STP Configuration

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Chapter 1   Configuring STP

1.1   STP Introduction

The standard Spanning Tree Protocol (STP) is based on the IEEE 802.1D standard. A switch stack appears as a single spanning-tree node to the rest of the network, and all stack members use the same bridge ID. Unless otherwise noted, the term switch refers to a standalone switch and to a switch stack.

The STP uses a spanning-tree algorithm to select one switch of a redundantly connected network as the root of the spanning tree. The algorithm calculates the best loop-free path through a switched Layer 2 network by assigning a role to each port based on the role of the port in the active topology.

STP is a Layer 2 link management protocol that provides path redundancy while preventing loops in the network. For a Layer 2 Ethernet network to function properly, only one active path can exist between any two stations. Multiple active paths among end stations cause loops in the network. If a loop exists in the network, end stations might receive duplicate messages. Switches might also learn end-station MAC addresses on multiple Layer 2 interfaces. These conditions result in an unstable network. Spanning-tree operation is transparent to end stations, which cannot detect whether they are connected to a single LAN segment or a switched LAN of multiple segments.

The STP uses a spanning-tree algorithm to select one switch of a redundantly connected network as the root of the spanning tree. The algorithm calculates the best loop-free path through a switched Layer 2 network by assigning a role to each port based on the role of the port in the active topology:

The standard Spanning-Tree Protocol (STP) is defined in IEEE 802.1D. It simplifies the LAN topology comprising several bridges to a sole spinning tree, preventing network loop from occurring and ensuring stable work of the network.

The algorithm of STP and its protocol configure the random bridging LAN to an active topology with simple connections. In the active topology, some bridging ports can forward frames; some ports are in the congestion state and cannot transmit frames. Ports in the congestion state may be concluded in the active topology. When the device is ineffective, added to or removed from the network, the ports may be changed to the transmitting state.

In the STP topology, a bridge can be viewed as root. For every LAN section, a bridging port will forward data from the network section to the root. The port is viewed as the designated port of the network section. The bridge where the port is located is viewed as the designated bridge of the LAN. The root is the designated bridge of all network sections that the root connects. In ports of each bridge, the port which is nearest to the root is the root port of the bridge. Only the root port and the designated port (if available) is in the transmitting state. Ports of another type are not shut down but they are not the root port or the designated port. We call these ports are standby ports.

The following parameters decides the structure of the stabilized active topology:

(1) Identifier of each bridge

(2) Path cost of each port

(3) Port identifier for each port of the bridge

The bridge with highest priority (the identifier value is the smallest) is selected as the root. Ports of each bridge has the attribute **Root Path Cost**, that is, the minimum of path cost summation of all ports from the root to the bridge. The designated port of each network segment refers to the port connecting to the network segment and having the minimum path cost.

When two ports on a switch are part of a loop, the spanning-tree port priority and path cost settings control which port is put in the forwarding state and which is put in the blocking state. The spanning-tree port priority value represents the location of a port in the network topology and how well it is located to pass traffic. The path cost value represents the media speed.

Our switch standard supports two modes of spanning tree protocol 802.1D STP and 802.1w RSTP. Some models of the switch support distributing STP mode according to VLAN and MSTP spanning tree protocol. For more details, please refer to 'STP Mode and Model Table' in chapter 2.

This chapter describes how to configure the standard spanning tree protocol that switch supports.

Note:

802.1D STP and 802.1w RSTP are abbreviated to SSTP and RSTP in this article. SSTP means Single Spanning-tree.

1.2   STP Model-to-Type Table

Model	Single STP	PVST	RSTP	MSTP
S2116, S2224D, S2448	√	√	√	√
S2224, S2448B, S2516, S2524	√	x	√	x
S2224M, S2226	√	√	√	x
S3224, S3224M, S3512	√	x	√	x
S3424, S3448	√	√	√	√
S6508	√	√	√	√
S8500	√	√	√	√

1.3   SSTP Configuratiom Task List

● Selecting STP Mode

- Disabling/Enabling STP

- Configuring the Switch Priority

- Configuring the Hello Time

- Configuring the Max-Age Time

- Configuring the Forward Delay Time

- Configuring Port Priority

- Configuring Path Cost

- Configuring the Auto-Designated port

- Monitoring STP Status

1.4 SSTP Configuration Task

1.4.1 Selecting STP Mode

Run the following command to configure the STP mode:

Run…	To…
spanning-tree mode {sstp | rstp}	Select the STP configuration.

1.4.2 Disabling/Enabling STP

Spanning tree is enabled by default. Disable spanning tree only if you are sure there are no loops in the network topology.

Follow these steps to disable spanning-tree:

command	purpose
no spanning-tree	Disables STP.

To enable spanning-tree, use the following command:

command	purpose
spanning-tree	Enables default mode STP (SSTP).
spanning-tree mode {**sstp** | **rstp**}	Enables a certain mode STP.

1.4.3 Configuring the Switch Priority

You can configure the switch priority and make it more likely that a standalone switch or a switch in the stack will be chosen as the root switch.

Follow these steps to configure the switch priority：

command	purpose

spanning-tree sstp priority *value*	Modifies sstp priority value.
no spanning-tree sstp priority	Returns sstp priority to default value (32768).

1.4.4 Configuring the Hello Time

User can configure the interval between STP data units sent by the root switch through changing the hello time.

Use the following command to configure Hello Time of SSTP：

command	purpose
spanning-tree sstp hello-time *value*	Configures sstp Hello Time.
no spanning-tree sstp hello-time	Returns sstp Hello Time to default value (4s).

1.4.5 Configuring the Max-Age Time

Use the sstp max age to configure the number of seconds a switch waits without receiving spanning-tree configuration messages before attempting a reconfiguration.

Follow these steps to configure the maximum-aging time：

command	purpose
spanning-tree sstp max-age *value*	Configures the sstp max-age time.
no spanning-tree sstp max-age	Returns the max-age time to default value (20s).

1.4.6 Configuring the Forward Delay Time

Configure sstp forward delay to determine the number of seconds an interface waits before changing from its spanning-tree learning and listening states to the forwarding state.

Use the following command to configure sstp forward delay：

command	purpose
spanning-tree sstp *forward-time*	Configures sstp Forward time.
no spanning-tree sstp forward-time	Returns forward time to default value (15s).

