Inspur

CN12900 Series

INOS-CN Layer 2 Switching Configuration Guide

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Preface

Objectives

This guide describes main functions of the CN12900 Series. To have a quick grasp of the CN12900 Series, please read this manual carefully.

Versions

The following table lists the product versions related to this document.

Product name	Version
CN12900 Series	

Conventions

Symbol conventions

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

Symbol	Description
⚠ Warning	Indicates a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
⚠ Caution	Indicates a potentially hazardous situation that, if not avoided, could cause equipment damage, data loss, and performance degradation, or unexpected results.
✎ Note	Provides additional information to emphasize or supplement important points of the main text.
🔍 Tip	Indicates a tip that may help you solve a problem or save time.

General conventions

Convention	Description
Boldface	Names of files, directories, folders, and users are in **boldface**. For example, log in as user **root**.

Convention	Description
Italic	Book titles are in *italics*.
`Lucida Console`	Terminal display is in `Lucida Console`.

Command conventions

Convention	Description
Boldface	The keywords of a command line are in **boldface**.
Italic	Command arguments are in *italics*.
[]	Items (keywords or arguments) in square brackets [ ] are optional.
{ x | y | ... }	Alternative items are grouped in braces and separated by vertical bars. One is selected.
[x | y | ...]	Optional alternative items are grouped in square brackets and separated by vertical bars. One or none is selected.
{ x | y | ... } *	Alternative items are grouped in braces and separated by vertical bars. A minimum of one or a maximum of all can be selected.
[x | y | ...] *	The parameter before the & sign can be repeated 1 to n times.

GUI conventions

Convention	Description
Boldface	Buttons, menus, parameters, tabs, windows, and dialog titles are in **boldface**. For example, click **OK**.
>	Multi-level menus are in boldface and separated by the ">" signs. For example, choose **File** > **Create** > **Folder**.

Keyboard operation

Format	Description
Key	Press the key. For example, press **Enter** and press **Tab**.
Key 1+Key 2	Press the keys concurrently. For example, pressing **Ctrl+C** means the two keys should be pressed concurrently.
Key 1, Key 2	Press the keys in turn. For example, pressing **Alt**, **A** means the two keys should be pressed in turn.

Mouse operation

Action	Description
Click	Select and release the primary mouse button without moving the pointer.
Double-click	Press the primary mouse button twice continuously and quickly without moving the pointer.
Drag	Press and hold the primary mouse button and move the pointer to a certain position.

Change history

Updates between document versions are cumulative. Therefore, the latest document version contains all updates made to previous versions.

Issue 01 (2020-02-24)

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CHAPTER 1 Overview

1.1 Layer 2 Ethernet Switching Overview

The device supports simultaneous, parallel connections between Layer 2 Ethernet segments. Switched connections between Ethernet segments last only for the duration of the packet. New connections can be made between different segments for the next packet.

The device solves congestion problems caused by high-bandwidth devices and a large number of users by assigning each device (for example, a server) to its own collision domain. Because each LAN port connects to a separate Ethernet collision domain, servers in a switched environment achieve full access to the bandwidth.

Because collisions cause significant congestion in Ethernet networks, an effective solution is full-duplex communication. Typically, 10/100-Mbps Ethernet operates in half-duplex mode, which means that stations can either receive or transmit. In full-duplex mode, which is configurable on these interfaces, two stations can transmit and receive at the same time. When packets can flow in both directions simultaneously, the effective Ethernet bandwidth doubles.

1.2 VLANs

A VLAN is a switched network that is logically segmented by function, project team, or application, without regard to the physical locations of the users. VLANs have the same attributes as physical LANs, but you can group end stations even if they are not physically located on the same LAN segment.

Any switch port can belong to a VLAN, and unicast, broadcast, and multicast packets are forwarded and flooded only to end stations in that VLAN. Each VLAN is considered as a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a bridge or a router.

All ports are assigned to the default VLAN (VLAN1) when the device first comes up. A VLAN interface, or switched virtual interface (SVI), is a Layer 3 interface that is created to provide communication between VLANs.

The devices support 4095 VLANs in accordance with the IEEE 802.1Q standard. These VLANs are organized into several ranges, and you use each range slightly differently. Some of these VLANs are reserved for internal use by the device and are not available for configuration.

1.3 Spanning Tree

This section discusses the implementation of the Spanning Tree Protocol (STP) on the software. Spanning tree is used to refer to IEEE 802.1w and IEEE 802.1s. When the IEEE 802.1D Spanning Tree Protocol is referred to in the publication, 802.1D is stated specifically.

1.3.1 STP Overview

STP provides a loop-free network at the Layer 2 level. Layer 2 LAN ports send and receive STP frames, which are called Bridge Protocol Data Units (BPDUs), at regular intervals. Network devices do not forward these frames but use the frames to construct a loop-free path.

802.1D is the original standard for STP, and many improvements have enhanced the basic loop-free STP. You can create a separate loop-free path for each VLAN, which is named Per VLAN Spanning Tree (PVST+). Additionally, the entire standard was reworked to make the loop-free convergence process faster to keep up with the faster equipment. This STP standard with faster convergence is the 802.1w standard, which is known as Rapid Spanning Tree (RSTP). Now, these faster convergence times are available as you create STP for each VLAN, which is known as Per VLAN Rapid Spanning Tree (Rapid PVST+).

Finally, the 802.1s standard, Multiple Spanning Trees (MST), allows you to map multiple VLANs into a single spanning tree instance. Each instance runs an independent spanning tree topology.

Although the software can interoperate with legacy 802.1D systems, the system runs Rapid PVST+ and MST. Rapid PVST+ is the default STP protocol for Inspur devices.

In addition, Inspur has created some proprietary features to enhance the spanning tree activities.

1.3.2 Rapid PVST+

Rapid PVST+ is the default spanning tree mode for the software and is enabled by default on the default VLAN and all newly created VLANs.

A single instance, or topology, of RSTP runs on each configured VLAN, and each Rapid PVST+ instance on a VLAN has a single root device. You can enable and disable STP on a per-VLAN basis when you are running Rapid PVST+.

1.3.3 MST

The software also supports MST. The multiple independent spanning tree topologies enabled by MST provide multiple forwarding paths for data traffic, enable load balancing, and reduce the number of STP instances required to support a large number of VLANs.

MST incorporates RSTP, so it also allows rapid convergence. MST improves the fault tolerance of the network because a failure in one instance (forwarding path) does not affect other instances (forwarding paths).

You can force specified interfaces to send prestandard, rather than standard, MST messages using the command-line interface.

1.3.4 STP Extensions

The software supports the following Inspur proprietary features:

- Spanning tree port types—The default spanning tree port type is normal. You can configure interfaces connected to Layer 2 hosts as edge ports and interfaces connected to Layer 2 switches or bridges as network ports.
- Bridge Assurance—Once you configure a port as a network port, Bridge Assurance sends BPDUs on all ports and moves a port into the blocking state if it no longer receives BPDUs. This enhancement is available only when you are running Rapid PVST+ or MST.
- BPDU Guard—BPDU Guard shuts down the port if that port receives a BPDU.
- BPDU Filter—BPDU Filter suppresses sending and receiving BPDUs on the port.
- Loop Guard—Loop Guard helps prevent bridging loops that could occur because of a unidirectional link failure on a point-to-point link.
- Root Guard—STP root guard prevents a port from becoming root port or blocked port. If a port configured for root guard receives a superior BPDU, the port immediately goes to the root-inconsistent (blocked) state.

1.4 Related Topics

The following documents are related to the Layer 2 switching features:

- *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
- *Inspur CN12900 Series INOS-CN Security Configuration Guide*
- *Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
- *Inspur CN12900 Series INOS-CN System Management Configuration Guide*

CHAPTER 2 Configuring Layer 2 Switching

2.1 Information About Layer 2 Switching

You can configure Layer 2 switching ports as access or trunk ports. Trunks carry the traffic of multiple VLANs over a single link and allow you to extend VLANs across an entire network. All Layer 2 switching ports maintain MAC address tables.

2.1.1 Layer 2 Ethernet Switching Overview

The device supports simultaneous, parallel connections between Layer 2 Ethernet segments. Switched connections between Ethernet segments last only for the duration of the packet. New connections can be made between different segments for the next packet.

The device solves congestion problems caused by high-bandwidth devices and a large number of users by assigning each device (for example, a server) to its own collision domain. Because each LAN port connects to a separate Ethernet collision domain, servers in a switched environment achieve full access to the bandwidth.

Because collisions cause significant congestion in Ethernet networks, an effective solution is full-duplex communication. Typically, 10/100-Mbps Ethernet operates in half-duplex mode, which means that stations can either receive or transmit. In full-duplex mode, which is configurable on these interfaces, two stations can transmit and receive at the same time. When packets can flow in both directions simultaneously, the effective Ethernet bandwidth doubles.

Switching Frames Between Segments

Each LAN port on a device can connect to a single workstation, server, or to another device through which workstations or servers connect to the network.

To reduce signal degradation, the device considers each LAN port to be an individual segment. When stations connected to different LAN ports need to communicate, the device forwards frames from one LAN port to the other at wire speed to ensure that each session receives full bandwidth.

To switch frames between LAN ports efficiently, the device maintains an address table. When a frame enters the device, it associates the media access control (MAC) address of the sending network device with the LAN port on which it was received.

Building the Address Table and Address Table Changes

The device dynamically builds the address table by using the MAC source address of the frames received. When the device receives a frame for a MAC destination address not listed in its address table, it floods the frame to all LAN ports of the same VLAN except the port that received the frame. When the destination station replies, the device adds its relevant MAC source address and port ID to the address table. The device then forwards subsequent frames to a single LAN port without flooding all LAN ports.

You can configure MAC addresses, which are called static MAC addresses, to statically point to specified interfaces on the device. These static MAC addresses override any dynamically learned MAC addresses on those interfaces. You cannot configure broadcast addresses as static MAC addresses. The static MAC entries are retained across a reboot of the device.

You must manually configure identical static MAC addresses on both devices connected by a virtual port channel (vPC) peer link. The MAC address table display is enhanced to display information on MAC addresses when you are using vPCs.

The address table can store a number of MAC address entries depending on the hardware I/O module. The device uses an aging mechanism, defined by a configurable aging timer, so if an address remains inactive for a specified number of seconds, it is removed from the address table.

Consistent MAC Address Tables on the Supervisor and on the Modules

Optimally, all the MAC address tables on each module exactly match the MAC address table on the supervisor. When you enter the **show forwarding consistency l2** command or the **show consistency-checker l2** command, the device displays discrepant, missing, and extra MAC address entries.

Layer 3 Static MAC Addresses

You can configure a static MAC address for the following Layer 3 interfaces:

- Layer 3 interfaces
- Layer 3 subinterfaces
- Layer 3 port channels
- VLAN network interface

See the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*, for information on configuring Layer 3 interfaces.

2.1.2 High Availability for Switching

You can upgrade or downgrade the software seamlessly, with respect to classical Ethernet switching. If you have configured static MAC addresses on Layer 3 interfaces, you must unconfigure those ports in order to downgrade the software.

2.2 Licensing Requirements for Layer 2 Switching

This table shows the licensing requirements for this feature:

Product	License Requirement
Inspur INOS-CN	Layer 2 switching require no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge.

2.3 Prerequisites for Configuring MAC Addresses

MAC addresses have the following prerequisites:

- You must be logged onto the device.
- If necessary, install the Advanced Services license.

2.4 Default Settings for Layer 2 Switching

This table lists the default setting for Layer 2 switching parameters.

Table 2：Default Layer 2 Switching Parameters

Parameters	Default
Aging time	1800 seconds

2.5 Configuring Layer 2 Switching by Steps

2.5.1 Configuring a Static MAC Address

You can configure MAC addresses, which are called static MAC addresses, to statically point to specified interfaces on the device. These static MAC addresses override any dynamically learned MAC addresses on those interfaces. You cannot configure broadcast or multicast addresses as static MAC addresses.

SUMMARY STEPS

1. **config t**
2. **mac address-table static** *mac-address* **vlan** *vlan-id* {[**drop** | **interface** {*type slot/port*} | **port-channel** *number*]}
3. **exit**
4. (Optional) **show mac address-table static**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**mac address-table static** *mac-address* **vlan** *vlan-id*
	{[**drop** | **interface** {*type slot/port*} | **port-channel** *number*]}
	Example:
	`switch(config)# mac address-table static 1.1.1`
	`vlan`
	` 2 interface ethernet 1/2`
		Specifies a static MAC address to add to the Layer 2 MAC
		address table.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits the configuration mode.

Step 4	(Optional) **show mac address-table static** **Example:** `switch# show mac address-table static`	Displays the static MAC addresses.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to put a static entry in the Layer 2 MAC address table:

```
switch# config t
switch(config)# mac address-table static 1.1.1 vlan 2 interface ethernet 1/2
switch(config)#
```

2.5.2 Configuring a Static MAC Address on a Layer 3 Interface

You can configure static MAC addresses on Layer 3 interfaces. You cannot configure broadcast or multicast addresses as static MAC addresses.

See the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*, for information on configuring Layer 3 interfaces.

SUMMARY STEPS

1. **config t**
2. **interface** [**ethernet** *slot/port* | **ethernet** *slot/port.number* | **port-channel** *number* | **vlan** *vlan-id*]
3. **mac-address** *mac-address*
4. **exit**
5. (Optional) **show interface** [**ethernet** *slot/port* | **ethernet** *slot/port.number* | **port-channel** *number* | **vlan** *vlan-id*]
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** [**ethernet** *slot/port* | **ethernet** *slot/port.number* | **port-channel** *number* | **vlan** *vlan-id*] **Example:** `switch(config)# interface ethernet 7/3`	Specifies the Layer 3 interface and enters the interface configuration mode. **Note** You must create the Layer 3 interface before you can assign the static MAC address.

Step 3	**mac-address** *mac-address*
	Example:
	`switch(config-if)# mac-address 22ab.47dd.ff89`
	`switch(config-if)#`
		Specified a static MAC address to add to the Layer 3 interface.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface mode.

Step 5	(Optional) **show interface** [**ethernet** *slot/port* | **ethernet** *slot/port.number* | **port-channel** *number* | **vlan** *vlan-id*] **Example:**	Displays information about the Layer 3 interface.

	Command or Action	Purpose
	`switch# show interface ethernet 7/3`	
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Layer 3 interface on slot 7, port 3 with a static MAC address:

```
switch# config t
switch(config)# interface ethernet 7/3
switch(config-if)# mac-address 22ab.47dd.ff89
switch(config-if)#
```

2.5.3 Configuring the Aging Time for the MAC Table

You can configure the amount of time that a MAC address entry (the packet source MAC address and port on which that packet was learned) remains in the MAC table, which contains the Layer 2 information.

SUMMARY STEPS

1. **config t**
2. **mac address-table aging-time** *seconds*
3. **exit**
4. (Optional) **show mac address-table aging-time**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**mac address-table aging-time** *seconds* **Example:** `switch(config)# mac address-table aging-time 600`	Specifies the time before an entry ages out and is discarded from the Layer 2 MAC address table. The range is from 120 to 918000; the default is 1800 seconds. Entering the value 0 disables the MAC aging.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits the configuration mode.

Step 4	(Optional) **show mac address-table aging-time**	Displays the aging time configuration for MAC

	Command or Action	Purpose
	Example: `switch# show mac address-table aging-time`	address retention.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the ageout time for entries in the Layer 2 MAC address table to 600 seconds (10 minutes):

```
switch# config t
switch(config)# mac address-table aging-time 600
switch(config)#
```

2.5.4 Checking Consistency of MAC Address Tables

You can check the match between the MAC address table on the supervisor and all the modules.

SUMMARY STEPS

1. **show consistency-checker l2 module** <*slot_number*>

DETAILED STEPS

	Command or Action	Purpose

Step 1	**show consistency-checker l2 module** <*slot_number*>
	Example:
	`switch# show consistency-checker l2 module 7`
	`switch#`
		Displays the discrepant, missing, and extra MAC addresses
		between the supervisor and the specified module.

Example

This example shows how to display discrepant, missing, and extra entries in the MAC address tables between the supervisor and the specified module:

```
switch# show consistency-checker l2 module 7
switch#
```

2.5.5 Clearing Dynamic Addresses from the MAC Table

You can clear all dynamic Layer 2 entries in the MAC address table. (You can also clear entries by designated interface or VLAN.)

SUMMARY STEPS

1. **clear mac address-table dynamic** {**address** *mac_addr*} {**interface** [**ethernet** *slot/port* | **port-channel**

channel-number]} {**vlan** *vlan_id*}

2. (Optional) **show mac address-table**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**clear mac address-table dynamic** {**address** *mac_addr*}
	{**interface** [**ethernet** *slot/port* | **port-channel** *channel-number*]} {**vlan** *vlan_id*}
	Example:
	`switch# clear mac address-table dynamic`
		Clears the dynamic address entries from the MAC address
		table in Layer 2.

Step 2	(Optional) **show mac address-table** **Example:** `switch# show mac address-table`	Displays the MAC address table.

Example

This example shows how to clear the dynamic entries in the Layer 2 MAC address table:

```
switch# clear mac address-table dynamic
switch#
```

2.5.6 Configuring MAC Address Limits

SUMMARY STEPS

1. **config t**
2. **mac address-table limit vlan** *vlan-id limit -value*
3. **exit**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**mac address-table limit vlan** *vlan-id limit -value*
	Example:
	`switch(config)# mac address-table limit vlan`
	`40`
	`108`
		Specifies the VLAN to which the MAC address limits
		should be applied.

Step 3	**exit** **Example:**	Exits the configuration mode.

	`switch(config)# exit`
	`switch#`	

Step 4	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

2.6 Verifying the Layer 2 Switching Configuration

To display Layer 2 switching configuration information, perform one of the following tasks:

Command	**Purpose**
show mac address-table	Displays information about the MAC address table.
show mac address-table limit	Displays information about the limits set for the MAC address table.
show mac address-table aging-time	Displays information about the aging time set for the MAC address entries.
show mac address-table static	Displays information about the static entries on the MAC address table.
show interface [*interface*] **mac-address**	Displays the MAC addresses and the burn-in MAC address for the interfaces.
show forwarding consistency l2 {*module*}	Displays discrepant, missing, and extra MAC addresses between the tables on the module and the supervisor.

2.7 Configuration Example for Layer 2 Switching

The following example shows how to add a static MAC address and how to modify the default global aging time for MAC addresses:

```
switch# configure terminal
switch(config)# mac address-table static 0000.0000.1234 vlan 10 interface ethernet
2/15 switch(config)# mac address-table aging-time 120
```

2.8 Additional References for Layer 2 Switching -- CLI Version

Related Topic	**Document Title**

Static MAC addresses	*Inspur CN12900 Series INOS-CN Security Configuration Guide*
Interfaces	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
System management	*Inspur CN12900 Series INOS-CN System Management Configuration Guide*

CHAPTER 3 Configuring VLANs

3.1 Information About VLANs

You can use VLANs to divide the network into separate logical areas at the Layer 2 level. VLANs can also be considered as broadcast domains.

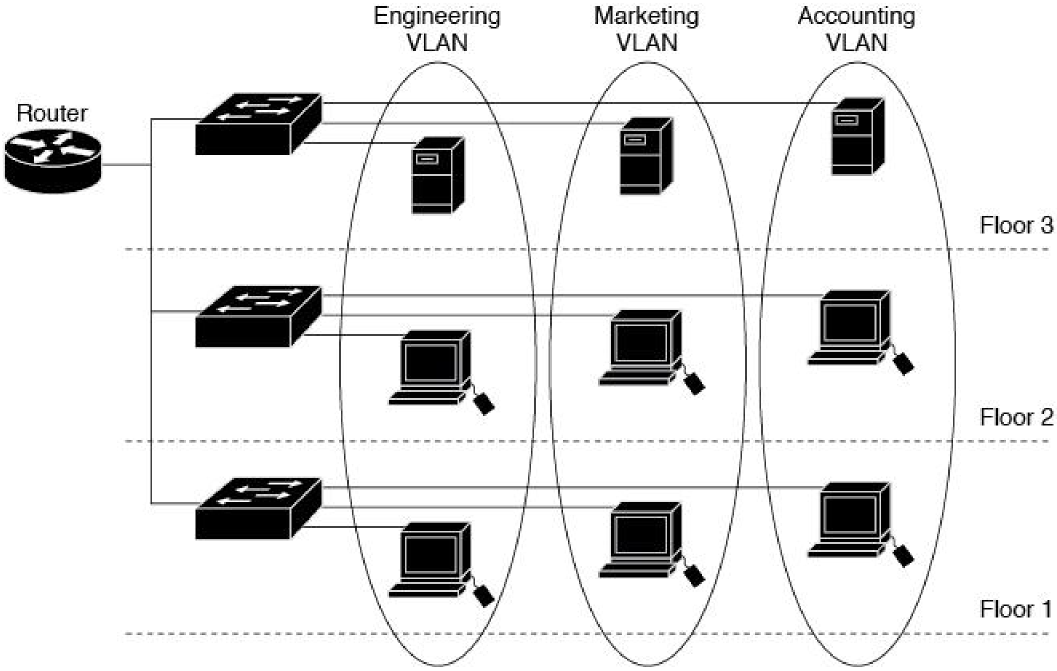
Any switch port can belong to a VLAN, and unicast broadcast and multicast packets are forwarded and flooded only to end stations in that VLAN. Each VLAN is considered a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a router.

3.1.1 Understanding VLANs

A VLAN is a group of end stations in a switched network that is logically segmented by function or application, without regard to the physical locations of the users. VLANs have the same attributes as physical LANs, but you can group end stations even if they are not physically located on the same LAN segment.

Any switch port can belong to a VLAN, and unicast, broadcast, and multicast packets are forwarded and flooded only to end stations in that VLAN. Each VLAN is considered as a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a router. The following figure shows VLANs as logical networks. The stations in the engineering department are assigned to one VLAN, the stations in the marketing department are assigned to another VLAN, and the stations in the accounting department are assigned to another VLAN.

Figure 1： VLANs as Logically Defined Networks



VLANs are usually associated with IP subnetworks. For example, all the end stations in a particular IP subnet belong to the same VLAN. To communicate between VLANs, you must route the traffic.

By default, a newly created VLAN is operational; that is, the newly created VLAN is in the no shutdown condition. Additionally, you can configure VLANs to be in the active state, which is passing traffic, or the suspended state, in which the VLANs are not passing packets. By default, the VLANs are in the active state and pass traffic.

A VLAN interface, or switched virtual interface (SVI), is a Layer 3 interface that is created to provide communication between VLANs. In order to route traffic between VLANs, you must create and configure a VLAN interface for each VLAN. Each VLAN requires only one VLAN interface.

3.1.2 VLAN Ranges

The device supports up to 4095 VLANs in accordance with the IEEE 802.1Q standard. The software organizes these VLANs into ranges, and you use each range slightly differently.

This table describes the VLAN ranges.

Table 3： VLAN Ranges

VLANs Numbers	Range	Usage
1	Normal	Inspur default. You can use this VLAN, but you cannot modify or delete it.
2—1005	Normal	You can create, use, modify, and delete these VLANs.
1006—3967	Extended	You can create, name, and use these VLANs. You cannot change the following parameters: • The state is always active. • The VLAN is always enabled. You cannot shut down these VLANs.
3968-4095	Internally allocated	These reserved VLANs are allocated for internal device use.

About Reserved VLANS

The following are notes about reserved VLANs (3968 to 4095):

- The software allocates a group of VLAN numbers for features like multicast and diagnostics, that need to use internal VLANs for their operation. By default, the system allocates a block of 128 reserved VLANs (3968 to 4095) for these internal uses.
- You can change the range of reserved VLANs with the system **vlan** *vlan-id* **reserve** command. This allows you to set a different range of VLANs to be used as the reserved VLANs. The selected VLANs must be reserved in groups of 128.
- You may configure VLANs 3968-4092 for other purposes.
- VLANs 4093-4095 are always reserved for internal use and cannot be used other purposes.

For example,

```
system vlan 400 reserve
```

reserves VLANs 400-527.

The new reserved range takes effect after the running configuration is saved and the device is reloaded.

- VLANs 4093-4095 are always reserved for internal use and cannot be used other purposes. In the example, the result of the command would be that VLANs 400-527 are reserved and that VLANs 4093-4095 are also reserved.
- The **no system vlan** *vlan-id* **reserve** command changes the range for reserved VLANs to the default range of 3968-4095 after the device is reloaded.
- Use the **show system vlan reserved** command to verify the range of the current and future reserved VLAN ranges.

Example of VLAN Reserve

The following is an example of configuring the VLAN reserve (before and after image reload):

```
      **************************************************
      CONFIGURE NON-DEFAULT RANGE, "COPY R S" AND RELOAD
      **************************************************
      switch(config)# system vlan 400 reserve



"vlan configuration 400-527" will be deleted automatically.
Vlans, SVIs and sub-interface encaps for vlans 400-527 need to be removed by the
user. Continue anyway? (y/n) [no] y
Note: After switch reload, VLANs 400-527 will be reserved for internal use.
      This requires copy running-config to startup-config before
      switch reload.  Creating VLANs within this range is not allowed.
switch(config)# show system vlan reserved

system current running vlan reservation: 3968-4095

system future running vlan reservation: 400-527


switch(config)# copy running-config startup-config
[########################################] 100%
switch(config)# reload
This command will reboot the system. (y/n)?  [n] y
************
AFTER RELOAD
************

switch# show system vlan reserved

system current running vlan reservation: 400-527
```

3.1.3 Creating, Deleting, and Modifying VLANs

VLANs are numbered from 1 to 3967. All ports that you have configured as switch ports belong to the default VLAN when you first bring up the switch as a Layer 2 device. The default VLAN (VLAN1) uses only default values, and you cannot create, delete, or suspend activity in the default VLAN.

You create a VLAN by assigning a number to it; you can delete VLANs and move them from the active operational state to the suspended operational state. If you attempt to create a VLAN with an existing VLAN ID, the device goes into the VLAN submode but does not create the same VLAN again.

Newly created VLANs remain unused until Layer 2 ports are assigned to the specific VLAN. All the ports are assigned to VLAN1 by default.

Depending on the range of the VLAN, you can configure the following parameters for VLANs (except the default VLAN):

- VLAN name
- VLAN state
- Shutdown or not shutdown

You can configure VLAN long-names of up to 128 characters. To configure VLAN long-names, VTP must be in transparent mode.

When you delete a specified VLAN, the ports associated to that VLAN become inactive and no traffic flows. When you delete a specified VLAN from a trunk port, only that VLAN is shut down and traffic continues to flow on all the other VLANs through the trunk port.

However, the system retains all the VLAN-to-port mapping for that VLAN, and when you reenable or re-create, that specified VLAN, the system automatically reinstates all the original ports to that VLAN. The static MAC addresses and aging time for that VLAN are not restored when the VLAN is reenabled.

3.1.4 High Availability for VLANs

The software supports high availability for both stateful and stateless restarts, as during a cold reboot, for VLANs. For the stateful restarts, the software supports a maximum of three retries. If you try more than 3 times within 10 seconds of a restart, the software reloads the supervisor module.

You can upgrade or downgrade the software seamlessly when you use VLANs.

3.2 Licensing Requirements for VLANs

The following table shows the licensing requirements for this feature.

Product	License Requirement
Inspur INOS-CN	VLANs require no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you.

3.3 Prerequisites for Configuring VLANs

VLANs have the following prerequisites:

- You must be logged onto the device.
- You must create the VLAN before you can do any modification of that VLAN.

3.4 Guidelines and Limitations for Configuring VLANs

VLANs have the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- You can configure a single VLAN or a range of VLANs.

When you configure a large number of VLANs, first create the VLANs using the **vlan** command (for example, **vlan** *200-300*, *303-500*). After the VLANS have been successfully created, name or configure those VLANs sequentially.

- You cannot create, modify, or delete any VLANs that are within the group of VLANs reserved for internal use.
- VLAN1 is the default VLAN. You cannot create, modify, or delete this VLAN.
- VLANs 1006 to 3967 are always in the active state and are always enabled. You cannot suspend the state or shut down these VLANs.
- When the spanning tree mode is changed, the Layer 3 subinterface VLANs that share the same VLAN IDs with Layer 2 VLANs might be affected by a few micro-seconds of traffic drops as a result of the hardware re-programming.
- VLANs 3968 to 4095 are reserved for internal device use by default.

3.5 Default Settings for VLANs

This table lists the default settings for VLAN parameters.

