RSTP
Configuration

Contents

1. STP Configuration

1.1 STP Overview

1.1.1 Function of STP

Spanning Tree Protocol (STP) is applied in loop network to block some undesirable redundant paths with certain algorithms and prune the network into a loop-free tree, thereby avoiding the proliferation and infinite cycling of the packet in the loop network.

1.1.2 Protocol Packets of STP

STP uses bridge protocol data units (BPDUs), also known as configuration messages, as its protocol packets.

STP identifies the network topology by transmitting BPDUs between STP-compliant network devices. BPDUs contain sufficient information for the network devices to complete the spanning tree calculation.

In STP, BPDUs come in two types:

- Configuration BPDUs, used for calculating spanning trees and maintaining the spanning tree topology.
- Topology change notification (TCN) BPDUs, used for notifying concerned devices of network topology changes, if any.

1.1.3 Basic Concepts in STP

1. Root Bridge

A tree network must have a root; hence the concept of “root bridge” has been introduced in STP.

There is one and only one root bridge in the entire network, and the root bridge can change alone with changes of the network topology. Therefore, the root bridge is not fixed.

Upon network convergence, the root bridge generates and sends out configuration BPDUs at a certain interval, and other devices just forward the BPDUs. This mechanism ensures topological stability.

2. Root Port

On a non-root bridge device, the root port is the port nearest to the root bridge. The root port is responsible for communication with the root bridge. A non-root-bridge device has one and only one root port. The root bridge has no root port.

3. Designated Bridge

For a device, Designated Bridge is the device directly connected with this device and responsible for forwarding BPDUs; For a LAN, Designated Bridge is the device responsible for forwarding BPDUs to this LAN segment.

4. Designated Port

For a device, Designated Port is the port through which the designated bridge forwards BPDUs to this device; For a LAN, Designated Port is the port through which the designated bridge forwards BPDUs to this LAN segment.

5. Path cost

Path cost is a reference value used for link selection in STP. By calculating the path cost, STP selects relatively “robust” links and blocks redundant links, and finally prunes the network into loop-free tree structure.

1.1.4 Spanning-Tree Interface States

Each Layer 2 interface on a switch using spanning tree exists in one of these states:

- **Disabled**

The interface is not participating in spanning tree because of a shutdown port, no link on the port, or no spanning-tree instance running on the port.

- **Blocking**

The interface does not participate in frame forwarding.

- **Listening**

The first transitional state after the blocking state when the spanning tree determines that the interface should participate in frame forwarding.

- **Learning**

The interface prepares to participate in frame forwarding.

- **Forwarding**

The interface forwards frames.

An interface moves through these states:

• From initialization to blocking

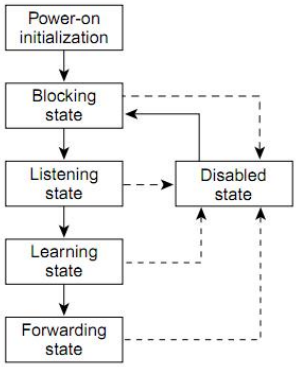
• From blocking to listening or to disabled

• From listening to learning or to disabled

• From learning to forwarding or to disabled

• From forwarding to disabled

Figure 1-1 Spanning-Tree Interface States



When you power up the switch, spanning tree is enabled by default, and every interface in the switch, VLAN, or network goes through the blocking state and the transitory states of listening and learning. Spanning tree stabilizes each interface at the forwarding or blocking state.

When the spanning-tree algorithm places a Layer 2 interface in the forwarding state, this process occurs:

1. The interface is in the listening state while spanning tree waits for protocol information to transition the interface to the blocking state.
2. While spanning tree waits the forward-delay timer to expire, it moves the interface to the learning state and resets the forward-delay timer.
3. In the learning state, the interface continues to block frame forwarding as the switch learns end-station location information for the forwarding database.
4. When the forward-delay timer expires, spanning tree moves the interface to the forwarding state, where both learning and frame forwarding are enabled.

1.2 How STP Works

STP identifies the network topology by transmitting configuration BPDUs between network devices. Configuration BPDUs contain sufficient information for network devices to complete the spanning tree calculation. Important fields in a configuration BPDU include:

- Root bridge ID: consisting of root bridge priority and MAC address.
- Root path cost: the cost of the shortest path to the root bridge.
- Designated bridge ID: designated bridge priority plus MAC address.
- Designated port ID, designated port priority plus port name.
- Message age: age of the configuration BPDU while it propagates in the network.
- Max age: maximum age of the configuration BPDU maintained in the device.
- Hello time: configuration BPDU interval.
- Forward delay: forward delay of the port.

Note:

For the convenience of description, the description and examples below involve only four parts of a configuration BPDU:

- Root bridge ID (in the form of device priority)
- Root path cost
- Designated bridge ID (in the form of device priority)
- Designated port ID (in the form of port name)

1) Specific calculation process of the STP algorithm

- Initial state

Upon initialization of a device, each port generates a BPDU with itself as the root bridge, in which the root path cost is 0, designated bridge ID is the device ID, and the designated port is the local port.

