iBiome - PVRST+ User Guide

RAPTOR™

Intelligent Cyber Secure Platform

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Contents

INTRODUCTION

1. Introduction

iS5Com PVRST+ (Per Virtual local area network Rapid Spanning Tree) (aka Rapid PVST+) protocol is an enhancement to RSTP (Rapid Spanning Tree Protocol) and works in conjunction with VLAN (Virtual Local Area Network) to provide better control over traffic in the network. PVRST allows a separate spanning tree is maintained for each active VLAN in the network; thus, providing Load balancing through Multiple Instances of Spanning Tree, Fault Tolerance (as failure of one spanning tree instance does not affect others), and Rapid Reconfiguration support through the RSTP.

Rapid PVST+ protocol, which is covered in this document, is as per the IEEE 802.1w standard RSTP which is implemented on a per VLAN basis. Rapid PVST+ interoperates with switches that run legacy IEEE 802.1D STP, as standard which mandates a single STP instance for all VLANs, rather than per VLAN.

Rapid Spanning Tree is a link management protocol that provides path redundancy while preventing undesirable loops in the network, where multiple active paths between stations create these loops. To establish path redundancy, STP (Spanning Tree Protocol) creates a tree that spans all switches in an extended network, forcing redundant paths into a standby or blocked state.

For an Ethernet network to function properly, only one active path must exist between two stations. Multiple active paths between stations in a bridged network can cause loops in which Ethernet frames can endlessly circulate. STP can logically break such loops and prevent looping traffic from clogging the network. The dynamic control of the topology provides continued network operation in the presence of redundant or unintended looping paths.

1.1. Purpose and Scope

This document describes the configuration of PVRST on the switch running IS5Com ISS (Intelligent Switch Solution). The user is expected to have a basic knowledge of the protocol as a pre-requisite

1.2. CLI Document Convention

To provide a consistent user experience, this CLI document convention adhere to the Industry Standard CLI syntax.

In addition, the font and format are updated to show DITA / Structured Framemaker 2019 layout.

Convention	Usage	DESCRIPTION
Italics	User inputs for CLI command	`configure terminal`
Font as shown	Syntax of the CLI command	`configure terminal`
< >	Parameter inside the brackets < > indicate the Input fields of syntax	`<integer (100-1000)>`
[ ]	Parameter inside [ ] indicate optional fields of syntax	`show split-horizon [all]`
{ }	Grouping parameters in the syntax	`ip address <ip-address> [secondary {node0 | node1}]`
|	Separating grouped parameters in the syntax	`set http authentication-scheme {default| basic| digest}`

Font & format as shown	Example & CLI command outputs	iS5comm# show split-horizon interface 1
		`Ingress Port VlanId StorageType Egress List`
		`========== ====== ========== ==========`
		`Gi0/1 - Volatile Gi0/2,Gi0/3,Gi0/6`

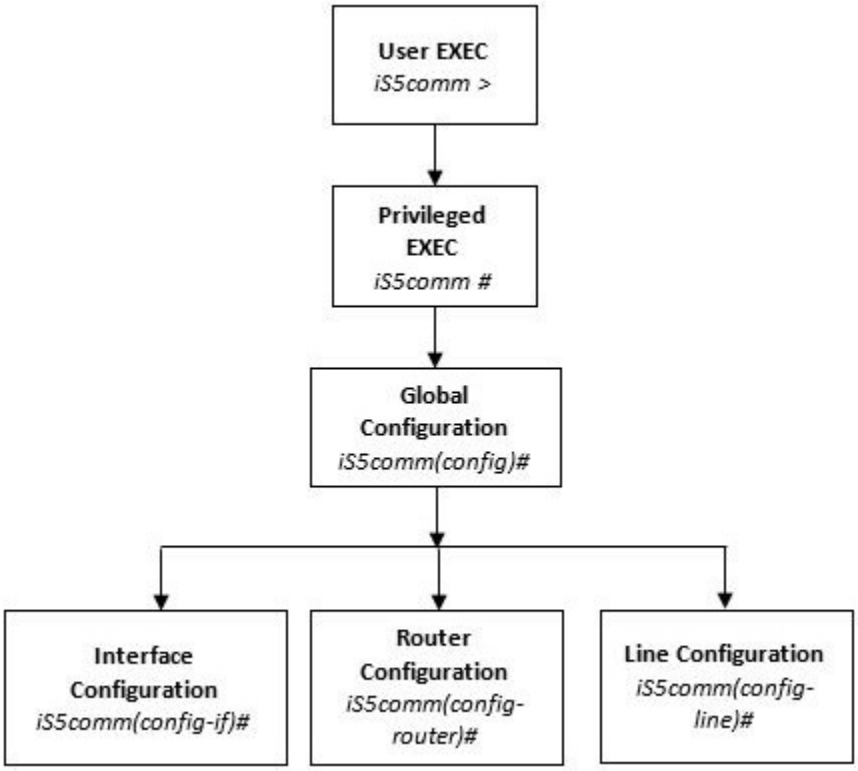
Note	Notes	**NOTE:** All commands are case-sensitive

1.3. CLI Command Modes

Depending on the CLI mode, iS5comm prompt will be specific. This cannot be changed by the end user. For example, when the command mode is Global Configuration, the prompt display will be `iS5comm(config)#.`

The hierarchical structure of the command modes is as shown on the figure below.

