when they receives BPDUs, and will report these cases to the administrator. Only the administrator can restore the state of the ports.</p>
BPDU Filter	<p>Enable or disable BPDU Filter. It is recommended to enable this function on edge ports.</p> <p>With BPDU filter function enabled, the port does not receive or forward BPDUs, but it sends out its own BPDUs. BPDU Filter can prevent the switch from being attacked as with BPDU Protect.</p>
BPDU Forward	<p>Enable or disable BPDU Forward. This function only takes effect when the spanning tree function is disabled globally.</p> <p>With BPDU forward enabled, the port can still forward spanning tree BPDUs when the spanning tree function is disabled.</p>

4.2 Using the CLI

4.2.1 Configuring the STP Security

Follow these steps to configure the Root protect feature, BPDU protect feature and BPDU filter feature for ports:

-
- | | |
|--------|--|
| Step 1 | configure
Enter global configuration mode. |
|--------|--|
-

Step 2 **interface {fastEthernet *port* | range fastEthernet *port-list* | gigabitEthernet *port* | range gigabitEthernet *port-list* | ten-gigabitEthernet *port* | range ten-gigabitEthernet *port-list* | port-channel *port-channel-id* | range port-channel *port-channel-list*}**

Enter interface configuration mode.

Step 3 **spanning-tree guard loop**

(Optional) Enable Loop Protect. It is recommended to enable this function on root ports and alternate ports.

When there are link congestions or link failures in the network, the switch will not receive BPDUs from the upstream device in time. Loop Protect is used to avoid loop caused by the recalculation in this situation. With Loop Protect function enabled, the port will temporarily transit to a blocking state after it does not receive BPDUs in time.

Step 4 **spanning-tree guard root**

(Optional) Enable Root Protect. It is recommended to enable this function on the designated ports of the root bridge.

Switches with faulty configurations may produce a higher-priority BPDUs than the root bridge's, and this situation will cause recalculation of the spanning tree. Root Protect is used to ensure that the desired root bridge will not lose its position in the scenario above. With root protect enabled, the port will temporarily transit to blocking state when it receives higher-priority BPDUs. After two forward delays, if the port does not receive any other higher-priority BPDUs, it will transit to its normal state.

Step 5 **spanning-tree guard tc**

(Optional) Enable the TC Guard function. It is recommended to enable this function on the ports of non-root switches.

TC Guard function is used to prevent the switch from frequently changing the MAC address table. With TC Guard function enabled, when the switch receives TC-BPDUs, it will not process the TC-BPDUs at once. The switch will wait for a fixed time and process the TC-BPDUs together after receiving the first TC-BPDU, then it will restart timing.

Step 6 **spanning-tree bpduguard**

(Optional) Enable the BPDU Protect function. It is recommended to enable this function on edge ports.

Edge ports in spanning tree are used to connect to the end devices and it doesn't receive BPDUs in the normal situation. If edge ports receive BPDUs, it may be an attack. BPDU Protect is used to protect the switch from the attack talked above. With BPDU protect function enabled, the edge ports will be shutdown when they receives BPDUs, and will report these cases to the administrator. Only the administrator can restore the state of the ports.

Step 7 **spanning-tree bpdufilter**

(Optional) Enable or disable BPDU Filter. It is recommended to enable this function on edge ports.

With BPDU filter function enabled, the port does not receive or forward BPDUs, but it sends out its own BPDUs. BPDU Filter can prevent the switch from being attacked as with BPDU Protect.

Step 8 spanning-tree bpduflood

(Optional) Enable BPDU Forward. This function only takes effect when the spanning tree function is disabled globally. By default, it is enabled.

With BPDU forward enabled, the port can still forward spanning tree BPDUs when the spanning tree function is disabled.

Step 9 show spanning-tree interface-security [fastEthernet port | gigabitEthernet port | ten-gigabitEthernet port | port-channel port-channel-id] [bpdufilter | bpduguard | bpduflood | loop | root | tc]

(Optional) View the protect information of ports.

port: Specify the port number.

lagid: Specify the ID of the LAG.

Step 10 end

Return to privileged EXEC mode.