1.4.7 Configuring the Port Priority

If a loop occurs, spanning tree uses the port priority when selecting an interface to put into the forwarding state. You can assign higher priority values (lower numerical values) to interfaces that you want selected first and lower priority values (higher numerical values) that you want selected last. If all interfaces have the same priority value, spanning tree puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

Follow these steps to configure the port priority of an interface：

command	purpose
spanning-tree port-priority *value*	Configures the port priority for an interface.
spanning-tree sstp port-priority *value*	Modifies sstp port priority.
no spanning-tree sstp port-priority	Returns port priority to default value (128).

1.4.8   Configuring the Path Cost

Follow these steps to configure the cost of an interface：

command	purpose
spanning-tree cost *value*	Configures the cost for an interface.
spanning-tree sstp cost *value*	Modifies sstp path cost.
no spanning-tree sstp cost	Returns path cost to default value.

1.4.9   Configuring Auto-Designated Port

The auto-designated port is a special function of S8500 switches. The function allows line card to automatically send BPDU to the auto-designated port, reducing the load of the MSU.

The auto-designated port function is effective in STP mode.

In global configuration mode, run the following commands to configure the auto-designated port function of S8500 series switches:

Command	Purpose
spanning-tree designated-auto	Enables the auto-designated port function.
no spanning-tree designated-auto	Disables the auto-designated port function.

1.4.10   Monitoring STP State

To monitor the STP configuration and state, use the following command in management mode:

command	purpose
show spanning-tree	Displays spanning-tree information on active interfaces only.
show spanning-tree detail	Displays a detailed summary of interface information.
show spanning-tree interface	Displays spanning-tree information for the specified interface.

1.5   Configuring VLAN STP

1.5.1   Overview

In SSTP mode, the whole network has only one STP entity. The state of the switch port in the STP decides its state in all VLANs. In the case that multiple VLANs exist in the network, the separation of the single STP and the network topology may cause communication congestion in some parts of network.

Our switches run independent SSTP on a certain number of PurposeVLANs, ensuring that the port has different state in different VLANs and that the load balance is realized between VLANs.

Note that the switch can run the independent STP in up to 30 VLANs. Other VLAN topologies is not controlled by the STP.

S2116, S2448, S3448, S6508 and S8500 support the VLAN-based STP case planning. For details, refer to relative device models and software version explanations.

1.5.2   VLAN STP Configuration Task

In global configuration mode, run the following commands to configure SSTP attributes in VLAN:

Command	Purpose
spanning-tree mode pvst	Starts the VLAN-based STP distribution mode.
spanning-tree vlan *vlan-list*	Distributes the STP case for the designated VLAN. vlan-list: the list of VLAN The switch distributes STP case for up to 30 VLANs.
no spanning-tree vlan *vlan-list*	Deletes the STP case in the designated VLA.
spanning-tree vlan *vlan-list* **priority** *value*	Configures the priority for the STP in the designated VLAN.
no spanning-tree *vlan-list* **priority**	Resumes the STP priority in the VLAN to the default configuration.
spanning-tree vlan *vlan-list* **forward-time** *value*	Configures Forward Delay for the designated VLAN.
no spanning-tree vlan *vlan-list* **forward-time**	Resumes Forward Delay of the designated VLAN to the default configuration.
spanning-tree vlan *vlan-list* **max-age** *value*	Configures Max-age for the designated VLAN.
no spanning-tree vlan *vlan-list* **max-age**	Resumes Max-age of the designated VLAN to the default configuration.
spanning-tree vlan *vlan-list* **hello-time** *value*	Configures HELLO-TIME for the designated VLAN.
no spanning-tree vlan *vlan-list* **hello-time**	Resumes HELLO-TIME of the designated VLAN to the default configuration.

In port configuration mode, run the following command to configure attributes of the port:

Command	Purpose
spanning-tree vlan *vlan-list* **cost**	Configures the path cost of the designated VLAN for the port.
no spanning-tree vlan *vlan-list* **cost**	Resumes the default path cost of the designated VLAN for the port.
spanning-tree vlan *vlan-list* **port-priority**	Configures the port priority in the VLAN.
no spanning-tree vlan *vlan-list* **port-priority**	Resumes the default port priority in the VLAN.

In monitor or configuration mode, run the following command to check the STP state in the specified VLAN:

Command	Purpose
show spanning-tree vlan *vlan-list*	Check the STP state in the VLAN.

1.6   RSTP Configuration Task List

- Enabling/Disabling Switch RSTP

- Configuring the Switch Priority

- Configuring the Forward Delay Time

- Configuring the Hello time

- Configuring the Max-Age

- Configuring the Path Cost

- Configuring the Port Priority

- Enabling Protocol Conversation Check

1.7   RSTP Configuration Task

1.7.1   Enabling/Disabling Switch RSTP

Follow these configurations in the global configuration mode:

command	purpose
spanning-tree mode rstp	Enables RSTP
no spanning-tree mode	Returns STP to default mode (SSTP)

1.7.2 Configuring the Switch Priority

You can configure the switch priority and make it more likely that a standalone switch or a switch in the stack will be chosen as the root switch.

Follow these steps to configure the switch priority：

Follow these configurations in the global configuration mode:

command	purpose
spanning-tree rstp priority *value*	Modifies rstp priority value.
no spanning-tree rstp priority	Returns rstp priority to default value.

Note: If the priority of all bridges in the whole switch network uses the same value, then the bridge with the least MAC address will be chosen as the root bridge. In the situation when the RSTP protocol is enabled, if the bridge priority value is modified, it will cause the recalculation of spanning tree.

The bridge priority is configured to 32768 by default.

1.7.3 Configuring the Forward Delay Time

Link failures may cause network to recalculate the spanning tree structure. But the latest configuration message can no be conveyed to the whole network. If the newly selected root port and the specified port immediately start forwarding data, this may cause temporary path loop. Therefore the protocol adopts a kind of state migration mechanism. There is an intermediate state before root port and the specified port starting data forwarding, after the intermediate state passing the Forward Delay Time, the forward state begins. This delay time ensures the newly configured message has been conveyed to the whole network. The Forward Delay characteristic of the bridge is related to the network diameter of the switch network. Generally, the grater the network diameter, the longer the Forward Delay Time should be configured.

Follow these configurations in the global configuration mode:

Command	purpose
spanning-tree rstp forward-time *value*	Configures Forward Delay
no spanning-tree rstp forward-time	Returns Forward Delay Time to default value (15s).

Note: If you configure the Forward Delay Time to a relatively small value, it may leads to a temporary verbose path. If you configure the Forward Delay Time to a relatively big value, the system may not resume connecting for a long time. We recommend user to use the default value.