Figure 1: CLI Command Modes


User EXEC
iS5comm >
Privileged EXEC
iS5comm #
Global Configuration
iS5comm(config)#
Interface Configuration
iS5comm(config-if)#
Router Configuration
iS5comm(config-router)#
Line Configuration
iS5comm(config-line)#

User Exec Mode

Prompt	Access method	Exit Method
`iS5comm>`	This is the initial mode to start a session.	logout

Privileged Exec Mode

Prompt	Access method	Exit Method
`iS5comm#`	The User EXEC mode command `enable` is used to enter the Privileged EXEC Mode	To return from the Privileged EXEC mode to User EXEC mode, the command `disable` is used.

Global Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(config)#`	The Privileged EXEC mode command `configure terminal` is used to enter the Global Configuration Mode.	To return from the Global Configuration Mode to Privileged Mode, the command `exit` is used.

Interface Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(config-if)#`	The Global Configuration mode command `interface <interface-type><interface-id>` is used to enter the Interface Configuration Mode.	To return from the Interface Configuration mode to Global Configuration Mode, the command `exit` is used. To exit from the Interface Configuration mode to Privileged EXEC Mode, the command `end` is used.

Port Channel Interface Configuration

Prompt	Access method	Exit Method
`iS5comm(config-if)#`	The Global Configuration mode command `interface port <port channel-id>` is used to enter the Port Channel Interface Configuration Mode.	To return from the Port Channel Interface Configuration mode to Global Configuration Mode, the command `exit` is used. To exit from the Port Channel Interface Configuration mode to Privileged EXEC Mode, the command `end` is used.

VLAN Interface Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(config-if)#`	The Global Configuration mode command `interface vlan <vlan id>` is used to enter the Port Channel Interface Configuration Mode.	To return from the VLAN Interface Configuration mode to Global Configuration Mode, the command `exit` is used. To exit from the VLAN Interface Configuration mode to Privileged EXEC Mode, the command `end` is used.

UFD Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(config-if)#`	The Global Configuration mode command `ufd group <group-id (1-65535)>` is used to enter the UFD Interface Configuration Mode.	To return from the UFD Configuration mode to Global Configuration Mode, the command `exit` is used. To exit from the UFD Configuration mode to Privileged EXEC Mode, the command `end` is used.

DHCP Pool Configuration Mode

Prompt	Access method	Exit Method
`iS5comm(dhcp-config)#`	The Global Configuration mode command **`iS5comm(config)# ip dhcp pool`***`<pool number (1-2147483647)>`* is used to enter the UFD Interface Configuration Mode.	To return from the DHCP Pool Configuration Mode to Global Configuration Mode, the command `exit` is used. To exit from the DHCP Pool Configuration Mode to Privileged EXEC Mode, the command `end` is used.

Privilege Levels and Command Access

The following table will list out the commands available for the different user levels in Privileged and User Exec levels.

Command	First Param	Guest	Tech	Admin	Description
archive	download-sw		x	x	Downloads software image
clear					Clears the specified parameters
	alarm	x	x	x	Alarm related information
	au-message	x	x	x	Address update messages related information
	cfa	x	x	x	CFA module related information
	interfaces	x	x	x	Protocol specific configuration of the interface
	meter-stats	x	x	x	Specific configuration for meter
	poe	x	x	x	PoE related configuration
	screen	x	x	x	Screen information
	ip		x	x	IP related configuration
	line		x	x	Configures line information
	logs		x	x	Log information
	protocol		x	x	Clears the specified protocol counters
	spanning-tree		x	x	Spanning tree related configuration
	tcp		x	x	TCP related configuration
clock	set		x	x	Sets the system clock value

Command	First Param	Guest	Tech	Admin	Description
config-restore					Configures the restore option
	flash		x	x	File in flash to be used for restoration
	norestore		x	x	No configuration restore
	remote		x	x	Remote location configuration
configure	terminal		x	x	Configures the terminal
copy			x	x	Various copy options
debug					Configures trace for the protocol
	ip	x	x	x	IP related configuration
	show	x	x	x	Show mempool status
	sntp	x	x	x	SNTP related configuration
	crypto		x	x	Crypto related information
	cybsec		x	x	Cybsec related information
	dot1x		x	x	PNAC related configuration
	etherchannel		x	x	Etherchannel related information
	firewall		x	x	Firewall related configuration
	garp		x	x	GARP related configuration
	interface		x	x	Configures trace for the interface management
	lacp		x	x	LACP related configuration
	lldp		x	x	LLDP related configuration
	lns		x	x	LCD notification server
	nat		x	x	Network Address Translation related configuration
	np		x	x	NPAPI configuration
	ptp		x	x	Precision time protocol related configuration
	qos		x	x	QOS related configuration
	security		x	x	Security related configuration

Command	First Param	Guest	Tech	Admin	Description
	spanning-tree		x	x	Spanning tree related protocol configuration
	ssh		x	x	SSH related configuration
	tacm		x	x	Transmission and admission control related configuration
	vlan		x	x	VLAN related configuration
display firewall rules				x	Display firewall rules
dot1x	clear	x	x	x	Clear dot1x configuration
	initialize		x	x	State machine and fresh authentication configuration
	re-authenticate		x	x	Re-authentication
dump					Display memory content from the given memory location
	mem		x	x	Dump memory
	que		x	x	Show the queue related information
	sem		x	x	Show the semaphore related information
	task		x	x	Show the task related information
egress bridge			x	x	
end			x	x	Exit to the privileged Exec (#) mode
erase			x	x	Clears the contents of the startup configuration
exit		x	x	x	Logout
factory reset				x	Reset to factory default configuration
factory reset	users			x	Reset all users on switch
firmware			x	x	Upgrades firmware
generate	tech		x	x	Generate the tech report of various system resources and protocol states for debugging