- Selection of the optimum configuration BPDU

Each device sends out its configuration BPDU and receives configuration BPDUs from other devices.

The process of selecting the optimum configuration BPDU is as follows:

Figure 1-2 Selection of the optimum configuration BPDU

Step	Description
1	Upon receiving a configuration BPDU on a port, the device performs the following processing: ● If the received configuration BPDU has a lower priority than that of the configuration BPDU generated by the port, the device will discard the received configuration BPDU without doing any processing on the configuration BPDU of this port. ● If the received configuration BPDU has a higher priority than that of the configuration BPDU generated by the port, the device will replace the content of the configuration BPDU generated by the port with the content of the received configuration BPDU.
2	The device compares the configuration BPDUs of all the ports and chooses the optimum configuration BPDU.

Note:

Principle for configuration BPDU comparison:

- The configuration BPDU that has the lowest root bridge ID has the highest priority.
- If all configuration BPDUs have the same root bridge ID, they will be compared for their root path costs. If the root path cost in a configuration BPDU plus the path cost corresponding to this port is S, the configuration BPDU with the smallest S value has the highest priority.

- If all configuration BPDUs have the same root path cost, they will be compared for their designated bridge IDs, then their designated port IDs, and then the IDs of the ports on which they are received. The smaller the ID, the higher message priority.

- Selection of the root bridge

At network initialization, each STP-compliant device on the network assumes itself to be the root bridge, with the root bridge ID being its own device ID. By exchanging configuration BPDUs, the devices compare one another's root bridge ID. The device with the smallest root bridge ID is elected as the root bridge.

- Selection of the root port and designated ports

The process of selecting the root port and designated ports is as follows:

Table 1-1 Selection of the root port and designated ports

Step	Description
1	A non-root-ridge device regards the port on which it received the optimum configuration BPDU as the root port.
2	Based on the configuration BPDU and the path cost of the root port, the device calculates a designated port configuration BPDU for each of the rest ports. ● The root bridge ID is replaced with that of the configuration BPDU of the root port. ● The root path cost is replaced with that of the configuration BPDU of the root port plus the path cost corresponding to the root port. ● The designated bridge ID is replaced with the ID of this device. ● The designated port ID is replaced with the ID of this port.
3	The device compares the calculated configuration BPDU with the configuration BPDU on the port of which the port role is to be defined, and does different things according to the comparison result: ● If the calculated configuration BPDU is superior, the device will consider this port as the designated port, and the configuration BPDU on the port will be replaced with the calculated configuration BPDU, which will be sent out periodically. ● If the configuration BPDU on the port is superior, the device will block this port without updating its configuration BPDU, so that the port will only receive BPDUs, but not send any, and will not forward data.

Note:

When the network topology is stable, only the root port and designated ports forward traffic, while other ports are all in the blocked state- they only receive STP packets but do not forward user traffic.

Once the root bridge, the root port on each non-root bridge and designated ports have been unsuccessfully elected, the entire tree-shaped topology has been constructed.

The following is an example of how the STP algorithm works. The specific network diagram is shown in Figure 1-3. In the feature, the priority of Device A is 0, the priority of Device B is 1, the priority of Device C is 2, and the path costs of these links are 5, 10 and 4 respectively.

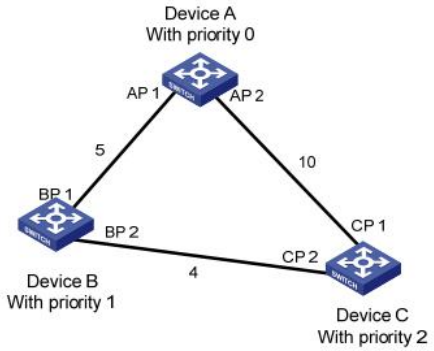


Figure 1-3 Network diagram for the STP algorithm

- Initial state of each device

The following table shows the initial state of each device.

Table 1-2 Initial state of each device

Device	Port name	BPDU of port
Device A	AP1	{0, 0, 0, AP1}
	AP2	{0, 0, 0, AP2}
Device B	BP1	{1, 0, 1, BP1}
	BP2	{1, 0, 1, BP2}
Device C	CP1	{2, 0, 2, CP1}
	CP2	{2, 0, 2, CP2}

- Comparison process and result on each device

The following table shows the comparison process and result on each device.