The Forward Delay Time of the bridge is 15 seconds.

1.7.4 Configuring the Hello Time

The proper hello time value can ensure that the bridge detect link failures in the network without occupying too much network resources.

Follow these configurations in the global configuration mode:

command	purpose
spanning-tree rstp hello-time *value*	Configures Hello Time
no spanning-tree rstp hello-time	Returns Hello Time to default value.

Note: We recommend user to use the default value.

The default Hello Time is 4 seconds.

1.7.5 Configuring the Max-Age

The ma-age is the number of seconds a switch waits without receiving spanning-tree configuration messages before attempting a reconfiguration.

Follow these configurations in the global configuration mode：

command	purpose
spanning-tree rstp max-age *value*	Configures the max-age value.
no spanning-tree rstp max-age	Returns the max-age time to default value (20s).

We recommend user to use the default value. Note: if you configure the Max Age to a relatively small value, then the calculation of the spanning tree will be relatively frequent, and the system may regard the network block as link failure. If you configure the Max Age to a relatively big value, then the link status will go unnoticed in time.

The Max Age of bridge is 20 seconds by default.

1.7.6 Configuring the Path Cost

The spanning-tree path cost default value is derived from the media speed of an interface. If a loop occurs, spanning tree uses cost when selecting an interface to put in the forwarding state. You can assign lower cost values to interfaces that you want selected first and higher cost values to interfaces that you want selected last. If all interfaces have the same cost value, spanning tree puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

Beginning in interface configuration mode, follow these steps to configure the cost of an interface:

command	purpose
spanning-tree rstp cost *value*	Configures the cost for an interface.
no spanning-tree rstp cost	Returns path cost to default value.

Note: The modification of the priority of the Ethernet port will arise the recalculation of the spanning tree. We recommend user to use the default value and let RSTP protocol calculate the path cost of the current Ethernet interface.

When the port speed is 10Mbps, the path cost of the Ethernet interface is 2000000.

When the port speed is 100Mbps, the path cost of the Ethernet interface is 200000.

1.7.7 Configuring the Port Priority

If a loop occurs, spanning tree uses the port priority when selecting an interface to put into the forwarding state. You can assign higher priority values (lower numerical values) to interfaces that you want selected first, and lower priority values (higher numerical values) that you want selected last. If all interfaces have the same priority value, spanning tree puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

Follow these configurations in the interface configuration mode：

command	purpose
spanning-tree rstp port-priority *value*	Configures the port priority for an interface.
no spanning-tree rstp port-priority	Returns the port priority to the default value.

Note: The modification of the priority of the Ethernet interface will arise the recalculation of the spanning tree.

The default Ethernet interface priority is 128.

1.7.8 Enabling Protocol Conversion Check

RSTP protocol allows switch to cooperate with traditional 802.1D STP switch via a kind of protocol conversion mechanism. If one interface of the switch receives configuration information of STP, then this interface will be converted to the one that only sends STP packet.

When an interface enters STP-compatible state，this interface won't returns to RSTP state even this interface no longer receives 802.1D STP BPDU. To return an interface to RSTP mode, user can use the **spanning-tree rstp migration-check** command to enable protocol conversion check process on an interface.

Note

Only switches supporting IEEE 802.1D 2004 RSTP support the **migration-check** command.

In global configuration mode, run the following command to restart the RSTP conversion check:

Command	Purpose
spanning-tree rstp migration-check	Restart the protocol conversion check on all ports.

In port configuration mode，run the following command to perform the protocol conversion check on the port:

Command	Purpose
spanning-tree rstp migration-check	Restart the protocol conversion check on the current port.

Chapter 2   Configuring MTSP

2.1   MSTP Overview

2.1.1   Introduction

Multiple Spanning Tree Protocol (MSTP) is used to create simple complete topology in the bridging LAN. MSTP can be compatible with the earlier Spanning Tree Protocol (STP) and Rapid Spanning Tree Protocol (RSTP).

Both STP and RSTP only can create sole STP topology. All VLAN messages are forwarded through the only STP. STP converges too slow, so RSTP ensures a rapid and stable network topology through the handshake mechanism.

MSTP inherits the rapid handshake mechanism of RSTP. At the same time, MST allows different VLAN to be distributed to different STPs, creating multiple topologies in the network. In networks created by MSTP, frames of different VLANs can be forwarded through different paths, realizing the load balance of the VLAN data.

Different from the mechanism that VLAN distributes STP, MSTP allows multiple VLANs to be distributed to one STP topology, effectively reducing STPs required to support lots of VLANs.

S2116, S2448, S3448 and S6508 switches support the MSTP mode. For details, refer to device models and relative software version documents.

2.1.2   MST Domain

In MSTP, the relationship between VLAN and STP is described through the MSTP configuration table. MSTP configuration table, configuration name and configuration edit number makes up of the MST configuration identifier.

In the network, interconnected bridges with same MST configuration identifier are considered in the same MST region. Bridges in the same MST region always have the same VLAN configuration, ensuring VLAN frames are sent in the MST region.

2.1.3   IST, CST, CIST and MSTI

Figure 2.1 shows an MSTP network, including three MST regions and a switch running 802.1D STP.
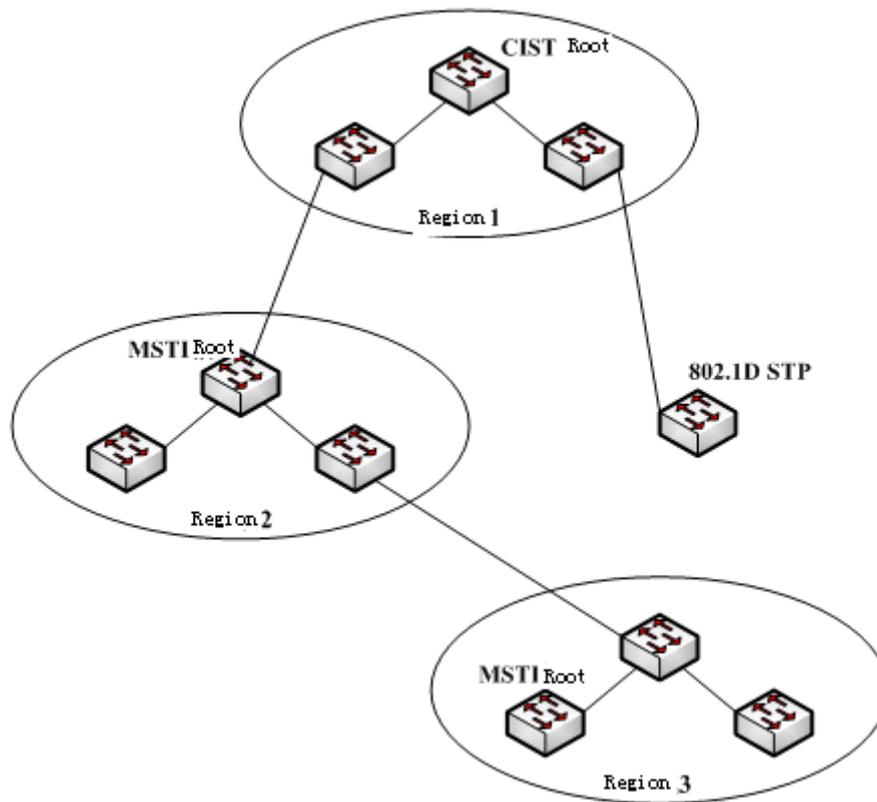
Figure 2.1 MSTP topology