Command	First Param	Guest	Tech	Admin	Description
help		x	x	x	Displays help for commands
ip	igmp snooping clear counters	x	x	x	Clears the IGMP snooping statistics
	clear counters		x	x	Clear operation
	dhcp		x	x	DHCP related configuration
	pim		x	x	PIM related configuration
	ssh		x	x	SSH related information
listuser			x	x	List the user, mode and groups
lock			x	x	Lock the console
logout		x	x	x	Logout
memtrace			x	x	Configures memtrace
no ip					IP related information
	dhcp		x	x	DHCP related configuration
	ssh		x	x	SSH related information
no debug					Configures trace for the module
	ip	x	x	x	Stops debugging on IGMP or PIM
	sntp	x	x	x	Stops debugging on SNTP related configurations
	additional options...		x	x	Stops debugging for other options
ping					
	A.B.C.D	x	x	x	Ping host
	ip dns host name	x	x	x	Ping host
	ip A.B.C.D	x	x	x	Ping host
	vrf	x	x	x	Ping vrf instance
readarpfromHardware ip	A.B.C.D		x	x	Reads the arp for the given IP
readregister			x	x	Reads the value of the register from the hardware

Command	First Param	Guest	Tech	Admin	Description
release dhcp			x	x	Performs release operation
reload			x	x	Restarts the switch
renew dhcp			x	x	Performs renew operation
run script			x	x	Runs CLI commands
shell				x	Shell to Linux prompt
show		x	x	x	Shows configuration or information
sleep		x	x	x	Puts the command prompt to sleep
ssl				x	Configures secure sockets layer related parameters
snmpwalk mib					Allows the user to view Management Information Base related configuration.
	name	x	x	x	
	oid	x	x	x	
traceroute					Traces route to the destination IP
	A.B.C.D		x	x	
write			x	x	Writes the running-config to a flash file
writeregister			x	x	writes in the specified register

Configuration Terminal Access

The Guest user level does not have access to the configuration terminal.

The Administration level has access to all commands in the configuration terminal.

The Technical level has access to all commands in the configuration terminal with the following exceptions listed below.

- bridge-mode
- enableuser
- mst
- password
- traffic

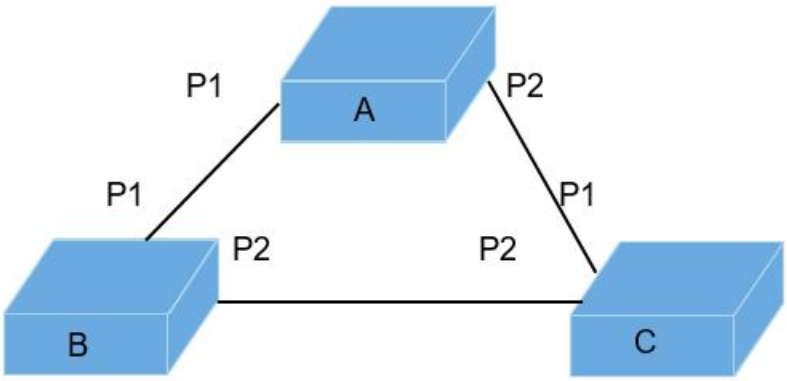
2. Configuring STP

For configuring PVRST+ on IS5Com ISS, refer to the following modules:

- Rapid Spanning Tree
- VLAN

The following sections describe the configuration of the STP.

Figure 1: Spanning Tree Topology



Switch A:

MAC Address: 00:01:02:03:04:01

VLAN 1 - 10.0.0.1/255.0.0.0

Switch B:

MAC Address: 00:02:02:03:04:01

VLAN 1 – 10.0.0.2 /255.0.0.0

Switch C:

MAC Address: 00:03:02:03:04:01

VLAN 1 – 10.0.0.3/255.0.0.0

2.1. STP Description

A Bridge allows interconnection of end stations attached to separate LANs (Local Area Networks) and allows the stations to communicate as if they were attached to a single LAN. The Bridge operates below the Media Access Control (MAC) service boundary and is transparent to the protocols operating above this boundary.

In complex networks, a loop may occur when there are two or more paths between two end points. This leads to the duplication of frames, which in turn leads to heavy traffic in the network. To avoid this, STP is used in the PVRST+ software. STP forms a logical, loop-free topology from the physical topology and forwards the frames without duplication. To avoid prolonged stabilization time following a reconfiguration event in Spanning Tree algorithm, PVRST+ provides support for RSTP. The operation of RSTP enables rapid recovery of connectivity following the failure of a Bridge/ Bridge Port or a LAN.

To isolate link fluctuations only to a particular VLAN segment and also to provide Load balancing, IS5Com's PVRST+ creates a separate Spanning tree for each VLAN. Spanning Tree to VLAN mapping will be configured on a Per VLAN basis.

PVRST+ protocol is an enhancement of RSTP, which works in conjunction with VLAN to provide better control over traffic in the network.