Step 11 copy running-config startup-config

Save the settings in the configuration file.

This example shows how to enable Loop Protect, Root Protect, BPDU Filter and BPDU Protect functions on port 1/0/3:

Switch#configure

Switch(config)#interface gigabitEthernet 1/0/3

Switch(config-if)#spanning-tree guard loop

Switch(config-if)#spanning-tree guard root

Switch(config-if)#spanning-tree bpdufilter

Switch(config-if)#spanning-tree bpduguard

Switch(config-if)#show spanning-tree interface-security gigabitEthernet 1/0/3

Interface	BPDU-Filter	BPDU-Guard	Loop-Protect	Root-Protect	TC-Protect	BPDU-Flood
-----	-----	-----	-----	-----	-----	-----
Gi1/0/3	Enable	Enable	Enable	Enable	Disable	Enable

Switch(config-if)#end

Switch#copy running-config startup-config

5 Configuration Example for MSTP

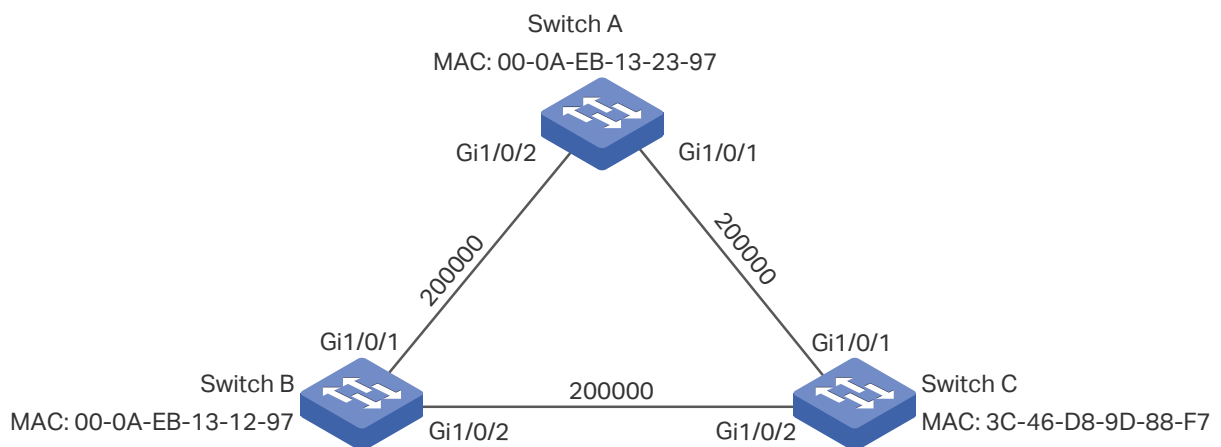
MSTP, backwards-compatible with STP and RSTP, can map VLANs to instances to implement load-balancing, thus providing a more flexible method in network management. Here we take the MSTP configuration as an example.

5.1 Network Requirements

As shown in figure 5-1, the network consists of three switches. Traffic in VLAN 101-VLAN 106 is transmitted in this network. The link speed between the switches is 100Mb/s (the default path cost of the port is 200000).

It is required that traffic in VLAN 101 - VLAN 103 and traffic in VLAN 104 - VLAN 106 should be transmitted along different paths.