1. CIST

Common and Internal Spanning Tree (CIST) means the spanning tree comprised by all single switches and interconnected LAN. These switches may belong to different MST regions. They may be switches running traditional STP or RSTP. Switches running STP or RSTP in the MST regions are considered to be in their own regions.

After the network topology is stable, the whole CIST chooses a CIST root bridge. An internal CIST root bridge will be choosed in each region, which is the shortest path from the heart of the region to CIST root.

2. CST

If each MST region is viewed as a single switch, Common Spanning Tree (CST) is the spanning tree connecting all "single switches". As shown in Figure 2.1, region 1, 2 and 3 and STP switches make up of the network CST.

3. IST

Internal Spanning Tree (IST) refers to part of CIST that is in an MST region, that is, IST and CST make up of the CIST.

4. MSTI

The MSTP protocol allows different VLANs to be distributed to different spanning trees. Multiple spanning tree instances are then created. Normally, No.0 spanning tree instance refers to CIST, which can be expanded to the whole network. Every spanning tree instance starting from No.1 is in a certain region. Each spanning tree instance can be distributed with multiple VLANs. In original state, all VLANs are distributed in CIST.

MSTI in the MST region is independent. They can choose different switches as their own roots.

2.1.4 Port Role

Ports in MSTP can function as different roles, similar to ports in RSTP.

1. Root port
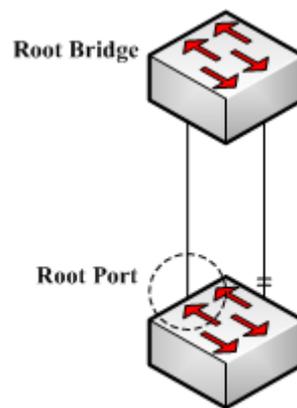
Figure 2.2 Root port

Root port stands for the path between the current switch and the root bridge, which has minimum root path cost.

2. Alternate port
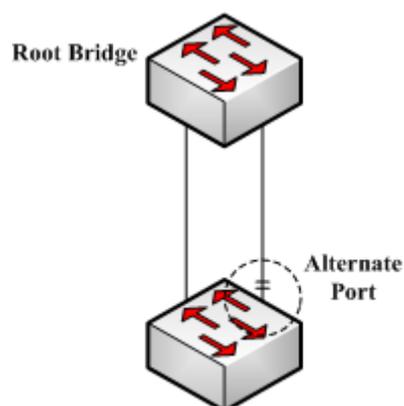
Figure 2.3 Alternate port

The alternate port is a backup path between the current switch and the root bridge. When the connection of root port is out of effect, the alternate port can promptly turn into a new root port without work interruption.

3. Designated port
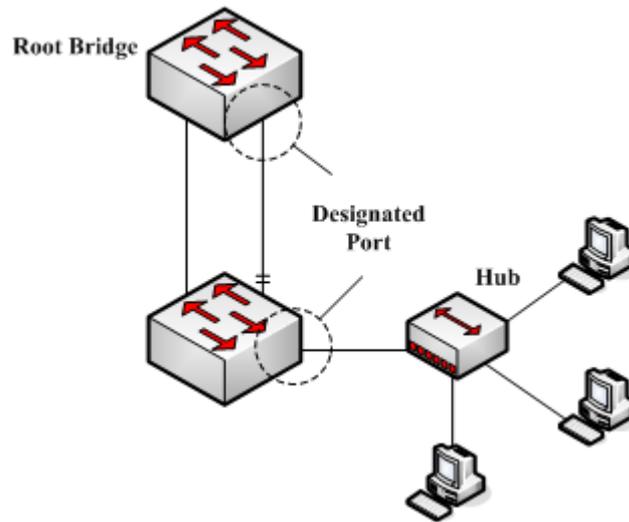
Figure 2.4 Designated port

The designated port can connect switches or LAN in the next region. It is the path between the current LAN and root bridge.

4. Backup port
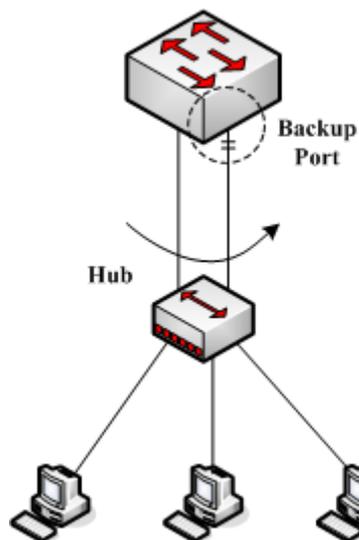
Figure 2.5 Backup port

When two switch ports directly connect or both connect to the same LAN, the port with lower priority is to be the backup port, the other port is to be the designated port. If the designated port breaks down, the backup port becames the designated port to continue working.

5. Master port
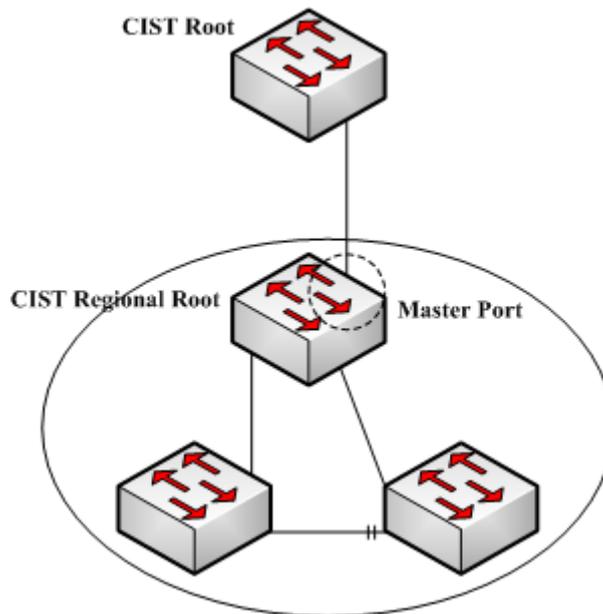
Figure 2.6 Master port

The Master port is the shortest path between MST region and CIST root bridge. Master port is the root port of the root bridge in the CIST region.