A switch takes the role of either a root or another type of designated switch.

STP assigns port roles to the port of switch as follows to calculate the best loop free path:

- **Root**—the port that offers the lowest cost path towards the Root bridge.
- **Designated**—a forwarding port elected for every switched LAN segment.
- **Alternate**—a blocked port providing an alternate path to the root bridge of the spanning tree.
- **Backup**—a blocked port that acts as a backup for the path provided by a Designated Port.

The following elements determine the stable and active spanning-tree topology of a switched network.

- Bridge ID (Instance ID, Switch Priority and MAC address)
- Path Cost to the Root Switch maintained for each instance
- Designated Bridge ID (The bridge through which Root Bridge is connected)
- Port Identifier (Port priority and the Port Number)

When switches in a network come up, each switch assumes itself to be the Root Bridge and starts sending configuration messages through all its ports. BPDUs (Bridge Protocol Data Units) are used to communicate and compute the spanning tree topology. These BPDUs contain the following information:

- VLANID to which this BPDU belongs
- Unique Bridge ID of the switch that has been identified as the Root
- The spanning-tree path cost to the Root
- The Bridge ID of the sending switch
- Message age
- The identifier of the sending interface (port priority and port number)
- Values for the hello, forward-delay, and max-age protocol timers

When a switch receives a superior configuration BPDU on a port, it stores the received information for that port. If the port is a root port, it forwards the updated message to all attached LANs for which this switch is the designated bridge.

If the switch receives an inferior configuration BPDU to that currently stored for that port, it discards the BPDU. If the switch is a designated switch for the LAN from which the inferior information was received, then the switch sends up-to-date information stored for that port, thus discarding inferior information

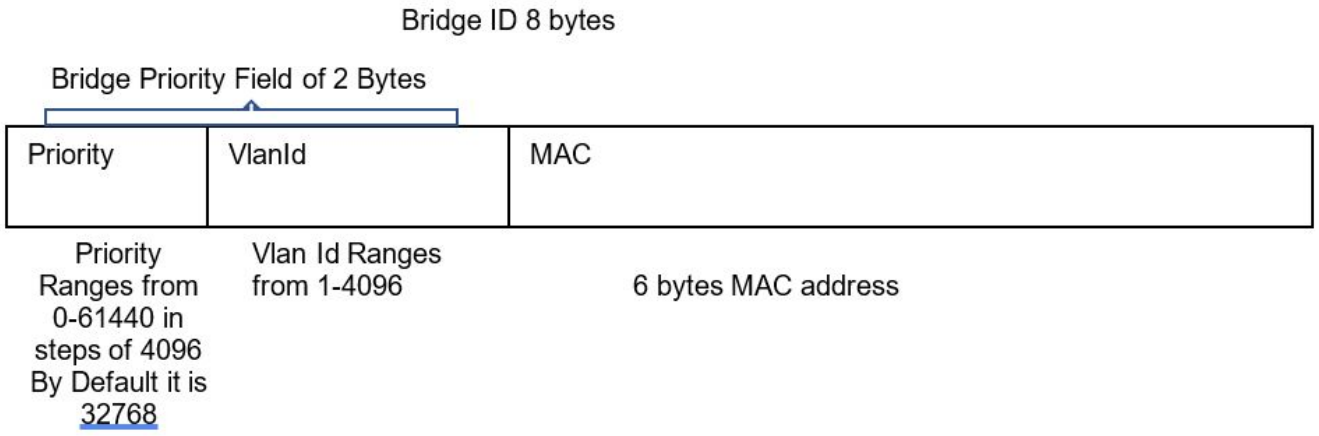
and propagating superior information in the network. Each Layer 2 interface in the switch running PVRST is in one of the following states for each Vlan Running on the switch.

- **Blocking**—the interface in this state discards the frames and does not learn the MAC addresses.
- **Listening**—this is the first state to which a port transit after blocking. The interface enters this state when spanning tree decides that the interface must participate in frame forwarding.
- **Learning**—an interface enters this state from listening state. In this state, the interface gets ready to participate in frame forwarding and learns MAC addresses from the packet received.
- **Forwarding**—in this state, the interface receives and forwards frames received on that port or forwards frames switched from another port. This transition from blocking to forwarding takes 30 seconds.

2.2. Bridge ID and Switch Priority

Each switch has a unique bridge identifier (bridge ID) that determines the selection of the Root Switch. The bridge ID is an 8-byte field that is composed of two subfields as shown in the figure below.

Figure 2: Bridge ID for Each VLAN



2.3. Election of Root Switch

All switches in a Layer 2 network, participating in STP, gather information on other switches in the network through an exchange of data messages called Bridge Protocol Data Units (BPDUs). The exchange of messages results in the following actions:

- Election of a unique Root Switch for each spanning tree instance
- Election of a Designated switch for every switched LAN segment
- Removal of loops in the switched network by blocking Layer 2 interfaces connected to redundant links

The switch with the highest switch priority (the lowest numerical priority value) is elected as the Root Switch. If all switches are configured with the default priority (32768) for Vlan with ID 1 (i.e. Bridge Priority of 32769), the switch with the lowest MAC address becomes the Root Switch. The switch priority value occupies the most significant bits of the bridge ID. The Root Switch is the logical center of the STP topology in a switched network. Redundant paths to the Root are put in STP blocking mode.