Table 1-3 Comparison process and result on each device

Device	Comparison process	BPDU of port after comparison
Device A	• Port AP1 receives the configuration BPDU of Device B {1, 0, 1, BP1}. Device A finds that the configuration BPDU of the local port {0, 0, 0, AP1} is superior to the configuration received message, and discards the received configuration BPDU. • Port AP2 receives the configuration BPDU of Device C {2, 0, 2, CP1}. Device A finds that the BPDU of the local port {0, 0, 0, AP2} is superior to the received configuration BPDU, and discards the received configuration BPDU. • Device A finds that both the root bridge and designated bridge in the configuration BPDUs of all its ports are Device A itself, so it assumes itself to be the root bridge. In this case, it does not make any change to the configuration BPDU of each port, and starts sending out configuration BPDUs periodically.	AP1: {0, 0, 0, AP1} AP2: {0, 0, 0, AP2}

Device B	• Port BP1 receives the configuration BPDU of Device A {0, 0, 0, AP1}. Device B finds that the received configuration BPDU is superior to the configuration BPDU of the local port {1, 0, 1, BP1}, and updates the configuration BPDU of BP1. • Port BP2 receives the configuration BPDU of Device C {2, 0, 2, CP2}. Device B finds that the configuration BPDU of the local port {1, 0, 1, BP2} is superior to the received configuration BPDU, and discards the received configuration BPDU	BP1: {0, 0, 0, AP1} BP2: {1, 0, 1, BP2}
	• Device B compares the configuration BPDUs of all its ports, and determines that the configuration BPDU of BP1 is the optimum configuration BPDU. Then, it uses BP1 as the root port, the configuration BPDUs of which will not be changed. • Based on the configuration BPDU of BP1 and the path cost of the root port (5), Device B calculates a designated port configuration BPDU for BP2 {0, 5, 1, BP2}. • Device B compares the calculated configuration BPDU {0, 5, 1, BP2} with the configuration BPDU of BP2. If the calculated BPDU is superior, BP2 will act as the designated port, and the configuration BPDU on this port will be replaced with the calculated configuration BPDU, which will be sent out periodically.	Root port BP1: {0, 0, 0, AP1} Designated port BP2: {0, 5, 1, BP2}
Device C	• Port CP1 receives the configuration BPDU of Device A {0, 0, 0, AP2}. Device C finds that the received configuration BPDU is superior to the configuration BPDU of the local port {2, 0, 2, CP1}, and updates the configuration BPDU of CP1. • Port CP2 receives the configuration BPDU of port BP2 of Device B {1, 0, 1, BP2} before the message was updated. Device C finds that the received configuration BPDU is superior to the configuration BPDU of the local port {2, 0, 2, CP2}, and updates the configuration BPDU of CP2.	CP1: {0, 0, 0, AP2} CP2: {1, 0, 1, BP2}

	By comparison: ● The configuration BPDU of CP1 is elected as the optimum configuration BPDU, so CP1 is identified as the root port, the configuration BPDUs of which will not be changed. ● Device C compares the calculated designated port configuration BPDU {0, 10, 2, CP2} with the configuration BPDU of CP2, and CP2 becomes the designated port, and the configuration BPDU of this port will be replaced with the calculated configuration BPDU.	Root port CP1: {0, 0, 0, AP2} Designated port CP2: {0, 10, 2, CP2}
	Next, port CP2 receives the updated configuration BPDU of Device B {0, 5, 1, BP2}. Because the received configuration BPDU is superior to its old one, Device C launches a BPDU update process. At the same time, port CP1 receives configuration BPDUs periodically from Device A. Device C does not launch an update process after comparison.	CP1: {0, 0, 0, AP2} CP2: {0, 5, 1, BP2}
	By comparison: ● Because the root path cost of CP2 (9) (root path cost of the BPDU (5) plus path cost corresponding to CP2 (4)) is smaller than the root path cost of CP1 (10) (root path cost of the BPDU (0) + path cost corresponding to CP2 (10)), the BPDU of CP2 is elected as the optimum BPDU, and CP2 is elected as the root port, the messages of which will not be changed. ● After comparison between the configuration BPDU of CP1 and the calculated designated port configuration BPDU, port CP1 is blocked, with the configuration BPDU of the port remaining unchanged, and the port will not receive data from Device A until a spanning tree calculation process is triggered by a new condition, for example, the link from Device B to Device C becomes down.	Blocked port CP2: {0, 0, 0, AP2} Root port CP2: {0, 5, 1, BP2}

After the comparison processes described in the table above, a spanning tree with Device A as the root bridge is stabilized, as shown in Figure 1-4.

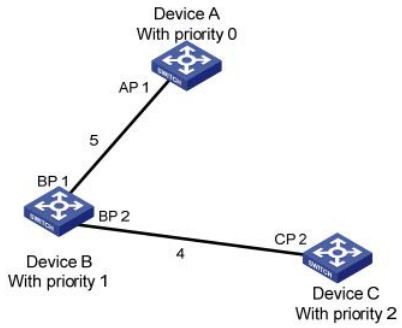


Figure 1-4 The final calculated spanning tree

Note:

To facilitate description, the spanning tree calculation process in this example is simplified, while the actual process is more complicated.