Figure 5-1 Network Topology

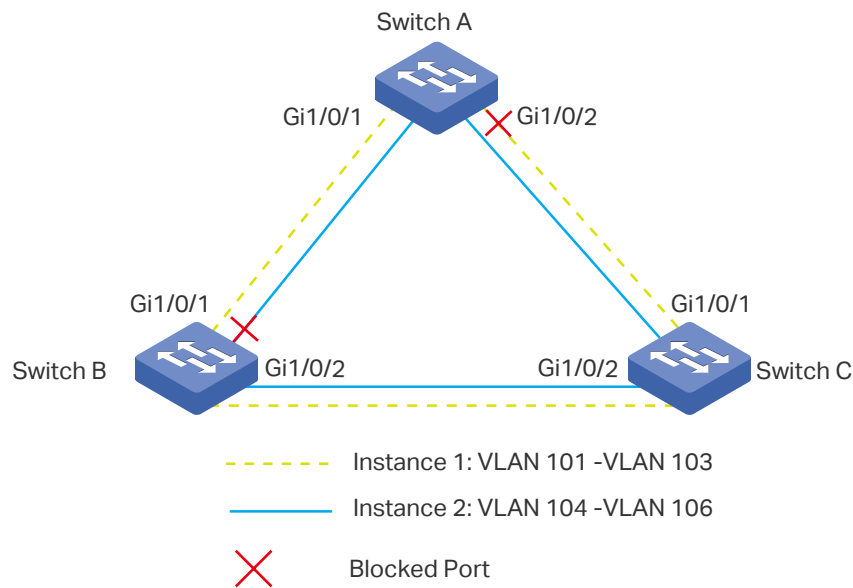


5.2 Configuration Scheme

To meet this requirement, you are suggested to configure MSTP function on the switches. Map the VLANs to different instances to ensure traffic can be transmitted along the respective instance.

Here we configure two instances to meet the requirement, as is shown below:

Figure 5-2 VLAN-Instance Mapping



The overview of configuration is as follows:

- 1) Enable the Spanning Tree function on the ports in each switch.
- 2) Configure Switch A, Switch B and Switch C in the same region. Configure the region name as 1, and the revision level as 100. Map VLAN 101 - VLAN 103 to instance 1 and VLAN 104 - VLAN 106 to instance 2.
- 3) Configure the priority of Switch B as 0 to set it as the root bridge in instance 1; configure the priority of Switch C as 0 to set it as the root bridge in instance 2.
- 4) Configure the path cost to block the specified ports. For instance 1, set the path cost of port 1/0/1 of Switch A to be greater than the default path cost (200000). For instance 2, set the path cost of port 1/0/2 of Switch B to be greater than the default path cost (200000).
- 5) Enable MSTP function in all the switches.

5.3 Using the GUI

■ Configurations for Switch A

- 1) Choose the menu **L2 FEATURES > Spanning Tree > STP Config > Port Config** to load the following page. Enable spanning tree function on port 1/0/1 and port 1/0/2. Here we leave the values of the other parameters as default settings. Click **Apply**.

Figure 5-3 Enable Spanning Tree Function on Ports

UNIT1		LAGS								
<input type="checkbox"/>	Port	Status	Priority	Ext-Path Cost	Int-Path Cost	Edge Port	P2P Link	MCheck	Port Mode	Port I
<input checked="" type="checkbox"/>	1/0/1	Enabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input checked="" type="checkbox"/>	1/0/2	Enabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/3	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/4	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/5	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/6	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/7	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/8	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/9	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--
<input type="checkbox"/>	1/0/10	Disabled	128	Auto	Auto	Disabled	Auto	--	--	--

Total: 28 2 entries selected.

- 2) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Region Config** to load the following page. Set the region name as 1 and the revision level as 100. Click **Apply**.

Figure 5-4 Configuring the MST Region

Region Config

Region Name:

Revision: (0-65535)

- 3) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Config**. Click Add, map VLAN101-VLAN103 to instance 1 and set the priority as 32768; map VLAN104-VLAN106 to instance 2 and set the priority as 32768. Click **Create**.

Figure 5-5 Configuring the VLAN-Instance Mapping

Instance Config

Instance ID: (1-8)

Priority: (0-61440, in increments of 4096)

VLAN ID: Add Delete

(1-4094, format:1,3,4-7,11-30)

- 4) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Port Config** to load the following page. Set the path cost of port 1/0/1 in instance 1 as 400000. Click **Apply**.

Figure 5-6 Configure the Path Cost of Port 1/0/1 In Instance 1

Instance Port Config

Instance ID:

<input type="checkbox"/>	Port	Priority	Path Cost	Port Role	Port Status	LAG
<input checked="" type="checkbox"/>	1/0/1	128	400000	--	--	--
<input type="checkbox"/>	1/0/2	128	Auto	--	--	--
<input type="checkbox"/>	1/0/3	128	Auto	--	--	--
<input type="checkbox"/>	1/0/4	128	Auto	--	--	--
<input type="checkbox"/>	1/0/5	128	Auto	--	--	--
<input type="checkbox"/>	1/0/6	128	Auto	--	--	--
<input type="checkbox"/>	1/0/7	128	Auto	--	--	--
<input type="checkbox"/>	1/0/8	128	Auto	--	--	--
<input type="checkbox"/>	1/0/9	128	Auto	--	--	--
<input type="checkbox"/>	1/0/10	128	Auto	--	--	--

Total: 28 1 entry selected.