BPDUs contain information about the sending switch and its ports. The information includes switch and port MAC addresses, switch priority, port priority, and path cost. The STP uses this information to elect the Root Switch and the root port for the switched network, and the root port and the designated port for each switched segment.

2.4. VLAN

VLAN is a network of computers that behave as if they are connected to the same wire even though they are physically located on different segments of a LAN. VLAN's are configured through software rather than hardware, which make them extremely flexible. One of the biggest advantages of VLAN's is that when a computer is physically moved to another location, it can stay on the same VLAN without any hardware reconfiguration.

NOTE: Current IS5Com's PVRST+ release does not support GVRP (Generic Attribute Registration Protocol VLAN Registration Protocol)

CONFIGURING PVRST+

3. Configuring PVRST

The following sections describe the configuration of is5 PVRST running as a part of is5 ISS.

3.1. Configuring RSTP

The following sections describe the configuration of the Rapid Spanning Tree Protocol used in PVRST+ Module.

PVRST+ Description

The Rapid Spanning Tree Protocol used in PVRST+ Module is based on the IEEE 802.1D rapid reconfiguration. The existing spanning tree protocol takes significant time to re-configure and restore the service on link failure/restoration. RSTP avoids re-convergence delay by calculating an alternate root port and immediately switching over to the alternate port if the root port becomes unavailable.

Port States

Table 1: Port States

STP (802.1D)Port State	RSTP (802.1W)Port State	Is Port Included in active topology?	Is Port Learning MAC address?
Disabled	Discarding	No	No
Blocking	Discarding	No	No
Listening	Discarding	No	No
Learning	Learning	No	Yes
Forwarding	Forwarding	Yes	Yes

Port Roles

Table 2: Port States

Port Role	Description
Root	Provides the best path to the root. This is the port that receives the best BPDU on a bridge.
Designated	A port is designated if it can send the best BPDU on a segment to which it is connected. Bridges connected to a given segment listen to the BPDUs of other bridges and agree on the bridge sending the best BPDU as the designated bridge for that segment and the port as designated port.
Alternate	A port blocked since another port on the bridge receives superior information from another bridge. This port corresponds to the blocking state of 802.1w
Back-up	A port blocked since another port receives superior information from the same bridge. This port also corresponds to the blocking state of 802.1w.

A root port or a designated port role is included in the active topology. A port such as alternate or backup port is excluded from the active topology.

Port Convergence

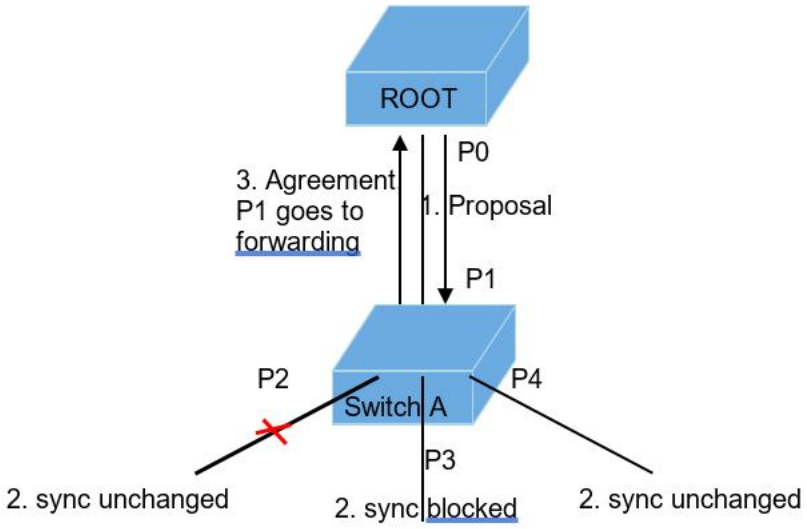
Faster convergence compared to legacy spanning tree algorithm is the most important feature in RSTP. RSTP relies on two new variables for achieving this.

- **Edge Port**—ports that are directly connected to end stations do not create bridging loops, so these ports rapidly transition to forwarding, skipping the learning and listening states. The topology-change is not triggered, when the link toggles on an edge port. When a BPDU is received on an edge port, it loses its edge port status and becomes a normal spanning tree port. IS5Com PVRST+ uses portfast keyword for edge port configuration.
- **Link Types**—PVRST+ achieves rapid transition on point-to-point links. The link type is automatically derived from the duplex mode of a port. A port operating in full-duplex mode is assumed to be point-to-point, while a half-duplex port will be considered as a shared port by default. This auto-matic link type setting is overridden by changing the configuration settings

Proposal Agreement Sequence

In a Spanning tree algorithm, a port selected as a designated port waits for 2 x fwd_delay (2 x 15) seconds before transitioning to forwarding state. In PVRST+, this port corresponds to a designated role and blocking state.

Figure 1: Proposal Agreement Handshake



- P0: Designated port,
- P1: New root port,
- P2: Alternate port,
- P3: Designated port, and
- P4: Edge Port.

If a new link is created between the Root and Switch A, then both the ports on this link are put in designated blocking state, until they receive a BPDU from their counterpart. The proposal bit on the BPDUs is set and sent out only when a designated port is in discarding or learning state. This happens for port P0 of the root bridge. Since switch A receives superior information; it immediately knows that P1 will be its new root port. Switch A then starts a sync operation to ensure that all of its ports are in-sync with this new information. A port is in-sync if it meets either of the following criteria:

- The port is in blocking state.
- The port is an edge port.