Table 4：Default VLAN Parameters

Parameters	Default
VLANs	Enabled
VLAN	VLAN1—A port is placed in VLAN1 when you configure it as a switch port.
VLAN ID	1
VLAN name	• Default VLAN (VLAN1)—default • All other VLANs—VLAN *vlan-id*
VLAN state	Active
STP	Enabled; Rapid PVST+ is enabled
VTP	Disabled
VTP version	1

3.6 Configuring a VLAN

3.6.1 Creating and Deleting a VLAN - CLI Version

You can create or delete all VLANs except the default VLAN and those VLANs that are internally allocated for use by the device.

Once a VLAN is created, it is automatically in the active state.

If you create a range of VLANs and some of these VLANs cannot be created, the software returns a message listing the failed VLANs, and all the other VLANs in the specified range are created.

SUMMARY STEPS

1. **config t**
2. **vlan** {*vlan-id* | *vlan-range*}
3. **Exit**
4. (Optional) **show vlan**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t**	Enters configuration mode.

	Command or Action	Purpose

	Example:
	`switch# config t`
	`switch(config)#`	

Step 2	**vlan** {*vlan-id* | *vlan-range*}
	Example:
	`switch(config)# vlan 5`
	`switch(config-vlan)#`
		Creates a VLAN or a range or VLANs. If you enter a number that is already assigned to a VLAN, the device puts you into the VLAN configuration submode for that VLAN.
		If you enter a number that is assigned to an internally allocated VLAN, the system returns an error message.
		However, if you enter a range of VLANs and one or more of the specified VLANs is outside the range of internally allocated VLANs, the command takes effect on only those VLANs outside the range. The range is from 2 to 3967;
		VLAN1 is the default VLAN and cannot be created or deleted. You cannot create or delete those VLANs that are reserved for internal use.

Step 3	**exit**
	Example:
	`switch(config-vlan)# exit`
	`switch(config)#`
		Exits the VLAN mode.

Step 4	(Optional) **show vlan** **Example:** `switch# show vlan`	Displays information and status of VLANs.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to create a range of VLANs from 15 to 20:

```
switch# config t
switch(config)# vlan 15-
20 switch(config-vlan)#
exit switch(config)#
```

3.6.2 Entering the VLAN Configuration Submode

To configure or modify the VLAN for the following parameters, you must be in the VLAN configuration submode:

- Name
- State
- Shut down

SUMMARY STEPS

1. **config t**
2. **vlan** {*vlan-id* | *vlan-range*}
3. **exit**
4. (Optional) **show vlan**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**vlan** {*vlan-id* | *vlan-range*}
	Example:
	`switch(config)# vlan 5`
	`switch(config-vlan)#`
		Places you into the VLAN configuration submode. This submode allows you to name, set the state, disable, and shut down the VLAN or range of VLANs.
		You cannot change any of these values for VLAN1 or the internally allocated VLANs.

Step 3	**exit**
	Example:
	`switch(config-vlan)# exit`
	`switch(config)#`
		Exits the VLAN configuration mode.

Step 4	(Optional) **show vlan** **Example:** `switch# show vlan`	Displays information and status of VLANs.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enter and exit the VLAN configuration submode:

```
switch# config t
```

```
switch(config)# vlan 15
switch(config-vlan)# exit
switch(config)#
```

3.6.3 Configuring a VLAN

To configure or modify a VLAN for the following parameters, you must be in the VLAN configuration submode:

- Name
- State
- Shut down

SUMMARY STEPS

DETAILED STEPS

1. **config t**
2. **vlan** {*vlan-id* | *vlan-range*}
3. **name** *vlan-name*
4. **state** {**active** | **suspend**}
5. **no shutdown**
6. **exit**
7. (Optional) **show vlan**
8. (Optional) **show vtp status**
9. **copy running-config startup-config**

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**vlan** {*vlan-id* | *vlan-range*}
	Example:
	`switch(config)# vlan 5`
	`switch(config-vlan)#`
		Places you into the VLAN configuration submode. If the VLAN does not exist, the system creates the specified VLAN and then enters the VLAN configuration submode.

Step 3	**name** *vlan-name* **Example:** `switch(config-vlan)# name accounting`	Names the VLAN. You can enter up to 32 alphanumeric characters to name the VLAN. You cannot change the name of VLAN1 or the internally allocated VLANs. The default value is VLANxxxx where xxxx represent four numeric digits (including leading zeroes) equal to the VLAN ID number. **Note** 128-character names are supported (VLAN

	Command or Action	Purpose
		Long-Name).

Step 4	**state** {**active** | **suspend**}
	Example:
	`switch(config-vlan)# state active`
		Sets the state of the VLAN to active or suspend. While the VLAN state is suspended, the ports associated with this VLAN become inactive, and that VLAN does not pass any traffic. The default state is active. You cannot suspend the state for the default VLAN or VLANs 1006 to 3967.

Step 5	**no shutdown** **Example:** `switch(config-vlan)# no shutdown`	Enables the VLAN. The default value is no shutdown (or enabled). You cannot shut down the default VLAN, VLAN1, or VLANs 1006 to 3967.

Step 6	**exit**
	Example:
	`switch(config-vlan)# exit`
	`switch(config)#`
		Exits the VLAN configuration submode.

Step 7	(Optional) **show vlan** **Example:** `switch# show vlan`	Displays information and status of VLANs.
Step 8	(Optional) **show vtp status** **Example:** `switch# show vtp status`	Displays information and status of VLAN Trunking Protocols (VTPs).
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration. **Note** Commands entered in the VLAN configuration submode are not immediately executed. You must exit the VLAN configuration submode for configuration changes to take effect.

Example

This example shows how to configure optional parameters for VLAN 5:

```
switch# config t
switch(config)# vlan 5
switch(config-vlan)# name accounting
switch(config-vlan)# state
active switch(config-vlan)# no
shutdown switch(config-vlan)#
exit switch(config)#
```

3.6.4 Configuring a VLAN Before Creating the VLAN

You can configure a VLAN before you create the VLAN. This procedure is used for IGMP snooping, VTP, and other configurations.

SUMMARY STEPS

1. **config t**
2. **vlan configuration** {*vlan-id*}

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**vlan configuration** {*vlan-id*}
	Example:
	`switch(config)# vlan configuration 20`
	`switch(config-vlan-config)#`
		Allows you to configure VLANs without actually creating
		them.

Example

This example shows how to configure a VLAN before creating it:

```
switch# config t
switch(config)# vlan configuration 20
switch(config-vlan-config)#
```

3.6.5 Enabling the VLAN Long-Name

You can configure VLAN long-names of up to 128 characters.

Before you begin

VTP must be in transparent or in off mode. VTP cannot be in client or server mode.

SUMMARY STEPS

1. **configure terminal**
2. **system vlan long-name**
3. (Optional) **copy running-config startup-config**
4. **show running-config vlan**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**system vlan long-name** **Example:** `switch(config)# system vlan long-name`	Allows you to enable VLAN names that have up to 128 characters. Use the **no** form of this command to disable this feature.
Step 3	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.
Step 4	**show running-config vlan** **Example:** `switch(config)# show running-config vlan`	Verifies that the system VLAN long-name feature is enabled.

Example

This example shows how to enable VLAN long-names.

```
switch# configure terminal
switch(config)# system vlan long-name
switch(config)# copy running config startup
config switch(config)# show running-config vlan
```

3.6.6 Configuring Inner VLAN and Outer VLAN Mapping on a Trunk Port

You can configure VLAN translation from an inner VLAN and an outer VLAN to a local (translated) VLAN on a port.

Notes for configuring inner VLAN and outer VLAN mapping:

- VLAN translation (mapping) is supported on Inspur CN12900 Series Series switches with a Network Forwarding Engine (NFE).
- Inner and outer VLAN cannot be on the trunk allowed list on a port where inner VLAN and outer VLAN is configured.

For example:

```
switchport vlan mapping 11 inner 12 111
switchport trunk allowed vlan 11-12,111 /***Not valid because 11 is outer VLAN and
12 is inner VLAN.***/
```

- On the same port, no two mapping (translation) configurations can have the same outer (or original) or translated VLAN. Multiple inner VLAN and outer VLAN mapping configurations can have the same inner VLAN.

For example:

```
switchport vlan mapping 101 inner 102 1001  /***Not valid because 101 is already used
switchport vlan mapping 101 inner 103 1002
as an original VLAN.***/                    /***Not valid because 1001 is already used
switchport vlan mapping 111 inner 104 1001
 as a translated VLAN.***/                  /***Valid because inner vlan can be the
switchport vlan mapping 106 inner 102 1003
same.***/
```

- Port VLAN mapping on a trunk port is supported on Inspur CN12900 Series switches with a Network Forwarding Engine (NFE), and Inspur CN12900 platform switches.
- VLAN translation is only supported on VXLAN enabled VLANs.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type port*
3. [**no**] **switchport mode trunk**
4. **switchport vlan mapping enable**
5. **switchport vlan mapping** *outer-vlan-id* **inner** *inner-vlan-id translated-vlan-id*
6. (Optional) **copy running-config startup-config**
7. (Optional) **show interface** [*if-identifier*] **vlan mapping**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal**	Enters global configuration mode.
Step 2	**interface** *type port*	Enters interface configuration mode.
Step 3	[**no**] **switchport mode trunk**	Enters trunk configuration mode.
Step 4	**switchport vlan mapping enable**	Enables VLAN translation on the switch port. VLAN translation is disabled by default. **Note** Use the **no** form of this command to disable VLAN translation.
Step 5	**switchport vlan mapping** *outer-vlan-id* **inner** *inner-vlan-id translated-vlan-id*	Translates inner VLAN and outer VLAN to another VLAN.
Step 6	(Optional) **copy running-config startup-config**	Copies the running configuration to the startup configuration. **Note** The VLAN translation configuration does not become effective until the switch port becomes an operational trunk port
Step 7	(Optional) **show interface** [*if-identifier*] **vlan**	Displays VLAN mapping information for a range of

	Command or Action	Purpose
	mapping	interfaces or for a specific interface.

Example

This example shows how to configure translation of double tag VLAN traffic (inner VLAN 12; outer VLAN 11) to VLAN 111.

```
switch# config t
switch(config)# interface ethernet1/1 switch(config-
if)# switchport mode trunk switch(config-if)#
switchport vlan mapping enable
switch(config-if)# switchport vlan mapping 11 inner 12
111 switch(config-if)# switchport trunk allowed vlan 101-
170 switch(config-if)# no shutdown
switch(config-if)# show mac address-table dynamic vlan 111

Legend:
        * - primary entry, G - Gateway MAC, (R) - Routed MAC, O - Overlay MAC
        age - seconds since last seen,+ - primary entry using vPC Peer-Link,
        (T) - True, (F) - False
   VLAN    MAC Address       Type    ----age       Secure  NTFY  Ports
---+       -----------------+dynamic--------     +------  +----+------------------
   111     0000.0092.0001            0            F      F    nve1(100.100.100.254)
*  111     0000.0940.0001    dynamic 0            F      F    Eth1/1
```

3.7 Verifying the VLAN Configuration

To display VLAN configuration information, perform one of the following tasks:

Command	Purpose
show running-config vlan *vlan-id*	Displays VLAN information.
show vlan [**all-ports** | **brief** | **id** *vlan-id* | **name** *name* | **dot1q tag native**]	Displays VLAN information.
show vlan summary	Displays a summary of VLAN information.
show vtp status	Displays VTP information.

3.8 Displaying and Clearing VLAN Statistics

To display VLAN configuration information, perform one of the following tasks:

Command	Purpose
clear vlan [**id** *vlan-id*] **counters**	Clears counters for all VLANs or for a specified VLAN.
show vlan counters	Displays information on Layer 2 packets in each VLAN.

3.9 Configuration Example for VLANs

The following example shows how to create and name a VLAN as well as how to make the state active and administratively up:

```
switch# configure terminal
switch(config)# vlan 10
switch(config-vlan)# name test
switch(config-vlan)# state
active switch(config-vlan)# no
shutdown switch(config-vlan)#
exit switch(config)#
```

3.10 Additional References for VLANs

Related Documents

Related Topic	Document Title
INOS-CN Layer 2 switching configuration	*Inspur CN12900 Series INOS-CN Layer 2 Switching Configuration Guide*
Interfaces, VLAN interfaces, IP addressing, and port channels	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
Multicast routing	*Inspur CN12900 Series INOS-CN Multicast Routing Configuration Guide*
INOS-CN fundamentals	*Inspur CN12900 Series INOS-CN Fundamentals Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
System management	*Inspur CN12900 Series INOS-CN System Management Configuration Guide*

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not — been modified by this feature.	

CHAPTER 4 Configuring VTP

4.1 Information About VTP

VTP is supported for VTP version 1 and 2.

4.1.1 VTP

VTP is a Layer 2 messaging protocol that maintains VLAN consistency by managing the addition, deletion, and renaming of VLANs within a VTP domain. A VTP domain is made up of one or more network devices that share the same VTP domain name and that are connected with trunk interfaces. Each network device can be in only one VTP domain.

Layer 2 trunk interfaces, Layer 2 port channels, and virtual port channels (vPCs) support VTP functionality.

The VTP is disabled by default on the device. You can enable and configure VTP using the command-line interface (CLI). When VTP is disabled, the device does not relay any VTP protocol packets.

When the device is in the VTP transparent mode, the device relays all VTP protocol packets that it receives on a trunk port to all other trunk ports. When you create or modify a VLAN that is in VTP transparent mode, those VLAN changes affect only the local device. A VTP transparent network device does not advertise its VLAN configuration and does not synchronize its VLAN configuration based on received advertisements.

4.1.2 VTP Overview

VTP allows each router or LAN device to transmit advertisements in frames on its trunk ports. These frames are sent to a multicast address where they can be received by all neighboring devices. They are not forwarded by normal bridging procedures. An advertisement lists the sending device's VTP management domain, its configuration revision number, the VLANs which it knows about, and certain parameters for each known VLAN. By hearing these advertisements, all devices in the same management domain learn about any new VLANs that are configured in the transmitting device. This process allows you to create and configure a new VLAN only on one device in the management domain, and then that information is automatically learned by all the other devices in the same management domain.

Once a device learns about a VLAN, the device receives all frames on that VLAN from any trunk port by default, and if appropriate, forwards them to each of its other trunk ports, if any. This process prevents unnecessary VLAN traffic from being sent to a device.

4.1.3 VTP Modes

VTP is supported in these modes:

- Transparent—Allows you to relay all VTP protocol packets that it receives on a trunk port to all other trunk ports. When you create or modify a VLAN that is in VTP transparent mode, those VLAN changes affect only the local device. A VTP transparent network device does not advertise its VLAN configuration and does not synchronize its VLAN configuration based on received advertisements.

If VTP is in transparent mode, you can configure VLAN long names of up to 128 characters.

4.1.4 VTP Per Interface

VTP allows you to enable or disable the VTP protocol on a per-port basis to control the VTP traffic. When a trunk is connected to a switch or end device, it drops incoming VTP packets and prevents VTP advertisements on this particular trunk. By default, VTP is enabled on all the switch ports.

4.2 Guidelines and Limitations for Configuring VTP

VTP has the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- In SNMP, the vlanTrunkPortVtpEnabled object indicates whether the VTP feature is enabled or not. The status of the vlanTrunkPortVtpEnabled object aligns with the output of the **show vtp trunk interface eth a/b** command.

4.3 Default Settings

This table lists the default settings for VTP parameters.

Table 5: Default VTP Parameters

Parameters	Default
VTP	Disabled
VTP Mode	Transparent
VTP Domain	blank
VTP Version	1
VTP per Interface	Enabled

4.4 Configuring VTP

You can configure VTP on Inspur CN12900 devices.

SUMMARY STEPS

1. **config t**
2. **feature vtp**
3. **vtp domain** *domain-name*
4. **vtp version** {**1** | **2**}
5. **vtp file** *file-name*
6. **vtp password** *password-value*
7. **exit**
8. (Optional) **show vtp status**
9. (Optional) **show vtp counters**
10. (Optional) **show vtp interface**
11. (Optional) **show vtp password**
12. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t** **Example:** `switch# config t`	Enters configuration mode.

	Command or Action	Purpose
	`switch(config)#`	

Step 2	**feature vtp**
	Example:
	`switch(config)# feature vtp`
	`switch(config)#`
		Enables VTP on the device. The default is disabled.

Step 3	**vtp domain** *domain-name* **Example:** `switch(config)# vtp domain accounting`	Specifies the name of the VTP domain that you want this device to join. The default is blank.

Step 4	**vtp version** {**1** | **2**}
	Example:
	`switch(config)# vtp version 2`
		Sets the VTP version that you want to use. The default is version 1.

Step 5	**vtp file** *file-name* **Example:** `switch(config)# vtp file vtp.dat`	Specifies the ASCII filename of the IFS file system file where the VTP configuration is stored.
Step 6	**vtp password** *password-value* **Example:** `switch(config)# vtp password inspur`	Specifies the password for the VTP administrative domain.

Step 7	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits the configuration submode.

Step 8	(Optional) **show vtp status** **Example:** `switch# show vtp status`	Displays information about the VTP configuration on the device, such as the version, mode, and revision number.
Step 9	(Optional) **show vtp counters** **Example:** `switch# show vtp counters`	Displays information about VTP advertisement statistics on the device.
Step 10	(Optional) **show vtp interface** **Example:** `switch# show vtp interface`	Displays the list of VTP-enabled interfaces.

	Command or Action	Purpose
Step 11	(Optional) **show vtp password** **Example:** `switch# show vtp password`	Displays the password for the management VTP domain.
Step 12	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

CHAPTER 5 Configuring Private VLANs Using INOS-CN

5.1 Information About Private VLANs

Starting in Inspur INOS-CN, the private VLAN feature is supported.

In certain instances where similar systems do not need to interact directly, private VLANs provide additional protection at the Layer 2 level. Private VLANs are an association of primary and secondary VLANs.

A primary VLAN defines the broadcast domain with which the secondary VLANs are associated. The secondary VLANs may either be isolated VLANs or community VLANs. Hosts on isolated VLANs communicate only with associated promiscuous ports in primary VLANs, and hosts on community VLANs communicate only among themselves and with associated promiscuous ports but not with isolated ports or ports in other community VLANs.

In configurations that use integrated switching and routing functions, you can assign a single Layer 3 VLAN network interface to each private VLAN to provide routing. The VLAN network interface is created for the primary VLAN. In such configurations, all secondary VLANs communicate at Layer 3 only through a mapping with the VLAN network interface on the primary VLAN. Any VLAN network interfaces previously created on the secondary VLANs are put out-of-service.

5.1.1 Private VLAN Overview

You must enable private VLANs before the device can apply the private VLAN functionality.

You cannot disable private VLANs if the device has any operational ports in a private VLAN mode.

Primary and Secondary VLANs in Private VLANs

The private VLAN feature addresses two problems that users encounter when using VLANs:

- Each VDC supports up to 4096 VLANs. If a user assigns one VLAN per customer, the number of customers that the service provider can support is limited.
- To enable IP routing, each VLAN is assigned with a subnet address space or a block of addresses, which can result in wasting the unused IP addresses and creating IP address management problems.

Using private VLANs solves the scalability problem and provides IP address management benefits and Layer 2 security for customers.

The private VLAN feature allows you to partition the Layer 2 broadcast domain of a VLAN into subdomains. A subdomain is represented by a pair of private VLANs: a primary VLAN and a secondary VLAN. A private VLAN domain can have multiple private VLAN pairs, one pair for each subdomain. All VLAN pairs in a private VLAN domain share the same primary VLAN. The secondary VLAN ID differentiates one subdomain from another.

Secondary VLANs provide Layer 2 isolation between ports within the same private VLAN. The following two types are secondary VLANs within a primary VLAN:

- Isolated VLANs—Ports within an isolated VLAN cannot communicate with each other at the Layer 2 level.
- Community VLANs—Ports within a community VLAN can communicate with each other but cannot communicate with ports in other community VLANs or in any isolated VLANs at the Layer 2 level.

Private VLAN Ports

The types of private VLAN ports are as follows:

- Promiscuous port—A promiscuous port belongs to the primary VLAN. The promiscuous port can communicate with all interfaces, including the community and isolated host ports, that belong to those secondary VLANs associated to the promiscuous port and associated with the primary VLAN. You can have several promiscuous ports in a primary VLAN. Each promiscuous port can have several secondary VLANs, or no secondary VLANs, associated to that port. You can associate a secondary VLAN to more than one promiscuous port, as long as the promiscuous port and secondary VLANs are within the same primary VLAN. You may want to do this association for load balancing or redundancy purposes. You can also have secondary VLANs that are not associated to any promiscuous port, but these secondary VLANs cannot communicate to the Layer 3 interface.

- Promiscuous trunk—You can configure a promiscuous trunk port to carry traffic for multiple primary VLANs. You map the private VLAN primary VLAN and either all or selected associated VLANs to the promiscuous trunk port. Each primary VLAN and one associated and secondary VLAN is a private VLAN pair, and you can configure a maximum of 16 private VLAN pairs on each promiscuous trunk port.
- Isolated port—An isolated port is a host port that belongs to an isolated secondary VLAN. This port has complete Layer 2 isolation from other ports within the same private VLAN domain, except that it can communicate with associated promiscuous ports. Private VLANs block all traffic to isolated ports except traffic from promiscuous ports. Traffic received from an isolated port is forwarded only to promiscuous ports. You can have more than one isolated port in a specified isolated VLAN, and each port is completely isolated from all other ports in the isolated VLAN.
- Isolated or secondary trunk—You can configure an isolated trunk port to carry traffic for multiple isolated VLANs. Each secondary VLAN on an isolated trunk port must be associated with a different primary VLAN. You cannot put two secondary VLANs that are associated with the same primary VLAN on an isolated trunk port. Each primary VLAN and one associated secondary VLAN is a private VLAN pair, and you can configure a maximum of 16 private VLAN pairs on each isolated trunk port.
- Community port—A community port is a host port that belongs to a community secondary VLAN. Community ports communicate with other ports in the same community VLAN and with associated promiscuous ports. These interfaces are isolated at Layer 2 from all other interfaces in other communities and from all isolated ports within the private VLAN domain.

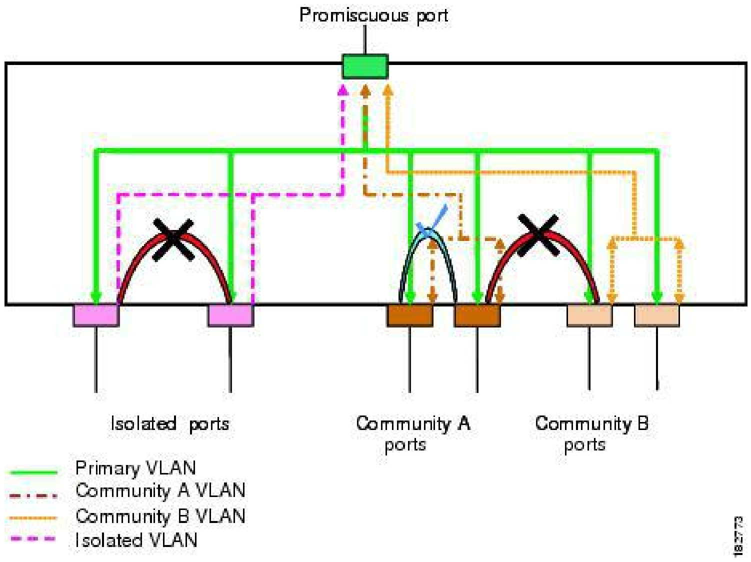
Primary, Isolated, and Community Private VLANs

Because the primary VLAN has the Layer 3 gateway, you associate secondary VLANs with the primary VLAN in order to communicate outside the private VLAN. Primary VLANs and the two types of secondary VLANs, isolated VLANs and community VLANs, have these characteristics:

- Primary VLAN— The primary VLAN carries traffic from the promiscuous ports to the (isolated and community) host ports and to other promiscuous ports.
- Isolated VLAN —An isolated VLAN is a secondary VLAN that carries unidirectional traffic upstream from the hosts toward the promiscuous ports and the Layer 3 gateway. You can configure one isolated VLAN in a primary VLAN. In addition, each isolated VLAN can have several isolated ports, and the traffic from each isolated port also remains completely separate.
- Community VLAN—A community VLAN is a secondary VLAN that carries upstream traffic from the community ports to the promiscuous port gateways and to other host ports in the same community. You can configure multiple community VLANs in a private VLAN domain. The ports within one community can communicate, but these ports cannot communicate with ports in any other community or isolated VLAN in the private VLAN.

Figure 2： Private VLAN Layer 2 Traffic Flows

This figure shows the Layer 2 traffic flows within a primary, or private VLAN, along with the types of VLANs and types of ports.



A promiscuous port can serve only one primary VLAN, but it can serve multiple isolated VLANs and multiple community VLANs. (Layer 3 gateways are connected to the device through a promiscuous port.) With a promiscuous port, you can connect a wide range of devices as access points to a private VLAN. For example, you can use a promiscuous port to monitor or back up all the private VLAN servers from an administration workstation.

Although you can have several promiscuous ports in a primary VLAN, you can have only one Layer 3 gateway per primary VLAN.

In a switched environment, you can assign an individual private VLAN and associated IP subnet to each individual or common group of end stations. The end stations need to communicate only with a default gateway to communicate outside the private VLAN.

Associating Primary and Secondary VLANs

To allow the host ports in secondary VLANs to communicate outside the private VLAN, you associate secondary VLANs to the primary VLAN. If the association is not operational, the host ports (isolated and community ports) in the secondary VLAN are brought down.

For an association to be operational, the following conditions must be met:

- The primary VLAN must exist.
- The secondary VLAN must exist.
- The primary VLAN must be configured as a primary VLAN.
- The secondary VLAN must be configured as either an isolated or community VLAN.

If you delete either the primary or secondary VLAN, the ports that are associated with the VLAN become inactive. When you reconvert the specified VLAN to private VLAN mode, the original associations are reinstated.
If the association is not operational on private VLAN trunk ports, only that VLAN goes down, not the entire port.

When you enter the **no private-vlan** command, the VLAN returns to the normal VLAN mode. All associations on that VLAN are suspended, but the interfaces remain in private VLAN mode.

If you enter the **no vlan** command for the primary VLAN, all private VLAN associations with that VLAN are lost. However, if you enter the **no vlan** command for a secondary VLAN, the private VLAN associations with that VLAN are suspended and return when you recreate the specified VLAN and configure it as the secondary VLAN.

In order to change the association between a secondary and primary VLAN, you must first remove the current association and then add the desired association.

Broadcast Traffic in Private VLANs

Broadcast traffic from ports in a private VLAN flows in the following ways:

- The broadcast traffic flows from all promiscuous ports to all ports in the primary VLAN. This broadcast traffic is distributed to all ports within the primary VLAN, including those ports that are not configured with private VLAN parameters.
- The broadcast traffic from all isolated ports is distributed only to those promiscuous ports in the primary VLAN that are associated to that isolated port.
- The broadcast traffic from community ports is distributed to all ports within the port's community and to all promiscuous ports that are associated to the community port. The broadcast packets are not distributed to any other communities within the primary VLAN or to any isolated ports.

Private VLAN Port Isolation

You can use private VLANs to control access to end stations as follows:

- Configure selected interfaces connected to end stations as isolated ports to prevent any communication at Layer 2. For example, if the end stations are servers, this configuration prevents Layer 2 communication between the servers.
- Configure interfaces connected to default gateways and selected end stations (for example, backup servers) as promiscuous ports to allow all end stations access to a default gateway.

Private VLANs and VLAN Interfaces

A VLAN interface to a Layer 2 VLAN is also called a switched virtual interface (SVI). Layer 3 devices communicate with a private VLAN only through the primary VLAN and not through secondary VLANs.

Configure VLAN network interfaces only for primary VLANs. Do not configure VLAN interfaces for secondary VLANs. VLAN network interfaces for secondary VLANs are inactive while the VLAN is configured as a secondary VLAN. You will see the following actions if you misconfigure the VLAN interfaces:

- If you try to configure a VLAN with an active VLAN network interface as a secondary VLAN, the configuration is not allowed until you disable the VLAN interface.
- If you try to create and enable a VLAN network interface on a VLAN that is configured as a secondary VLAN, that VLAN interface remains disabled and the system returns an error.

When the primary VLAN is associated with and mapped to the secondary VLAN, any configuration on the primary VLAN is propagated to the secondary VLANs. For example, if you assign an IP subnet to the VLAN network interface on the primary VLAN, this subnet is the IP subnet address of the entire private VLAN.