- 5) Choose the menu **L2 FEATURES > Spanning Tree > STP Config > STP Config** to load the following page. Enable MSTP function globally, here we leave the values of the other global parameters as default settings. **Click Apply.**

Figure 5-7 Configure the Global MSTP Parameters of the Switch

Global Config

Spanning Tree: Enable

Mode:

Parameters Config

CIST Priority: (0-61440, in increments of 4096)


Hello Time: seconds (1-10)

Max Age: seconds (6-40)

Forward Delay: seconds (4-30)

Tx Hold Count: pps (1-20)

Max Hops: (1-40)

- 6) Click  **Save** to save the settings.

■ **Configurations for Switch B**

- 1) Choose the menu **L2 FEATURES > Spanning Tree > STP Config > Port Config** to load the following page. Enable the spanning tree function on port 1/0/1 and port 1/0/2. Here we leave the values of the other parameters as default settings. **Click Apply.**

Figure 5-8 Enable Spanning Tree Function on Ports

UNIT1		LAGS		Port	Status	Priority	Ext-Path Cost	Int-Path Cost	Edge Port	P2P Link	MCheck	Port Mode	Port I
<input checked="" type="checkbox"/>	1/0/1	Enabled	128	Auto	Auto	Disabled	Auto	--	--				
<input checked="" type="checkbox"/>	1/0/2	Enabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/3	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/4	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/5	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/6	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/7	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/8	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/9	Disabled	128	Auto	Auto	Disabled	Auto	--	--				
<input type="checkbox"/>	1/0/10	Disabled	128	Auto	Auto	Disabled	Auto	--	--				

Total: 28 2 entries selected.

- 2) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Region Config** to load the following page. Set the region name as 1 and the revision level as 100. Click **Apply**.

Figure 5-9 Configuring the Region

Region Config

Region Name:

Revision: (0-65535)

- 3) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Config**. Click Add. map VLAN101-VLAN103 to instance 1 and set the Priority as 0; map VLAN104-VLAN106 to instance 2 and set the priority as 32768. Click **Create**.

Figure 5-10 Configuring the VLAN-Instance Mapping

Instance Config

Instance ID: (1-8)

Priority: (0-61440, in increments of 4096)

VLAN ID: Add Delete

(1-4094, format:1,3,4-7,11-30)

- 4) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Port Config** to load the following page. Set the path cost of port 1/0/2 in instance 2 as 400000. Click **Apply**.

Figure 5-11 Configure the Path Cost of Port 1/0/2 in Instance 2

Instance Port Config

Instance ID:

<input type="checkbox"/>	Port	Priority	Path Cost	Port Role	Port Status	LAG
<input type="checkbox"/>	1/0/1	128	Auto	--	--	---
<input checked="" type="checkbox"/>	1/0/2	128	Auto	--	--	---
<input type="checkbox"/>	1/0/3	128	Auto	--	--	---
<input type="checkbox"/>	1/0/4	128	Auto	--	--	---
<input type="checkbox"/>	1/0/5	128	Auto	--	--	---
<input type="checkbox"/>	1/0/6	128	Auto	--	--	---
<input type="checkbox"/>	1/0/7	128	Auto	--	--	---
<input type="checkbox"/>	1/0/8	128	Auto	--	--	---
<input type="checkbox"/>	1/0/9	128	Auto	--	--	---
<input type="checkbox"/>	1/0/10	128	Auto	--	--	---

Total: 28 1 entry selected.

- 5) Choose the menu **L2 FEATURES > Spanning Tree > STP Config > STP Config** to load the following page. Enable MSTP function globally. Here we leave the values of the other global parameters as default settings. Click **Apply**.