6. Boundary port

The concept of boundary port in CIST is a little different from that in each MSTI. In MSTI, the role of the boundary port means that the spanning tree instance does not expand on the port.

7. Edge port

In the RSTP protocol or MSTP protocol, edge port means the port directly connecting the network host. These ports can directly enter the forwarding state without causing any loop in the network.
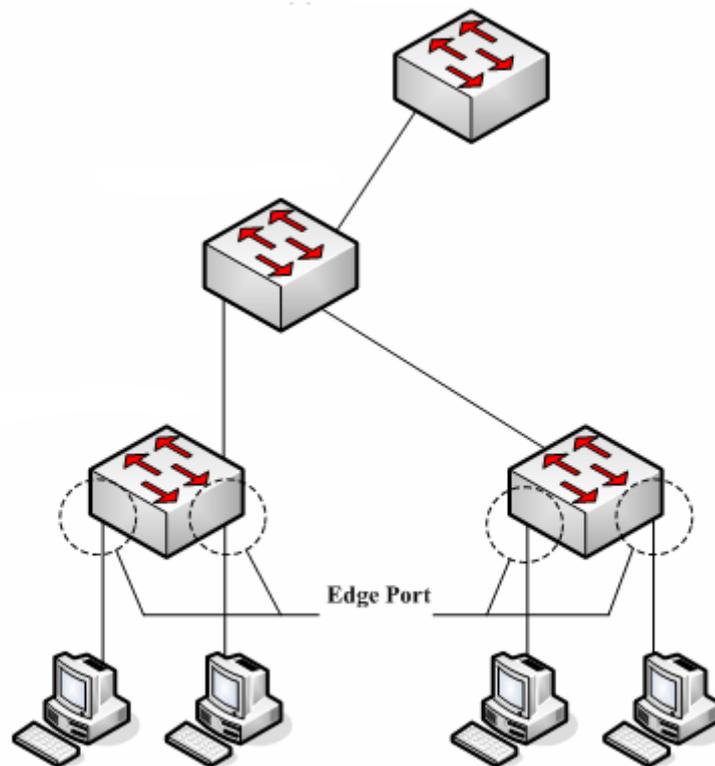
Figure 2.7 Edge port

In original state, MTSP and RSTP do not take all ports as edge ports, ensuring the network topology can be rapidly created. In this case, if a port receives BPDU from other switches, the port is resumed from the edge state to the normal state. If the port receives 802.1D STP BPDU, the port has to wait for double Forward Delay time and then enter the forwarding state.

2.1.5   MSTP BPDU

Similar to STP and RSTP, switches running MSTP can communicate with each other through Bridge Protocol Data Unit (BPDU). All configuration information about the CIST and MSTI can be carried by BPDU. Table 2.1 and Table 2.2 list the structure of BPDU used by the MSTP.

Table 2.1 MSTP BPDU

Field Name	Byte Number
Protocol Identifier	1 – 2
Protocol Version Identifier	3
BPDU Type	4
CIST Flags	5
CIST Root Identifier	6 – 13
CIST External Root Path Cost	14 – 17

CIST Regional Root Identifier	18 – 25
CIST Port Identifier	26 – 27
Message Age	28 – 29
Max Age	30 – 31
Hello Time	32 – 33
Forward Delay	34 – 35
Version 1 Length	36
Version 3 Length	37 – 38
Format Selector	39
Configuration Name	40 – 71
Revision	72 – 73
Configuration Digest	74 – 89
CIST Internal Root Path Cost	90 – 93
CIST Bridge Identifier	94 – 101
CIST Remaining Hops	102
MSTI Configuration Messages	103 ~

Table 2.2 MST configuration information

Field Name	Byte Number
MSTI FLAGS	1
MSTI Regional Root Identifier	2 – 9
MSTI Internal Root Path Cost	10 – 13
MSTI Bridge Priority	14
MSTI Port Priority	15
MSTI Remaining Hops	16

2.1.6   Stable State

The MSTP switch performs calculation and compares operations according to the received BPDU, and finally ensures that:

(1)   One switch is selected as the CIST root of the whole network.

(2)   Each switch and LAN segment can decide the minimum cost path to the CIST root, ensuring a complete connection and prevent loops.

(3)   Each region has a switch as the CIST regional root. The switch has the minimum cost path to the CIST root.

(4)   Each MSTI can independently choose a switch as the MSTI regional root.

(5)   Each switch in the region and the LAN segment can decide the minimum cost path to the MSTI root.

(6)　　The root port of CIST provides the minimum-cost path between the CIST regional root and the CIST root.

(7)　　The designated port of the CIST provided its LAN with the minimum-cost path to the CIST root.

(8)　　The Alternate port and the Backup port provides connection when the switch, port or the LAN does not work or is removed.

(9)　　The MSTI root port provides the minimum cost path to the MSTI regional root.

(10)　　The designated port of MSTI provides the minimum cost path to the MSTI regional root.

(11)　　A master port provides the connection between the region and the CIST root. In the region, the CIST root port of the CIST regional root functions as the master port of all MSTI in the region.

2.1.7　Hop Count

Different from STP and RSTP, the MSTP protocol does not use Message Age and Max Age in the BPDU configuration message to calculate the network topology. MSTP uses Hop Count to calculate the network topology.

To prevent information from looping, MSTP relates the transmitted information to the attribute of hop count in each spanning tree. The attribute of hop count for BPDU is designated by the CIST regional root or the MSTI regional root and reduced in each receiving port. If the hop count becomes 0 in the port, the information will be dropped and then the port turns to be a designated port.

2.1.8　STP Compatibility

MSTP allows the switch to work with the traditional STP switch through protocol conversion mechanism. If one port of the switch receives the STP configuration message, the port then only transmits the STP message. At the same time, the port that receives the STP information is then considered as a boundary port.