If an alternate port P2, a designated forwarding port P3, and an edge port P4 exist on Switch A, P2 and P4 already meet one of the listed criteria. To be in sync, switch A blocks port P3 by assigning the discarding state to it. If all ports are in sync, switch A unblocks its newly selected root port P1 and replies to the Root by sending an agreement message (step 3). This message is a copy of the proposal BPDU with the agreement bit set instead of the proposal bit. This ensures that port P0 knows exactly to which proposal the agreement it receives corresponds.When port P0 receives that agreement, port P0 immediately transition to forwarding. Port P3, which was left in a designated discarding state after the sync, is exactly in the same state as port P0 before receiving the agreement (refer to Step 1). The Port P3 then starts proposing to its neighbor to quickly transit to forwarding. This handshake mechanism propagates quickly towards the edge of the network and quickly restores connectivity after a change in the topology

Topology Change and Topology Change Detection

When an 802.1D Bridge detects a topology change, it first notifies the Root Bridge using a reliable mechanism. Once the Root Bridge is aware of a change in the topology of the network, it sets the Topology Change (TC) flag on the BPDUs it sends out. The BPDUs are then relayed to all bridges in the network. When a bridge receives a BPDU with the TC flag bit set, it reduces its bridging-table aging time to forward delay seconds, ensuring a relatively quick flushing of stale information.

In RSTP, only non-edge ports moving to the forwarding state cause a TC. Thus, a loss of connectivity is not considered as a TC any more, which is contrary to 802.1D (that is, a port moving to blocking does no longer generate a TC). When a RSTP bridge detects a TC, the following happens:

- RSTP bridge starts the TC while timer with a value equal to twice the Hello Time for all its non-edge designated ports and its root port, if necessary.
- It flushes the MAC addresses associated with all these Non-edge designated ports.
- As long as the TC while timer is running on a port, the BPDUs sent out of that port have the TC bit set. The BPDUs are also sent on the root port while the timer is active.

Default Configuration

Table 3: Default Configuration

Feature	Default Setting
Spanning Tree mode	RSTP (Rapid Spanning Tree Protocol)
Spanning Tree Status	Enabled
Spanning tree timers	Hello time: 2 seconds Forward-delay time: 15 seconds. Maximum-aging time: 20 seconds.
Switch Priority	32768
Spanning-tree port priority (configurable on a per-interface basis)	128
Spanning-tree port cost (configurable on a per-interface basis)	200000
PVRST Module	Disabled
Port’s Type	Hybrid
GVRP	Enabled
VLAN Module	Enabled

When an IS5Com switch starts, RSTP is enabled. PVRST+ is started and enabled once GVRP is disabled.

Configuring Spanning Tree Bridge Priority

For Topology, refer to figure Spanning Tree Topology. All switches must be in default configurations. Start and Enable PVRST+ on all switches. After the topology stabilizes, switch A is elected as Root since it has the least MAC address. All ports of all switches (except Port 2 of switch C) are in forwarding state. Port 2 of Switch C has been detected as an alternate port and is in discarding state.

1. Execute the following commands in the switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Set the priority for the STP.

   ```
   iS5comm(config)# spanning-tree mode pvrst
   iS5comm(config)# spanning-tree vlan 1 brg-priority 4096
   ```

   – Configure STP is per VLAN in PVRST+.

   For priority, the user can provide a value from 0 to 61440 in increments of 4096. The priority provided by the user is combined with VLAN Id to get actual Priority for the instance created for this VLAN. If no value is specified, then VLAN Id is combined with a default value of 32768. The lower the number, the more likely that the switch will be chosen as the Root Switch.

   Valid priority values are 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, and 61440. All other values are rejected.

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config)#end
   ```

   NOTE: Observation after configuring the Bridge priority for Switch C: Switch C has been detected as the Root and Port 1 of Switch B is the Alternate Port.

2. View the spanning tree information by executing the following show command.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree vlan 1
   ```

   In Switch A

   ```
   Spanning-tree for VLAN 1
   Root Id         Priority   4097
   Address    00:03:02:03:04:01
   Cost       200000
   Port       2
   Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

   Spanning Tree Enabled Protocol PVRST
   Bridge Id       Priority 32769
   Address 00:01:02:03:04:01
   ```

```
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name   Role        State        Cost   Prio   Type
----   ----        -----        ----   ----   -----
Gi0/1  Designated  Forwarding   200000 128    SharedLan
Gi0/2  Root        Forwarding   200000 128    SharedLan
```

In Switch B

```
Spanning-tree for VLAN 1
Root Id         Priority   4097
Address    00:03:02:03:04:01
Cost       200000
Port       2
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role        State        Cost    Prio   Type
----    ----        -----        ----    ----   -----
Gi0/1   Alternate   Discarding   200000  128    SharedLan
Gi0/2   Root        Forwarding   200000  128    SharedLan
```

In Switch C

```
Spanning-tree for VLAN 1
Root Id         Priority   4097
Address    00:03:02:03:04:01
Cost       200000
Port       2
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 4097
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role        State        Cost   Prio   Type
----    ----        -----        ----   ----   -----
Gi0/1   Designated  Forwarding   200000  128    SharedLan
Gi0/2   Designated  Forwarding   200000  128    SharedLan
```

NOTE: Execute the no spanning-tree vlan <Vlan-Id> brg-priority Global Configuration mode command to set the Priority to its default value.

```
iS5comm(config)# no spanning-tree vlan <Vlan-Id> brg-priority
```

Configuring Spanning Tree Path Cost

CONTEXT:

When a loop occurs in the network topology, STP path cost can be used to determine the spanning-tree states of the ports. Path cost is obtained from the speed of the interface. A user configures lower path cost for an interface if the port needs to be selected first, or the user configures higher path cost if the port needs to be selected last for putting it into forwarding state.