Figure 5-12 Configuring the MSTP Globally

Global Config

Spanning Tree: Enable

Mode:

Parameters Config

CIST Priority: (0-61440, in increments of 4096)

Hello Time: seconds (1-10)

Max Age: seconds (6-40)

Forward Delay: seconds (4-30)

Tx Hold Count: pps (1-20)

Max Hops: (1-40)

- 6) Click  **Save** to save the settings.

■ **Configurations for Switch C**

- 1) Choose the menu **L2 FEATURES > Spanning Tree > STP Config > Port Config** to load the following page. Enable the spanning tree function on port 1/0/1 and port 1/0/2. Here we leave the values of the other parameters as default settings. Click **Apply**.

Figure 5-13 Enable Spanning Tree Function on Ports

UNIT1		LAGS								
<input type="checkbox"/>	Port	Status	Priority	Ext-Path Cost	Int-Path Cost	Edge Port	P2P Link	MCheck	Port Mode	Port I
<input checked="" type="checkbox"/>	1/0/1	Enabled	128	Auto	Auto	Disabled	Auto	--	--	
<input checked="" type="checkbox"/>	1/0/2	Enabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/3	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/4	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/5	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/6	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/7	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/8	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/9	Disabled	128	Auto	Auto	Disabled	Auto	--	--	
<input type="checkbox"/>	1/0/10	Disabled	128	Auto	Auto	Disabled	Auto	--	--	

Total: 28 2 entries selected.

- 2) Choose the menu **Spanning Tree > MSTP Instance > Region Config** to load the following page. Set the region name as 1 and the revision level as 100. Click **Apply**.

Figure 5-14 Configuring the Region

Region Config

Region Name:

Revision: (0-65535)

- 3) Choose the menu **L2 FEATURES > Spanning Tree > MSTP Instance > Instance Config**. Click Add, map VLAN101-VLAN103 to instance 1 and set the priority as 32768; map VLAN104-VLAN106 to instance 2 and set the priority as 0. Click **Create**.

Figure 5-15 Configuring the VLAN-Instance Mapping

Instance Config

Instance ID: (1-8)

Priority: (0-61440, in increments of 4096)

VLAN ID: Add Delete

(1-4094, format:1,3,4-7,11-30)

- 4) Choose the menu **L2 FEATURES > Spanning Tree > STP Instance > STP Config** to load the following page. Enable MSTP function globally, here we leave the values of the other global parameters as default settings. Click **Apply**.

Figure 5-16 Configuring the MSTP Globally

Global Config

Spanning Tree: Enable

Mode: MSTP

Apply

Parameters Config

CIST Priority: 32768 (0-61440, in increments of 4096)

Hello Time: 2 seconds (1-10)

Max Age: 20 seconds (6-40)

Forward Delay: 15 seconds (4-30)

Tx Hold Count: 5 pps (1-20)

Max Hops: 20 (1-40)

Apply

- 5) Click  Save to save the settings.

5.4 Using the CLI

■ Configurations for Switch A

- 1) Enable the spanning tree function on port 1/0/1 and port 1/0/2, and specify the path cost of port 1/0/1 in instance 1 as 400000.

```
Switch#configure
```

```
Switch(config)#interface gigabitEthernet 1/0/1
```

```
Switch(config-if)#spanning-tree
```

```
Switch(config-if)#spanning-tree mst instance 1 cost 400000
```

```
Switch(config-if)#exit
```

```
Switch(config)#interface gigabitEthernet 1/0/2
```

```
Switch(config-if)#spanning-tree
```

```
Switch(config-if)#exit
```

- 2) Configure the region name as 1, the revision number as 100; map VLAN101-VLAN103 to instance 1; map VLAN104-VLAN106 to instance 2:

```
Switch(config)#spanning-tree mst configuration
```

```
Switch(config-mst)#name 1
```

```
Switch(config-mst)#revision 100
```

```
Switch(config-mst)#instance 1 vlan 101-103
```

```
Switch(config-mst)#instance 2 vlan 104-106
```

```
Switch(config-mst)#exit
```