Note：

When a port is in the STP-compatible state, the port will not automatically resume to the MSTP state even if the port does not receive the STP message any more. In this case, you can run **spanning-tree mstp migration-check** to clear the STP message that the port learned, and make the port to return to the MSTP state.

The switch that runs the RSTP protocol can identify and handle the MSTP message. Therefore, the MSTP switch does not require protocol conversion when it works with the RSTP switch.

2.2　MSTP Configuration Task List

● 　Default MSTP configuration

● 　Enabling and disabling MSTP

- Configuring MSTP region

- Configuring network root

- Configuring secondary root

- Configuring bridge priority

- Configuring time parameters of STP

- Configuring network diameter

- Configuring maximum hop count

- Configuring port priority

- Configuring path cost for port

- Configuring port connection type

- Activating MST-compatible mode

2.2.1 Activating MST-Compatible Mode

The MSTP protocol that our switches support is based on IEEE 802.1s. In order to be compatible with other MSTPs, especially MSTP that the Cisco switches support, the MSTP protocol can work in MST-compatible mode. Switches running in MSTP-compatible mode can identify the message structure of other MSTPs, check the contained MST regional identifier and establish the MST region.

The MST-compatible mode and the STP-compatible mode are based on MSTP protocol conversion mechanism. If one port of the switch receives BPDU in compatible mode, the port automatically changes to the mode and sends BPDU in compatible mode. To resume the port to standard MST mode, you can run **spanning-tree mstp migration-check**.

In global configuration mode, run the following commands to activate or disable the MST-compatible mode:

Command	Purpose
spanning-tree mstp mst-compatible	Activates the MST-compatible mode for the switch.
no spanning-tree mstp mst-compatible	Disables the MST-compatible mode for the switch.

Note:

The main function of the compatible mode is to create the MST area for switches and other MSTP-running switches. In actual networking, make sure that the switch has the same configuration name and the same edit number. It is recommended to configure switches running other MSTP protocols to the CIST root, ensuring that the switch enters the compatible mode by receiving message.

If the MST-compatible mode is not activated, the switch will not resolve the whole BPDU-compatible content and take the content as the common RSTP BPDU. In this way, the switch cannot be in the same area with the MST-compatible switch that it connects.

A port in compatible mode cannot automatically resumes to send standard MST BPDU even if the compatible mode is shut down in global configuration mode. In this case, run **migration-check**.

- Restart the protocol conversion check.

- Check the MSTP message.

2.3   MSTP Configuration Task

2.3.1   Default MSTP Configuration

Attribute	Default Settings
STP mode	SSTP (PVST, RSTP and MSTP is not started)
Area name	Character string of MAC address
Area edit level	0
MST configuration list	All VLANs are mapped in CIST (MST00).
Spanning-tree priority (CIST and all MSTI)	32768
Spanning-tree port priority (CIST and all MSTI)	128
Path cost of the spanning-tree port (CIST and all MSTI)	1000 Mbps：20000 100 Mbps：200000 10 Mbps：2000000
Hello Time	2 seconds
Forward Delay	15 seconds
Maximum-aging Time	20 seconds
Maximum hop count	20

2.3.2   Enabling and Disabling MSTP

The STP protocol can be started in PVST or SSTP mode by default. You can stop it running when the spanning-tree is not required.

Run the following command to set the STP to the MSTP mode:

Command	Purpose
spanning-tree	Enables STP in default mode.
spanning-tree mode mstp	Enables MSTP.

Run the following command to disable STP:

Command	Purpose
no spanning-tree	Disable the STP.

2.3.3 Configuring MST Area

The MST area where the switch resides is decided by three attributes: configuration name, edit number, the mapping relation between VLAN and MSTI. You can configure them through area configuration commands. Note that the change of any of the three attributes will cause the change of the area where the switch resides.

In original state, the MST configuration name is the character string of the MAC address of the switch. The edit number is 0 and all VLANs are mapped in the CIST (MST00). Because different switch has different MAC address, switches that run MSTP are in different areas in original state. You can run **spanning-tree mstp instance** *instance-id* **vlan** *vlan-list* to create a new MSTI and map the designated VLAN to it. If the MSTI is deleted, all these VLANs are mapped to the CIST again.

Run the following command to set the MST area information:

Command	Purpose
spanning-tree mstp name *string*	Configures the MST configuration name.
	string means the character string of the configuration name. It contains up to 32 characters, capital sensitive. The default value is the character string of the MAC address.
no spanning-tree mstp name	Sets the MST configuration name to the default value.
spanning-tree mstp revision *value*	Sets the MST edit number.
	value represents the edit number, ranging from 0 to 65535. The default value is 0.
no spanning-tree mstp revision	Sets the MST edit number to the default value.
spanning-tree mstp instance *instance-id* **vlan** *vlan-list*	Maps VLAN to MSTI.
	instance-id represents the instance number of the spanning tree, meaning an MSTI. It ranges from 1 to 15.
	vlan-list means the VLAN list that is mapped to the spanning tree. It ranges from 1 to 4094.
	instance-id is an independent value representing a spanning tree instance.
	vlan-list can represent a group of VLANs, such as "1,2,3", "1-5" and "1,2,5-10".
no spanning-tree mstp instance *instance-id*	Cancels the VLAN mapping of MSTI and disables the spanning tree instance.
	instance-id represents the instance number of the spanning tree, meaning an MSTI. It ranges from 1 to 15.

Run the following command to check the configuration of the MSTP area:

Command	Purpose
show spanning-tree mstp region	Displays the configuration of the MSTP area.

2.3.4   Configuring Network Root

In MSTP, each spanning tree instance has a bridge ID, containing the priority value and MAC address of the switch. During the establishment of spanning tree topology, the switch with comparatively small bridge ID is selected as the network root.

MSTP can set the switch to the network switch through configuration. You can run the command **Spanning-tree mstp Spanning-tree mstp** *instance-id* **rootroot** to modify the priority value of the switch in a spanning tree instance from the default value to a sufficiently small value, ensuring the switch turns to be the root in the spanning tree instance.

In general, after the previous command is executed, the protocol automatically check the bridge ID of the current network root and then sets the priority field of the bridge ID to **24576** when the value **24576** ensures that the current switch becomes the root of the spanning tree.

If the network root's priority value is smaller than the value **24576**, MSTP automatically sets the spanning tree's priority of the current bridge to a value that is 4096 smaller than the priority value of the root. Note that the number **4096** is a step length of network priority value.