2) The BPDU forwarding mechanism in STP

- Upon network initiation, every switch regards itself as the root bridge, generates configuration BPDUs with itself as the root, and sends the configuration BPDUs at a regular interval of hello time.
- If it is the root port that received the configuration BPDU and the received configuration BPDU is superior to the configuration BPDU of the port, the device will increase message age carried in the configuration BPDU by a certain rule and start a timer to time the configuration BPDU while it sends out this configuration BPDU through the designated port.
- If the configuration BPDU received on the designated port has a lower priority than the configuration BPDU of the local port, the port will immediately send out its better configuration BPDU in response.
- If a path becomes faulty, the root port on this path will no longer receive new configuration BPDUs and the old configuration BPDUs will be discarded due to timeout. In this case, the device will generate a configuration BPDU with itself as the root and sends out the BPDU. This triggers a new spanning tree calculation process so that a new path is established to restore the network connectivity.

However, the newly calculated configuration BPDU will not be propagated throughout the network immediately, so the old root ports and designated ports that have not detected the topology change continue forwarding data along the old path. If the new root port and designated port begin to forward data as soon as they are elected, a temporary loop may occur.

3) STP timers

STP calculations need three important timing parameters: forward delay, hello time, and max age.

- Forward delay is the delay time for device state transition. A path failure will cause re-calculation of the spanning tree, and the spanning tree structure will change accordingly. However, the new configuration BPDU as the calculation result cannot be propagated throughout the network immediately. If the newly elected root port and designated ports start

to forward data right away, a temporary loop is likely to occur. For this reason, as a mechanism for state transition in STP, a newly elected root port or designated port requires twice the forward delay time before transitioning to the forwarding state, when the new configuration BPDU has been propagated throughout the network.

- Hello time is the time interval at which a device sends hello packets to the surrounding devices to ensure that the paths are fault-free.

- Max age is a parameter used to determine whether a configuration BPDU held by the device has expired. A configuration BPDU beyond the max age will be discarded.

1.3 Implement RSTP on Ethernet Switch

The Ethernet Switch implements the Rapid Spanning Tree Protocol (RSTP), i.e., the enhancement of STP. The Forward Delay for the root ports and designated ports to enter forwarding state is greatly reduced in certain conditions, thereby shortening the time period for stabilizing the network topology.

To achieve the rapid transition of the root port state, the following requirement should be met: The old root port on this switch has stopped data forwarding and the designated port in the upstream has begun forwarding data.

The conditions for rapid state transition of the designated port are:

- The port is an Edge port that does not connect with any switch directly or indirectly. If the designated port is an edge port, it can switch to forwarding state directly without immediately forwarding data.
- The port is connected with the point-to-point link, that is, it is the master port in aggregation ports or full duplex port. It is feasible to configure a point-to-point connection. However, errors may occur and therefore this configuration is not recommended. If the designated port is connected with the point-to-point link, it can enter the forwarding state right after handshaking with the downstream switch and receiving the response.

The switch that uses RSTP is compatible with the one using STP. Both protocol packets can be identified by the switch running RSTP and used in spanning tree calculation.

Note:

RSTP is the protocol of single spanning tree. A switching network only has one spanning tree. To guarantee the normal communication inside a VLAN, the devices of a VLAN shall have routes to one another on the Spanning Tree, otherwise, the communication inside the VLAN will be affected if some links inside a VLAN are blocked.
For some VLAN that cannot be arranged along the spanning tree paths for some special requirements, you have to disable RSTP on the switch port corresponding to the VLAN.

1.4 Configure RSTP

1.4.1 RSTP Configuration Task List

Table 1-4 RSTP Configuration Task List

Configuration Task List		Remarks	
RSTP basic configuration	Enable STP	Required	1.4.2
	Select the working mode	Required	1.4.2
Configure RSTP	Configure STP bridge priority	Optional	1.4.3
	Configure Hello-packet sending interval	Optional	1.4.4
	Configure STP forward-delay	Optional	1.4.4
	Configure STP max-age	Optional	1.4.4
	Configure STP path cost	Optional	1.4.5
	Configure STP port priority	Optional	1.4.6
	Configure STP mcheck	Optional	1.4.7
	Configure STP point-to-point mode	Optional	1.4.8
	Configure STP portfast	Optional	1.4.9
	Configure STP transit limit	Optional	1.4.10
Show RSTP		Optional	1.4.11

1.4.2 Enable RSTP

After enabling STP globally, all ports will be defaulted to join the STP topology calculating by default. If some port is not allowed to take part in the STP calculation, administrator can use **no spanning-tree** command in interface configuration mode to disable STP on this port.

Table 1-5 Enable STP

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enable STP globally	**spanning-tree**	Required,default is RSTP
Select STP mode	**spanning-tree mode {stp|rstp|mstp}**	Optional
Enter interface configuration mode	**interface ethernet** device/slot/port	-
Enable/disable STP on port	**(no)spanning-tree**	Optional

Note:

When enable STP globally, the system is working under RSTP mode.