Private VLANs Across Multiple Devices

You can extend private VLANs across multiple devices by trunking the primary, isolated, and community VLANs to other devices that support private VLANs. To maintain the security of your private VLAN configuration and to avoid other uses of the VLANs configured to be private VLANs, configure private VLANs on all intermediate devices, including devices that have no private VLAN ports.

5.1.2 High Availability for Private VLANs

The software supports high availability for both stateful and stateless restarts, as during a cold reboot, for private VLANs. For the stateful restarts, the software supports a maximum of three retries. If you try more than 3 times within 10 seconds of a restart, the software reloads the supervisor module.

5.2 Licensing Requirements for Private VLANs

The following table shows the licensing requirements for this feature:

Product	License Requirement

Inspur INOS-CN	Private VLANs require no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you.

5.3 Prerequisites for Private VLANs

Private VLANs have the following prerequisites:

- You must be logged onto the device.
- If necessary, install the Advanced Services license.
- You must enable the private VLAN feature.

5.4 Guidelines and Limitations for Configuring Private VLANs

Private VLANs (PVLANs) have the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- You must enable PVLANs before the device can apply the PVLAN functionality.
- PVLANs are supported over vPCs and port channels for *Inspur CN12900* Series.
- You must enable the VLAN interface feature before the device can apply this functionality.
- Shut down the VLAN network interface for all VLANs that you plan to configure as secondary VLANs before you configure these VLANs.
- When a static MAC is created on a regular VLAN and then that VLAN is converted to a secondary VLAN, the Inspur INOS-CN maintains the MAC that was configured on the secondary VLAN as the static MAC.
- PVLANs support PVLAN port modes as follows:
- Promiscuous.
- Promiscuous trunk.
- Isolated host.
- Isolated host trunk.
- Community host.
- Private VLANs do not provide port mode support for port channels.
- Private VLANs do not provide port mode support for virtual port channels (vPCs) interfaces.
- When you configure PVLAN promiscuous trunks or PVLAN isolated trunks, we recommend that you allow non-PVLANs in the list specified by the switchport private-vlan trunk allowed id command. PVLANs are mapped or associated depending on the PVLAN trunk mode.
- PVLANs support PACLs and RACLs.
- PVLANs support SVIs as follows:
- SVIs on the primary VLANs.
- Primary and secondary IP addresses on the SVI.
- HSRP on the primary SVI.
- PVLANs support Layer 2 forwarding.
- PVLANs support STP as follows:
- RSTPs
- MSTs
- PVLANs are supported across switches through a regular trunk port.
- On Network Forwarding Engines (NFE), PVLANs do not provide support on breakout.
- PVLANs are not supported on vPC or port channel FEX ports.
- PVLANs do not provide support for IP multicast or IGMP snooping.
- PVLANs do not provide support for DHCP snooping.
- PVLANs do not provide support for PVLAN QoS.
- PVLANs do not provide support for VACLs.

- PVLANs do not provide support for VTP.
- PVLANs do not provide support for tunnels.
- PVLANs do not provide support for VXLANs.
- PVLANs do not provide support for SPAN when the source is a PVLAN VLAN.
- You cannot configure a shared interface to be part of a PVLAN. For more details, see the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*.
- Although the Inspur INOS-CN CLI allows the configuration of multiple isolated VLAN configurations per PVLAN group, such a configuration is not supported. A PVLAN group can have at most one isolated VLAN.
- PVLAN association on a VLAN is not supported.
- The **no private-vlan primary** command causes the association under the PVLAN to become inactive. Issuing a subsequent **private-vlan primary** command does not make the association under the PVLAN become operational. You need to apply the association again under the PVLAN.
- To change the private port mode to non-PVLAN port mode, you must enter the **default interface** command and then configure non-PVLAN port mode under the interface.

5.5 Default Settings for Private VLANs

This table lists the default setting for private VLANs.

Table 5 : Default Private VLAN Setting

Parameters	**Default**
Private Disabled VLANs	Disabled

5.6 Configuring a Private VLAN

You must have already created the VLAN before you can assign the specified VLAN as a private VLAN.

See the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*, for information on assigning IP addresses to VLAN interfaces.

5.6.1 Enabling Private VLANs - CLI Version

You must enable private VLANs on the device to have the private VLAN functionality.

SUMMARY STEPS

1. **config t**
2. **feature private-vlan**
3. **exit**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	**Purpose**

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**feature private-vlan**	Enables private VLAN functionality on the device.

	Command or Action	Purpose

	Example:
	`switch(config)# feature private-vlan`
	`switch(config)#`
		Note You must completely remove any PVLAN configuration before disabling the private VLAN feature using the **no feature private-vlan** command. For earlier software releases, you must bring any PVLAN ports to the operationally down state before applying the **no feature private-vlan** command.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits the configuration mode.

Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable private VLAN functionality on the device:

```
switch# config t
switch(config)# feature private-vlan
switch(config)#
```

5.6.2 Configuring a VLAN as a Private VLAN - CLI Version

You can configure a VLAN as a private VLAN.

To create a private VLAN, you first create a VLAN and then configure that VLAN to be a private VLAN.

You create all VLANs that you want to use in the private VLAN as a primary VLAN, a community VLAN, or an isolated VLAN. You will later associate multiple isolated and multiple community VLANs to one primary VLAN. You can have many primary VLANs and associations, which means that you could have many private VLANs.

If you delete either the primary or secondary VLAN, the ports that are associated with the VLAN become inactive.

On private VLAN trunk ports, if you delete either the secondary or primary VLAN, only that specific VLAN becomes inactive; the trunk ports stay up.

SUMMARY STEPS

1. **config t**
2. **vlan** {*vlan-id* | *vlan-range*}
3. [**no**] **private-vlan** {**community** | **isolated** | **primary**}
4. **exit**
5. (Optional) **show vlan private-vlan** [*type*]
6. (Optional) copy running-config startup-config

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**vlan** {*vlan-id* | *vlan-range*}
	Example:
	`switch(config)# vlan 5`
	`switch(config-vlan)#`
		Places you into the VLAN configuration submode.

Step 3	[**no**] **private-vlan** {**community** | **isolated** | **primary**}
	Example:
	`switch(config-vlan)# private-vlan primary`
		Configures the VLAN as either a community, isolated, or primary private VLAN. In a private VLAN, you must have one primary VLAN. You can have multiple community and isolated VLANs.
		or
		Removes the private VLAN configuration from the specified VLAN(s) and returns it to normal VLAN mode. If you delete either the primary or secondary VLAN, the ports that are associated with the VLAN become inactive.

Step 4	**exit**
	Example:
	`switch(config-vlan)# exit`
	`switch(config)#`
		Exits the VLAN configuration submode.

Step 5	(Optional) **show vlan private-vlan** [*type*] **Example:** `switch# show vlan private-vlan`	Displays the private VLAN configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to assign VLAN 5 to a private VLAN as the primary VLAN:

```
switch# config t
switch(config)# vlan 5
switch(config-vlan)# private-vlan primary
switch(config-vlan)# exit switch(config)#
```

5.7 Associating Secondary VLANs with a Primary Private VLAN - CLI Version

Follow these guidelines when you associate secondary VLANs with a primary VLAN:

- The *secondary-vlan-list* parameter cannot contain spaces. It can contain multiple comma-separated items. Each item can be a single secondary VLAN ID or a hyphenated range of secondary VLAN IDs.
- The *secondary-vlan-list* parameter can contain multiple community and isolated VLAN IDs.
- Enter a *secondary-vlan-list* or enter the **add** keyword with a *secondary-vlan-list* to associate secondary VLANs with a primary VLAN.
- Enter the **remove** keyword with a *secondary-vlan-list* to clear the association between secondary VLANs and a primary VLAN.
- You change the association between a secondary and primary VLAN by removing the existing association and then adding the desired association.

If you delete either the primary or secondary VLAN, the ports that are associated with the VLAN become inactive.

When you enter the **no private-vlan** command, the VLAN returns to the normal VLAN mode. All associations on that VLAN are suspended, but the interfaces remain in private VLAN mode.

When you reconvert the specified VLAN to private VLAN mode, the original associations are reinstated.

If you enter the **no vlan** command for the primary VLAN, all private VLAN associations with that VLAN are lost. However, if you enter the **no vlan** command for a secondary VLAN, the private VLAN associations with that VLAN are suspended and return when you recreate the specified VLAN and configure it as the previous secondary VLAN.

Before you begin

Ensure that the private VLAN feature is enabled.

SUMMARY STEPS

1. **config t**
2. **vlan** *primary-vlan-id*
3. [**no**] **private-vlan association** {[**add**] *secondary-vlan-list* | **remove** *secondary-vlan-list*}
4. **exit**
5. (Optional) **show vlan private-vlan** [**type**]
6. **(Optional) copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**vlan** *primary-vlan-id* **Example:** `switch(config)# vlan 5`	Enters the number of the primary VLAN that you are working in for the private VLAN configuration.

	Command or Action	Purpose
	`switch(config-vlan)#`	

Step 3	[**no**] **private-vlan association** {[**add**] *secondary-vlan-list*
	| **remove** *secondary-vlan-list*}
	Example:
	`switch(config-vlan)# private-vlan association 100-105,109`
		Use one form of the command to
		Associate the secondary VLANs with the primary VLAN.
		or
		Remove all associations from the primary VLAN and return
		it to normal VLAN mode.

Step 4	**exit**
	Example:
	`switch(config-vlan)# exit`
	`switch(config)#`
		Exits the VLAN configuration submode.

Step 5	(Optional) **show vlan private-vlan** [**type**] **Example:** `switch# show vlan private-vlan`	Displays the private VLAN configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to associate community VLANs 100 through 105 and isolated VLAN 109 with primary VLAN 5:

```
switch(config)# vlan 5

switch(config-vlan)# private-vlan association 100-105, 109
switch(config-vlan)#
exit switch(config)#
```

5.7.1 Mapping Secondary VLANs to the VLAN Interface of a Primary VLAN - CLI Version

You map secondary VLANs to the VLAN interface of a primary VLAN. Isolated and community VLANs are both called secondary VLANs. To allow Layer 3 processing of private VLAN ingress traffic, you map secondary VLANs to the VLAN network interface of a primary VLAN.

Before you begin

- Enable the private VLAN feature.
- Enable the VLAN interface feature.
- Ensure that you are working on the correct primary VLAN Layer 3 interface to map the secondary VLANs.

SUMMARY STEPS

1. **config t**

2. **interface vlan** *primary-vlan-ID*
3. [**no**] **private-vlan mapping** {[**add**] *secondary-vlan-list* | **remove** *secondary-vlan-list*}
4. **exit**
5. (Optional) **show interface vlan** *primary-vlan-id* **private-vlan mapping**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface vlan** *primary-vlan-ID*
	Example:
	`switch(config)# interface vlan 5`
	`switch(config-if)#`
		Enters the number of the primary VLAN that you are working in for the private VLAN configuration. Places you into the interface configuration mode for the primary VLAN.

Step 3	[**no**] **private-vlan mapping** {[**add**] *secondary-vlan-list* |
	remove *secondary-vlan-list*}
	Example:
	`switch(config-if)# private-vlan mapping 100-105,`
	`109`
		Map the secondary VLANs to the SVI or Layer 3 interface of the primary VLAN. This action allows the Layer 3 switching of private VLAN ingress traffic.
		or
		Clear the mapping to the Layer 3 interface between the secondary VLANs and the primary VLANs.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface configuration mode.

Step 5	(Optional) **show interface vlan** *primary-vlan-id* **private-vlan mapping**
	Example:
	`switch(config)# show interface vlan 101`
	`private-vlan mapping`
		Displays the interface private VLAN information.

Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to map the secondary VLANs 100 through 105 and 109 on the Layer 3 interface of the primary VLAN 5:

```
switch #config t
switch(config)# interface vlan 5
switch(config-if)# private-vlan mapping 100-105, 109

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

5.7.2 Configuring a Layer 2 Interface as a Private VLAN Host Port

You can configure a Layer 2 interface as a private VLAN host port. In private VLANs, host ports are part of the secondary VLANs, which are either community VLANs or isolated VLANs.

You then associate the host port with both the primary and secondary VLANs.

Before you begin

Ensure that the private VLAN feature is enabled.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **switchport mode private-vlan host**
4. [**no**] **switchport private-vlan host-association** {*primary-vlan-id*} {*secondary-vlan-id*}
5. **exit**
6. (Optional) **show interface switchport**
7. **(Optional) copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 2/1`
	`switch(config-if)#`
		Selects the Layer 2 port to configure as a private VLAN host port.

Step 3	**switchport mode private-vlan host**
	Example:
	`switch(config-if)# switchport mode private-vlan host`
	`switch(config-if)#`
		Configures the Layer 2 port as a host port for a private VLAN.

Step 4	[**no**] **switchport private-vlan host-association**	Associate the Layer 2 host port with the primary

	Command or Action	Purpose

	{*primary-vlan-id*} {*secondary-vlan-id*}
	Example:
	`switch(config-if)# switchport private-vlan host-association 10 50`
		and secondary VLANs of a private VLAN. The secondary VLAN can be either an isolated or community VLAN.
		or
		Remove the private VLAN association from the port.

Step 5	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface configuration mode.

Step 6	(Optional) **show interface switchport** **Example:** `switch# show interface switchport`	Displays information on all interfaces configured as switch ports.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Layer 2 port 2/1 as a host port for a private VLAN and associate it to primary VLAN 10 and secondary VLAN 50:

```
switch# config t
switch(config)# interface ethernet 2/1 switch(config-
if)# switchport mode private-vlan host
switch(config-if)# switchport private-vlan host-association 10 50
switch(config-if)#
exit switch(config)#
```

5.7.3 Configuring a Layer 2 Interface as a Private VLAN Isolated Trunk Port

You can configure a Layer 2 interface as a private VLAN isolated trunk port. These isolated trunk ports carry traffic for multiple secondary VLANs as well as normal VLANs.

Before you begin

Ensure that the private VLAN feature is enabled.

SUMMARY STEPS

1. **config t**
2. **interface** {*type slot/port*}
3. **switchport**
4. **switchport mode private-vlan trunk secondary**

5. (Optional) **switchport private-vlan trunk native vlan** *vlan-id*
6. **switchport private-vlan trunk allowed vlan** {**add** *vlan-list* | **all** | **except** *vlan-list* | **none** | **remove** *vlan-list*}
7. [**no**] **switchport private-vlan association trunk** {*primary-vlan-id* [*secondary-vlan-id*]}
8. **exit**
9. (Optional) **show interface switchport**
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {*type slot/port*}
	Example:
	`switch(config)# interface ethernet 2/11`
	`switch(config-if)#`
		Selects the Layer 2 port to configure as a private VLAN isolated trunk port.

Step 3	**switchport**
	Example:
	`switch(config-if)# switchport`
	`switch(config-if)#`
		Configures the Layer 2 port as a switch port.

Step 4	**switchport mode private-vlan trunk secondary**
	Example:
	`switch(config-if)# switchport mode private-vlan`
	`trunk secondary`
	`switch(config-if)#`
		Configures the Layer 2 port as an isolated trunk port to carry traffic for multiple isolated VLANs.
		Note You cannot put community VLANs into the isolated trunk port.

Step 5	(Optional) **switchport private-vlan trunk native vlan** *vlan-id*
	Example:
	`switch(config-if)# switchport private-vlan trunk`
	` native vlan 5`
		Sets the native VLAN for the 802.1Q trunk. Valid values are from 1 to 3968 and 4048 to 4093. The default value is 1.
		Note If you are using a private VLAN as the native VLAN for the isolated trunk port, you must enter a value for a secondary VLAN or a normal VLAN; you cannot configure a primary VLAN as the native VLAN.

Step 6	**switchport private-vlan trunk allowed vlan** {**add**	Sets the allowed VLANs for the private VLAN isolated

	Command or Action	Purpose

	vlan-list | **all** | **except** *vlan-list* | **none** | **remove** *vlan-list*}
	Example:
	`switch(config-if)# switchport private-vlan trunk allowed vlan add 1`
	`switch(config-if)#`
		trunk interface. Valid values are from 1 to 3968 and 4048 to 4093.
		When you map the private primary and secondary VLANs to the isolated trunk port, the system automatically puts all the primary VLANs into the allowed VLAN list for this port.
		Note Ensure that the native VLAN is part of the allowed VLAN list. The default for this command is to allow no VLANs on this interface, so you must configure the native VLAN as an allowed VLAN, unless it is already added as an associated VLAN, to pass native VLAN traffic.

Step 7	[**no**] **switchport private-vlan association trunk**
	{*primary-vlan-id* [*secondary-vlan-id*]}
	Example:
	`switch(config-if)# switchport private-vlan`
	`association trunk 10 101`
	`switch(config-if)#`
		Associate the Layer 2 isolated trunk port with the primary and secondary VLANs of private VLANs. The secondary VLAN must be an isolated VLAN. You can associate a maximum of 16 private VLAN primary and secondary pairs on each isolated trunk port. You must reenter the command for each pair of primary and secondary VLANs that you are working with.
		Note Each secondary VLAN on an isolated trunk port must be associated with a different primary VLAN. You cannot put two isolated VLANs that are associated with the same primary VLAN into a private VLAN isolated trunk port. If you do, the last entry overwrites the previous entry.
		or
		Remove the private VLAN association from the private

	Command or Action	Purpose
		VLAN isolated trunk port.

Step 8	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface configuration mode.

Step 9	(Optional) **show interface switchport** **Example:** `switch# show interface switchport`	Displays information on all interfaces configured as switch ports.
Step 10	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Layer 2 port 2/1 as a private VLAN isolated trunk port associated with three different primary VLANs and an associated secondary VLAN:

```
switch# config t

switch(config)# interface ethernet 2/1 switch(config-
if)# switchport mode private-vlan trunk
switch(config-if)# switchport private-vlan trunk allowed vlan add 1
switch(config-if)# switchport private-vlan association trunk 10 101
switch(config-if)# switchport private-vlan association trunk 20 201
switch(config-if)# switchport private-vlan association trunk 30 102
switch(config-if)# exit
switch(config)#
```

5.7.4 Configuring a Layer 2 Interface as a Private VLAN Promiscuous Port

You can configure a Layer 2 interface as a private VLAN promiscuous port and then associate that promiscuous port with the primary and secondary VLANs.

Before you begin

Ensure that the private VLAN feature is enabled.

SUMMARY STEPS

1. **config t**
2. **interface** {*type slot/port*}
3. **switchport mode private-vlan promiscuous**
4. [**no**] **switchport private-vlan mapping** {*primary-vlan-id*} {*secondary-vlan-list* | **add** *secondary-vlan-list* | **remove** *secondary-vlan-list*}
5. **exit**
6. (Optional) **show interface switchport**
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {*type slot/port*}
	Example:
	`switch(config)# interface ethernet 2/1`
	`switch(config-if)#`
		Selects the Layer 2 port to configure as a private VLAN promiscuous port.

Step 3	**switchport mode private-vlan promiscuous** **Example:** `switch(config-if)# switchport mode private-vlan promiscuous`	Configures the Layer 2 port as a promiscuous port for a private VLAN.

Step 4	[**no**] **switchport private-vlan mapping** {*primary-vlan-id*} {*secondary-vlan-list* | **add** *secondary-vlan-list* | **remove** *secondary-vlan-list*}
	Example:
	`switch(config-if)# switchport private-vlan mapping 10 50`
		Configure the Layer 2 port as a promiscuous port and associates the specified port with a primary VLAN and a selected list of secondary VLANs. The secondary VLAN can be either an isolated or community VLAN.
		or
		Clear the mapping from the private VLAN.

Step 5	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface configuration mode.

Step 6	(Optional) **show interface switchport** **Example:** `switch# show interface switchport`	Displays information on all interfaces configured as switch ports.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Layer 2 port 2/1 as a promiscuous port associated with the primary VLAN 10 and the secondary isolated VLAN 50:

```
switch# config t
switch(config)# interface ethernet 2/1
switch(config-if)# switchport mode private-vlan promiscuous
switch(config-if)# switchport private-vlan mapping 10 50
switch(config-if)#
exit switch(config)#
```

5.7.5 Configuring a Layer 2 Interface as a Private VLAN Promiscuous Trunk Port

You can configure a Layer 2 interface as a private VLAN promiscuous trunk port and then associate that promiscuous trunk port with multiple primary VLANs. These promiscuous trunk ports carry traffic for multiple primary VLANs as well as normal VLANs.

Before you begin

Ensure that the private VLAN feature is enabled.

SUMMARY STEPS

1. **config t**
2. **interface** {*type slot/port*}
3. **switchport**
4. **switchport mode private-vlan trunk promiscuous**
5. (Optional) **switchport private-vlan trunk native vlan** *vlan-id*
6. **switchport mode private-vlan trunk allowed vlan** {**add** *vlan-list* | **all** | **except** *vlan-list* | **none** | **remove** *vlan-list*}
7. [**no**]**switchport private-vlan mapping trunk** *primary-vlan-id* [*secondary-vlan-id*] {**add** *secondary-vlan-list* | **remove** *secondary-vlan-id*}
8. **exit**
9. (Optional) **show interface switchport**
10. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {*type slot/port*}
	Example:
	`switch(config)# interface ethernet 2/1`
	`switch(config-if)#`
		Selects the Layer 2 port to configure as a private VLAN promiscuous trunk port.

Step 3	**switchport**
	Example:
	`switch(config-if)# switchport`
	`switch(config-if)#`
		Configures the Layer 2 port as a switch port.

	Command or Action	Purpose

Step 4	**switchport mode private-vlan trunk promiscuous**
	Example:
	`switch(config-if)# switchport mode private-vlan`
	`trunk promiscuous`
	`switch(config-if)#`
		Configures the Layer 2 port as a promiscuous trunk port to carry traffic for multiple private VLANs as well as normal VLANs.

Step 5	(Optional) **switchport private-vlan trunk native vlan** *vlan-id*
	Example:
	`switch(config-if)# switchport private-vlan trunk`
	` native vlan 5`
		Sets the native VLAN for the 802.1Q trunk. Valid values are from 1 to 3968 and 4048 to 4093. The default value is 1.
		Note If you are using a private VLAN as the native VLAN for the promiscuous trunk port, you must enter a value for a primary VLAN or a normal VLAN; you cannot configure a secondary VLAN as the native VLAN.

Step 6	**switchport mode private-vlan trunk allowed vlan** {**add** *vlan-list* | **all** | **except** *vlan-list* | **none** | **remove** *vlan-list*}
	Example:
	`switch(config-if)# switchport private-vlan trunk`
	` allowed vlan add 1`
	`switch(config-if)#`
		Sets the allowed VLANs for the private VLAN promiscuous trunk interface. Valid values are from 1 to 3968 and 4048 to 4093.
		When you map the private primary and secondary VLANs to the promiscuous trunk port, the system automatically puts all the primary VLANs into the allowed VLAN list for this port.
		Note Ensure that the native VLAN is part of the allowed VLAN list. The default for this command is to allow no VLANs on this interface, so you must configure the native VLAN as an allowed VLAN, unless it is already added as an associated VLAN, to pass native VLAN traffic.

Step 7	[no]**switchport private-vlan mapping trunk** *primary-vlan-id* [*secondary-vlan-id*] {**add** *secondary-vlan-list* | **remove** *secondary-vlan-id*}	Map or remove the mapping for the promiscuous trunk port with the primary VLAN and a selected list of associated secondary VLANs. The secondary VLAN can

	Command or Action	Purpose

	Example:
	`switch(config-if)# switchport private-vlan mapping`
	` trunk 4 5`
	`switch(config-if)#`
		be either an isolated or community VLAN. The private VLAN association between primary and secondary VLANs must be operational to pass traffic. You can map a maximum of 16 private VLAN primary and secondary pairs on each promiscuous trunk port. You must reenter the command for each primary VLAN that you are working with.
		or
		Remove the private VLAN promiscuous trunk mappings from the interface.

Step 8	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the interface configuration mode.

Step 9	(Optional) **show interface switchport** **Example:** `switch# show interface switchport`	Displays information on all interfaces configured as switch ports.
Step 10	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Layer 2 port 2/1 as a promiscuous trunk port associated with two primary VLANs and their associated secondary VLANs:

```
switch# config t

switch(config)# interface ethernet
2/1 switch(config-if)# switchport
switch(config-if)# switchport mode private-vlan trunk
promiscuous switch(config-if)# switchport private-vlan trunk
allowed vlan add 1 switch(config-if)# switchport private-vlan
mapping trunk 10 20 switch(config-if)# switchport private-vlan
mapping trunk 11 21 switch(config-if)# exit
switch(config)#
```

5.8 Verifying the Private VLAN Configuration

To display private VLAN configuration information, perform one of the following tasks:

Command	Purpose
show running-config vlan *vlan-id*	Displays VLAN information.
show vlan private-vlan [*type*]	Displays information on private VLANs.
show interface private-vlan mapping	Displays information on interfaces for private VLAN mapping.
show interface vlan *primary-vlan-id* **private-vlan mapping**	Displays information on interfaces for private VLAN mapping.
show interface switchport	Displays information on all interfaces configured as switch ports.

5.9 Displaying and Clearing Private VLAN Statistics

To display private VLAN configuration information, perform one of the following tasks:

Command	Purpose
clear vlan [**id** *vlan-id*] **counters**	Clears counters for all VLANs or for a specified VLAN.
show vlan counters	Displays information on Layer 2 packets in each VLAN.

5.10 Configuration Examples for Private VLANs

The following example shows how to create the three types of private VLANs, how to associate the secondary VLANs to the primary VLAN, how to create a private VLAN host and promiscuous port and assign them to the correct VLAN, and how to create a VLAN interface, or SVI, to allow the primary VLAN to communicate with the rest of the network:

```
switch# configure terminal
switch(config)# vlan 2 switch(config-
vlan)# private-vlan primary
switch(config-vlan)# exit switch(config)#
vlan 3
switch(config-vlan)# private-vlan community
switch(config-vlan)# exit
switch(config)# vlan 4 switch(config-
vlan)# private-vlan isolated
switch(config-vlan)# exit
switch(config)# vlan 2
switch(config-vlan)# private-vlan association
3,4 switch(config-vlan)# exit
switch(config)# interface ethernet
1/11 switch(config-if)# switchport
switch(config-if)# switchport mode private-vlan host
switch(config-if)# exit
switch(config)# interface ethernet
1/12 switch(config-if)# switchport
switch(config-if)# switchport mode private-vlan promiscuous
switch(config-if)# exit


switch(config)# interface ethernet 1/11
switch(config-if)# switchport private-vlan host-association 2
3 switch(config-if)# exit
switch(config)# interface ethernet 1/12 switch(config-
if)# switchport private-vlan mapping 2 3,4
switch(config-if)# exit
switch(config)# interface vlan 2
switch(config-vlan)# private-vlan mapping
3,4 switch(config-vlan)# exit
switch(config)#
```

5.11 Additional References for Private VLANs -- CLI Version

Related Documents

Related Topic	Document Title
VLAN interfaces, IP addressing	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
Static MAC addresses, security	*Inspur CN12900 Series INOS-CN Security Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
System management	Inspur CN12900 Series INOS-CN System Management Configuration Guide

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

CHAPTER 6 Configuring Switching Modes

6.1 Information About Switching Modes

The switching mode determines whether the switch begins forwarding the frame as soon as the switch has read the destination details in the packet header or waits until the entire frame has been received and checked for cyclic redundancy check (CRC) errors before forwarding them to the network.

The switching mode is applicable to all packets being switched or routed through the hardware and can be saved persistently through reboots and restarts.

The switch operates in either of the following switching modes:

Cut-Through Switching Mode

Cut-through switching mode is enabled by default. Switches operating in cut-through switching mode start forwarding the frame as soon as the switch has read the destination details in the packet header. A switch in cut-through mode forwards the data before it has completed receiving the entire frame.

The switching speed in cut-through mode is faster than the switching speed in store-and-forward switching mode.

Store-and-Forward Switching Mode

When store-and-forward switching is enabled, the switch checks each frame for cyclic redundancy check (CRC) errors before forwarding them to the network. Each frame is stored until the entire frame has been received and checked.

Because it waits to forward the frame until the entire frame has been received and checked, the switching speed in store-and-forward switching mode is slower than the switching speed in cut-through switching mode.

6.2 Guidelines and Limitations for Switching Modes

Consider the following guidelines and limitations for each of the switching modes:

Cut-Through Switching Mode Guidelines and Limitations

- **show** commands with the **internal** keyword are not supported.
- When an FCS error is discovered, FCS error packets are not immediately dropped. (The packet transmission may have already been in progress.) For this situation, the packet is truncated and marked with error marking in EOF. The packet is then dropped at the next node.
- Packets with FCS errors are not mirrored if SPAN is configured.
- By default, all HiGig™ links operate at 42G to compensate for the HiGig™ header over fabric and to support the full line rate of 40G from the front-panel ports. However, the speed mismatch could result in packets being forwarded in store-and-forward mode. To make sure that the traffic is cut through, you can use the **switching-mode fabric-speed 40g** command to change the HiGig™ links on the 42G ports to operate at 40G and use the **show switching-mode fabric-speed** command to verify the configuration. This feature is supported for the Inspur CN12900 Series switches. Operating at 40G improves latency but prevents the fabric from supporting the full line rate. See the *Inspur CN12900 Series INOS-CN Layer 2 Configuration Guide* for more information.
- Cut-through switching is supported on the Inspur CN12900 Series switch.

Store-and-Forward Switching Mode Guidelines and Limitations

- **show** commands with the **internal** keyword are not supported.
- The store-and-forward switching mode is supported on Inspur CN12900 Series switches.
- The store-and-forward switching mode is supported on Inspur CN12908 switches.

- Packets with FCS errors are dropped.
- Packets with FCS errors are not mirrored if SPAN is configured.
- The CPU port always operates in store-and-forward mode. Any packets forwarded to the CPU with FCS errors are dropped.
- Store-and-forward mode activates automatically for a port when the switch identifies that the port is oversubscribed and the ingress rate is greater than the switching capacity of the egress port. For example, when the port ingress rate is 10 gigabit and the switching capacity of the egress port is 1 gigabit.

6.3 Licensing Requirements for Switching Modes

Cut-through switching mode and store-and-forward switching modes do not require licenses. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you. For a complete explanation of the Inspur INOS-CN licensing scheme, see the Inspur INOS-CN *Licensing Guide*.

6.4 Default Settings for Switching Modes

Cut-through switching is enabled by default.

6.5 Configuring Switching Modes

6.5.1 Enabling Store-and-Forward Switching

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config) # **switching-mode store-forward**
3. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config) # **switching-mode store-forward**	Enables store-and-forward switching mode.
Step 3	(Optional) switch(config)# **copy running-config** **startup-config**	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to enable store-and-forward switching:

```
switch# configure terminal
switch(config) # switching-mode store-forward
switch(config) #
```

6.5.2 Reenabling Cut-Through Switching

Cut-through switching is enabled by default. To reenable cut-through switching, use the **no** form of the **switching-mode store-forward** command.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config) # **no switching-mode store-forward**
3. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config) # **no switching-mode store-forward**	Disables store-and-forward switching mode. Enables cut-through switching mode.
Step 3	(Optional) switch(config)# **copy running-config** **startup-config**	Saves the change persistently through reboots and restarts by copying the running configuration to the startup configuration.

Example

This example shows how to reenable cut-through switching:

```
switch# configure terminal

switch(config) # no switching-mode store-forward
switch(config) #
```

CHAPTER 7 Configuring Rapid PVST+ Using Inspur INOS-CN

7.1 Information About Rapid PVST+

The Spanning Tree Protocol (STP) was implemented to provide a loop-free network at Layer 2 of the network. Rapid PVST+ is an updated implementation of STP that allows you to create one spanning tree topology for each VLAN. Rapid PVST+ is the default STP mode on the device.

The Rapid PVST+ protocol is the IEEE 802.1w standard, Rapid Spanning Tree Protocol (RSTP), implemented on a per VLAN basis. Rapid PVST+ interoperates with the IEEE 802.1Q VLAN standard, which mandates a single STP instance for all VLANs, rather than per VLAN.

Rapid PVST+ is enabled by default on the default VLAN (VLAN1) and on all newly created VLANs on the device. Rapid PVST+ interoperates with devices that run legacy IEEE 802.1D STP.

RSTP is an improvement on the original STP standard, 802.1D, which allows faster convergence.

7.1.1 STP

STP is a Layer 2 link-management protocol that provides path redundancy while preventing loops in the network.

Overview of STP

In order for a Layer 2 Ethernet network to function properly, only one active path can exist between any two stations. STP 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.

When you create fault-tolerant internetworks, you must have a loop-free path between all nodes in a network. The STP algorithm calculates the best loop-free path throughout a switched Layer 2 network. Layer 2 LAN ports send and receive STP frames, which are called Bridge Protocol Data Units (BPDUs), at regular intervals. Network devices do not forward these frames but use the frames to construct a loop-free path.

Multiple active paths between end stations cause loops in the network. If a loop exists in the network, end stations might receive duplicate messages and network devices might learn end station MAC addresses on multiple Layer 2 LAN ports.

STP defines a tree with a root bridge and a loop-free path from the root to all network devices in the Layer 2 network. STP forces redundant data paths into a blocked state. If a network segment in the spanning tree fails and a redundant path exists, the STP algorithm recalculates the spanning tree topology and activates the blocked path.

When two Layer 2 LAN ports on a network device are part of a loop, the STP port priority and port path-cost setting determine which port on the device is put in the forwarding state and which port is put in the blocking state. The STP port priority value is the efficiency with which that location allows the port to pass traffic. The STP port path-cost value is derived from the media speed.

How a Topology is Created

All devices in a LAN that participate in a spanning tree gather information about other switches in the network by exchanging BPDUs. This exchange of BPDUs results in the following actions:

- The system elects a unique root switch for the spanning tree network topology.
- The system elects a designated switch for each LAN segment.
- The system eliminates any loops in the switched network by placing redundant switch ports in a backup state; all paths that are not needed to reach the root device from anywhere in the switched network are placed in an STP-blocked state.

The topology on an active switched network is determined by the following:

- The unique device identifier Media Access Control (MAC) address of the device that is associated with each device
- The path cost to the root that is associated with each switch port
- The port identifier that is associated with each switch port

In a switched network, the root switch is the logical center of the spanning tree topology. STP uses BPDUs to elect the root switch and root port for the switched network.

Bridge ID

Each VLAN on each network device has a unique 64-bit bridge ID that consists of a bridge priority value, an extended system ID (IEEE 802.1t), and an STP MAC address allocation.

Bridge Priority Value

The bridge priority is a 4-bit value when the extended system ID is enabled.

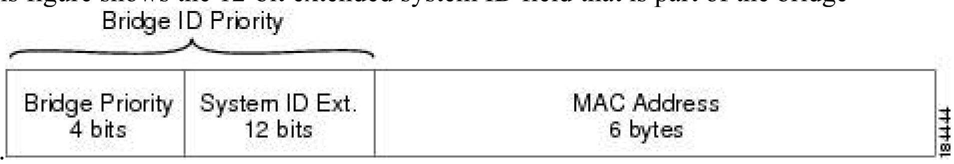
You can only specify a device bridge ID (used by the spanning tree algorithm to determine the identity of the root bridge; the lowest number is preferred) as a multiple of 4096.

Extended System ID

The device always uses the 12-bit extended system ID.

Figure 3：Bridge ID with Extended System ID

This figure shows the 12-bit extended system ID field that is part of the bridge ID.



This table shows how the system ID extension combined with the bridge ID functions as the unique identifier for a VLAN.

Table 6：Bridge Priority Value and Extended System ID with the Extended System ID Enabled

Bridge Priority Value				Extended System ID (Set Equal to the VLAN ID)											
Bit 16	**Bit 15**	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**
32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1

STP MAC Address Allocation

Because MAC address reduction is always enabled on the device, you should also enable MAC address reduction on all other Layer 2 connected network devices to avoid undesirable root bridge election and spanning tree topology issues.

When MAC address reduction is enabled, the root bridge priority becomes a multiple of 4096 plus the VLAN ID. You can only specify a device bridge ID (used by the spanning tree algorithm to determine the identity of the root bridge; the lowest number is preferred) as a multiple of 4096. Only the following values are possible:

- 0
- 4096
- 8192

- 12288
- 16384
- 20480
- 24576
- 28672
- 32768
- 36864
- 40960
- 45056
- 49152
- 53248
- 57344
- 61440

STP uses the extended system ID plus a MAC address to make the bridge ID unique for each VLAN.

BPDUs

Network devices transmit BPDUs throughout the STP instance. Each network device sends configuration BPDUs to communicate and compute the spanning tree topology. Each configuration BPDU contains the following minimal information:

- The unique bridge ID of the network device that the transmitting network device believes to be the root bridge
- The STP path cost to the root
- The bridge ID of the transmitting bridge
- The message age
- The identifier of the transmitting port
- Values for the hello, forward delay, and max-age protocol timer
- Additional information for STP extension protocols

When a network device transmits a Rapid PVST+ BPDU frame, all network devices connected to the VLAN on which the frame is transmitted receive the BPDU. When a network device receives a BPDU, it does not forward the frame but instead uses the information in the frame to calculate a BPDU. If the topology changes, the device initiates a BPDU exchange.

A BPDU exchange results in the following:

- One network device is elected as the root bridge.
- The shortest distance to the root bridge is calculated for each network device based on the path cost.
- A designated bridge for each LAN segment is selected. This network device is closest to the root bridge through which frames are forwarded to the root.
- A root port is elected. This port provides the best path from the bridge to the root bridge.
- Ports included in the spanning tree are selected.

Election of the Root Bridge

For each VLAN, the network device with the lowest numerical ID is elected as the root bridge. If all network devices are configured with the default priority (32768), the network device with the lowest MAC address in the VLAN becomes the root bridge. The bridge priority value occupies the most significant bits of the bridge ID.

When you change the bridge priority value, you change the probability that the device will be elected as the root bridge. Configuring a lower value increases the probability; a higher value decreases the probability.

The STP root bridge is the logical center of each spanning tree topology in a Layer 2 network. All paths that are not needed to reach the root bridge from anywhere in the Layer 2 network are placed in STP blocking mode.

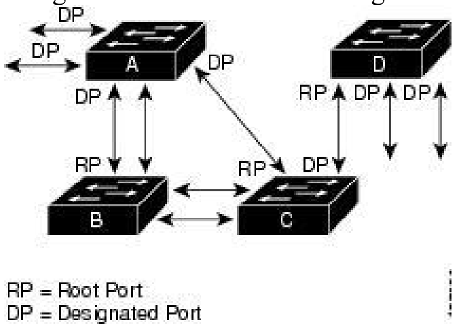
BPDUs contain information about the transmitting bridge and its ports, including bridge and MAC addresses, bridge priority, port priority, and path cost. STP uses this information to elect the root bridge for the STP instance, to elect the root port that leads to the root bridge, and to determine the designated port for each Layer 2 segment.

Creating the Spanning Tree Topology

By lowering the numerical value of the ideal network device so that it becomes the root bridge, you force an STP recalculation to form a new spanning tree topology with the ideal network device as the root.

Figure 4: Spanning Tree Topology

In this figure, switch A is elected as the root bridge because the bridge priority of all the network devices is set to the default (32768) and switch A has the lowest MAC address. However, due to traffic patterns, the number of forwarding ports, or link types, switch A might not be the ideal root bridge.



When the spanning tree topology is calculated based on default parameters, the path between the source and destination end stations in a switched network might not be ideal. For instance, connecting higher-speed links to a port that has a higher number than the current root port can cause a root-port change. The goal is to make the fastest link the root port.

For example, assume that one port on switch B is a fiber-optic link, and another port on switch B (an unshielded twisted-pair [UTP] link) is the root port. Network traffic might be more efficient over the high-speed fiber-optic link. By changing the STP port priority on the fiber-optic port to a higher priority (lower numerical value) than the root port, the fiber-optic port becomes the new root port.

7.1.2 Rapid PVST+

Rapid PVST+ is the default spanning tree mode for the software and is enabled by default on the default VLAN and all newly created VLANs.

A single instance, or topology, of RSTP runs on each configured VLAN, and each Rapid PVST+ instance on a VLAN has a single root device. You can enable and disable STP on a per-VLAN basis when you are running Rapid PVST+.

Overview of Rapid PVST+

Rapid PVST+ is the IEEE 802.1w (RSTP) standard implemented per VLAN. A single instance of STP runs on each configured VLAN (if you do not manually disable STP). Each Rapid PVST+ instance on a VLAN has a single root switch. You can enable and disable STP on a per-VLAN basis when you are running Rapid PVST+.

Rapid PVST+ uses point-to-point wiring to provide rapid convergence of the spanning tree. The spanning tree reconfiguration can occur in less than 1 second with Rapid PVST+ (in contrast to 50 seconds with the default settings in the 802.1D STP). The device automatically checks the PVID.

Using Rapid PVST+, STP convergence occurs rapidly. By default, each designated port in the STP sends out a BPDU every 2 seconds. On a designated port in the topology, if hello messages are missed three consecutive times, or if the maximum age expires, the port immediately flushes all protocol information in the table. A port considers that it loses connectivity to its direct neighbor designated port if it misses three BPDUs or if the maximum age expires. This rapid aging of the protocol information allows quick failure detection.

Rapid PVST+ provides for rapid recovery of connectivity following the failure of a device, a device port, or a LAN. It provides rapid convergence for edge ports, new root ports, and ports connected through point-to-point links as follows:

- Edge ports—When you configure a port as an edge port on an RSTP device, the edge port immediately transitions to the forwarding state. You should only configure ports that connect to a single end station as edge ports. Edge ports do not generate topology changes when the link changes.

Enter the spanning-tree port type interface configuration command to configure a port as an STP edge port.

- Root port—If Rapid PVST+ selects a new root port, it blocks the old root port and immediately transitions the new root port to the forwarding state.
- Point-to-point links—If you connect a port to another port through a point-to-point link and the local port becomes a designated port, it negotiates a rapid transition with the other port by using the proposal-agreement handshake to ensure a loop-free topology.

Rapid PVST+ achieves rapid transition to the forwarding state only on edge ports and point-to-point links. Although the link type is configurable, the system automatically derives the link type information from the duplex setting of the port. Full-duplex ports are assumed to be point-to-point ports, while half-duplex ports are assumed to be shared ports.

Edge ports do not generate topology changes, but all other designated and root ports generate a topology change (TC) BPDU when they either fail to receive three consecutive BPDUs from the directly connected neighbor or the maximum age times out. At this point, the designated or root port sends a BPDU with the TC flag set. The BPDUs continue to set the TC flag as long as the TC While timer runs on that port. The value of the TC While timer is the value set for the hello time plus 1 second. The initial detector of the topology change immediately floods this information throughout the entire topology.

When Rapid PVST+ detects a topology change, the protocol does the following:

- Starts the TC While timer with a value equal to twice the hello time for all the nonedge root and designated ports, if necessary.
- Flushes the MAC addresses associated with all these ports.

The topology change notification floods quickly across the entire topology. The system flushes dynamic entries immediately on a per-port basis when it receives a topology change.

The proposal and agreement sequence then quickly propagates toward the edge of the network and quickly restores connectivity after a topology change.

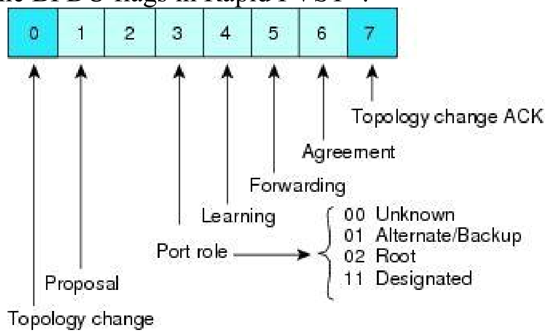
Rapid PVST+ BPDUs

Rapid PVST+ and 802.1w use all six bits of the flag byte to add the following:

- The role and state of the port that originates the BPDU
- The proposal and agreement handshake

Figure 5: Rapid PVST+ Flag Byte in BPDU

This figure shows the use of the BPDU flags in Rapid PVST+.



Another important change is that the Rapid PVST+ BPDU is type 2, version 2, which makes it possible for the device to detect connected legacy (802.1D) bridges. The BPDU for 802.1D is type 0, version 0.

Proposal and Agreement Handshake

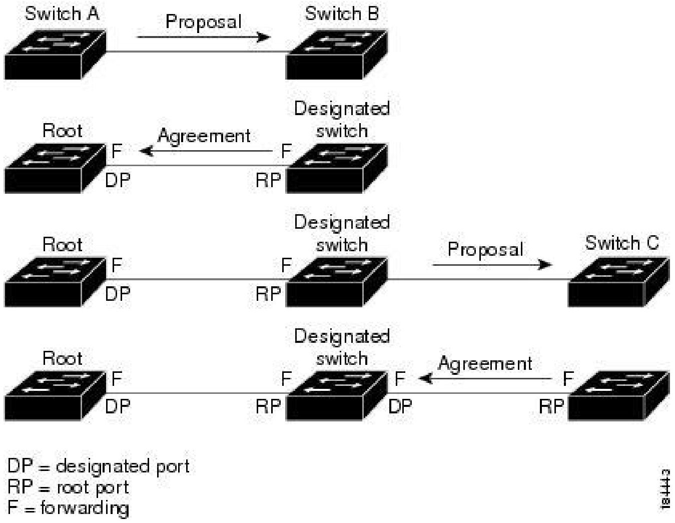
Figure 6: Proposal and Agreement Handshaking for Rapid Convergence

In this figure, switch A is connected to switch B through a point-to-point link, and all of the ports are in the blocking state. Assume that the priority of switch A is a smaller numerical value than the priority of switch B. Switch A sends a proposal message (a configuration BPDU with the proposal flag set) to switch B, proposing itself as the designated switch.

After receiving the proposal message, switch B selects as its new root port the port from which the proposal message was received, forces all nonedge ports to the blocking state, and sends an agreement message (a BPDU with the agreement flag set) through its new root port.

After receiving the agreement message from switch B, switch A also immediately transitions its designated port to the forwarding state. No loops in the network can form because switch B blocked all of its nonedge ports and because there is a point-to-point link between switches A and B.

When switch C connects to switch B, a similar set of handshaking messages are exchanged. Switch C selects the port connected to switch B as its root port, and both ends of the link immediately transition to the forwarding state. With each iteration of this handshaking process, one more switch joins the active topology. As the network converges, this proposal-agreement handshaking progresses from the root toward the leaves of the spanning tree as shown in this figure.



The switch learns the link type from the port duplex mode; a full-duplex port is considered to have a point-to-point connection and a half-duplex port is considered to have a shared connection. You can override the default setting that is controlled by the duplex setting by entering the spanning-tree link-type interface configuration command.

This proposal/agreement handshake is initiated only when a nonedge port moves from the blocking to the forwarding state. The handshaking process then proliferates step-by-step throughout the topology.

Protocol Timers

This table describes the protocol timers that affect the Rapid PVST+ performance.

Table 7：Rapid PVST+ Protocol Timers

Variable	Description
Hello timer	Determines how often each device broadcasts BPDUs to other network devices. The default is 2 seconds, and the range is from 1 to 10.
Forward delay timer	Determines how long each of the listening and learning states last before the port

	begins forwarding. This timer is generally not used by the protocol, but it is used when interoperating with the 802.1D spanning tree. The default is 15 seconds, and the range is from 4 to 30 seconds.
Maximum age timer	Determines the amount of time that protocol information received on a port is stored by the network device. This timer is generally not used by the protocol, but it is used when interoperating with the 802.1D spanning tree. The default is 20 seconds; the range is from 6 to 40 seconds.

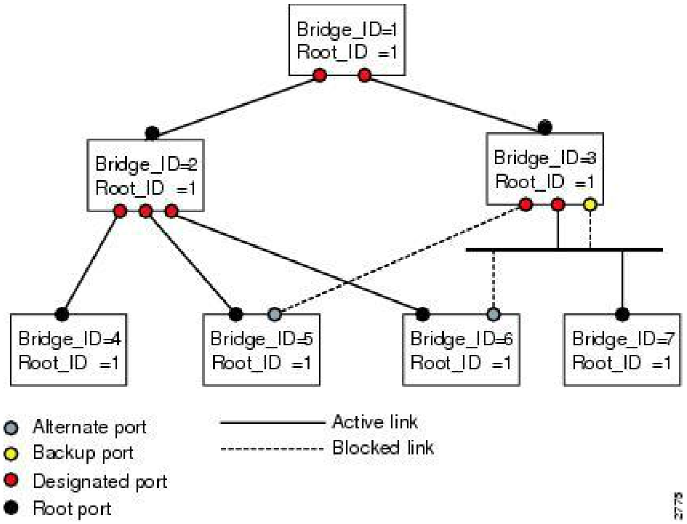
Port Roles

Rapid PVST+ provides rapid convergence of the spanning tree by assigning port roles and learning the active topology. Rapid PVST+ builds upon the 802.1D STP to select the device with the highest switch priority (lowest numerical priority value) as the root bridge. Rapid PVST+ assigns one of these port roles to individual ports:

- Root port—Provides the best path (lowest cost) when the device forwards packets to the root bridge.
- Designated port—Connects to the designated device that has the lowest path cost when forwarding packets from that LAN to the root bridge. The port through which the designated device is attached to the LAN is called the designated port.
- Alternate port—Offers an alternate path toward the root bridge to the path provided by the current root port. An alternate port provides a path to another device in the topology.
- Backup port—Acts as a backup for the path provided by a designated port toward the leaves of the spanning tree. A backup port can exist only when two ports are connected in a loopback by a point-to-point link or when a device has two or more connections to a shared LAN segment. A backup port provides another path in the topology to the device.
- Disabled port—Has no role within the operation of the spanning tree.

In a stable topology with consistent port roles throughout the network, Rapid PVST+ ensures that every root port and designated port immediately transition to the forwarding state while all alternate and backup ports are always in the blocking state. Designated ports start in the blocking state. The port state controls the operation of the forwarding and learning processes.

Figure 4： Sample Topology Demonstrating Port Roles



This figure shows port roles. A port with the root or a designated port role is included in the active topology. A port with the alternate or backup port role is excluded from the active topology.

Rapid PVST+ Port State Overview

Propagation delays can occur when protocol information passes through a switched LAN. As a result, topology changes can take place at different times and at different places in a switched network. When a Layer 2 LAN port transitions directly from nonparticipation in the spanning tree topology to the forwarding state, it can create temporary data loops. Ports must wait for new topology information to propagate through the switched LAN before starting to forward frames.

Each Layer 2 LAN port on the device that uses Rapid PVST+ or MST exists in one of the following four states:

- Blocking—The Layer 2 LAN port does not participate in frame forwarding.
- Learning—The Layer 2 LAN port prepares to participate in frame forwarding.
- Forwarding—The Layer 2 LAN port forwards frames.
- Disabled—The Layer 2 LAN port does not participate in STP and is not forwarding frames.

When you enable Rapid PVST+, every port in the device, VLAN, and network goes through the blocking state and the transitory states of learning at power up. If properly configured, each Layer 2 LAN port stabilizes to the forwarding or blocking state.

When the STP algorithm places a Layer 2 LAN port in the forwarding state, the following process occurs:

1. The Layer 2 LAN port is put into the blocking state while it waits for protocol information that suggests it should go to the learning state.
2. The Layer 2 LAN port waits for the forward delay timer to expire, moves the Layer 2 LAN port to the learning state, and restarts the forward delay timer.
3. In the learning state, the Layer 2 LAN port continues to block frame forwarding as it learns the end station location information for the forwarding database.
4. The Layer 2 LAN port waits for the forward delay timer to expire and then moves the Layer 2 LAN port to the forwarding state, where both learning and frame forwarding are enabled.

Blocking State

A Layer 2 LAN port in the blocking state does not participate in frame forwarding.

A Layer 2 LAN port in the blocking state performs as follows:

- Discards frames received from the attached segment.
- Discards frames switched from another port for forwarding.
- Does not incorporate the end station location into its address database. (There is no learning on a blocking Layer 2 LAN port, so there is no address database update.)
- Receives BPDUs and directs them to the system module.
- Receives, processes, and transmits BPDUs received from the system module.
- Receives and responds to control plane messages.

Learning State

A Layer 2 LAN port in the learning state prepares to participate in frame forwarding by learning the MAC addresses for the frames. The Layer 2 LAN port enters the learning state from the blocking state.

A Layer 2 LAN port in the learning state performs as follows:

- Discards frames received from the attached segment.
- Discards frames switched from another port for forwarding.
- Incorporates the end station location into its address database.
- Receives BPDUs and directs them to the system module.
- Receives, processes, and transmits BPDUs received from the system module.
- Receives and responds to control plane messages.

Forwarding State

A Layer 2 LAN port in the forwarding state forwards frames. The Layer 2 LAN port enters the forwarding state from the learning state.

A Layer 2 LAN port in the forwarding state performs as follows:

- Forwards frames received from the attached segment.
- Forwards frames switched from another port for forwarding.
- Incorporates the end station location information into its address database.
- Receives BPDUs and directs them to the system module.
- Processes BPDUs received from the system module.
- Receives and responds to control plane messages.

Disabled State

A Layer 2 LAN port in the disabled state does not participate in frame forwarding or STP. A Layer 2 LAN port in the disabled state is virtually nonoperational.

A disabled Layer 2 LAN port performs as follows:

- Discards frames received from the attached segment.
- Discards frames switched from another port for forwarding.
- Does not incorporate the end station location into its address database. (There is no learning, so there is no address database update.)
- Does not receive BPDUs from neighbors.
- Does not receive BPDUs for transmission from the system module.

Summary of Port States

This table lists the possible operational and Rapid PVST+ states for ports and whether the port is included in the active topology.

Table 8： Port State Active Topology

Operational Status	Port State	Is Port Included in the Active Topology?
Enabled	Blocking	No
Enabled	Learning	Yes
Enabled	Forwarding	Yes
Disabled	Disabled	No

Synchronization of Port Roles

When the device receives a proposal message on one of its ports and that port is selected as the new root port, Rapid PVST+ forces all other ports to synchronize with the new root information.

The device is synchronized with superior root information received on the root port if all other ports are synchronized. An individual port on the device is synchronized if either of the following applies:

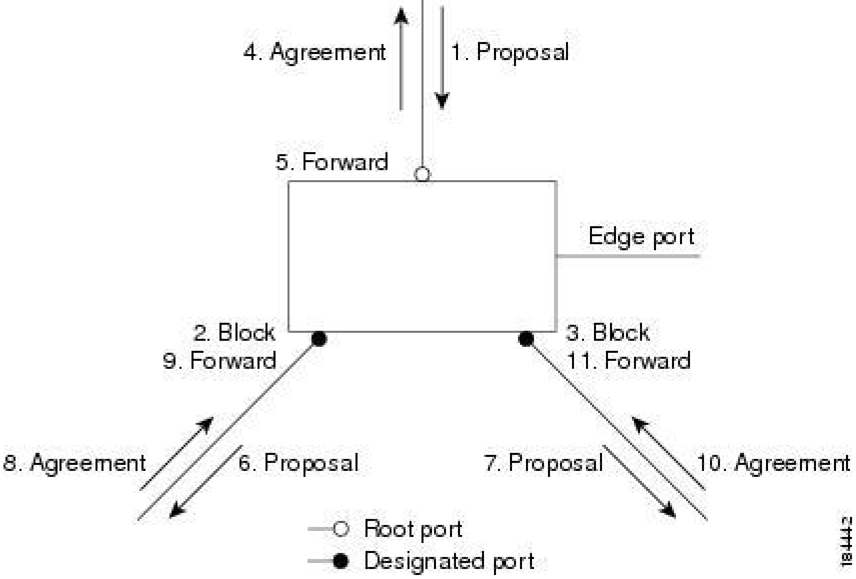
- That port is in the blocking state.
- It is an edge port (a port configured to be at the edge of the network).

If a designated port is in the forwarding state and is not configured as an edge port, it transitions to the blocking state when the Rapid PVST+ forces it to synchronize with new root information. In general, when the Rapid PVST+ forces a port to synchronize with root information and the port does not satisfy any of the above conditions, its port state is set to blocking.

After ensuring that all of the ports are synchronized, the device sends an agreement message to the designated device that corresponds to its root port. When the devices connected by a point-to-point link are in agreement about their port roles, Rapid PVST+ immediately transitions the port states to the forwarding state.

Table 9：Sequence of Events During Rapid Convergence

This figure shows the sequence of events during synchronization.



Processing Superior BPDU Information

A superior BPDU is a BPDU with root information (such as a lower switch ID or lower path cost) that is superior to what is currently stored for the port.

If a port receives a superior BPDU, Rapid PVST+ triggers a reconfiguration. If the port is proposed and is selected as the new root port, Rapid PVST+ forces all the designated, nonedge ports to synchronize.

If the received BPDU is a Rapid PVST+ BPDU with the proposal flag set, the device sends an agreement message after all of the other ports are synchronized. The new root port transitions to the forwarding state as soon as the previous port reaches the blocking state.

If the superior information received on the port causes the port to become a backup port or an alternate port, Rapid PVST+ sets the port to the blocking state and sends an agreement message. The designated port continues sending BPDUs with the proposal flag set until the forward-delay timer expires. At that time, the port transitions to the forwarding state.

Processing Inferior BPDU Information

An inferior BPDU is a BPDU with root information (such as a higher switch ID or higher path cost) that is inferior to what is currently stored for the port.

If a designated port receives an inferior BPDU, it immediately replies with its own information.

Detecting Unidirectional Link Failure:Rapid PVST+

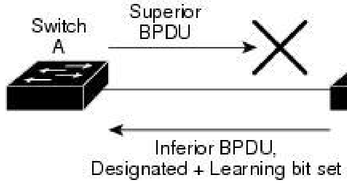
The software checks the consistency of the port role and state in the received BPDUs to detect unidirectional link failures that could cause bridging loops using the Unidirectional Link Detection (UDLD) feature. This feature is based on the dispute mechanism.

See the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*, for information on UDLD.

When a designated port detects a conflict, it keeps its role, but reverts to a discarding state because disrupting connectivity in case of inconsistency is preferable to opening a bridging loop.

Figure 9: Detecting Unidirectional Link Failure

This figure illustrates a unidirectional link failure that typically creates a bridging loop. Switch A is the root bridge, and its BPDUs are lost on the link leading to switch B. The 802.1w-standard BPDUs include the role and state of the sending port. With this information, switch A can detect that switch B does not react to the superior BPDUs that it sends and that switch B is the designated, not root port. As a result, switch A blocks (or keeps blocking) its port, which prevents the bridging loop.



Port Cost

This table shows how the STP port path-cost default value is determined from the media speed and path-cost calculation method of a LAN interface.

Table 10：Default Port Cost

Bandwidth	Short Path-Cost Method of Port Cost	Long Path-Cost Method of Port Cost
10 Mbps	100	2,000,000
100 Mbps	19	200,000
1 Gigabit Ethernet	4	20,000
10 Gigabit Ethernet	2	2,000
40 Gigabit Ethernet	1	500

If a loop occurs, STP considers the port cost when selecting a LAN interface to put into the forwarding state.

You can assign the lower cost values to LAN interfaces that you want STP to select first and higher cost values to LAN interfaces that you want STP to select last. If all LAN interfaces have the same cost value, STP puts the LAN interface with the lowest LAN interface number in the forwarding state and blocks other LAN interfaces.

On access ports, you assign the port cost by the port. On trunk ports, you assign the port cost by the VLAN; you can configure the same port cost to all the VLANs on a trunk port.

Port Priority

RapiIf a redundant path occurs and multiple ports have the same path cost, Rapid PVST+ considers the port priority when selecting which LAN port to put into the forwarding state. You can assign lower priority values to LAN ports that you want Rapid PVST+ to select first and higher priority values to LAN ports that you want Rapid PVST+ to select last.

If all LAN ports have the same priority value, Rapid PVST+ puts the LAN port with the lowest LAN port number in the forwarding state and blocks other LAN ports. The possible priority range is from 0 through 224 (the default is 128), configurable in increments of 32. The device uses the port priority value when the LAN port is configured as an access port and uses the VLAN port priority values when the LAN port is configured as a trunk port.

7.1.3 d PVST+ and IEEE 802.1Q Trunks

The 802.1Q trunks impose some limitations on the STP strategy for a network. In a network of Inspur network devices connected through 802.1Q trunks, the network devices maintain one instance of STP for each VLAN allowed on the trunks. However, non-Inspur 802.1Q network devices maintain only one instance of STP for all VLANs allowed on the trunks, which is the Common Spanning Tree (CST).

When you connect a Inspur network device to a non- Inspur device through an 802.1Q trunk, the Inspur network device combines the STP instance of the 802.1Q VLAN of the trunk with the STP instance of the non- Inspur 802.1Q network device. However, all per-VLAN STP information that is maintained by Inspur network devices is separated by a cloud of non- Inspur 802.1Q network devices. The non- Inspur 802.1Q cloud that separates the Inspur network devices is treated as a single trunk link between the network devices.

For more information on 802.1Q trunks, see the Inspur CN12900 Series INOS-CN Interfaces Configuration Guide.

7.1.4 Rapid PVST+ Interoperation with Legacy 802.1D STP

Rapid PVST+ can interoperate with devices that are running the legacy 802.1D protocol. The device knows that it is interoperating with equipment running 802.1D when it receives a BPDU version 0. The BPDUs for Rapid PVST+ are version 2. If the BPDU received is an 802.1w BPDU version 2 with the proposal flag set, the device sends an agreement message after all of the other ports are synchronized. If the BPDU is an 802.1D BPDU version 0, the device does not set the proposal flag and starts the forward-delay timer for the port. The new root port requires twice the forward-delay time to transition to the forwarding state.

The device interoperates with legacy 802.1D devices as follows:

- Notification—Unlike 802.1D BPDUs, 802.1w does not use TCN BPDUs. However, for interoperability with 802.1D devices, the device processes and generates TCN BPDUs.
- Acknowledgment—When an 802.1w device receives a TCN message on a designated port from an 802.1D device, it replies with an 802.1D configuration BPDU with the TCA bit set. However, if the TC-while timer (the same as the TC timer in 802.1D) is active on a root port connected to an 802.1D device and a configuration BPDU with the TCA set is received, the TC-while timer is reset.

This method of operation is required only for 802.1D devices. The 802.1w BPDUs do not have the TCA bit set.

- Protocol migration—For backward compatibility with 802.1D devices, 802.1w selectively sends 802.1D configuration BPDUs and TCN BPDUs on a per-port basis.

When a port is initialized, the migrate-delay timer is started (specifies the minimum time during which 802.1w BPDUs are sent), and 802.1w BPDUs are sent. While this timer is active, the device processes all BPDUs received on that port and ignores the protocol type.

If the device receives an 802.1D BPDU after the port migration-delay timer has expired, it assumes that it is connected to an 802.1D device and starts using only 802.1D BPDUs. However, if the 802.1w device is using 802.1D BPDUs on a port and receives an 802.1w BPDU after the timer has expired, it restarts the timer and starts using 802.1w BPDUs on that port.

7.1.5 Rapid PVST+ Interoperation with 802.1s MST

Rapid PVST+ interoperates seamlessly with the IEEE 802.1s Multiple Spanning Tree (MST) standard. No user configuration is needed. To disable this seamless interoperation, you can use PVST Simulation.

7.1.6 High Availability for Rapid PVST+

The software supports high availability for Rapid PVST+. However, the statistics and timers are not restored when Rapid PVST+ restarts. The timers start again and the statistics begin from 0.

7.2 Licensing Requirements for Rapid PVST+

The following table shows the licensing requirements for this feature:

Product	**License Requirement**
Inspur INOS-CN	Rapid PVST+ requires no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you.

7.3 Prerequisites for Configuring Rapid PVST+

Rapid PVST+ has the following prerequisites:

- You must be logged onto the device.

7.4 Guidelines and Limitations for Configuring Rapid PVST+

Rapid PVST+ has the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- For VLAN configuration limits please see the *Inspur CN12900 Series INOS-CN Verified Scalability Guide*.
- Port channeling—The port-channel bundle is considered as a single port. The port cost is the aggregation of all the configured port costs assigned to that channel.
- We recommend that you configure all ports connected to Layer 2 hosts as STP edge ports.
- Always leave STP enabled.
- Do not change timers because changing timers can adversely affect stability.
- Keep user traffic off the management VLAN; keep the management VLAN separate from the user data.
- Choose the distribution and core layers as the location of the primary and secondary root switches.
- When you connect two Inspur devices through 802.1Q trunks, the switches exchange spanning tree BPDUs on each VLAN allowed on the trunks. The BPDUs on the native VLAN of the trunk are sent untagged to the reserved 802.1D spanning tree multicast MAC address (01-80-C2-00-00-00). The BPDUs on all VLANs on the trunk are sent tagged to the reserved Inspur Shared Spanning Tree Protocol (SSTP) multicast MAC address (01-00-0c-cc-cc-cd).

7.5 Default Settings for Rapid PVST+

This table lists the default settings for Rapid PVST+ parameters.

Table 11： Default Rapid PVST+ Parameters

Parameters	**Default**
Spanning Tree	Enabled on all VLANs.
Spanning Tree mode	Rapid PVST+ **Caution** Changing the spanning tree mode disrupts the traffic because all spanning tree instances are stopped for the previous mode and started for the new mode.
VLAN	All ports assigned to VLAN1.
Extended system ID	Always enabled.
MAC address reduction	Always enabled.
Bridge ID priority	32769 (default bridge priority plus system ID extension of default VLAN1).
Port state	Blocking (changes immediately after convergence).
Port role	Designated (changes after convergence).

Parameters	Default
Port/VLAN priority	128.
Path-cost calculation method	Short.
Port/VLAN cost	Auto The default port cost is determined by the media speed and path-cost method calculation, as follows: • 1 Gigabit Ethernet: • short: 4 • long: 20,000 • 10 Gigabit Ethernet: • short: 2 • long: 2,000 • 40 Gigabit Ethernet: • short: 1 • long: 500
Hello time	2 seconds.
Forward delay time	15 seconds.
Maximum aging time	20 seconds.
Link type	Auto The default link type is determined by the duplex, as follows: • Full duplex: point-to-point link • Half duplex: shared link

7.6 Configuring Rapid PVST+

Rapid PVST+, which has the 802.1 w standard applied to the PVST+ protocol, is the default STP setting in the device.

You enable Rapid PVST+ on a per-VLAN basis. The device maintains a separate instance of STP for each VLAN (except on those VLANS on which you disable STP). By default, Rapid PVST+ is enabled on the default VLAN and on each VLAN that you create.

7.6.1 Enabling Rapid PVST+ - CLI Version

If you disable Rapid PVST+ on any VLANs, you must reenable Rapid PVRST+ on the specified VLANs. If you have enabled MST on the device and now want to use Rapid PVST+, you must enable Rapid PVST+ on the device.

Rapid PVST+ is the default STP mode. You cannot simultaneously run MST and Rapid PVST+ in the same chassis.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mode rapid-pvst**
3. **exit**
4. (Optional) **show running-config spanning-tree all**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mode rapid-pvst** **Example:** `switch(config)# spanning-tree mode rapid-pvst`	Enables Rapid PVST+ on the device. Rapid PVST+ is the default spanning tree mode. **Note** Changing the spanning tree mode disrupts traffic because all spanning tree instances are stopped for the previous mode and started for the new mode.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show running-config spanning-tree all** **Example:** `switch# show running-config spanning-tree all`	Displays information about the currently running STP configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable Rapid PVST+ on the device:

```
switch# config t

switch(config)# spanning-tree mode rapid-pvst
switch(config)#
```

```
exit switch#
```

7.6.2 Disabling or Enabling Rapid PVST+ Per VLAN - CLI Version

You can enable or disable Rapid PVST+ on each VLAN.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* or **no spanning-tree vlan** *vlan-range*
3. **exit**
4. (Optional) **show spanning-tree**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* or **no spanning-tree vlan** *vlan-range* **Example:** `switch(config)# spanning-tree vlan 5`	• **spanning-tree vlan** *vlan-range* Enables Rapid PVST+ (default STP) on a per VLAN basis. The *vlan-range* value can be 2 through 3967 except for reserved VLAN values. • **no spanning-tree vlan** *vlan-range* Disables Rapid PVST+ on the specified VLAN. See the Caution for information regarding this command.

Step 3	**exit**
	Example
	:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree** **Example** **:** `switch# show spanning-tree`	Displays the STP configuration.
Step 5	(Optional) **copy running-config startup-config** **Example** **:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable STP on VLAN 5:

```
switch# config t
switch(config)# spanning-tree vlan 5
switch(config)#
exit switch#
```

Caution	We do not recommend disabling spanning tree even in a topology that is free of physical loops. Spanning tree serves as a safeguard against misconfigurations and cabling errors. Do not disable spanning tree in a VLAN without ensuring that no physical loops are present in the VLAN.

7.6.3 Configuring the Root Bridge ID

The device maintains a separate instance of STP for each active VLAN in Rapid PVST+. For each VLAN, the network device with the lowest bridge ID becomes the root bridge for that VLAN.

To configure a VLAN instance to become the root bridge, modify the bridge priority from the default value (32768) to a significantly lower value.

When you enter the **spanning-tree vlan** *vlan-range* **root primary** command, the device sets the bridge priority to 24576 if this value will cause the device to become the root for the specified VLANs. If any root bridge for the specified VLAN has a bridge priority lower than 24576, the device sets the bridge priority for the specified VLANs to 4096 less than the lowest bridge priority.

Caution	The root bridge for each instance of STP should be a backbone or distribution device. Do not configure an access device as the STP primary root.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **root primary**
3. **exit**
4. (Optional) **show spanning-tree**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* **root primary** **Example:** `switch(config)# spanning-tree vlan 2 root primary`	Sets the bridge priority for the spanning tree.
Step 3	**exit** **Example:** `switch(config)# exit`	Exits configuration mode.

	Command or Action	Purpose
	`switch#`	
Step 4	(Optional) **show spanning-tree** **Example:** `switch# show spanning-tree`	Displays the STP configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the device as the root bridge:

```
switch# config t

switch(config)# spanning-tree vlan 2 root primary
switch(config)#
exit switch#
```

7.6.4 Configuring a Secondary Root Bridge-CLI Version

When you configure a device as the secondary root, the STP bridge priority is modified from the default value (32768) so that the device is likely to become the root bridge for the specified VLANs if the primary root bridge fails (assuming the other network devices in the network use the default bridge priority of 32768). STP sets the bridge priority to 28672.

Enter the **diameter** keyword to specify the Layer 2 network diameter (that is, the maximum number of bridge hops between any two end stations in the Layer 2 network). When you specify the network diameter, the software automatically selects an optimal hello time, forward delay time, and maximum age time for a network of that diameter, which can significantly reduce the STP convergence time. You can enter the **hello-time** keyword to override the automatically calculated hello time.

You can configure more than one device in this manner to have multiple backup root bridges. Enter the same network diameter and hello time values that you used when configuring the primary root bridge.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **root secondary** [**diameter** *dia* [**hello-time** *hello-time*]]
3. **exit**
4. (Optional) **show spanning-tree vlan** *vlan_id*
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* **root secondary**	Configures a device as the secondary root bridge.

	Command or Action	Purpose

	[**diameter**
	dia [**hello-time** *hello-time*]]
	Example:
	`switch(config)# spanning-tree vlan 5 root secondary`
	`diameter 4`
		The
		vlan-range value can be 2 through 3967 (except for reserved
		VLAN values). The *dia* default is 7. The *hello-time* can be
		from 1 to 10 seconds, and the default value is 2 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree vlan** *vlan_id* **Example:** `switch# show spanning-tree vlan 5`	Displays the STP configuration for the specified VLANs.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the device as the secondary root bridge for VLAN 5 with a network diameter of 4:

```
switch# config t

switch(config)# spanning-tree vlan 5 root secondary diameter 4
switch(config)#
exit switch#
```

7.6.5 Configuring the Rapid PVST+ Bridge Priority of a VLAN

You can configure the Rapid PVST+ bridge priority of a VLAN. This is another method of configuring root bridges.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **priority** *value*
3. **exit**
4. (Optional) **show spanning-tree vlan** *vlan_id*
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t**	Enters configuration mode.

	Example:
	`switch# config t`
	`switch(config)#`	

Step 2	**spanning-tree vlan** *vlan-range* **priority** *value* **Example:** `switch(config)# spanning-tree vlan 5 priority 8192`	Configures the bridge priority of a VLAN. Valid values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. All other values are rejected. The default value is 32768.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree vlan** *vlan_id* **Example:** `switch# show spanning-tree vlan 5`	Displays the STP configuration for the specified VLANs.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the priority of VLAN 5 on Gigabit Ethernet port 1/4 to 8192:

```
switch# config t

switch(config)# spanning-tree vlan 5 priority 8192
switch(config)#
exit switch#
```

7.6.6 Configuring the Rapid PVST+ Port Priority - CLI Version

You can assign lower priority values to LAN ports that you want Rapid PVST+ to select first and higher priority values to LAN ports that you want Rapid PVST+ to select last. If all LAN ports have the same priority value, Rapid PVST+ puts the LAN port with the lowest LAN port number in the forwarding state and blocks other LAN ports.

The device uses the port priority value when the LAN port is configured as an access port and uses the VLAN port priority values when the LAN port is configured as a trunk port.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree** [**vlan** *vlan-list*] **port-priority** *priority*
4. **exit**
5. (Optional) **show spanning-tree interface** {**ethernet** *slot/port* | *port channel channel-number*}

6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure and enters the interface configuration mode.

Step 3	**spanning-tree** [**vlan** *vlan-list*] **port-priority** *priority* **Example:** `switch(config-if)# spanning-tree port-priority 160`	Configures the port priority for the LAN interface. The *priority* value can be from 0 to 224. A lower value indicates a higher priority. The priority values are 0, 32, 64, 96, 128, 160, 192, and 224. All other values are rejected. The default value is 128.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree interface** {**ethernet** *slot/port* | *port channel channel-number*}
	Example:
	`switch# show spanning-tree interface ethernet 2/10`
		Displays the STP configuration for the specified interface.

Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the port priority of Ethernet access port 1/4 to 160:

```
switch# config t
switch (config)# interface ethernet 1/4
switch(config-if)# spanning-tree port-priority 160
switch(config-if)#
exit switch(config)#
```

7.6.7 Configuring the Rapid PVST+ Path-Cost Method and Port Cost - CLI Version

On access ports, you can assign the port cost for each port. On trunk ports, you can assign the port cost for each VLAN; you can configure all the VLANs on a trunk with the same port cost.

SUMMARY STEPS

1. **config t**
2. **spanning-tree pathcost method** {**long** | **short**}
3. **interface** *type slot/port*
4. **spanning-tree** [**vlan** *vlan-id*] **cost** [*value* | *auto*]
5. **exit**
6. (Optional) **show spanning-tree pathcost method**
7. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree pathcost method** {**long** | **short**}
	Example:
	`switch(config)# spanning-tree pathcost method long`
		Selects the method used for Rapid PVST+ path-cost calculations. The default method is the short method.

Step 3	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)`
		Specifies the interface to configure and enters the interface configuration mode.

Step 4	**spanning-tree** [**vlan** *vlan-id*] **cost** [*value* | *auto*] **Example:** `switch(config-if)# spanning-tree cost 1000`	Configures the port cost for the LAN interface. The cost value, depending on the path-cost calculation method, can be as follows: • short—1 to 65535 • long—1 to 200000000 **Note** You configure this parameter per port on access ports and per VLAN on trunk ports. The default is **auto**, which sets the port cost on both the path-cost calculation method and the media speed.

	Command or Action	Purpose

Step 5	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 6	(Optional) **show spanning-tree pathcost method** **Example:** `switch# show spanning-tree pathcost method`	Displays the STP path-cost method.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the port cost of Ethernet access port 1/4 to 1000:

```
switch# config t

switch (config)# spanning-tree pathcost method long
switch (config)# interface ethernet 1/4
switch(config-if)# spanning-tree cost 1000
switch(config-if)#
exit switch(config)#
```

7.6.8 Configuring the Rapid PVST+ Hello Time for a VLAN - CLI Version

You can configure the Rapid-PVST+ hello time for a VLAN.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **hello-time** *value*
3. **exit**
4. (Optional) **show spanning-tree vlan** *vlan_id*
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* **hello-time** *value* **Example:**	Configures the hello time of a VLAN. The hello time value can be from 1 to 10 seconds, and the default is 2 seconds.

	Command or Action	Purpose
	`switch(config)# spanning-tree vlan 5 hello-time 7`	

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree vlan** *vlan_id* **Example:** `switch# show spanning-tree vlan 5`	Displays the STP configuration per VLAN.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the hello time for VLAN 5 to 7 seconds:

```
switch# config t

switch(config)# spanning-tree vlan 5 hello-time 7
switch(config)#
exit switch#
```

7.6.9 Configuring the Rapid PVST+ Forward Delay Time for a VLAN - CLI Version

You can configure the forward delay time per VLAN when using Rapid PVST+.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **forward-time** *value*
3. **exit**
4. (Optional) **show spanning-tree vlan** *vlan_id*
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* **forward-time** *value* **Example:**	Configures the forward delay time of a VLAN. The forward delay time value can be from 4 to 30 seconds, and

	Command or Action	Purpose
	`switch(config)# spanning-tree vlan 5 forward-time 21`	the default is 15 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree vlan** *vlan_id* **Example:** `switch# show spanning-tree vlan 5`	Displays the STP configuration per VLAN.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the forward delay time for VLAN 5 to 21 seconds:

```
switch# config t

switch(config)# spanning-tree vlan 5 forward-time 21
switch(config)#
exit switch#
```

7.6.10 Configuring the Rapid PVST+ Maximum Age Time for a VLAN - CLI Version

You can configure the maximum age time per VLAN when using Rapid PVST+.

SUMMARY STEPS

1. **config t**
2. **spanning-tree vlan** *vlan-range* **max-age** *value*
3. **exit**
4. (Optional) **show spanning-tree vlan** *vlan_id*
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree vlan** *vlan-range* **max-age** *value*	Configures the maximum aging time of a VLAN. The

	Command or Action	Purpose
	Example: `switch(config)# spanning-tree vlan 5 max-age 36`	maximum aging time value can be from 6 to 40 seconds, and the default is 20 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree vlan** *vlan_id* **Example:** `switch# show spanning-tree vlan 5`	Displays the STP configuration per VLAN.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the maximum aging time for VLAN 5 to 36 seconds:

```
switch# config t
switch(config)# spanning-tree vlan 5 max-age 36
switch(config)#
exit switch#
```

7.6.11 Specifying the Link Type for Rapid PVST+ - CLI Version

Rapid connectivity (802.1w standard) is established only on point-to-point links. By default, the link type is controlled from the duplex mode of the interface. A full-duplex port is considered to have a point-to-point connection; a half-duplex port is considered to have a shared connection.

If you have a half-duplex link physically connected point to point to a single port on a remote device, you can override the default setting on the link type and enable rapid transitions.

If you set the link to shared, STP falls back to 802.1D.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree link-type** {*auto* | *point-to-point* | *shared*}
4. **exit**
5. (Optional) **show spanning-tree**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t**	Enters configuration mode.

	Command or Action	Purpose

	Example:
	`switch# config t`
	`switch(config)#`	

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure and enters the interface configuration mode.

Step 3	**spanning-tree link-type** {*auto* | *point-to-point* | *shared*}
	Example:
	`switch(config-if)# spanning-tree link-type`
	`point-to-point`
		Configures the link type to be either a point-to-point link or shared link. The system reads the default value from the device connection, as follows: half duplex links are shared and full-duplex links are point to point. If the link type is shared, the STP falls back to 802.1D. The default is auto, which sets the link type based on the duplex setting of the interface.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree** **Example:** `switch# show spanning-tree`	Displays the STP configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the link type as a point-to-point link:

```
switch# config t

switch (config)# interface ethernet 1/4 switch(config-
if)# spanning-tree link-type point-to-point
switch(config-if)#
exit switch(config)#
```

7.6.12 Reinitializing the Protocol for Rapid PVST+

A bridge that runs Rapid PVST+ can send 802.1D BPDUs on one of its ports when it is connected to a legacy bridge. However, the STP protocol migration cannot determine whether the legacy device has been removed from the link unless the legacy device is the designated switch. You can reinitialize the protocol negotiation (force the renegotiation with neighboring devices) on the entire device or on specified interfaces.

SUMMARY STEPS

1. **clear spanning-tree detected-protocol** [**interface** {**ethernet** *slot/port* | **port channel** *channel-number*}]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**clear spanning-tree detected-protocol** [**interface** {**ethernet** *slot/port* | **port channel** *channel-number*}] **Example:** `switch# clear spanning-tree detected-protocol`	Reinitializes Rapid PVST+ on all interfaces on the device or specified interfaces.

Example

This example shows how to reinitialize Rapid PVST+ on the Ethernet interface on slot 2, port 8:

```
switch# clear spanning-tree detected-protocol interface ethernet 2/8
switch#
```

7.7 Verifying the Rapid PVST+ Configurations

To display Rapid PVST+ configuration information, perform one of the following tasks:

Command	Purpose
show running-config spanning-tree [**all**]	Displays STP information.
show spanning-tree summary	Displays summary STP information.
show spanning-tree detail	Displays detailed STP information.
show spanning-treeshow spanning-tree{**vlan***vlan-id* | **interface** {[**ethernet***slot/port*] | [**port-channel***channel-number*]}} [**detail**]	Displays STP information per VLAN and interface.
show spanning-tree vlanshow spanning-tree vlan *vlan-id* **bridge**	Displays information on the STP bridge.

7.8 Displaying and Clearing Rapid PVST+ Statistics -- CLI Version

To display Rapid PVRST+ configuration information, perform one of the following tasks:

Command	Purpose

Command	Purpose
clear spanning-tree counters [**interface** *type slot/port* | **vlan***vlan-id*]	Clears the counters for STP.
show spanning-tree {**vlan** *vlan-id* | **interface** {[**ethernet** *slot/port*] | [**port-channel** *channel-number*]}} **detail**	Displays information about STP by interface or VLAN including BPDUs sent and received.

7.9 Rapid PVST+ Example Configurations

The following example shows how to configure Rapid PVST+:

```
switch# configure terminal

switch(config)# spanning-tree port type edge bpduguard default
switch(config)# spanning-tree port type edge bpdufilter
default switch(cnfig)# spanning-tree port type network default
switch(config)# spanning-tree vlan 1-10 priority 24576
switch(config)# spanning-tree vlan 1-10 hello-time 1
switch(config)# spanning-tree vlan 1-10 forward-time 9
switch(config)# spanning-tree vlan 1-10 max-age 13

switch(config)# interface Ethernet 3/1

switchport switch(config-if)# spanning-tree port

type edge switch(config-if)# exit

switch(config)# spanning-tree port type
edge switch(config-if)# switchport
switch(config-if)# switchport mode trunk
switch(config-if)# spanning-tree guard root
switch(config-if)# exit
switch(config)#
```

7.10 Additional References for Rapid PVST+ -- CLI Version

Related Documents

Related Topic	Document Title
Layer 2 interfaces	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
Inspur INOS-CN fundamentals	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
System management	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*

Standards

Standards	Title
IEEE 802.1Q-2006 (formerly known as IEEE 802.1s), IEEE 802.1D-2004 (formerly known as IEEE — 802.1w), IEEE 802.1D, IEEE 802.1t	

CHAPTER 8 Configuring MST Using Inspur INOS-CN

8.1 Information About MST

MST, which is the IEEE 802.1s standard, allows you to assign two or more VLANs to a spanning tree instance. MST is not the default spanning tree mode; Rapid per VLAN Spanning Tree (Rapid PVST+) is the default mode. MST instances with the same name, revision number, and VLAN-to-instance mapping combine to form an MST region. The MST region appears as a single bridge to spanning tree configurations outside the region. MST forms a boundary to that interface when it receives an IEEE 802.1D Spanning Tree Protocol (STP) message from a neighboring device.

8.1.1 MST Overview

MST maps multiple VLANs into a spanning tree instance, with each instance having a spanning tree topology independent of other spanning tree instances. This architecture provides multiple forwarding paths for data traffic, enables load balancing, and reduces the number of STP instances required to support a large number of VLANs. MST improves the fault tolerance of the network because a failure in one instance (forwarding path) does not affect other instances (forwarding paths).

MST provides rapid convergence through explicit handshaking because each MST instance uses the IEEE 802.1w standard, which eliminates the 802.1D forwarding delay and quickly transitions root bridge ports and designated ports to the forwarding state.

MAC address reduction is always enabled on the device. You cannot disable this feature.

MST improves spanning tree operation and maintains backward compatibility with these STP versions:

- Original 802.1D spanning tree
- Rapid per-VLAN spanning tree (Rapid PVST+)

8.1.2 MST Regions

To allow devices to participate in MST instances, you must consistently configure the devices with the same MST configuration information.

A collection of interconnected devices that have the same MST configuration is an MST region. An MST region is a linked group of MST bridges with the same MST configuration.

The MST configuration controls the MST region to which each device belongs. The configuration includes the name of the region, the revision number, and the VLAN-to-MST instance assignment mapping.

A region can have one or multiple members with the same MST configuration. Each member must be capable of processing 802.1w bridge protocol data units (BPDUs). There is no limit to the number of MST regions in a network.

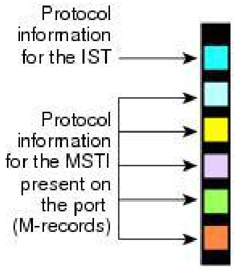
Each device can support up to 65 MST instances (MSTIs), including Instance 0, in a single MST region. Instances are identified by any number in the range from 1 to 4094. The system reserves Instance 0 for a special instance, which is the IST. You can assign a VLAN to only one MST instance at a time.

The MST region appears as a single bridge to adjacent MST regions and to other Rapid PVST+ regions and 802.1D spanning tree protocols.

8.1.3 MST BPDUs

Each device has only one MST BPDU per interface, and that BPDU carries an M-record for each MSTI on the device. Only the IST sends BPDUs for the MST region; all M-records are encapsulated in that one BPDU that the IST sends. Because the MST BPDU carries information for all instances, the number of BPDUs that need to be processed to support MST is significantly reduced compared with Rapid PVST+.

Figure 5 : MST BPDU with M-Records for MSTIs


Protocol information for the IST
Protocol information for the MSTI present on the port (M-records)

8.1.4 MST Configuration Information

The MST configuration that must be identical on all devices within a single MST region is configured by the user.

You can configure the three parameters of the MST configuration as follows:

- Name—32-character string, null padded and null terminated, identifying the MST region
- Revision number—Unsigned 16-bit number that identifies the revision of the current MST configuration
- VLAN-to-MST instance mapping—4096-element table that associates each of the potential VLANs supported to a given instance with the first (0) and last element (4095) set to 0. The value of element number X represents the instance to which VLAN X is mapped.

MST BPDUs contain these three configuration parameters. An MST bridge accepts an MST BPDU into its own region only if these three configuration parameters match exactly. If one configuration attribute differs, the MST bridge considers the BPDU to be from another MST region.

8.1.5 IST, CIST, and CST

IST, CIST, and CST Overview

Unlike Rapid PVST+, in which all the STP instances are independent, MST establishes and maintains IST, CIST, and CST spanning trees, as follows:

- An IST is the spanning tree that runs in an MST region.

MST establishes and maintains additional spanning trees within each MST region; these spanning trees are called multiple spanning tree instances (MSTIs).

Instance 0 is a special instance for a region, known as the IST. The IST always exists on all ports; you cannot delete the IST, or Instance 0. By default, all VLANs are assigned to the IST. All other MST instances are numbered from 1 to 4094.

The IST is the only STP instance that sends and receives BPDUs. All of the other MSTI information is contained in MST records (M-records), which are encapsulated within MST BPDUs.

All MSTIs within the same region share the same protocol timers, but each MSTI has its own topology parameters, such as the root bridge ID, the root path cost, and so forth.

An MSTI is local to the region; for example, MSTI 9 in region A is independent of MSTI 9 in region B, even if regions A and B are interconnected. Only CST information crosses region boundaries.

- The CST interconnects the MST regions and any instance of 802.1D and 802.1w STP that may be running on the network. The CST is the one STP instance for the entire bridged network and encompasses all MST regions and 802.1w and 802.1D instances.
- A CIST is a collection of the ISTs in each MST region. The CIST is the same as an IST inside an MST region, and the same as a CST outside an MST region.

The spanning tree computed in an MST region appears as a subtree in the CST that encompasses the entire switched domain. The CIST is formed by the spanning tree algorithm running among devices that support the 802.1w, 802.1s, and 802.1D standards. The CIST inside an MST region is the same as the CST outside a region.

Spanning Tree Operation Within an MST Region

The IST connects all the MSTdevices in a region. When the IST converges, the root of the IST becomes the CIST regional root. The CIST regional root is also the CIST root if there is only one region in the network. If the CIST root is outside the region, the protocol selects one of the MST devices at the boundary of the region as the CIST regional root.

When an MST device initializes, it sends BPDUs that identify itself as the root of the CIST and the CIST regional root, with both the path costs to the CIST root and to the CIST regional root set to zero. The device also initializes all of its MSTIs and claims to be the root for all of them. If the device receives superior MSTI root information (lower switch ID, lower path cost, and so forth) than the information that is currently stored for the port, it relinquishes its claim as the CIST regional root.

During initialization, an MST region might have many subregions, each with its own CIST regional root. As devices receive superior IST information from a neighbor in the same region, they leave their old subregions and join the new subregion that contains the true CIST regional root. This action causes all subregions to shrink except for the subregion that contains the true CIST regional root.

All devices in the MST region must agree on the same CIST regional root. Any two devices in the region will only synchronize their port roles for an MSTI if they converge to a common CIST regional root.

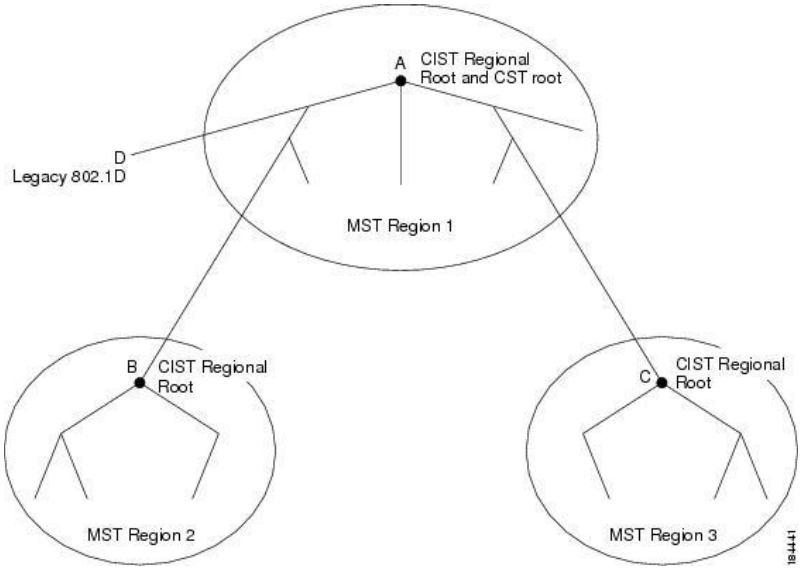
Spanning Tree Operations Between MST Regions

If you have multiple regions or 802.1 w or 802.1D STP instances within a network, MST establishes and maintains the CST, which includes all MST regions and all 802.1w and 802.1D STP devices in the network. The MSTIs combine with the IST at the boundary of the region to become the CST.

The IST connects all the MST devices in the region and appears as a subtree in the CIST that encompasses the entire switched domain. The root of the subtree is the CIST regional root. The MST region appears as a virtual device to adjacent STP devices and MST regions.

Figure 6：MST Regions, CIST Regional Roots, and CST Root

This figure shows a network with three MST regions and an 802.1D device (D). The CIST regional root for region 1 (A) is also the CIST root. The CIST regional root for region 2 (B) and the CIST regional root for region 3 (C) are the roots for their respective subtrees within the CIST.



Only the CST instance sends and receives BPDUs. MSTIs add their spanning tree information into the BPDUs (as M-records) to interact with neighboring devices within the same MST region and compute the final spanning tree topology. The spanning tree parameters related to the BPDU transmission (for example, hello time, forward time, max-age, and max-hops) are configured only on the CST instance but affect all MSTIs. You can configure the parameters related to the spanning tree topology (for example, the switch priority, the port VLAN cost, and the port VLAN priority) on both the CST instance and the MSTI.

MST devices use Version 3 BPDUs. If the MST device falls back to 802.1D STP, the device uses only 802.1D BPDUs to communicate with 802.1D-only devices. MST devices use MST BPDUs to communicate with MST devices.

MST Terminology

MST naming conventions include identification of some internal or regional parameters. These parameters are used only within an MST region, compared to external parameters that are used throughout the whole network. Because the CIST is the only spanning tree instance that spans the whole network, only the CIST parameters require the external qualifiers and not the internal or regional qualifiers. The MST terminology is as follows:

- The CIST root is the root bridge for the CIST, which is the unique instance that spans the whole network.
- The CIST external root path cost is the cost to the CIST root. This cost is left unchanged within an MST region. An MST region looks like a single device to the CIST. The CIST external root path cost is the root path cost calculated between these virtual devices and devices that do not belong to any region.
- If the CIST root is in the region, the CIST regional root is the CIST root. Otherwise, the CIST regional root is the closest device to the CIST root in the region. The CIST regional root acts as a root bridge for the IST.
- The CIST internal root path cost is the cost to the CIST regional root in a region. This cost is only relevant to the IST, instance 0.

8.1.6 Hop Count

MST does not use the message-age and maximum-age information in the configuration BPDU to compute the STP topology inside the MST region. Instead, the protocol uses the path cost to the root and a hop-count mechanism similar to the IP time-to-live (TTL) mechanism.

By using the **spanning-tree mst max-hops** global configuration command, you can configure the maximum hops inside the region and apply it to the IST and all MST instances in that region.

The hop count achieves the same result as the message-age information (triggers a reconfiguration). The root bridge of the instance always sends a BPDU (or M-record) with a cost of 0 and the hop count set to the maximum value. When a device receives this BPDU, it decrements the received remaining hop count by one and propagates this value as the remaining hop count in the BPDUs that it generates. When the count reaches zero, the device discards the BPDU and ages the information held for the port.

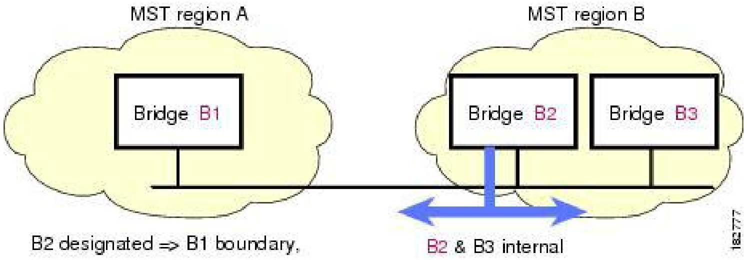
The message-age and maximum-age information in the 802.1w portion of the BPDU remain the same throughout the region (only on the IST), and the same values are propagated by the region-designated ports at the boundary.

You configure a maximum aging time as the number of seconds that a device waits without receiving spanning tree configuration messages before attempting a reconfiguration.

8.1.7 Boundary Ports

A boundary port is a port that connects to a LAN, the designated bridge of which is either a bridge with a different MST configuration (and so, a separate MST region) or a Rapid PVST+ or 802.1D STP bridge. A designated port knows that it is on the boundary if it detects an STP bridge or receives an agreement proposal from an MST bridge with a different configuration or a Rapid PVST+ bridge. This definition allows two ports that are internal to a region to share a segment with a port that belongs to a different region, creating the possibility of receiving both internal and external messages on a port.

Figure 7 : MST Boundary Ports



At the boundary, the roles of MST ports do not matter; the system forces their state to be the same as the IST port state. If the boundary flag is set for the port, the MST port-role selection process assigns a port role to the boundary and assigns the same state as the state of the IST port. The IST port at the boundary can take up any port role except a backup port role.

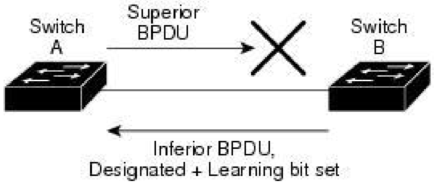
8.1.8 Detecting Unidirectional Link Failure: MST

Currently, this feature is not present in the IEEE MST standard, but it is included in the standard-compliant implementation; it is based on the dispute mechanism. The software checks the consistency of the port role and state in the received BPDUs to detect unidirectional link failures that could cause bridging loops. This feature is based on the dispute mechanism.

When a designated port detects a conflict, it keeps its role, but reverts to a discarding state because disrupting connectivity in case of inconsistency is preferable to opening a bridging loop.

Figure 13: Detecting a Unidirectional Link Failure

This figure shows a unidirectional link failure that typically creates a bridging loop. Switch A is the root bridge, and its BPDUs are lost on the link leading to switch B. Rapid PVST+ (802.1w) and MST BPDUs include the role and state of the sending port. With this information, switch A can detect that switch B does not react to the superior BPDUs that it sends and that switch B is the designated, not root port. As a result, switch A blocks (or keeps blocking) its port, which prevents the bridging loop.



8.1.9 Port Cost and Port Priority

Spanning tree uses port costs to break a tie for the designated port. Lower values indicate lower port costs, and spanning tree chooses the least costly path. Default port costs are taken from the bandwidth of the interface, as follows:

- 1 Gigabit Ethernet—20,000
- 10 Gigabit Ethernet—2,000
- 40 Gigabit Ethernet—500

You can configure the port costs in order to influence which port is chosen.

The system uses port priorities to break ties among ports with the same cost. A lower number indicates a higher priority. The default port priority is 128. You can configure the priority to values between 0 and 224, in increments of 32.

8.1.10 Interoperability with IEEE 802.1D

A device that runs MST supports a built-in protocol migration feature that enables it to interoperate with 802.1D STP devices. If this device receives an 802.1D configuration BPDU (a BPDU with the protocol version set to 0), it sends only 802.1D BPDUs on that port. In addition, an MST device can detect that a port is at the boundary of a region when it receives an 802.1D BPDU, an MST BPDU (Version 3) associated with a different region, or an 802.1w BPDU (Version 2).

However, the device does not automatically revert to the MST mode if it no longer receives 802.1D BPDUs because it cannot detect whether the 802.1D device has been removed from the link unless the 802.1D device is the designated device. A device might also continue to assign a boundary role to a port when the device to which this device is connected has joined the region.

To restart the protocol migration process (force the renegotiation with neighboring devices), enter the **clear spanning-tree detected-protocols** command.

All Rapid PVST+ switches (and all 8021.D STP switches) on the link can process MST BPDUs as if they are 802.1w BPDUs. MST devices can send either Version 0 configuration and topology change notification (TCN) BPDUs or Version 3 MST BPDUs on a boundary port. A boundary port connects to a LAN, the designated device of which is either a single spanning tree device or a device with a different MST configuration.

MST interoperates with the Inspur prestandard MSTP whenever it receives prestandard MSTP on an MST port; no explicit configuration is necessary.

You can also configure the interface to proactively send prestandard MSTP messages.

8.1.11 High Availability for MST

The software supports high availability for MST. However, the statistics and timers are not restored when MST restarts. The timers start again and the statistics begin from 0.

The device supports full nondisruptive upgrades for MST. See the *Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*, for complete information on nondisruptive upgrades and high-availability features.

8.2 Licensing Requirements for MST

The following table shows the licensing requirements for this feature:

Product	License Requirement
Inspur INOS-CN	MST requires no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you.

8.3 Prerequisites for MST

MST has the following prerequisites:

- You must be logged onto the device.

8.4 Guidelines and Limitations for Configuring MST

MST has the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- You must enable MST; Rapid PVST+ is the default spanning tree mode.
- You can assign a VLAN to only one MST instance at a time.
- You cannot map VLANs 3968 to 4095 to an MST instance. These VLANs are reserved for internal use by the

device.

- You can have up to 65 MST instances on one device.
- By default, all VLANs are mapped to MSTI 0 or the IST.
- You can load balance only within the MST region.
- Ensure that trunks carry all of the VLANs that are mapped to an MSTI or exclude all those VLANs that are mapped to an MSTI.
- Always leave STP enabled.
- Do not change timers because you can adversely affect your network stability.
- Keep user traffic off the management VLAN; keep the management VLAN separate from user data.
- Choose the distribution and core layers as the location of the primary and secondary root switches.
- Port channeling—The port channel bundle is considered as a single port. The port cost is the aggregation of all the configured port costs assigned to that channel.
- When you map a VLAN to an MSTI, the system automatically removes that VLAN from its previous MSTI.
- You can map any number of VLANs to an MSTI.
- All MST boundary ports must be forwarding for load balancing between Rapid PVST+ and an MST cloud or between a PVST+ and an MST cloud. The CIST regional root of the MST cloud must be the root of the CST. If the MST cloud consists of multiple MST regions, one of the MST regions must contain the CST root and all of the other MST regions must have a better path to the root contained within the MST cloud than a path through the Rapid PVST+ or PVST+ cloud.
- Do not partition the network into a large number of regions. However, if this situation is unavoidable, we recommend that you partition the switched LAN into smaller LANs interconnected by non-Layer 2 devices.
- When you are in the MST configuration submode, the following guidelines apply:
- Each command reference line creates its pending regional configuration.
- The pending region configuration starts with the current region configuration.
- To leave the MST configuration submode without committing any changes, enter the **abort** command.
- To leave the MST configuration submode and commit all the changes that you made before you left the submode, enter the **exit** or **end** commands, or press **Ctrl + Z**.

8.5 Default Settings for MST

This table lists the default settings for MST parameters.

Table 12： Default MST Parameters

Parameters	**Default**
Spanning tree	Enabled
Spanning tree mode	Rapid PVST+ is enabled by default **Caution** Changing the spanning tree mode disrupts the traffic because all spanning tree instances are stopped for the previous mode and started for the new mode.
Name	Empty string
VLAN mapping	All VLANs mapped to a CIST instance
Revision	0
Instance ID	Instance 0; VLANs 1 to 3967 are mapped to Instance 0 by

Parameters	Default
	default
MSTIs per MST region	65
Bridge priority (configurable per CIST port)	32768
Spanning tree port priority (configurable per CIST port)	128
Spanning tree port cost (configurable per CIST port)	Auto The default port cost is determined by the port speed as follows: • 1 Gigabit Ethernet: 20,000 • 10 Gigabit Ethernet: 2,000 • 40 Gigabit Ethernet: 500
Hello time	2 seconds
Forward-delay time	15 seconds
Maximum-aging time	20 seconds
Maximum hop count	20 hops
Link type	Auto The default link type is determined by the duplex, as follows: • Full duplex: point-to-point link • Half duplex: shared link

8.6 Configuring MST

8.6.1 Enabling MST - CLI Version

You can enable MST; Rapid PVST+ is the default.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mode mst** or **no spanning-tree mode mst**.
3. **exit**
4. (Optional) **show running-config spanning-tree all**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t**	Enters configuration mode.

	Command or Action	Purpose

	Example:
	`switch# config t`
	`switch(config)#`	

Step 2	**spanning-tree mode mst** or **no spanning-tree mode mst**. **Example:** `switch(config)# spanning-tree mode mst`	• **spanning-tree mode mst** Enables MST on the device. • **no spanning-tree mode mst** Disables MST on the device and returns you to Rapid PVST+.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show running-config spanning-tree all** **Example:** `switch# show running-config spanning-tree all`	Displays the currently running STP configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable MST on the device:

```
switch# config t

switch(config)# spanning-tree mode mst
switch(config)#
exit switch#
```

8.6.2 Entering MST Configuration Mode

You enter MST configuration mode to configure the MST name, VLAN-to-instance mapping, and MST revision number on the device.

If two or more devices are in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst configuration** or **no spanning-tree mst configuration**
3. **exit** or **abort**
4. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst configuration** or **no spanning-tree mst configuration**
	Example:
	`switch(config)# spanning-tree mst configuration`
	`switch(config-mst)#`
		• **spanning-tree mst configuration**
		Enters MST configuration submode on the system. You must be in the MST configuration submode to assign the MST configuration parameters, as follows:
		• MST name
		• VLAN-to-MST instance mapping
		• MST revision number
		• **no spanning-tree mst configuration**
		Returns the MST region configuration to the following default values:
		• The region name is an empty string.
		• No VLANs are mapped to any MST instance (all VLANs are mapped to the CIST instance).
		• The revision number is 0.

Step 3	**exit** or **abort**
	Example:
	`switch(config-mst)# exit`
	`switch(config)#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without committing any of the changes.

Step 4	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enter the MST configuration submode on the device:

```
switch# config t
switch(config)# spanning-tree mst configuration
switch(config-mst)#
exit switch(config)#
```

8.6.3 Specifying the MST Name

You can configure a region name on the bridge. If two or more bridges are in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst configuration**
3. **name** *name*
4. **exit** or **abort**
5. (Optional) **show spanning-tree mst configuration**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst configuration**
	Example:
	`switch(config)# spanning-tree mst configuration`
	`switch(config-mst)#`
		Enters MST configuration submode.

Step 3	**name** *name* **Example:** `switch(config-mst)# name accounting`	Specifies the name for the MST region. The *name* string has a maximum length of 32 characters and is case sensitive. The default is an empty string.

Step 4	**exit** or **abort**
	Example:
	`switch(config-mst)# exit`
	`switch(config)#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without committing any of the changes.

Step 5	(Optional) **show spanning-tree mst configuration**	Displays the MST configuration.

	Command or Action	Purpose
	Example: `switch# show spanning-tree mst configuration`	
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the name of the MST region:

```
switch# config t
switch(config)#  spanning-tree mst configuration
switch(config-mst)# name
accounting switch(config-mst)#
exit switch(config)#
```

8.6.4 Specifying the MST Configuration Revision Number

You configure the revision number on the bridge. If two or more bridges are in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst configuration**
3. **revision** *version*
4. **exit** or **abort**
5. (Optional) **show spanning-tree mst configuration**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst configuration**
	Example:
	`switch(config)# spanning-tree mst configuration`
	`switch(config-mst)#`
		Enters MST configuration submode.

Step 3	**revision** *version* **Example:** `switch(config-mst)# revision 5`	Specifies the revision number for the MST region. The range is from 0 to 65535, and the default value is 0.

	Command or Action	Purpose

Step 4	**exit** or **abort**
	Example:
	`switch(config-mst)# exit`
	`switch(config)#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without committing any of the changes.

Step 5	(Optional) **show spanning-tree mst configuration** **Example:** `switch# show spanning-tree mst configuration`	Displays the MST configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the revision number of the MSTI region to 5:

```
switch# config t
switch(config)# spanning-tree mst configuration
switch(config-mst)# revision 5
switch(config-mst)#
```

8.6.5 Specifying the Configuration on an MST Region

If two or more devices are to be in the same MST region, they must have the same VLAN-to-instance mapping, the same configuration revision number, and the same MST name.

A region can have one member or multiple members with the same MST configuration; each member must be capable of processing IEEE 802.1w RSTP BPDUs. There is no limit to the number of MST regions in a network, but each region can support only up to 65 MST instances. You can assign a VLAN to only one MST instance at a time.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst configuration**
3. **instance** *instance-id* **vlan** *vlan-range*
4. **name** *name*
5. **revision** *version*
6. **exit** or **abort**
7. **show spanning-tree mst configuration**
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t**	Enters configuration mode.

	Command or Action	Purpose

	Example:
	`switch# config t`
	`switch(config)#`	

Step 2	**spanning-tree mst configuration**
	Example:
	`switch(config)# spanning-tree mst configuration`
	`switch(config-mst)#`
		Enters MST configuration submode.

Step 3	**instance** *instance-id* **vlan** *vlan-range* **Example:** `switch(config-mst)# instance 1 vlan 10-20`	Maps VLANs to an MST instance as follows: • For *instance-id*, the range is from 1 to 4094. • For **vlan** *vlan-range*, the range is from 1 to 3967. When you map VLANs to an MST instance, the mapping is incremental, and the VLANs specified in the command are added to or removed from the VLANs that were previously mapped. To specify a VLAN range, enter a hyphen; for example, enter the **instance 1 vlan 1-63** command to map VLANs 1 through 63 to MST instance 1. To specify a VLAN series, enter a comma; for example, enter the **instance 1 vlan 10, 20, 30** command to map VLANs 10, 20, and 30 to MST instance 1.
Step 4	**name** *name* **Example:** `switch(config-mst)# name region1`	Specifies the instance name. The name string has a maximum length of 32 characters and is case sensitive.
Step 5	**revision** *version* **Example:** `switch(config-mst)# revision 1`	Specifies the configuration revision number. The range is from 0 to 65535.

Step 6	**exit** or **abort**
	Example:
	`switch(config-mst)# exit`
	`switch(config)#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without

	Command or Action	Purpose
		committing any of the changes.
Step 7	**show spanning-tree mst configuration** **Example:** `switch# show spanning-tree mst configuration`	(Optional) Displays the MST configuration.
Step 8	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Copies the running configuration to the startup configuration.

Example

This example shows how to enter MST configuration mode, map VLANs 10 to 20 to MST instance 1, name the region *region1*, set the configuration revision to 1, display the pending configuration, apply the changes, and return to global configuration mode:

```
switch# config t

switch(config)# spanning-tree mst
configuration switch(config-mst)# instance 1
vlan 10-20 switch(config-mst)# name region1
switch(config-mst)# revision 1 switch(config-
mst#) exit
switch(config)# show spanning-tree mst configuration

Name      [region1]

Revision  1
Instances configured 2



                 Instance  Vlans Mapped
                           --------------------
                 0-------- 1-9,21-4094
                 1         10-20
-------------------------------
switch(config)#
```

8.6.6 Mapping or Unmapping a VLAN to an MST Instance - CLI Version

If two or more bridges are to be in the same MST region, they must have the identical MST name, VLAN-to-instance mapping, and MST revision number.

You cannot map VLANs 3968 to 4095 to an MST instance. These VLANs are reserved for internal use by the device.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst configuration**
3. **instance** *instance-id* **vlan** *vlan-range* or **no instance** *instance-id* **vlan** *vlan-range*
4. **exit** or **abort**

5. (Optional) **show spanning-tree mst configuration**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst configuration**
	Example:
	`switch(config)# spanning-tree mst configuration`
	`switch(config-mst)#`
		Enters MST configuration submode.

Step 3	**instance** *instance-id* **vlan** *vlan-range* or **no instance** *instance-id* **vlan** *vlan-range* **Example:** `switch(config-mst)# instance 3 vlan 200`	• **instance** *instance-id* **vlan** *vlan-range* Maps VLANs to an MST instance as follows: • For *instance_id*, the range is from 1 to 4094. Instance 0 is reserved for the IST for each MST region. • For *vlan-range*, the range is from 1 to 3967. When you map VLANs to an MSTI, the mapping is incremental, and the VLANs specified in the command are added to or removed from the VLANs that were previously mapped. • **no instance** *instance-id* **vlan** *vlan-range* Deletes the specified instance and returns the VLANs to the default MSTI, which is the CIST.

Step 4	**exit** or **abort**
	Example:
	`switch(config-mst)# exit`
	`switch(config)#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without committing any of the changes.

Step 5	(Optional) **show spanning-tree mst configuration**	Displays the MST configuration.

	Command or Action	Purpose
	Example: `switch# show spanning-tree mst configuration`	
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to map VLAN 200 to MSTI 3:

```
switch# config t
switch(config)# spanning-tree mst configuration
switch(config-mst)# instance 3 vlan
200 switch(config-mst)# exit
switch(config)#
```

8.6.7 Configuring the Root Bridge

You can configure the device to become the MST root bridge.

The **spanning-tree vlan** *vlan_ID* **primary root** command fails if the value required to be the root bridge is less than 4096. If the software cannot lower the bridge priority any lower, the device returns the following message:

```
Error: Failed to set root bridge for VLAN 1
It may be possible to make the bridge root by setting the priority
for some (or all) of these instances to zero.
```

Enter the **diameter** keyword, which is available only for MSTI 0 (or the IST), to specify the Layer 2 network diameter (that is, the maximum number of Layer 2 hops between any two end stations in the Layer 2 network). When you specify the network diameter, the device automatically sets an optimal hello time, forward-delay time, and maximum-age time for a network of that diameter, which can significantly reduce the convergence time. You can enter the **hello** keyword to override the automatically calculated hello time.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]] or **no spanning-tree mst** *instance-id* **root**
3. **exit** or **abort**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

	Command or Action	Purpose
Step 2	**spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]] or **no** **spanning-tree mst** *instance-id* **root** **Example:** `switch(config)# spanning-tree mst 5 root primary`	• **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia* [**hello-time** *hello-time*]] Configures a device as the root bridge as follows: • For *instance-id*, specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For **diameter** *net-diameter*, specify the maximum number of Layer 2 hops between any two end stations. The default is 7. This keyword is available only for MST instance 0. • For **hello-time** *seconds*, specify the interval in seconds between the generation of configuration messages by the root bridge. The range is from 1 to 10 seconds; the default is 2 seconds. • **no spanning-tree mst** *instance-id* **root** Returns the switch priority, diameter, and hello time to default values.

Step 3	**exit** or **abort**
	Example:
	`switch(config)# exit`
	`switch#`
		• **exit**
		Commits all the changes and exits MST configuration submode.
		• **abort**
		Exits the MST configuration submode without committing any of the changes.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:**	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	`switch(config)# copy running-config startup-config`	

Example

This example shows how to configure the device as the root switch for MSTI 5:

```
switch# config t
switch(config)# spanning-tree mst 5 root primary
switch(config)# exit
switch(config)#
```

8.6.8 Configuring an MST Secondary Root Bridge

You use this command on more than one device to configure multiple backup root bridges. Enter the same network diameter and hello-time values that you used when you configured the primary root bridge with the **spanning-tree mst root primary** global configuration command.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia*[**hello-time** *hello-time*]] or **no spanning-tree mst** *instance-id* **root**
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia*[**hello-time** *hello-time*]] or **no** **spanning-tree mst** *instance-id* **root** **Example:** `switch(config)# spanning-tree mst 5 root secondary`	• **spanning-tree mst** *instance-id* **root** {**primary** | **secondary**} [**diameter** *dia*[**hello-time** *hello-time*]] Configures a device as the secondary root bridge as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094. • For **diameter** *net-diameter*, specify the maximum

	Command or Action	Purpose
		number of Layer 2 hops between any two end stations. The default is 7. This keyword is available only for MST instance 0. • For **hello-time** *seconds*, specify the interval in seconds between the generation of configuration messages by the root bridge. The range is from 1 to 10 seconds; the default is 2 seconds. • **no spanning-tree mst** *instance-id* **root** Returns the switch priority, diameter, and hello-time to default values.

Step 3	**exit**
	Example:
	`switch# exit`
	`switch(config)#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the device as the secondary root switch for MSTI 5:

```
switch# config t
switch(config)# spanning-tree mst 5 root secondary
switch(config)#
exit switch#
```

8.6.9 Configuring the MST Switch Priority

You can configure the switch priority for an MST instance so that it is more likely that the specified device is chosen as the root bridge.

SUMMARY STEPS

1. **config t**

2. **spanning-tree mst** *instance-id* **priority** *priority-value*
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst** *instance-id* **priority** *priority-value* **Example:** `switch(config)# spanning-tree mst 5 priority 4096`	Configures a device priority as follows: • For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from1 to 4094. • For *priority-value* the range is from 0 to 61440 in increments of 4096; the default is 32768. A lower number indicates that the device will most likely be chosen as the root bridge. Priority values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152,53248, 57344, and 61440. The system rejects all other values.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the priority of the bridge to 4096 for MSTI 5:

```
switch# config t
switch(config)# spanning-tree mst 5 priority 4096
switch(config)#
exit switch#
```

8.6.10 Configuring the MST Port Priority

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

SUMMARY STEPS

1. **config t**
2. **interface** {{*type slot/port*} | {**port-channel** *number*}}
3. **spanning-tree mst** *instance-id* **port-priority** *priority*
4. **exit**
5. (Optional) **show spanning-tree mst**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {{*type slot/port*} | {**port-channel** *number*}}
	Example:
	`switch(config)# interface ethernet 3/1`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface configuration mode.

Step 3	**spanning-tree mst** *instance-id* **port-priority** *priority*
	Example:
	`switch(config-if)# spanning-tree mst 3`
	`port-priority 64`
		Configures the port priority as follows:
		• For *instance-id*, you can specify a single MSTI, a range of MSTIs separated by a hyphen, or a series of MSTIs separated by a comma. The range is from 1 to 4094.
		• For *priority*, the range is from 0 to 224 in increments of 32. The default is 128. A lower number indicates a higher priority.
		The priority values are 0, 32, 64, 96, 128, 160, 192, and 224. The system rejects all other values.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

	Command or Action	Purpose
Step 5	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the MST interface port priority for MSTI 3 on Ethernet port 3/1 to 64:

```
switch# config t

switch(config)# interface ethernet 3/1 switch(config-
if)# spanning-tree mst 3 port-priority 64
switch(config-if)#
exit switch(config)#
```

8.6.11 Configuring the MST Port Cost

The MST port cost default value is derived from the media speed of an interface. If a loop occurs, MST uses the 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 to interfaces values that you want selected last. If all interfaces have the same cost value, MST puts the interface with the lowest interface number in the forwarding state and blocks the other interfaces.

SUMMARY STEPS

1. **config t**
2. **interface** {{*type slot/port*} | {**port-channel** *number*}}
3. **spanning-tree mst** *instance-id* **cost** {*cost* | *auto*}
4. **exit**
5. (Optional) **show spanning-tree mst**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {{*type slot/port*} | {**port-channel** *number*}}
	Example:
	`switch# config t`
	`switch(config)# interface ethernet 3/1`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface
		configuration mode.

Step 3	**spanning-tree mst** *instance-id* **cost** {*cost* | *auto*}	Configures the cost.

	Command or Action	Purpose

	Example:
	`switch(config-if)# spanning-tree mst 4 cost`
	`17031970`
		If a loop occurs, MST uses the path cost when selecting an interface to place into the forwarding state. A lower path cost represents higher-speed transmission as follows:
		• For *instance-id*, you can specify a single instance, a range of instances separated by a hyphen, or a series of instances separated by a comma. The range is from 1 to 4094.
		• For *cost*, the range is from 1 to 200000000. The default value is **auto**, which is derived from the media speed of the interface.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the MST interface port cost on Ethernet 3/1 for MSTI 4:

```
switch# config t
switch(config)# interface ethernet 3/1 switch(config-
if)# spanning-tree mst 4 cost 17031970
switch(config-if)#
exit switch(config)#
```

8.6.12 Configuring the MST Hello Time

You can configure the interval between the generation of configuration messages by the root bridge for all instances on the device by changing the hello time.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst hello-time** *seconds*
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst hello-time** *seconds* **Example:** `switch(config)# spanning-tree mst hello-time 1`	Configures the hello time for all MST instances. The hello time is the interval between the generation of configuration messages by the root bridge. These messages mean that the device is alive. For *seconds*, the range is from 1 to 10, and the default is 2 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the hello time of the device to 1 second:

```
switch# config t

switch(config)# spanning-tree mst hello-time 1
switch(config)#
exit switch#
```

8.6.13 Configuring the MST Forwarding-Delay Time

You can set the forward delay timer for all MST instances on the device with one command.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst forward-time** *seconds*
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst forward-time** *seconds* **Example:** `switch(config)# spanning-tree mst forward-time 10`	Configures the forward time for all MST instances. The forward delay is the number of seconds that a port waits before changing from its spanning tree blocking and learning states to the forwarding state. For *seconds*, the range is from 4 to 30, and the default is 15 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the forward-delay time of the device to 10 seconds:

```
switch# config t
switch(config)# spanning-time mst forward-time 10
switch(config)#
exit switch#
```

8.6.14 Configuring the MST Maximum-Aging Time

You can set the maximum-aging timer for all MST instances on the device with one command (the maximum age time only applies to the IST).

The maximum-aging timer is the number of seconds that a device waits without receiving spanning tree configuration messages before attempting a reconfiguration.

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst max-age** *seconds*
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst max-age** *seconds* **Example:** `switch(config)# spanning-tree mst max-age 40`	Configures the maximum-aging time for all MST instances. The maximum-aging time is the number of seconds that a device waits without receiving spanning tree configuration messages before attempting a reconfiguration. For *seconds*, the range is from 6 to 40, and the default is 20 seconds.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the maximum-aging timer of the device to 40 seconds:

```
switch# config t

switch(config)# spanning-tree mst max-age 40
switch(config)#
exit switch#
```

8.6.15 Configuring the MST Maximum-Hop Count

You can configure the maximum hops inside the region and apply it to the IST and all MST instances in that region. MST uses the path cost to the IST regional root and a hop-count mechanism similar to the IP time-to-live (TTL) mechanism. The hop count achieves the same result as the message-age information (triggers a reconfiguration).

SUMMARY STEPS

1. **config t**
2. **spanning-tree mst max-hops** *hop-count*
3. **exit**
4. (Optional) **show spanning-tree mst**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree mst max-hops** *hop-count* **Example:** `switch(config)# spanning-tree mst max-hops 40`	Specifies the number of hops in a region before the BPDU is discarded and the information held for a port is aged. For *hop-count*, the range is from 1 to 255, and the default value is 20 hops.

Step 3	**exit**
	Example:
	`switch(config-mst)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the maximum hops to 40:

```
switch# config t

switch(config)# spanning-tree mst max-hops 40
switch(config)#
exit switch#
```

8.6.16 Configuring an Interface to Proactively Send Prestandard MSTP Messages - CLI Version

By default, interfaces on a device running MST send prestandard, rather than standard, MSTP messages after they receive a prestandard MSTP message from another interface. You can configure the interface to proactively send prestandard MSTP messages. That is, the specified interface would not have to wait to receive a prestandard MSTP message; the interface with this configuration always sends prestandard MSTP messages.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree mst pre-standard**
4. **exit**
5. (Optional) **show spanning-tree mst**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure and enters the interface configuration mode.

Step 3	**spanning-tree mst pre-standard** **Example:** `switch(config-if)# spanning-tree mst pre-standard`	Specifies that the interface always sends MSTP messages in the prestandard format, rather than in the MSTP standard format.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree mst** **Example:** `switch# show spanning-tree mst`	Displays the MST configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to set the MST interface so that it always sends MSTP messages in the prestandard format:

```
switch# config t
switch (config)# interface ethernet 1/4
switch(config-if)# spanning-tree mst pre-standard
switch(config-if)#
exit switch(config)#
```

8.6.17 Specifying the Link Type for MST - CLI Version

Rapid connectivity (802.1w standard) is established only on point-to-point links. By default, the link type is controlled from the duplex mode of the interface. A full-duplex port is considered to have a point-to-point connection; a half-duplex port is considered to have a shared connection.

If you have a half-duplex link physically connected point to point to a single port on a remote device, you can override the default setting on the link type and enable rapid transitions.

If you set the link to shared, STP falls back to 802.1D.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree link-type** {*auto* | *point-to-point* | *shared*}
4. **exit**
5. (Optional) **show spanning-tree**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure and enters the interface configuration mode.

Step 3	**spanning-tree link-type** {*auto* | *point-to-point* | *shared*}
	Example:
	`switch(config-if)# spanning-tree link-type`
	`point-to-point`
		Configures the link type to be either a point-to-point link or shared link. The system reads the default value from the device connection, as follows: half duplex links are shared and full-duplex links are point to point. If the link type is shared, the STP falls back to 802.1D. The default is auto,

	Command or Action	Purpose
		which sets the link type based on the duplex setting of the interface.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree** **Example:** `switch# show spanning-tree`	Displays the STP configuration.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the link type as a point-to-point link:

```
switch# config t

switch (config)# interface ethernet 1/4 switch(config-
if)# spanning-tree link-type point-to-point
switch(config-if)#
exit switch(config)#
```

8.6.18 Reinitializing the Protocol for MST

An MST bridge can detect that a port is at the boundary of a region when it receives a legacy BPDU or an MST BPDU that is associated with a different region. However, the STP protocol migration cannot determine whether the legacy device, which is a device that runs only IEEE 802.1D, has been removed from the link unless the legacy device is the designated switch. Enter this command to reinitialize the protocol negotiation (force the renegotiation with neighboring devices) on the entire device or on specified interfaces.

SUMMARY STEPS

1. **clear spanning-tree detected-protocol** [**interface** *interface* [*interface-num* | *port-channel*]]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**clear spanning-tree detected-protocol** [**interface** *interface* [*interface-num* | *port-channel*]] **Example:** `switch# clear spanning-tree detected-protocol`	Reintializes MST on an entire device or specified interfaces.

Example

This example shows how to reinitialize MST on the Ethernet interface on slot 2, port 8:

```
switch# clear spanning-tree detected-protocol interface ethernet 2/8
```

8.7 Verifying the MST Configuration

To display MST configuration information, perform one of the following tasks:

Command	Purpose
show running-config spanning-tree [**all**]	Displays STP information.
show spanning-tree mst configuration	Displays MST information.
show spanning-tree mst [**detail**]	Displays information about MST instances.
show spanning-tree mst *instance-id* [**detail**]	Displays information about the specified MST instance.
show spanning-tree mst *instance-id* **interface** {**ethernet** *slot/port* | **port-channel** *channel-number*} [**detail**]	Displays MST information for the specified interface and instance.
show spanning-tree summary	Displays summary STP information.
show spanning-tree detail	Displays detailed STP information.
show spanning-tree {**vlan** *vlan-id* | **interface** {[**ethernet** *slot/port*] | [**port-channel** *channel-number*]}} [**detail**]	Displays STP information per VLAN and interface.
show spanning-tree vlan *vlan-id* **bridge**	Displays information on the STP bridge.

8.8 Displaying and Clearing MST Statistics -- CLI Version

To display MST configuration information, perform one of the following tasks:

Command	Purpose
clear spanning-tree counters [**interface** *type slot/port* | **vlan***vlan-id*]	Clears the counters for STP.
show spanning-tree {**vlan** *vlan-id* | **interface** {[**ethernet** *slot/port*] | [**port-channel***channel-number*]}} **detail**	Displays information about STP by interface or VLAN including BPDUs sent and received.

8.9 MST Example Configuration

The following example shows how to configure MST:

```
switch# configure terminal
switch(config)# spanning-tree mode mst
switch(config)# spanning-tree port type edge bpduguard default
switch(config)# spanning-tree port type edge bpdufilter
default switch(config)# spanning-tree port type network
default switch(config)# spanning-tree mst 0-64 priority 24576
switch(config)# spanning-tree mst configuration switch(config-
mst)# name Inspur_region_1
switch(config-mst)# revision 2 switch(config-
mst)# instance 1 vlan 1-21 switch(config-mst)#
instance 2 vlan 22-42 switch(config-mst)#
instance 3 vlan 43-63 switch(config-mst)#
instance 4 vlan 64-84 switch(config-mst)#
instance 5 vlan 85-105 switch(config-mst)#
instance 6 vlan 106-126 switch(config-mst)#
instance 6 vlan 106-126 switch(config-mst)#
instance 7 vlan 127-147 switch(config-mst)#
instance 8 vlan 148-168 switch(config-mst)#
instance 9 vlan 169-189 switch(config-mst)#
instance 10 vlan 190-210 switch(config-mst)#
instance 11 vlan 211-231 switch(config-mst)#
instance 12 vlan 232-252 switch(config-mst)#
instance 13 vlan 253-273 switch(config-mst)#
instance 14 vlan 274-294 switch(config-mst)#
instance 15 vlan 295-315 switch(config-mst)#
instance 16 vlan 316-336 switch(config-mst)#
instance 17 vlan 337-357 switch(config-mst)#
instance 18 vlan 358-378 switch(config-mst)#
instance 19 vlan 379-399 switch(config-mst)#
instance 20 vlan 400-420 switch(config-mst)#
instance 21 vlan 421-441 switch(config-mst)#
instance 22 vlan 442-462 switch(config-mst)#
instance 23 vlan 463-483 switch(config-mst)#
instance 24 vlan 484-504 switch(config-mst)#
instance 25 vlan 505-525 switch(config-mst)#
instance 26 vlan 526-546 switch(config-mst)#
instance 27 vlan 547-567 switch(config-mst)#
instance 28 vlan 568-588 switch(config-mst)#
instance 29 vlan 589-609 switch(config-mst)#
instance 30 vlan 610-630 switch(config-mst)#
instance 31 vlan 631-651 switch(config-mst)#
instance 32 vlan 652-672 switch(config-mst)#
instance 33 vlan 673-693 switch(config-mst)#
instance 34 vlan 694-714 switch(config-mst)#
instance 35 vlan 715-735 switch(config-mst)#
instance 36 vlan 736-756 switch(config-mst)#
instance 37 vlan 757-777 switch(config-mst)#
instance 38 vlan 778-798 switch(config-mst)#
instance 39 vlan 799-819 switch(config-mst)#
instance 40 vlan 820-840 switch(config-mst)#
instance 41 vlan 841-861 switch(config-mst)#
instance 42 vlan 862-882 switch(config-mst)#
instance 43 vlan 883-903 switch(config-mst)#
instance 44 vlan 904-924 switch(config-mst)#
instance 45 vlan 925-945 switch(config-mst)#
instance 46 vlan 946-966
```

```
switch(config-mst)# instance 47 vlan 967-987
switch(config-mst)# instance 48 vlan 988-1008
switch(config-mst)# instance 49 vlan 1009-1029
switch(config-mst)# instance 50 vlan 1030-1050
switch(config-mst)# instance 51 vlan 1051-1071
switch(config-mst)# instance 52 vlan 1072-1092
switch(config-mst)# instance 53 vlan 1093-1113
switch(config-mst)# instance 54 vlan 1114-1134
switch(config-mst)# instance 55 vlan 1135-1155
switch(config-mst)# instance 56 vlan 1156-1176
switch(config-mst)# instance 57 vlan 1177-1197
switch(config-mst)# instance 58 vlan 1198-1218
switch(config-mst)# instance 59 vlan 1219-1239
switch(config-mst)# instance 60 vlan 1240-1260
switch(config-mst)# instance 61 vlan 1261-1281
switch(config-mst)# instance 62 vlan 1282-1302
switch(config-mst)# instance 63 vlan 1303-1323
switch(config-mst)# instance 64 vlan 1324-1344
switch(config-mst)# exit
switch(config)# interface ethernet 3/1
switch(config-if)# switchport switch(config-if)# no
shutdown switch(config-if)# spanning-tree port type
edge switch(congig-if)# exit

switch(config)# interface ethernet 3/2
switch(config-if)# switchport switch(config-if)#
switchport mode trunk switch(config-if)# no
shutdown switch(config-if)# spanning-tree guard
root switch(config-if)# exit
switch(config)#
```

8.10 Additional References for MST -- CLI Version

Related Documents

Related Topic	Document Title
Layer 2 interface	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
INOS-CN fundamentals	*Inspur CN12900 Series INOS-CN Fundamentals Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
System management	*Inspur CN12900 Series INOS-CN System Management Configuration Guide*

Standards

Standards	Title
IEEE 802.1Q-2006 (formerly known as IEEE 802.1s), IEEE 802.1D-2004 (formerly known as IEEE — 802.1w), IEEE 802.1D, IEEE 802.1t	

CHAPTER 9 Configuring STP Extensions Using Inspur INOS-CN

9.1 Information About STP Extensions

Inspur has added extensions to STP that enhances loop prevention, protects against some possible user misconfigurations, and provides better control over the protocol parameters. Although, in some cases, similar functionality may be incorporated into the IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) standard, we recommend using these extensions. All of these extensions, except PVST Simulation, can be used with both Rapid PVST+ and MST. You use PVST Simulation only with MST.

The available extensions are spanning tree edge ports (which supply the functionality previously known as PortFast), Bridge Assurance, BPDU Guard, BPDU Filtering, Loop Guard, Root Guard, and PVT Simulation. Many of these features can be applied either globally or on specified interfaces.

9.1.1 STP Port Types

You can configure a spanning tree port as an edge port, a network port, or a normal port. A port can be in only one of these states at a given time. The default spanning tree port type is normal.

Edge ports, which are connected to Layer 2 hosts, can be either an access port or a trunk port.

Network ports are connected only to Layer 2 switches or bridges.

STP Edge Ports

You connect STP edge ports only to Layer 2 hosts. The edge port interface immediately transitions to the forwarding state, without moving through the blocking or learning states.

Interfaces that are connected to Layer 2 hosts should not receive STP bridge protocol data units (BPDUs).

9.1.2 Bridge Assurance

You can use Bridge Assurance to protect against certain problems that can cause bridging loops in the network. Specifically, you use Bridge Assurance to protect against a unidirectional link failure or other software failure and a device that continues to forward data traffic when it is no longer running the spanning tree algorithm.

Bridge Assurance is enabled by default and can only be disabled globally. Also, Bridge Assurance can be enabled only on spanning tree network ports that are point-to-point links. Finally, both ends of the link must have Bridge Assurance enabled. If the device on one side of the link has Bridge Assurance enabled and the device on the other side either does not support Bridge Assurance or does not have this feature enabled, the connecting port is blocked.

With Bridge Assurance enabled, BPDUs are sent out on all operational network ports, including alternate and backup ports, for each hello time period. If the port does not receive a BPDU for a specified period, the port moves into the blocking state and is not used in the root port calculation. Once that port receives a BPDU, it resumes the normal spanning tree transitions.

Figure 8：Network with Normal STP Topology

This figure shows a normal STP topology.

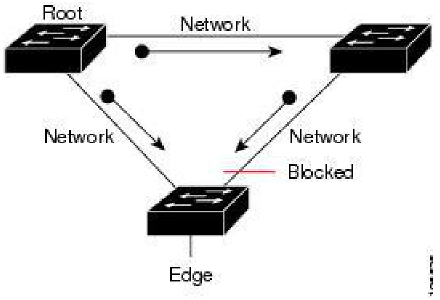


Figure 9： Network Problem without Running Bridge Assurance

This figure demonstrates a potential network problem when the device fails and you are not running Bridge Assurance.

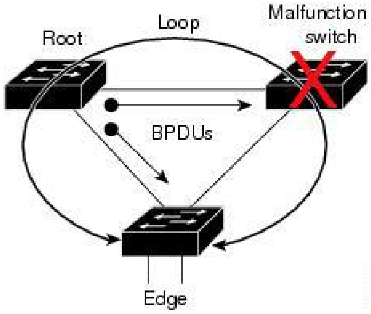


Figure 10： Network STP Topology Running Bridge Assurance

This figure shows the network with Bridge Assurance enabled, and the STP topology progressing normally with bidirectional BPDUs issuing from every STP network port.

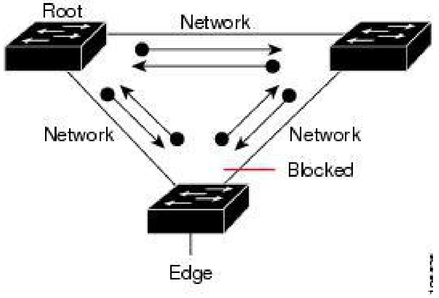
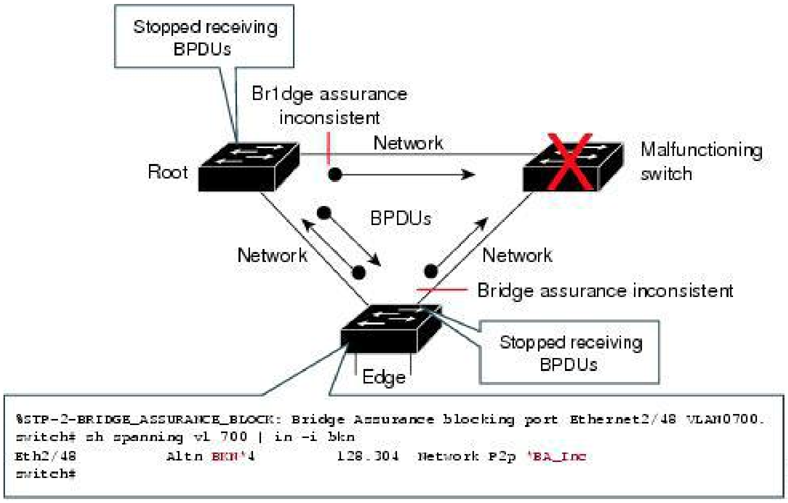


Figure 11： Network Problem Averted with Bridge Assurance Enabled

This figure shows how the potential network problem does not happen when you have Bridge Assurance enabled on your network.