Path cost is used to determine the topology only if the loop in the network cannot be resolved using only the Bridge IDs. If all ports have same path cost values, then the spanning tree first puts the lowest numbered port into forwarding state.

Refer to Figure Spanning Tree Topology for topology. After the topology stabilizes and switch A is elected as Root, the ports of all switches, except Port 2 of switch C, are in forwarding state. Port 2 of Switch C is an alternate port and is in discarding state.

This example configures the path cost associated with port 0/1 to 2000.

1. Execute the following commands in the switch C.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Specify the interface for which the path cost is to be configured.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   NOTE: Valid interfaces include physical interfaces and port-channel logical interfaces (port-channel port-channel-number).

   – Configure the cost for the interface.

   For cost, the range is 1 to 200000000 and the default value is derived from the media speed of the interface.

   ```
   iS5comm(config-if)# spanning-tree vlan 1 cost 2000
   ```

   NOTE: Observation after configuring the Path Cost for port 1 in Switch C: Port 2 of Switch B is the Alternate Port and Port 2 of Switch C is a Designated Port.

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#end
   ```

2. View the spanning tree information by executing the following show command.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree vlan 1
   ```

   In Switch B

   ```
   Spanning-tree for VLAN 1
   Root Id         Priority 32769
   Address    00:03:02:03:04:01
   Cost       200000
   Port       2
   ```

```
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role       State       Cost    Prio   Type
----    ----       -----       ----    ----   -----
Gi0/1   Root       Forwarding  200000  128    SharedLan
Gi0/2   Alternate  Forwarding  200000  128    SharedLan
```

In Switch C

```
Spanning-tree for VLAN 1
Root Id         Priority 32769
Address    00:03:02:03:04:01
Cost       200000
Port       2
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role        State        Cost    Prio   Type
----    ----        -----        ----    ----   -----
Gi0/1   Root        Discarding   2000    128    SharedLan
Gi0/2   Designated  Forwarding   200000  128    SharedLan
```

NOTE: Execute the no spanning-tree vlan <vlan-id> cost Interface Configuration mode command to set the default value of the Spanning Tree Path Cost

```
iS5comm(config-if)# no spanning-tree vlan <vlan-id>  cost
```

Configuring Spanning Tree Link Type

CONTEXT:

If a port is configured as point-to-point link and its port role is designated, then IS5Com PVRST+ negotiates a rapid transition to forwarding with the other port by using a proposal-handshake agreement mechanism to ensure that the topology is loop free. By default, if the interface is full-duplex, it is considered to have a point-to-point connection. If the interface is half duplex, then it is considered to have a

shared connection. This default setting of link type can be overridden to enable rapid transition to forwarding port state.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Specify the interface for which the link type is to be configured.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   NOTE: Valid interfaces include physical interfaces and port-channel logical interfaces (port-channel port-channel-number).

   – Configure link type of interface as point-to-point.

   iS5comm(config-if) # spanning-tree link-type point-to-point

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#end
   ```

2. View the spanning tree information by executing the following show command.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree vlan 1
   Spanning-tree for VLAN 1
   We are the root of the Spanning Tree
   Root Id         Priority   32769
   Address    00:01:02:03:04:01
   Cost       0
   Port       0
   Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec
   Spanning Tree Enabled Protocol PVRST
   Bridge Id       Priority 32769
   Address 00:01:02:03:04:01
   Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
   Name   Role         State       Cost     Prio   Type
   ----   ----         -----       ----     ----   ------
   Gi0/1  Designated   Forwarding  200000   128    P2P
   Gi0/2  Designated   Forwarding  200000   128    SharedLan
   ```

   NOTE: Execute the no spanning-tree link-type Interface Configuration mode command to set the default value of the link type.

   ```
   iS5comm(config-if)# no spanning-tree link-type
   ```

Configuring Spanning Tree Portfast

CONTEXT:

All ports that are directly connected to end stations cannot create bridging loops and can rapidly transition to forwarding skipping the learning and listening states.

To allow immediate transition of the port into forwarding state, enable the STP Portfast feature. Portfast immediately transitions the port into STP forwarding mode upon linkup. The port still participates in STP. So, if the port is to be a part of the loop, the port eventually transitions into STP blocking mode

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Specify the interface for which the auto edge configuration is to be done.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   NOTE: Valid interfaces include physical interfaces and port-channel logical interfaces (port-channel port-channel-number).

   – Shutdown the interface.

   ```
   iS5comm(config-if)# shutdown
   ```

   – Specify that the port has only hosts connected to it and hence can transition the port to forwarding rapidly.

   ```
   iS5comm(config-if) # spanning-tree portfast
   Warning: portfast should only be enabled on ports connected to a single
   host.
   Connecting hubs, concentrators, switches, bridges, etc... to this
   interface when portfast is enabled, can cause temporary bridging loops.
   Use with CAUTION
   ```

   – Execute the no shutdown command to make the interface up.