1.4.3 Configure STP Bridge Priority

The priority of bridge determines this switch can be root or not. If this switch is needed to be the root, the priority can be configured inferior.

By default, the switch bridge priority is 32768.

Table 1-6 Configure STP priority

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Configure STP priority	**spanning-tree priority** *bridge priority*	Optional

1.4.4 Configure Time Parameter

There are three time parameters: Forward Delay, Hello Time and Max Age.

User can configure these three parameters for RSTP calculation.

Table 1-7 Configure the time parameter

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Configure Hello-packet sending interval	**spanning-tree hello-time** *seconds*	Optional
Configure STP forward-delay	**spanning-tree forward-time** *seconds*	Optional
Configure STP max-age	**spanning-tree max-age** *seconds*	Optional

Note:

- Too long Hello Time may cause link failure thought by network bridge for losing packets of the link to restart accounting STP; too smaller Hello Time may cause network bridge frequently to send configuration packet to strengthen the load of network and CPU. Hello Time ranges from 1 to 10 seconds. It is suggested to use the default time of 2 seconds. Hello Time ≤ Forward Delay-2.
- If Forward Delay is configured too small, temporary redundancy will be caused; if Forward Delay is configured too large, network will not be restored linking for a long time. Forward Delay ranges from 4 to 30 seconds. The default forward delay time, 15 seconds is suggested to use. Forward Delay≥Hello Time + 2.
- Max Age is used to configure the longest aging interval of STP. Lose packet when over-timing. The STP will be frequently accounts and take crowded network to be link fault, if the value is too small. If the value is too large, the link fault cannot be known timely. Max Age is determined by diameter of network, and the default time of 20

seconds is suggested. 2*(Hello Time + 1) ≤ Max Age ≤ 2*(ForwardDelay – 1) When enable STP globally, the system is working under RSTP mode.

1.4.5 Configure STP Path Cost

Configure interface STP path cost and choose the path with the smallest path cost to be the effective path.

The path cost is related to the link speed rate. The larger the speed rate is, the less the cost is. STP can auto-detect the link speed rate of current interface and converse it to be the cost.

Configure port path cost will make STP re-calculating. The value of the path cost is 1-65535. It is suggested using the default vaule, which makes the STP to calculate the current port cost by itself. By default, the path cost is determined by the current port speed.

When the port is 10M, the default cost is 200,000; when the port is 100M, the default cost is 20,000; 1000M, 2,000.

Table 1-8 Configure STP path cost

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	Optional
Configure STP path cost	**spanning-tree cost** *path-cost*	Optional

1.4.6 Configure STP Port Priority

Specify specified port in STP by configuring port priority. Generally, the smaller the value is, the superior the priority is, and the port will be more possible to be included in STP. If the priorities are the same, the port number is considered.

The smaller the value is, the superior the priority is, and the port is easier to be the root interface. Change the port priority may cause the re-calculating of the STP. The port priority ranges from 0 to 255. The default port priority is 128.

Table 1-9 Configure STP port priority

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	-
Configure STP port priority	**spanning-tree port-priority** *priority*	Optional

1.4.7 Configure STP mcheck

Switch working under RSTP mode can be connected to switch with STP. But when the neighbor is working under RSTP, the two connected ports are still work under STP mode. Mcheck is for force

port sending RSTP packet to make sure the two neighbor ports can be working under RSTP. If yes, the working mode will turn to be RSTP.

Table 1-10 Configure STP mcheck

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	-
Configure STP mcheck	**spanning-tree mcheck**	Optional

1.4.8 Configure STP Point-to-Point Mode

In rstp, the requirement of interface quickly in transmission status is that the interface must be point to point link not media sharing link. It can be specified interface link mode manually and can also judge it by network bridge.

Table 1-11 Configure STP point-to-point mode

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	-
Configure switch auto-check the point-to-point	**spanning-tree point-to-point auto**	Optional
Configure STP point-to-point mode forcetrue	**spanning-tree point-to-point forcetrue**	Optional
Configure STP point-to-point mode forcefalse	**spanning-tree point-to-point forcefalse**	Optional

1.4.9 Configure STP Portfast

Edge port is the port connecting to the host which can be in transmission status in very short time after linkup, but once the port receiving STP packet, it will shift to be non-edge port.

Table 1-12 Configure STP portfast

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	-
Configure STP portfast	**spanning-tree portfast**	Optional

1.4.10 Configure STP Transit Limit

Restrict STP occupying bandwidth by restricting the speed of sending BPDU packet. The speed is determined by the number of BPDU sent in each hello time.

By default, port will send 3 BPDU packets in every Hello time interval.