When setting the root, you can run the **diameter** subcommand to the network diameter of the spanning tree network. The keyword is effective only when the spanning tree instance ID is 0. After the network diameter is set, MSTP automatically calculates proper STP time parameters to ensure the stability of network convergence. Time parameters include Hello Time, Forward Delay and Maximum Age. The subcommand Hello-time can be used to set a new hello time to replace the default settings.

Run the following command to set the switch to the network root:

Command	Purpose
spanning-tree mstp *instance-id* **root primary** [**diameter** *net-diameter* [**hello-time** *seconds*]]	Sets the switch to the root in the designated spanning tree instance. **instance-id** represents the number of the spanning tree instance, ranging from 0 to 15. **net-diameter** represents the network diameter, which is an optional parameter. It is effective when **instance-id** is 0. It ranges from 2 to 7. **seconds** represents the unit of the hello time, ranging from 1 to 10.
no spanning-tree mstp *instance-id* **root**	Cancels the root configuration of the switch in the spanning tree. **instance-id** means the number of the spanning tree instance, ranging from 0 to 15.

Run the following command to check the MSTP message:

Command	Purpose
show spanning-tree mstp [**instance** *instance-id*]	Checks the MSTP message.

2.3.5 Configuring Secondary Root

After the network root is configured, you can run **spanning-tree mstp *instance-id* root secondary** to set one or multiple switches to the secondary roots or the backup roots. If the root does not function for certain reasons, the secondary roots will become the network root.

Different from the primary root configuration, after the command to configure the primary root is run, MSTP sets the spanning tree priority of the switch to **28672**. In the case that the priority value of other switches is the default value **32768**, the current switch can be the secondary root.

When configuring the secondary root, you can run the subcommands **diameter** and **hello-time** to update the STP time parameters. When the secondary root becomes the primary root and starts working, all these parameters starts functioning.

Run the following command to set the switch to the secondary root of the network:

Command	Purpose
spanning-tree mstp *instance-id* **root secondary** [**diameter** *net-diameter* [**hello-time** *seconds*]]	Sets the switch to the secondary root in the designated spanning tree instance. **instance-id** represents the number of the spanning tree instance, ranging from 0 to 15. **net-diameter** represents the network diameter, which is an optional parameter. It is effective when **instance-id** is 0. It ranges from 2 to 7. **seconds** represents the unit of the hello time, ranging from 1 to 10.
no spanning-tree mstp *instance-id* **root**	Cancels the root configuration of the switch in the spanning tree. **instance-id** means the number of the spanning tree instance, ranging from 0 to 15.

Run the following command to check the MSTP message:

Command	Purpose
show spanning-tree mstp [**instance** *instance-id*]	Check the message about the MST instance.

2.3.6 Configuring Bridge Priority

In some cases, you can directly set the switch to the network root by configuring the bridge priority. It means that you can set the switch to the network root without running the subcommand **root**. The priority value of the switch is independent in each spanning tree instance. Therefore, the priority of the switch can be set independently.

Run the following command to configure the priority of the spanning tree:

Command	Purpose
spanning-tree mstp *instance-id* **priority** *value*	Sets the priority of the switch. instance-id represents the number of the spanning tree

	instance, ranging from 0 to 15.
	value represents the priority of the bridge. It can be one of the following values:
	0, 4096, 8192, 12288, 16384, 20480, 24576, 28672,
	32768, 36864, 40960, 45056, 49152, 53248, 57344, 61440
no spanning-tree mstp *instance-id* **priority**	Resumes the bridge priority of the switch to the default value.
	instance-id means the number of the spanning tree instance, ranging from 0 to 15.

2.3.7 Configuring STP Time Parameters

The following are STP time parameters:

- **Hello Time**：

    The interval to send the configuration message to the designated port when the switch functions as the network root.

- **Forward Delay**：

    Time that the port needs when it changes from the **Blocking** state to the **learning** state and to the **forwarding** state in STP mode.

- **Max Age**：

    The maximum live period of the configuration information about the spanning tree.

To reduce the shock of the network topology, the following requirements for the time parameters must be satisfied:

- $2 \times (fwd\_delay - 1.0) >= max\_age$

- $max\_age >= (hello\_time + 1) \times 2$

Command	Purpose
spanning-tree mstp hello-time *seconds*	Sets the parameter **Hello Time**.
	The parameter **seconds** is the unit of **Hello Time**, ranging from 1 to 10 seconds. Its default value is two seconds.
no spanning-tree mstp hello-time	Resumes **Hello Time** to the default value.
spanning-tree mstp forward-time *seconds*	Sets the parameter **Forward Delay**.
	The parameter **seconds** is the unit of **Forward Delay**, ranging from 4 to 30 seconds. Its default value is 15 seconds.
no spanning-tree mstp forward-time	Resumes **Forward Delay** to the default value.
spanning-tree mstp max-age *seconds*	Sets the parameter **Max Age**.
	The parameter **seconds** is the unit of **Max Age**, ranging from 6 to 40 seconds. Its default value is 20 seconds.
no spanning-tree mstp max-age	Resumes **Max Age** to the default value.

It is recommended to modify STP time parameters by setting root or network diameter, which ensures correct modification of time parameters.

The newly-set time parameters are valid even if they do not comply with the previous formula's requirements. Pay attention to the notification on the console when you perform configuration.

2.3.8   Configuring Network Diameter

Network diameter stands for the maximum number of switches between two hosts in the network, representing the scale of the network.

You can set the MSTP network diameter by running the command **spanning-tree mstp diameter *net-diameter*.** The parameter **net-diameter** is valid only to CIST. After configuration, three STP time parameters is automatically updated to comparatively better values.

Run the following command to configure **net-diameter**:

Command	Purpose
spanning-tree mstp diameter *net-diameter*	Configure **net-diameter**. The parameter **net-diameter** ranges from 2 to 7. The default value is 7.
no spanning-tree mstp diameter	Resumes **net-diameter** to the default value.

The parameter **net-diameter** is not saved as an independent setup in the switch. Only when modified by setting the network diameter can the time parameter be saved.

2.3.9   Configuring Maximum Hop Count

Run the following command to configure the maximum hop count.

Command	Purpose
spanning-tree mstp max-hops *hop-count*	Set the maximum hops. **hop-count** ranges from 1 to 40. Its default value is 20.
no spanning-tree mstp *hop-count*	Resume the maximum hop count to the default value.

2.3.10   Configuring Port Priority

If a loop occurs between two ports of the switch, the port with higher priority will enter the **forwarding** state and the port with lower priority is blocked. If all ports have the same priority, the port with smaller port number will first enter the **forwarding** state.