```
%STP-2-BRIDGE_ASSURANCE_BLOCK: Bridge Assurance blocking port Ethernet2/48 VLAN0700.
switch# sh spanning vl 700 | in -i bkn
Eth2/48          Altn BKN*4         128.304  Network P2p *BA_Inc
switch#
```

9.1.3 BPDU Guard

Enabling BPDU Guard shuts down that interface if a BPDU is received.

You can configure BPDU Guard at the interface level. When configured at the interface level, BPDU Guard shuts the port down as soon as the port receives a BPDU, regardless of the port type configuration.

When you configure BPDU Guard globally, it is effective only on operational spanning tree edge ports. In a valid configuration, Layer 2 LAN edge interfaces do not receive BPDUs. A BPDU that is received by an edge Layer 2 LAN interface signals an invalid configuration, such as the connection of an unauthorized device.

BPDU Guard, when enabled globally, shuts down all spanning tree edge ports when they receive a BPDU.

BPDU Guard provides a secure response to invalid configurations, because you must manually put the Layer 2 LAN interface back in service after an invalid configuration.

9.1.4 BPDU Filtering

1You can use BPDU Filtering to prevent the device from sending or even receiving BPDUs on specified ports.

When configured globally, BPDU Filtering applies to all operational spanning tree edge ports. You should connect edge ports only to hosts, which typically drop BPDUs. If an operational spanning tree edge port receives a BPDU, it immediately returns to a normal spanning tree port type and moves through the regular transitions. In that case, BPDU Filtering is disabled on this port, and spanning tree resumes sending BPDUs on this port.

In addition, you can configure BPDU Filtering by the individual interface. When you explicitly configure BPDU Filtering on a port, that port does not send any BPDUs and drops all BPDUs that it receives. You can effectively override the global BPDU Filtering setting on individual ports by configuring the specific interface.

This BPDU Filtering command on the interface applies to the entire interface, whether the interface is trunking or not.

Caution	Use care when configuring BPDU Filtering per interface. If you explicitly configure BPDU Filtering on a port that is not connected to a host, it can result in bridging loops because the port will ignore any BPDU that it receives and go to forwarding.

This table lists all the BPDU Filtering combinations.

Table 13：BPDU Filtering Configurations

BPDU Filtering Per Port Configuration	BPDU Filtering Global Configuration	STP Edge Port Configuration	BPDU Filtering State
Default [1]	Enable	Enable	Enable [2]

Default	Enable	Disable	Disable
Default	Disable	Not applicable	Disable
Disable	Not applicable	Not applicable	Disable
Enable	Not applicable	Not applicable	Enable

1 No explicit port configuration.

2 The port transmits at least 10 BPDUs. If this port receives any BPDUs, the port returns to the spanning tree normal port state and BPDU filtering is disabled.

9.1.5 Loop Guard

Loop Guard helps prevent bridging loops that could occur because of a unidirectional link failure on a point-to-point link.

An STP loop occurs when a blocking port in a redundant topology erroneously transitions to the forwarding state. Transitions are usually caused by a port in a physically redundant topology (not necessarily the blocking port) that stops receiving BPDUs.

When you enable Loop Guard globally, it is useful only in switched networks where devices are connected by point-to-point links. On a point-to-point link, a designated bridge cannot disappear unless it sends an inferior BPDU or brings the link down. However, you can enable Loop Guard on shared links per interface,

You can use Loop Guard to determine if a root port or an alternate/backup root port receives BPDUs. If the port that was previously receiving BPDUs is no longer receiving BPDUs, Loop Guard puts the port into an inconsistent state (blocking) until the port starts to receive BPDUs again. If such a port receives BPDUs again, the port—and link—is deemed viable again. The protocol removes the loop-inconsistent condition from the port, and the STP determines the port state because the recovery is automatic.

Loop Guard isolates the failure and allows STP to converge to a stable topology without the failed link or bridge. Disabling Loop Guard moves all loop-inconsistent ports to the listening state.

You can enable Loop Guard on a per-port basis. When you enable Loop Guard on a port, it is automatically applied to all of the active instances or VLANs to which that port belongs. When you disable Loop Guard, it is disabled for the specified ports.

Enabling Loop Guard on a root device has no effect but provides protection when a root device becomes a nonroot device.

9.1.6 Root Guard

When you enable Root Guard on a port, Root Guard does not allow that port to become a root port. If a received BPDU triggers an STP convergence that makes that designated port become a root port, that port is put into a root-inconsistent (blocked) state. After the port stops receiving superior BPDUs, the port is unblocked again. Through STP, the port moves to the forwarding state. Recovery is automatic.

When you enable Root Guard on an interface, this functionality applies to all VLANs to which that interface belongs.

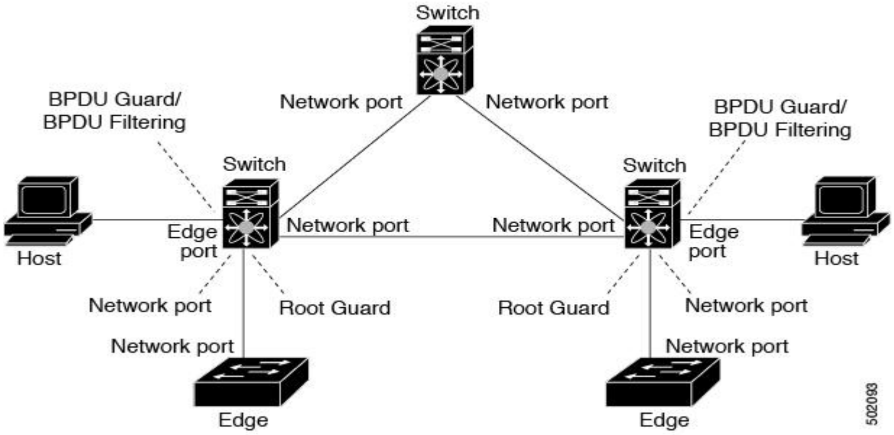
You can use Root Guard to enforce the root bridge placement in the network. Root Guard ensures that the port on which Root Guard is enabled is the designated port. Normally, root bridge ports are all designated ports, unless two or more of the ports of the root bridge are connected. If the bridge receives superior BPDUs on a Root Guard-enabled port, the bridge moves this port to a root-inconsistent STP state. In this way, Root Guard enforces the position of the root bridge.

You cannot configure Root Guard globally.

9.1.7 Applying STP Extension Features

Figure 12：Network with STP Extensions Correctly Deployed

We recommend that you configure the various STP extension features through your network as shown in this figure. Bridge Assurance is enabled on the entire network. You should enable either BPDU Guard or BPDU Filtering on the host interface.



9.1.8 PVST Simulation

MST interoperates with Rapid PVST+ with no need for user configuration. The PVST simulation feature enables this interoperability.

However, you may want to control the connection between MST and Rapid PVST+ to protect against accidentally connecting an MST-enabled port to a port enabled to run Rapid PVST+. Because Rapid PVST+ is the default STP mode, you may encounter many Rapid PVST+ connections.

Disabling Rapid PVST+ simulation, which can be done per port or globally for the entire device, moves the MST-enabled port to the blocking state once it detects it is connected to a Rapid PVST+-enabled port. This port remains in the inconsistent state until the port stops receiving Rapid PVST+/SSTP BPDUs, and then the port resumes the normal STP transition process.

The root bridge for all STP instances must all be in either the MST region or the Rapid PVST+ side. If the root bridge for all STP instances are not on one side or the other, the software moves the port into a PVST simulation-inconsistent state.

9.1.9 High Availability for STP

The software supports high availability for STP. However, the statistics and timers are not restored when STP restarts. The timers start again and the statistics begin from 0.

9.2 Licensing Requirements for STP Extensions

The following table shows the licensing requirements for this feature:

Product	License Requirement
Inspur INOS-CN	STP extensions require no license. Any feature not included in a license package is bundled with the Inspur INOS-CN system images and is provided at no extra charge to you.

9.3 Prerequisites for STP Extensions

STP has the following prerequisites:

- You must be logged onto the device.
- You must have STP configured already.

9.4 Guidelines and Limitations for Configuring STP Extensions

STP extensions have the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- Connect STP network ports only to switches.
- You should configure host ports as STP edge ports and not as network ports.
- If you enable STP network port types globally, ensure that you manually configure all ports connected to hosts as STP edge ports.
- You should configure all access and trunk ports connected to Layer 2 hosts as edge ports.
- Bridge Assurance runs only on point-to-point spanning tree network ports. You must configure each side of the link for this feature.
- We recommend that you enable Bridge Assurance throughout your network.
- We recommend that you enable BPDU Guard on all edge ports.
- Enabling Loop Guard globally works only on point-to-point links.
- Enabling Loop Guard per interface works on both shared and point-to-point links.
- Root Guard forces a port to always be a designated port; it does not allow a port to become a root port. Loop Guard is effective only if the port is a root port or an alternate port. You cannot enable Loop Guard and Root Guard on a port at the same time.
- Loop Guard has no effect on a disabled spanning tree instance or a VLAN.
- Spanning tree always chooses the first operational port in the channel to send the BPDUs. If that link becomes unidirectional, Loop Guard blocks the channel, even if other links in the channel are functioning properly.
- If you group together a set of ports that are already blocked by Loop Guard to form a channel, spanning tree loses all the state information for those ports and the new channel port may obtain the forwarding state with a designated role.
- If a channel is blocked by Loop Guard and the channel members go back to an individual link status, spanning tree loses all the state information. The individual physical ports may obtain the forwarding state with the designated role, even if one or more of the links that formed the channel are unidirectional.

Caution	You can enable UniDirectional Link Detection (UDLD) aggressive mode to isolate the link failure. A loop may occur until UDLD detects the failure, but Loop Guard will not be able to detect it. See the *Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*, for information on UDLD.

- You should enable Loop Guard globally on a switch network with physical loops.
- You should enable Root Guard on ports that connect to network devices that are not under direct administrative control.
- After the maximum MAC learning limit , all incoming packets are not learnt in the MAC table and are forwarded based on the destination MAC.

9.5 Default Settings for STP Extensions

This table lists the default settings for STP extensions.

Table 14 : Default STP Extension Parameters

Parameters	Default

Port type	Normal
Bridge Assurance	Enabled (on STP network ports only)
Global BPDU Guard	Disabled
BPDU Guard per interface	Disabled
Global BPDU Filtering	Disabled
BPDU Filtering per interface	Disabled
Global Loop Guard	Disabled
Loop Guard per interface	Disabled
Root Guard per interface	Disabled
PVST simulation	Enabled

9.6 Configuring STP Extensions Steps

You can enable Loop Guard per interface on either shared or point-to-point links.

9.6.1 Configuring Spanning Tree Port Types Globally

The spanning tree port type designation depends on the device the port is connected to, as follows:

- Edge—Edge ports are connected to Layer 2 hosts and are access ports.
- Network—Network ports are connected only to Layer 2 switches or bridges and can be either access or trunk ports.
- Normal—Normal ports are neither edge ports nor network ports; they are normal spanning tree ports. These ports can be connected to any device.

You can configure the port type either globally or per interface. By default, the spanning tree port type is normal.

Before you begin

Before you configure the spanning port type, you should do the following:

- Ensure that STP is configured.
- Ensure that you are configuring the ports correctly as to the device to which the port is connected.

SUMMARY STEPS

1. **config t**
2. **spanning-tree port type edge default** or **spanning-tree port type network default**
3. **exit**
4. (Optional) **show spanning-tree summary**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t** **Example:** `switch# config t`	Enters configuration mode.

	Command or Action	Purpose
	`switch(config)#`	
Step 2	**spanning-tree port type edge default** or **spanning-tree port type network default** **Example:** `switch(config)# spanning-tree port type edge default`	• **spanning-tree port type edge default** Configures all access ports connected to Layer 2 hosts as edge ports. Edge ports immediately transition to the forwarding state without passing through the blocking or learning state at linkup. By default, spanning tree ports are normal port types. • **spanning-tree port type network default** Configures all interfaces connected to Layer 2 switches and bridges as spanning tree network ports. If you enable Bridge Assurance, it automatically runs on network ports. By default, spanning tree ports are normal port types. **Note** If you configure interfaces connected to Layer 2 hosts as network ports, those ports automatically move into the blocking state.

Step 3	**exit**
	Example
	:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree summary** **Example** **:** `switch# show spanning-tree summary`	Displays the STP configuration including STP port types if configured.
Step 5	(Optional) **copy running-config startup-config** **Example** **:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure all access ports connected to Layer 2 hosts as spanning tree edge ports:

```
switch# config t
switch(config)# spanning-tree port type edge default
switch(config)#
exit switch#
```

This example shows how to configure all ports connected to Layer 2 switches or bridges as spanning tree network ports:

```
switch# config t
switch(config)# spanning-tree port type network default
switch(config)#
exit switch#
```

9.6.2 Configuring Spanning Tree Edge Ports on Specified Interfaces

You can configure spanning tree edge ports on specified interfaces. Interfaces configured as spanning tree edge ports immediately transition to the forwarding state, without passing through the blocking or learning states, on linkup.

This command has four states:

- **spanning-tree port type edge**—This command explicitly enables edge behavior on the access port.
- **spanning-tree port type edge trunk**—This command explicitly enables edge behavior on the trunk port.
- **spanning-tree port type normal**—This command explicitly configures the port as a normal spanning tree port and the immediate transition to the forwarding state is not enabled.
- **no spanning-tree port type**—This command implicitly enables edge behavior if you define the **spanning-tree port type edge default** command in global configuration mode. If you do not configure the edge ports globally, the **no spanning-tree port type** command is equivalent to the **spanning-tree port type normal** command.

Before you begin

Before you configure the spanning port type, you should do the following:

- Ensure that STP is configured.
- Ensure that you are configuring the ports correctly as to the device to which the port is connected.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree port type edge**
4. **exit**
5. (Optional) **show spanning-tree interface** *type slot/port*
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port* **Example:**	Specifies the interface to configure, and enters the interface configuration mode.

	Command or Action	Purpose

	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`	

Step 3	**spanning-tree port type edge** **Example:** `switch(config-if)# spanning-tree port type edge`	Configures the specified access interfaces to be spanning edge ports. Edge ports immediately transition to the forwarding state without passing through the blocking or learning state at linkup. By default, spanning tree ports are normal port types.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface configuration mode.

Step 5	(Optional) **show spanning-tree interface** *type slot/port* **Example:** `switch# show spanning-tree ethernet 1/4`	Displays the STP configuration including the STP port type if configured.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to configure the Ethernet access interface 1/4 to be a spanning tree edge port:

```
switch# config t

switch(config)# interface ethernet 1/4
switch(config-if)# spanning-tree port type edge
switch(config-if)#
exit switch(config)#
```

9.6.3 Configuring Spanning Tree Network Ports on Specified Interfaces

You can configure spanning tree network ports on specified interfaces.
Bridge Assurance runs only on spanning tree network ports.

This command has three states:

- **spanning-tree port type network**—This command explicitly configures the port as a network port. If you enable Bridge Assurance globally, it automatically runs on a spanning tree network port.
- **spanning-tree port type normal** —This command explicitly configures the port as a normal spanning tree port and Bridge Assurance cannot run on this interface.
- **no spanning-tree port type**—This command implicitly enables the port as a spanning tree network port if you define the **spanning-tree port type network default** command in global configuration mode. If you enable

Bridge Assurance globally, it automatically runs on this port.

Before you begin

Before you configure the spanning port type, you should do the following:

- Ensure that STP is configured.
- Ensure that you are configuring the ports correctly as to the device to which the port is connected.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree port type network**
4. **exit**
5. (Optional) **show spanning-tree interface** *type slot/port*
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure, and enters the interface configuration mode.

Step 3	**spanning-tree port type network** **Example:** `switch(config-if)# spanning-tree port type network`	Configures the specified interfaces to be spanning network ports. If you enable Bridge Assurance, it automatically runs on network ports. By default, spanning tree ports are normal port types.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface configuration mode.

Step 5	(Optional) **show spanning-tree interface** *type slot/port* **Example:** `switch# show spanning-tree interface ethernet 1/4`	Displays the STP configuration including the STP port type if configured.
Step 6	(Optional) **copy running-config startup-config** **Example:**	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	`switch# copy running-config startup-config`	

Example

This example shows how to configure the Ethernet interface 1/4 to be a spanning tree network port:

```
switch# config t
switch(config)# interface ethernet 1/4 switch(config-
if)# spanning-tree port type network


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

9.6.4 Enabling BPDU Guard Globally

You can enable BPDU Guard globally by default. In this condition, the system shuts down an edge port that receives a BPDU.

Before you begin

Before you configure the spanning port type, you should do the following:

- Ensure that STP is configured.
- Ensure that you are configuring the ports correctly as to the device to which the port is connected.

SUMMARY STEPS

1. **config t**
2. **spanning-tree port type edge bpduguard default**
3. **exit**
4. (Optional) **show spanning-tree summary**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree port type edge bpduguard default** **Example:** `switch(config)# spanning-tree port type edge bpduguard default`	Enables BPDU Guard by default on all spanning tree edge ports. By default, global BPDU Guard is disabled.
Step 3	**exit** **Example:**	Exits configuration mode.

	Command or Action	Purpose

	`switch(config)# exit`
	`switch#`	

Step 4	(Optional) **show spanning-tree summary** **Example:** `switch# show spanning-tree summary`	Displays summary STP information.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable BPDU Guard on all spanning tree edge ports:

```
switch# config t
switch(confiig)# spanning-tree port type edge bpduguard default
switch(config)#
exit switch#
```

9.6.5 Enabling BPDU Guard on Specified Interfaces

You can enable BPDU Guard on specified interfaces. Enabling BPDU Guard shuts down the port if it receives a BPDU.

You can configure BPDU Guard on specified interfaces as follows:

- **spanning-tree bpduguard enable** —Unconditionally enables BPDU Guard on the interface.
- **spanning-tree bpduguard disable** —Unconditionally disables BPDU Guard on the interface.
- **no spanning-tree bpduguard** —Enables BPDU Guard on the interface if it is an operational edge port and if the **spanning-tree port type edge bpduguard default** command is configured.

Before you begin

Before you configure this feature, you should do the following:

- Ensure that STP is configured.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree bpduguard** {**enable** | **disable**} or **no spanning-tree bpduguard**
4. **exit**
5. (Optional) **show spanning-tree interface** *type slot/port* **detail**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**config t** **Example:** `switch# config t`	Enters configuration mode.

	Command or Action	Purpose
	`switch(config)#`	

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure, and enters the interface configuration mode.

Step 3	**spanning-tree bpduguard** {**enable** | **disable**} or **no spanning-tree bpduguard** **Example:** `switch(config-if)# spanning-tree bpduguard enable`	• **spanning-tree bpduguard** {**enable** | **disable**} Enables or disables BPDU Guard for the specified spanning tree edge interface. By default, BPDU Guard is disabled on the interfaces. • **no spanning-tree bpduguard** Falls back to the default BPDU Guard global setting that you set for the interfaces by entering the **spanning-tree port type edge bpduguard default** command.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree interface** *type slot/port* **detail**
	Example:
	`switch# show spanning-tree interface ethernet`
	`detail`
		Displays summary STP information.

Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to explicitly enable BPDU Guard on the Ethernet edge port 1/4:

```
switch# config t

switch(config)# interface ethernet 1/4
switch(config-if)# spanning-tree bpduguard enable
switch(config-if)#
exit switch(config)#
```

9.6.6 Enabling BPDU Filtering Globally

You can enable BPDU Filtering globally by default on spanning tree edge ports.

If an edge port with BPDU Filtering enabled receives a BPDU, it loses its operation status as edge port and resumes the regular STP transitions. However, this port maintains its configuration as an edge port.

Caution	Be careful when using this command. Using this command incorrectly can cause bridging loops

Before you begin

Before you configure this feature, you should do the following:

- Ensure that STP is configured.
- Ensure that you have configured some spanning tree edge ports.

SUMMARY STEPS

1. **config t**
2. **spanning-tree port type edge bpdufilter default**
3. **exit**
4. (Optional) **show spanning-tree summary**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree port type edge bpdufilter default** **Example:** `switch(config)# spanning-tree port type edge bpdufilter default`	Enables BPDU Filtering by default on all operational spanning tree edge ports. Global BPDU Filtering is disabled by default.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree summary** **Example:** `switch# show spanning-tree summary`	Displays summary STP information.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable BPDU Filtering on all operational spanning tree edge ports:

```
switch# config t
switch(config)# spanning-tree port type edge bpdufilter default
switch(config)#
exit switch#
```

9.6.7 Enabling BPDU Filtering on Specified Interfaces

You can apply BPDU Filtering to specified interfaces. When enabled on an interface, that interface does not send any BPDUs and drops all BPDUs that it receives. This BPDU Filtering functionality applies to the entire interface, whether trunking or not.

Caution	Be careful when you enter the **spanning-tree bpdufilter enable** command on specified interfaces. Explicitly configuring BPDU Filtering on a port that is not connected to a host can result in bridging loops because the port will ignore any BPDU that it receives and go to forwarding.

You can enter this command to override the port configuration on specified interfaces.

This command has three states:

- **spanning-tree bpdufilter enable**—Unconditionally enables BPDU Filtering on the interface.
- **spanning-tree bpdufilter disable—**Unconditionally disables BPDU Filtering on the interface.
- **no spanning-tree bpdufilter** ——Enables BPDU Filtering on the interface if the interface is in operational edge port and if you configure the **spanning-tree port type edge bpdufilter default** command.

Before you begin

Before you configure this feature, you should do the following:

- Ensure that STP is configured.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree bpdufilter** {**enable** | **disable**} or **no spanning-tree bpdufilter**
4. **exit**
5. (Optional) **show spanning-tree summary**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port* **Example:** `switch(config)# interface ethernet 1/4`	Specifies the interface to configure, and enters the interface configuration mode.

	Command or Action	Purpose
	`switch(config-if)#`	
Step 3	**spanning-tree bpdufilter** {**enable** | **disable**} or **no spanning-tree bpdufilter** **Example:** `switch(config-if)# spanning-tree bpdufilter enable`	• **spanning-tree bpdufilter** {**enable** | **disable**} Enables or disables BPDU Filtering for the specified spanning tree edge interface. By default, BPDU Filtering is disabled. • **no spanning-tree bpdufilter** Enables BPDU Filtering on the interface if the interface is an operational spanning tree edge port and if you enter the **spanning-tree port type edge bpdufilter default** command.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree summary** **Example:** `switch# show spanning-tree summary`	Displays summary STP information.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to explicitly enable BPDU Filtering on the Ethernet spanning tree edge port 1/4:

```
switch# config t

switch(config)# interface ethernet 1/4 switch(config-
if)# spanning-tree bpdufilter enable
switch(config-if)# exit
switch(config)#
```

9.6.8 Enabling Loop Guard Globally

You can enable Loop Guard globally by default on all point-to-point spanning tree normal and network ports. Loop Guard does not run on edge ports.

Loop Guard provides additional security in the bridge network. Loop Guard prevents alternate or root ports from becoming the designated port because of a failure that could lead to a unidirectional link.

Before you begin

Before you configure this feature, you should do the following:

- Ensure that STP is configured.
- Ensure that you have spanning tree normal ports or have configured some network ports.

SUMMARY STEPS

1. **config t**
2. **spanning-tree loopguard default**
3. **exit**
4. (Optional) **show spanning-tree summary**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**spanning-tree loopguard default** **Example:** `switch(config)# spanning-tree loopguard default`	Enables Loop Guard by default on all spanning tree normal and network ports. By default, global Loop Guard is disabled.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree summary** **Example:** `switch# show spanning-tree summary`	Displays summary STP information.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable Loop Guard on all spanning tree normal or network ports:

```
switch# config t

switch(config)# spanning-tree loopguard default
switch(config)#
exit switch#
```

9.6.9 Enabling Loop Guard or Root Guard on Specified Interfaces

You can enable either Loop Guard or Root Guard on specified interfaces.

Enabling Root Guard on a port means that port cannot become a root port, and Loop Guard prevents alternate or root ports from becoming the designated port because of a failure that could lead to a unidirectional link

Both Loop Guard and Root Guard enabled on an interface apply to all VLANs to which that interface belongs.

Before you begin

Before you configure this feature, you should do the following:

- Ensure that STP is configured.
- Ensure that you are configuring Loop Guard on spanning tree normal or network ports.

SUMMARY STEPS

1. **config t**
2. **interface** *type slot/port*
3. **spanning-tree guard** {**loop** | **root** | **none**}
4. **exit**
5. **interface** *type slot/port*
6. **spanning-tree guard** {**loop** | **root** | **none**}
7. **exit**
8. (Optional) **show spanning-tree interface** *type slot/port* **detail**
9. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/4`
	`switch(config-if)#`
		Specifies the interface to configure, and enters the interface configuration mode.

Step 3	**spanning-tree guard** {**loop** | **root** | **none**}
	Example:
	`switch(config-if)# spanning-tree guard loop`
		Enables or disables either Loop Guard or Root Guard for the specified interface. By default, Root Guard is disabled by default, and Loop Guard on specified ports is also disabled.
		Note Loop Guard runs only on spanning tree normal and network interfaces. This example shows Loop Guard is enabled on the specified interface.

Step 4	**exit** **Example:**	Exits interface mode.

	Command or Action	Purpose

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

Step 5	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 1/10`
	`switch(config-if)#`
		Specifies the interface to configure, and enters the interface configuration mode.

Step 6	**spanning-tree guard** {**loop** | **root** | **none**}
	Example:
	`switch(config-if)# spanning-tree guard root`
		Enables or disables either Loop Guard or Root Guard for the specified interface. By default, Root Guard is disabled by default, and Loop Guard on specified ports is also disabled.
		The example shows Root Guard is enabled on a different interface.

Step 7	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 8	(Optional) **show spanning-tree interface** *type slot/port* **detail** **Example:** `switch# show spanning-tree interface ethernet 1/4 detail`	Displays summary STP information.
Step 9	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to enable Root Guard on Ethernet port 1/4:

```
switch# config t
switch(config)# interface etherent 1/4
switch(config-if)# spanning-tree guard root
switch(config-if)#
exit switch(config)#
```

9.6.10 Configuring PVST Simulation Globally-CLI Version

MST interoperates with Rapid PVST+. However, to prevent an accidental connection to a device that does not run MST as the default STP mode, you may want to disable this automatic feature. If you disable PVST simulation, the MST-enabled port moves to the blocking state once it detects it is connected to a Rapid PVST+-enabled port. This port remains in the inconsistent state until the port stops receiving BPDUs, and then the port resumes the normal STP transition process.

You can block this automatic feature either globally or per port. You can enter the global command and change the PVST simulation setting for the entire device while you are in interface command mode.

SUMMARY STEPS

1. **config t**
2. **no spanning-tree mst simulate pvst global**
3. **exit**
4. (Optional) **show spanning-tree summary**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**no spanning-tree mst simulate pvst global**
	Example:
	`switch(config)# no spanning-tree mst simulate pvst`
	` global`
		Disables all interfaces on the switch from automatically
		interoperating with a connected device that is running in
		Rapid PVST+ mode. The default for this is enabled; by
		default, all interfaces on the device operate between Rapid
		PVST+ and MST.

Step 3	**exit**
	Example:
	`switch(config)# exit`
	`switch#`
		Exits configuration mode.

Step 4	(Optional) **show spanning-tree summary** **Example:** `switch# show spanning-tree summary`	Displays detailed STP information.
Step 5	(Optional) **copy running-config startup-config** **Example:** `switch# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to prevent the device from automatically interoperating with a connecting device that is running Rapid PVST+:

```
switch# config t
```

```
switch(config)# no spanning-tree mst simulate pvst global
switch(config)
# exit switch#
```

9.6.11 Configuring PVST Simulation Per Port

You can configure PVST simulation only when you are running MST on the device (Rapid PVST+ is the default STP mode). MST interoperates with Rapid PVST+. However, to prevent an accidental connection to a device that does not run MST as the default STP mode, you may want to disable this automatic feature. If you disable PVST simulation, the MST-enabled port moves to the blocking state once it detects that it is connected to a Rapid PVST+-enabled port. This port remains in the inconsistent state until the port stops receiving Rapid PVST+ BPDUs, and then the port resumes the normal STP transition process.

You can block this automatic feature either globally or per port.

SUMMARY STEPS

1. **config t**
2. **interface** {{*type slot/port*} |{**port-channel** *number*}}
3. **spanning-tree mst simulate pvst disable** or **spanning-tree mst simulate pvst** or **no spanning-tree mst simulate pvst**
4. **exit**
5. (Optional) **show spanning-tree interface** *type slot/port* **detail**
6. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**config t**
	Example:
	`switch# config t`
	`switch(config)#`
		Enters configuration mode.

Step 2	**interface** {{*type slot/port*} |{**port-channel** *number*}}
	Example:
	`switch(config)# interface ethernet 3/1`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface
		configuration mode.

Step 3	**spanning-tree mst simulate pvst disable** or **spanning-tree** **mst simulate pvst** or **no spanning-tree mst simulate** **pvst** **Example:** `switch(config-if)# spanning-tree mst simulate pvst`	• **spanning-tree mst simulate pvst disable** Disables specified interfaces from automatically interoperating with a connected device that is running in Rapid PVST+ mode. By default, all interfaces on the device operate between Rapid PVST+ and MST. • **spanning-tree mst simulate pvst** Reenables seamless operation between MST and Rapid

	Command or Action	Purpose
		PVST+ on specified interfaces. • **no spanning-tree mst simulate pvst** Sets the interface to the device-wide MST and Rapid PVST+ interoperation that you configured using the **spanning-tree mst simulate pvst global** command.

Step 4	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits interface mode.

Step 5	(Optional) **show spanning-tree interface** *type slot/port* **detail** **Example:** `switch# show spanning-tree interface ethernet 3/1 detail`	Displays detailed STP information.
Step 6	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Example

This example shows how to prevent the specified interfaces from automatically interoperating with a connecting device that is not running MST:

```
switch(config-if)# spanning-tree mst simulate pvst
switch(config-if)#
```

9.7 Verifying the STP Extension Configuration

To display the configuration information for the STP extensions, perform one of the following tasks:

Command	Purpose
show running-config spanning-tree [**all**]	Displays information about STP.
show spanning-tree summary	Displays summary information on STP.
show spanning-tree mst *instance-id* **interface** {**ethernet** *slot/port* | **port-channel** *channel-number*} [**detail**]	Displays MST information for the specified interface and instance.

9.8 Configuration Examples for STP Extension

The following example shows how to configure the STP extensions:

```
switch# configure terminal
switch(config)# spanning-tree port type network default
switch(config)# spanning-tree port type edge bpduguard default
switch(config)# spanning-tree port type edge bpdufilter default
switch(config)# interface ethernet 1/1
switch(config-if)# spanning-tree port type
edge switch(config-if)# exit
switch(config)# interface ethernet 1/2
switch(config-if)# spanning-tree port type
edge switch(config-if)# exit
switch(config)#
```

9.9 Additional References for STP Extensions -- CLI Version

Related Documents

Related Topic	Document Title
Layer 2 interfaces	*Inspur CN12900 Series INOS-CN Interfaces Configuration Guide*
INOS-CN fundamentals	*Inspur CN12900 Series INOS-CN Fundamentals Configuration Guide*
High availability	*Inspur CN12900 Series INOS-CN High Availability and Redundancy Guide*
System management	*Inspur CN12900 Series INOS-CN System Management Configuration Guide*

Standards

Standards	Title
IEEE 802.1Q-2006 (formerly known as IEEE 802.1s), IEEE 802.1D-2004 (formerly known as IEEE — 802.1w), IEEE 802.1D, IEEE 802.1t	

CHAPTER 10 Configuring Reflective Relay for Layer 2 Switching

10.1 About Reflective Relay 802.1Qbg

Inspur CN12900 series switches support the switching option, reflective relay.This feature is a tagless approach of IEEE standard 802.1Qbg. It forwards all traffic to an external switch that applies policy and sends the traffic back to the destination or target VM on the server as needed. There is no local switching. For broadcast or multicast traffic, reflective relay provides packet replication to each VM locally on the server.

Reflective relay leverages the external switch for switching features and management capabilities, freeing server resources to support the VMs. Reflective relay applies the policies you configure on the Inspur switches to traffic between the VMs on the same server.

You can enable reflective relay to turn back traffic out of the same port it came in on. You can enable reflective relay on a Layer 2 physical port or port-channel interface policy using the INOS-CN CLI. This feature is disabled by default.

The term Virtual Ethernet Port Aggregator (VEPA) is also used to describe 802.1Qbg functionality.

10.1.1 Reflective Relay Support

Reflective relay supports the following:

- IEEE standard 802.1Qbg tagless approach, known as reflective relay.
- Physical domains—virtual domains are not supported.
- Physical ports and port channels—If reflective relay is enabled on an unsupported interface, a fault is raised, and the last valid configuration is retained. Disabling reflective relay on the port clears the fault.

10.2 Guidelines and Limitations for Reflective Relay

Reflective relay has the following configuration guideline or limitation:

- You must configure all server facing interfaces to support reflective relay.

10.3 Configuring Reflective Relay Using the INOS-CN CLI

Reflective relay is disabled by default; however, you can enable it on a port or port channel as a Layer 2 interface policy on the switch. In the INOS-CN CLI, you can use a template to enable reflective relay on multiple ports or you can enable it on individual ports.

Step 1 `configure terminal`

Example:

```
switch# configure
terminal
switch(config)#
```

Enters global configuration mode.

Step 2 `interface ethernet 1/2`

Example:

```
switch(config)# interface
ethernet 1/2 switch(config-if)#
```

Enables the port.

Step 3 **`switchport mode virtual-ethernet-bridge`**

Example:

```
switch(config-if)# switchport mode virtual-ethernet-
bridge switch(config-if)#
```

Configures the Layer 2 port as a host port for the reflective relay feature.

Step 4 **`[no] switchport virtual-ethernet-bridge`**

Example:

```
switch(config-if)# switchport virtual-ethernet-bridge
```

Enables the reflective relay feature.

Note The reflective relay feature is only supported on access or trunk ports.