Table 1-13 Configure STP transit limit

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	-
Enter interface configuration mode	**interface ethernet** *interface-num*	-
Configure STP transit limit	**spanning-tree transit-limit** *transit-limit*	Optional

1.4.11 Configure Root Protection of a Port

The root bridge may receive the higher priority configuration message due to misconfiguration of the maintenance personnel or malicious attacks in the network. Thus, the current root bridge can lose the status of the root bridge and cause incorrect network topology changes. Assume that the original traffic is forwarded over a high-speed link, this illegal change will cause the traffic passing through the high-speed link to be traced to the low-speed link, which results in network congestion. Root protection can prevent from happening.

For a port with root protection enabled, the port role can only be the designated port. Once a high-priority configuration has been received on the port, there are two options for configuring the status of these ports:

Block-port: The port state is set for discarding, discarding BPDU configuration messages and not forwarding data packets.

Drop-packets: Port state is forwarding, only the BPDU configuration is discarded, and ordinary packets can be forwarded.

Configure Root Protection of a Port

operation	command	remark
Enter the global configuration mode	**configure terminal**	-
Configure the action of the root protection port to process message	**spanning-tree root-guard action {block-port | drop-packets}**	
Enter the port configuration mode	**interface ethernet** *interface-num*	-
Enable the root protection function of the port	**spanning-tree root-guard**	optional
Disable the root protection function of the port	**no spanning-tree root-guard**	

1.4.12 Configure Loop-guard Function

Loop-guard function: To prevent a blocked port because of un-normal link (not two-way communication) not receive the BPDU configuration information, which becomes forwarding state. When the port is configured with this option, the port remains blocked even if BPDU configuration is not received.

Configure port loop-guard function

operation	command	remark
Enter the global configuration mode	**configure terminal**	-
Enter the port configuration mode	**interface thernet** *interface-num*	
Enable the loop-guard function	**spanning-tree loop-guard**	not share with root-guard
Disable the loop-guard function	**no spanning-tree loop-guard**	

1.4.13 Configure Bpdu-guard Function

For an access layer device, an access port is usually directly connected with a user terminal (such as a PC) or a file server. In this case, the access port is configured as an edge port to implement rapid transition. When these ports receive BPDU messages, the system will automatically set these ports as non-edge ports and recalculate spanning trees to cause network topology changes. These ports should normally not receive BPDU message. If someone forges BPDU to attack the device maliciously, the network will become unstable.

The device provides the BPDU guard function to prevent such attacks: after the BPDU guard function is enabled on a device, if a port configured with an edge port attribute receives BPDU message, the device will SHUTDOWN the port and prompt the user with the syslog information. The port is restored by manual NO SHUTDOWN.

Configure the bpdu-guard function on a port

operation	command	remark
Enter the global configuration mode	**configure terminal**	-
Enable bpdu-guard globally	**spanning-tree bpdu-guard**	In global mode, this function is enabled on all ports
Disable bpdu-guard globally	**no spanning-tree bpdu-guard**	
Enter the port configuration mode	**interface ethernet** *interface-num*	
Enable the bpdu-guard function	**spanning-tree bpdu-guard**	This function takes effect on a port
Disable the bpdu-guard function	**no spanning-tree bpdu-guard**	

Note:

The port BPDU guard function takes effect only on the port configured with the edge port attribute.

For a port that is configured with edge port attribute, receives BPDU message from another port and

becomes a non-edge port again, if the BPDU guard function is enabled, the port can take effect only when it is restarted as an edge port.

1.4.14 Configure Bpdu-filter Function

After the bpdu-filter is set on the edge port, the device will discard the received BPDU message, and the port will not send BPDU message.

Configure bpdu-filter function for port

operation	command	remark
Enter the global configuration mode	**configure terminal**	-
Enable bpdu-filter globally	**spanning-tree bpdu-filter**	In global mode, this function is enabled on all ports
Disable bpdu-filter globally	**no spanning-tree bpdu-filter**	
Enter the port configuration mode	**interface ethernet** *interface-num*	
Enable the bpdu-filter function	**spanning-tree bpdu-filter**	This function takes effect on a port
Disable the bpdu-filter function	**no spanning-tree bpdu-filter**	

1.4.15 Bpdu-car Function

When a large number of bpdu messages are on the CPU, it causes likely CPU busy, so the bpdu-car function limits the rate of bppu message on the cpu.

Configure BPDU-Car

operation	command	remark
Enter the global configuration mode	configure terminal	-
Enable/disable Port-Car	[no]port-car	Optional, enable by default
Configure the bpdu rate of cpu	port-car-rate ***value***	Optional, (number of ports * 30) pps by default
Enter the port configuration mode	interface ethernet ***port-number***	-
Enable/disable Port-Car	[no]port-car	Optional, open by default

Configure the bpdu rate of cpu	port-car-rate ***value***	Optional, 30pps by default
View the configuration information	show port-car	optional

1.4.16 Discard-BPDU Function

The Discard-bpdu function is used to drop spanning tree message. If the device does not want to receive BPDU message from other networks and cause the switch spanning tree to vibrate. This function can be opened.

This function is usually enabled on the edge port.