- 3) Configure the spanning tree mode as MSTP, then enable spanning tree function globally.

```
Switch(config)#spanning-tree mode mstp
```

```
Switch(config)#spanning-tree
```

```
Switch(config)#end
```

```
Switch#copy running-config startup-config
```

■ Configurations for Switch B

- 1) Enable the spanning tree function on port 1/0/1 and port 1/0/2, and specify the path cost of port 1/0/2 in instance 2 as 400000.

```
Switch#configure
```

```
Switch(config)#interface gigabitEthernet 1/0/2
```

```
Switch(config-if)#spanning-tree
```

```
Switch(config-if)#spanning-tree mst instance 2 cost 400000
```

```
Switch(config-if)#exit
```

```
Switch(config)#interface gigabitEthernet 1/0/1
```

```
Switch(config-if)#spanning-tree
```

```
Switch(config-if)#exit
```

- 2) Configure the region name as 1, the revision number as 100; map VLAN101-VLAN103 to instance 1; map VLAN104-VLAN106 to instance 2; configure the priority of Switch B in instance 1 as 0 to set it as the root bridge in instance 1:

```
Switch(config)#spanning-tree mst configuration
```

```
Switch(config-mst)#name 1
```

```
Switch(config-mst)#revision 100
```

```
Switch(config-mst)#instance 1 vlan 101-103
```

```
Switch(config-mst)#instance 2 vlan 104-106
```

```
Switch(config-mst)#exit
```

```
Switch(config)#spanning-tree mst instance 1 priority 0
```

- 3) Configure the spanning tree mode as MSTP, then enable spanning tree function globally.

```
Switch(config)#spanning-tree mode mstp
```

```
Switch(config)#spanning-tree
Switch(config)#end
Switch#copy running-config startup-config
```

■ Configurations for Switch C

- 1) Enable the spanning tree function on port 1/0/1 and port 1/0/2.

```
Switch#configure
Switch(config)#interface range gigabitEthernet 1/0/1-2
Switch(config-if-range)#spanning-tree
Switch(config-if-range)#exit
```

- 2) Configure the region name as 1, the revision number as 100; map VLAN101-VLAN103 to instance 1; map VLAN104-VLAN106 to instance 2; configure the priority of Switch C in instance 2 as 0 to set it as the root bridge in instance 2:

```
Switch(config)#spanning-tree mst configuration
Switch(config-mst)#name 1
Switch(config-mst)#revision 100
Switch(config-mst)#instance 1 vlan 101-103
Switch(config-mst)#instance 2 vlan 104-106
Switch(config-mst)#exit
Switch(config)#spanning-tree mst instance 2 priority 0
```

- 3) Configure the spanning tree mode as MSTP, then enable spanning tree function globally.

```
Switch(config)#spanning-tree mode mstp
Switch(config)#spanning-tree
Switch(config)#end
Switch#copy running-config startup-config
```

Verify the Configurations

■ Switch A

Verify the configurations of Switch A in instance 1:

```
Switch(config)#show spanning-tree mst instance 1
MST-Instance 1
Root Bridge
```

```

Priority    :0
Address    :00-0a-eb-13-12-ba
Internal Cost : 400000
Root Port  :1
Designated Bridge
Priority    :0
Address    :00-0a-eb-13-12-ba
Local Bridge
Priority    :32768
Address    :00-0a-eb-13-23-97

```

Interface	Prio	Cost	Role	Status	LAG
-----	----	-----	-----	-----	----
Gi1/0/1	128	400000	Root	Fwd	N/A
Gi1/0/2	128	200000	Altn	Blk	N/A

Verify the configurations of Switch A in instance 2:

```
Switch(config)#show spanning-tree mst instance 2
```

```
MST-Instance 2
```

```
Root Bridge
```

```
Priority    :0
```

```
Address    :3c-46-d8-9d-88-f7
```

```
Internal Cost : 200000
```

```
Root Port  :2
```

```
Designated Bridge
```

```
Priority    :0
```

```
Address    :3c-46-d8-9d-88-f7
```

```
Local Bridge
```

```
Priority    :32768
```



```

Address   : 00-0a-eb-13-23-97

Interface Prio  Cost   Role   Status  LAG
-----  ----  -
Gi1/0/1   128   200000 Desg   Fwd    N/A
Gi1/0/2   128   200000 Root   Fwd    N/A