In port configuration mode, run the following command to set the priority of the STP port:

Command	Purpose
spanning-tree mstp *instance-id* **port-priority** *priority*	Sets the priority of the STP port. **instance-id** stands for the number of the spanning tree instance, ranging from 0 to 15.

	priority stands for the port priority. It can be one of the following values: 0, 16, 32, 48, 64, 80, 96, 112 128, 144, 160, 176, 192, 208, 224, 240
spanning-tree port-priority *value*	Sets the port priority in all spanning tree instances. value stands for the port priority. It can be one of the following values: 0, 16, 32, 48, 64, 80, 96, 112 128, 144, 160, 176, 192, 208, 224, 240
no spanning-tree mstp *instance-id* port-priority	Resumes the port priority to the default value.
no spanning-tree port-priority	Resumes the port priority to the default value in all spanning tree instances.

Run the following command to check the information about the MSTP port.

Command	Purpose
show spanning-tree mstp interface *interface-id*	Check MSTP port information. interface-id stands for the port name, such as "F0/1" and "FastEtnernet0/3".

2.3.11   Configuring Path Cost of the Port

In MSTP, the default value of the port's path cost is based on the connection rate. If a loop occurs between two switches, the port with less path cost will enter the forwarding state. The less the path cost is, the higher rate the port is. If all ports have the same path cost, the port with smaller port number will first enter the forwarding state.

In port configuration mode, run the following command to set the path cost of the port:

Command	Purpose
spanning-tree mstp *instance-id* cost *cost*	Sets the path cost of the port. instance-id stands for the number of the spanning tree instance, ranging from 0 to 15. cost stands for the path cost of the port, which ranges from 1 to 200000000.
spanning-tree cost *value*	Sets the path cost of the port in all spanning tree instances. Value stands for the path cost of the port, which ranges from 1 to 200000000.
no spanning-tree mstp *instance-id* cost	Resumes the path cost of the port to the default value.
no spanning-tree cost	Resumes the path cost of the port to the default value in all spanning tree instances.

2.3.12   Configuring Port Connection Type

If the connection between MSTP-supported switches is the point-to-point direct connection, the switches can rapidly establish connection through handshake

mechanism. When you configure the port connection type, set the port connection to the point-to-point type.

The protocol decides whether to use the point-to-point connection or not according to the duplex attribute. If the port works in full-duplex mode, the protocol considers the connection is a point-to-point one. If the port works in the half-duplex mode, the protocol considers the connection is a shared one.

If the switch that the port connects run the RSTP protocol or the MSTP protocol, you can set the port connection type to **point-to-point**, ensuring that a handshake is rapidly established.

In port configuration mode, run the following command to set the port connection type.

Command	Purpose
spanning-tree mstp point-to-point force-true	Sets the port connection type to **point-to-point**.
spanning-tree mstp point-to-point force-false	Sets the port connection type to **shared**.
spanning-tree mstp point-to-point auto	Automatically checks the port connection type.
no spanning-tree mstp point-to-point	Resumes the port connection type to the default settings.

2.3.13   Activating MST-Compatible Mode

The MSTP protocol that our switches support is based on IEEE 802.1s. In order to be compatible with other MSTPs, especially MSTP that the Cisco switches support, the MSTP protocol can work in MST-compatible mode. Switches running in MSTP-compatible mode can identify the message structure of other MSTPs, check the contained MST regional identifier and establish the MST region.

The MST-compatible mode and the STP-compatible mode are based on MSTP protocol conversion mechanism. If one port of the switch receives BPDU in compatible mode, the port automatically changes to the mode and sends BPDU in compatible mode. To resume the port to standard MST mode, you can run **spanning-tree mstp migration-check**.

In global configuration mode, run the following commands to enable or disable the MST-compatible mode:

Command	Purpose
spanning-tree mstp mst-compatible	Enable the MST-compatible mode of the switch.
no spanning-tree mstp mst-compatible	Disable the MST-compatible mode of the switch.

Note:

The main function of the compatible mode is to create the MST area for switches and other MSTP-running switches. In actual networking, make sure that the switch has the same configuration name and the same edit number. It is recommended to configure switches running other MSTP protocols to the CIST root, ensuring that the switch enters the compatible mode by receiving message.

If the MST-compatible mode is not activated, the switch will not resolve the whole BPDU-compatible content and take the content as the common RSTP BPDU. In this way, the switch cannot be in the same area with the MST-compatible switch that it connects.

A port in compatible mode cannot automatically resumes to send standard MST BPDU even if the compatible mode is shut down in global configuration mode. In this case, run migration-check.

2.3.14   Restarting Protocol Conversion Check

MSTP allows the switch to work with the traditional STP switch through protocol conversion mechanism. If one port of the switch receives the STP configuration message, the port then only transmits the STP message. At the same time, the port that receives the STP information is then considered as a boundary port.

Note：

When a port is in the STP-compatible state, the port will not automatically resume to the MSTP state even if the port does not receive the STP message any more. In this case, you can run **spanning-tree mstp migration-check** to clear the STP message that the port learned, and make the port to return to the MSTP state.

The switch that runs the RSTP protocol can identify and handle the MSTP message. Therefore, the MSTP switch does not require protocol conversion when it works with the RSTP switch.

In global configuration mode, run the following command to clear all STP information that is detected by all ports of the switch:

Command	Purpose
spanning-tree mstp migration-check	Clears all STP information that is detected by all ports of the switch.

In port configuration mode, run the following command to clear STP information detected by the port.

Command	Purpose
spanning-tree mstp migration-check	Clears STP information detected by the port.

2.3.15   Check MSTP Information

In monitor command, global configuration command or port configuration command, run the following command to check all information about MSTP.

Command	Purpose
show spanning-tree	Checks MSTP information. (Information about SSTP, PVST, RSTP and MSTP can be checked)
show spanning-tree detail	Checks the details of MSTP information. (Information about SSTP, PVST, RSTP and MSTP can be checked)〕
show spanning-tree interface *interface-id*	Checks the STP interface information. (Information about SSTP, PVST, RSTP and MSTP can be checked)〕
show spanning-tree mstp	Checks all MST instances.
show spanning-tree mstp region	Checks the MST area configuration.
show spanning-tree mstp instance *instance-id*	Checks information about a MST instance.
show spanning-tree mstp detail	Checks detailed MST information.

show spanning-tree mstp interface *interface-id*	Checks MST port configuration.
show spanning-tree mstp protocol-migration	Checks the protocol conversion state of the port.