The Discard-BPDU function is disabled by default. Global configuration and port configuration are mutually exclusive: globally, all ports are enabled. If you only need to enable certain designated ports and other ports are not enabled, you need not configure them globally to directly enter the specified port enabling function.

Configure the global Discard-BPDU

operation	command	remark
Enter the global configuration mode	configure terminal	-
Enable/disable BPDU	[no] discard-bpdu	Required, off by default
View the configuration information	show discard-bpdu	optional

Configure port Discard-BPDU

operation	command	remark
Enter the port configuration mode	interface ethernet ***port-num***	-
Enable/disable BPDU	[no]discard-bpdu	Required, off by default
View configuration information	show discard-bpdu	optional

1.4.17 RSTP Monitor and Maintenance

After finishing above configuration, user can check the configurations by command below.

Table 1-14 RSTP monitor and maintenance

Operation	Command	Remarks
Show STP interface	**show spanning-tree interface [brief [ethernet** *device/slot/port*]]	On any configuratio

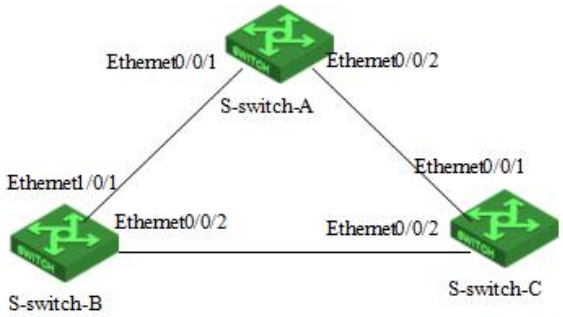
		n mode

1.5 STP Configuration Example

II. Network requirements

As shown in following figure, S-switch-A is core switch as the root. S-switch-B is the bridge. The link between S-switch-A and S-switch-B is backup link. When there is failure between S-switch-B and S-switch-C, the link between S-switch-A and S-switch-B can work normally.

III. Network diagram



IV. Configuration procedure

The default STP mode is RSTP. Enable global RSTP and use its default time parameter.

Configure Switch A

#configure Ethernet0/0/1 and Ethernet0/0/2 to be trunk, and enable root-guard

S-switch-A(config)#interface range ethernet 0/0/1 ethernet 0/0/2

S-switch-A(config-if-range)#switchport mode trunk

S-switch-A(config-if-range)#spanning-tree root-guard

S-switch-A(config-if-range)#exit

configure S-switch-A priority to be 0 to make sure S-switch-A is root

S-switch-A(config)#spanning-tree priority 0

Enable global RSTP

S-switch-A(config)#spanning-tree

Configure Switch B

#configure Ethernet0/0/1 and Ethernet0/0/2 to be trunk

S-switch-B(config)#interface range ethernet 0/0/1 ethernet 0/0/2

S-switch-B(config-if-range)#switchport mode trunk

S-switch-B(config-if-range)#exit

configure S-switch-B priority to be 4096 to make sure S-switch-B is bridge. Configure cost of Ethernet0/0/1 and Ethernet0/0/2 to be 10

S-switch-B(config)#spanning-tree priority 4096

S-switch-B(config)#interface range ethernet 0/0/1 ethernet 0/0/2

S-switch-B(config-if-range)#spanning-tree cost 10

S-switch-B(config-if-range)#exit

Enable global RSTP

S-switch-B(config)#spanning-tree

Configure Switch C

#configure Ethernet0/0/1 and Ethernet0/0/2 to be trunk

S-switch-C(config)#interface range ethernet 0/0/1 ethernet 0/0/2

S-switch-C(config-if-range)#switchport mode trunk

S-switch-C(config-if-range)#exit

#Configure cost of Ethernet0/0/1 and Ethernet0/0/2 to be 10 to make sure link between S-switch-B and S-switch-C to be main link

S-switch-C(config)#interface range ethernet 0/0/1 ethernet 0/0/2

S-switch-C(config-if-range)#spanning-tree cost 10

S-switch-C(config-if-range)#exit

Enable global RSTP

S-switch-C(config)#spanning-tree

Check the configuration

S-switch-A

S-switch-A(config)#show spanning-tree interface ethernet 0/0/1 ethernet 0/0/2

The bridge is executing the IEEE Rapid Spanning Tree protocol

The bridge has priority 0, MAC address: 000a.5a13.b13d

Configured Hello Time 2 second(s), Max Age 20 second(s),

Forward Delay 15 second(s)

Root Bridge has priority 0, MAC address 000a.5a13.b13d

Path cost to root bridge is 0

Stp top change 3 times

Port e0/0/1 of bridge is Forwarding
Spanning tree protocol is enabled
remote loop detect is disabled
The port is a DesignatedPort
Port path cost 200000
Port priority 128
root guard enabled and port is not in root-inconsistent state
Designated bridge has priority 0, MAC address 000a.5a13.b13d
The Port is a non-edge port
Connected to a point-to-point LAN segment
Maximum transmission limit is 3 BPDUs per hello time
Times: Hello Time 2 second(s), Max Age 20 second(s)
Forward Delay 15 second(s), Message Age 0
sent BPDU: 54
TCN: 0, RST: 54, Config BPDU: 0
received BPDU: 10
TCN: 0, RST: 10, Config BPDU: 0