```

- **Switch B**

Verify the configurations of Switch B in instance 1:

```
Switch(config)#show spanning-tree mst instance 1
```

```
MST-Instance 1
```

```
Root Bridge
```

```
Priority   : 0
```

```
Address    : 00-0a-eb-13-12-ba
```

```
Local bridge is the root bridge
```

```
Designated Bridge
```

```
Priority   : 0
```

```
Address    : 00-0a-eb-13-12-ba
```

```
Local Bridge
```

```
Priority   : 0
```

```
Address    : 00-0a-eb-13-12-ba
```

```
Interface Prio  Cost   Role   Status
-----  ----  -

```

```
Gi1/0/1   128   200000 Desg   Fwd
```

```
Gi1/0/2   128   200000 Desg   Fwd
```

Verify the configurations of Switch B in instance 2:

```
Switch(config)#show spanning-tree mst instance 2
```

```
MST-Instance 2
```

```
Root Bridge
```

```
Priority   : 0
```

```
Address    : 3c-46-d8-9d-88-f7
```

```

Internal Cost : 400000

Root Port   : 2

Designated Bridge

Priority    : 0

Address     : 3c-46-d8-9d-88-f7

Local Bridge

Priority    : 32768

Address     : 00-0a-eb-13-12-ba

Interface  Prio  Cost    Role   Status
-----  ----  -
Gi1/0/1   128   200000 Altn   Blk
Gi1/0/2   128   200000 Root   Fwd

```

- **Switch C**

Verify the configurations of Switch C in instance 1:

```
Switch(config)#show spanning-tree mst instance 1
```

```

MST-Instance 1

Root Bridge

Priority    : 0

Address     : 00-0a-eb-13-12-ba

Internal Cost : 200000

Root Port   : 2

Designated Bridge

Priority    : 0

Address     : 00-0a-eb-13-12-ba

Local Bridge

Priority    : 32768

Address     : 3c-46-d8-9d-88-f7

Interface  Prio  Cost    Role   Status
-----  ----  -
Gi1/0/1   128   200000 Desg   Fwd

```

```
Gi1/0/2    128    200000  Root    Fwd
```

Verify the configurations of Switch C in instance 2:

```
Switch(config)#show spanning-tree mst instance 2
```

```
MST-Instance 2
```

```
Root Bridge
```

```
Priority   :0
```

```
Address    : 3c-46-d8-9d-88-f7
```

```
Local bridge is the root bridge
```

```
Designated Bridge
```

```
Priority   :0
```

```
Address    : 3c-46-d8-9d-88-f7
```

```
Local Bridge
```

```
Priority   :0
```

```
Address    : 3c-46-d8-9d-88-f7
```

Interface	Prio	Cost	Role	Status
-----	-----	-----	-----	-----
Gi1/0/1	128	200000	Desg	Fwd
Gi1/0/2	128	200000	Desg	Fwd

6 Appendix: Default Parameters

Default settings of the Spanning Tree feature are listed in the following table.

Table 6-1 Default Settings of the Global Parameters

Parameter	Default Setting
Spanning-tree	Disabled
Mode	STP
CIST Priority	32768
Hello Time	2 seconds
Max Age	20 seconds
Forward Delay	15 seconds
Tx Hold Count	5 pps
Max Hops	20 hops

Table 6-2 Default Settings of the Port Parameters

Parameter	Default Setting
Status	Disabled
Priority	128
Ext-Path Cost	Auto
In-Path Cost	Auto
Edge Port	Disabled
P2P Link	Auto
MCheck	-----

Table 6-3 Default Settings of the MSTP Instance

Parameter	Default Setting
Status	Disabled
Revision Level	0

Parameter	Default Setting
Priority	32768
Port Priority	128
Path Cost	Auto

Table 6-4 Default Settings of the STP Security

Parameter	Default Setting
Loop Protect	Disabled
Root Protect	Disabled
TC Guard	Disabled
BPDU Protect	Disabled
BPDU Filter	Disabled
BPDU Forward	Enabled