Port e0/0/2 of bridge is Forwarding
Spanning tree protocol is enabled
remote loop detect is disabled
The port is a DesignatedPort
Port path cost 200000
Port priority 128
root guard enabled and port is not in root-inconsistent state
Designated bridge has priority 0, MAC address 000a.5a13.b13d
The Port is a non-edge port
Connected to a point-to-point LAN segment
Maximum transmission limit is 3 BPDUs per hello time
Times: Hello Time 2 second(s), Max Age 20 second(s)
Forward Delay 15 second(s), Message Age 0
sent BPDU: 16
TCN: 0, RST: 17, Config BPDU: 0

received BPDU: 3

TCN: 0, RST: 3, Config BPDU: 0

S-switch-B

S-switch-B(config)#show spanning-tree interface ethernet 0/0/1 ethernet 0/0/2

The bridge is executing the IEEE Rapid Spanning Tree protocol

The bridge has priority 4096, MAC address: 0000.0077.8899

Configured Hello Time 2 second(s), Max Age 20 second(s),

Forward Delay 15 second(s)

Root Bridge has priority 0, MAC address 000a.5a13.b13d

Path cost to root bridge is 10

Stp top change 3 times

Port e0/0/1 of bridge is Forwarding

Spanning tree protocol is enabled

remote loop detect is disabled

The port is a RootPort

Port path cost 10

Port priority 128

root guard disabled and port is not in root-inconsistent state

Designated bridge has priority 0, MAC address 000a.5a13.b13d

The Port is a non-edge port

Connected to a point-to-point LAN segment

Maximum transmission limit is 3 BPDUs per hello time

Times: Hello Time 2 second(s), Max Age 20 second(s)

Forward Delay 15 second(s), Message Age 0

sent BPDU: 21

TCN: 0, RST: 12, Config BPDU: 9

received BPDU: 204

TCN: 0, RST: 202, Config BPDU: 2

Port e0/0/2 of bridge is Forwarding

Spanning tree protocol is enabled

remote loop detect is disabled

The port is a DesignatedPort

Port path cost 10

Port priority 128

root guard disabled and port is not in root-inconsistent state

Designated bridge has priority 4096, MAC address 0000.0077.8899

The Port is a non-edge port

Connected to a point-to-point LAN segment

Maximum transmission limit is 3 BPDUs per hello time

Times: Hello Time 2 second(s), Max Age 20 second(s)

Forward Delay 15 second(s), Message Age 1

sent BPDU: 191

TCN: 0, RST: 188, Config BPDU: 3

received BPDU: 13

TCN: 0, RST: 5, Config BPDU: 8

S-switch-C

S-switch-C(config)#show spanning-tree interface ethernet 0/0/1 ethernet 0/0/2

The bridge is executing the IEEE Rapid Spanning Tree protocol

The bridge has priority 32768, MAC address: 000a.5a13.f48e

Configured Hello Time 2 second(s), Max Age 20 second(s),

Forward Delay 15 second(s)

Root Bridge has priority 0, MAC address 000a.5a13.b13d

Path cost to root bridge is 20

Stp top change 3 times

Port e0/0/1 of bridge is Discarding

Spanning tree protocol is enabled

remote loop detect is disabled

The port is a AlternatePort

Port path cost 200000

Port priority 128

root guard disabled and port is not in root-inconsistent state

Designated bridge has priority 0, MAC address 000a.5a13.b13d

The Port is a non-edge port

Connected to a point-to-point LAN segment

Maximum transmission limit is 3 BPDUs per hello time
Times: Hello Time 2 second(s), Max Age 20 second(s)
Forward Delay 15 second(s), Message Age 0
sent BPDU: 3
TCN: 0, RST: 3, Config BPDU: 0
received BPDU: 396
TCN: 0, RST: 396, Config BPDU: 0

Port e0/0/2 of bridge is Forwarding
Spanning tree protocol is enabled
remote loop detect is disabled
The port is a RootPort
Port path cost 10
Port priority 128
root guard disabled and port is not in root-inconsistent state
Designated bridge has priority 4096, MAC address 0000.0077.8899
The Port is a non-edge port
Connected to a point-to-point LAN segment
Maximum transmission limit is 3 BPDUs per hello time
Times: Hello Time 2 second(s), Max Age 20 second(s)
Forward Delay 15 second(s), Message Age 1
sent BPDU: 8
TCN: 0, RST: 8, Config BPDU: 0
received BPDU: 418
TCN: 0, RST: 418, Config BPDU: 0