   ```
   iS5comm(config-if)# no shutdown
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#end
   ```

2. View the spanning tree information by executing the following show command.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree interface gigabitethernet 0/1 portfast
   spanning-tree portfast is Enabled
   ```

   NOTE: Execute the no spanning-tree portfast Interface Configuration mode command to set the default spanning tree portfast for an interface.

   ```
   iS5comm(config-if)# no spanning-tree portfast
   ```

Configuring Spanning Tree Timers

CONTEXT:

The following table describes the timers.

Table 4: Timers

Variable	Description
forward-time	Controls how fast a port changes its spanning tree state from Blocking state to Forwarding state.
hello-time	Determines how often the switch broadcasts its hello message to other switches. In case a bridge is root bridge for a topology then all bridges in that topology will use the value of hello time from the root bridge to broadcast their hello message.
max-age	The maximum time allowed for the Spanning Tree Protocol information learnt from the network on any port to be retained before it is discarded.

1. Execute the following commands to configure forward-time in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure the spanning tree timer.

   NOTE: The forward-time range is 4-30. Default value is 15 seconds.

   ```
   % PVRST is Started Enter Vlan Id For Configuration
   iS5comm(config)# spanning-tree vlan 3 forward-time 5
   ```

   NOTE: If you get a message “Forward Time for the given instance is set”, then apply the no form of the forward-time command as shown below. The following relation should be observed.

2*(ForwardDelay -1)>=MaxAge >= 2*(Hello Time + 1),

then choose a new value for forward-time.

```
iS5comm(config)# spanning-tree vlan 2 forward-time 11
Forward Time for the given instance is set.
```

– Return to the Privileged EXEC Mode.

```
iS5comm(config)# exit
```

2. Execute the following commands to configure Hello Time.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure hello-time.

   NOTE: The hello-time range is 1-2. Default value is 2 seconds.

   ```
   iS5comm(config)# spanning-tree vlan 3 hello-time 2
   Hello Time for the given instance is set
   ```

– Return to the Privileged EXEC Mode.

```
iS5comm(config)# exit
```

3. Execute the following commands to configure Max Age.

FOR EXAMPLE: Type the following:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Configure max-age.

NOTE: The max-age range is 6-40. Default value is 20 seconds.

```
iS5comm(config)# spanning-tree vlan 3 max-age 19
Max Agefor the given instance is set
```

– Return to the Privileged EXEC Mode.

```
iS5comm(config)# exit
```

4. View the spanning tree information by executing the following show command.

FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree vlan 1
Hello Time 2 Sec, Max Age 19 Sec, Forward Delay 11 Sec
Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 19 sec, Forward Delay 11 sec
Name   Role         State        Cost     Prio   Type
----   ----         -----        ----     ----   -----
Gi0/1  Designated   Forwarding   200000   128    SharedLan
Gi0/2  Designated   Forwarding   200000   128    SharedLan
```

NOTE: Execute the no form of the timer command (in Global Configuration mode) to set the spanning tree timers to their default values.

```
iS5comm(config-if)# no spanning-tree vlan <vlan-id> forward-time
iS5comm(config-if)# no spanning-tree vlan <vlan-id> hello-time
iS5comm(config-if)# no spanning-tree vlan <vlan-id> max-age
% PVRST is Started Enter Vlan Id For Configuration
```

Displaying Spanning Tree Status

CONTEXT:

The following commands display the Spanning Tree status.

1. Execute the following commands in the switch to view the Spanning Tree Status.

FOR EXAMPLE: Type the following:

```
iS5comm# show spanning-tree active
Spanning-tree for VLAN 1
```

```
We are the root of the Spanning Tree
Root Id         Priority   32769
Address    00:01:02:03:04:01
Cost       0
Port       0
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name    Role         State        Cost     Prio   Type
----    ----         -----        ----     ----   ------
Gi0/1   Designated   Forwarding   200000   128    SharedLan

Spanning-tree for VLAN 2
We are the root of the Spanning Tree
Root Id         Priority   32770
Address    00:01:02:03:04:01
Cost       0
Port       0
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32770
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ------
Gi0/1  Designated  Discarding   200000   128    SharedLan


iS5comm# show spanning-tree detail
Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32769, Address 00:01:02:03:04:01
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
We are the root of the spanning tree
Number of Topology Changes 0
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec
```

```
Port 1 [Gi0/1] of VLAN 1 is Designated, Forwarding
Port PathCost 200000, Port Priority 128, Port Identifier  128.1
Designated Root has priority 32769, address 00:01:02:03:04:01
Designated Bridge has priority 32769, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :1
BPDUs : sent 41 , received 0

Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32770, Address 00:01:02:03:04:01
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
We are the root of the spanning tree
Number of Topology Changes 1
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Gi0/1] of VLAN 2 is Designated, Forwarding
Port PathCost 200000, Port Priority 128      , Port Identifier  128.1
Designated Root has priority 32770, address 00:01:02:03:04:01
Designated Bridge has priority 32770, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :1
BPDUs : sent 29 , received 0

iS5comm# show spanning-tree vlan 1 active
Spanning-tree for VLAN 1
We are the root of the Spanning Tree
Root Id         Priority   32769
Address    00:01:02:03:04:01
Cost       0
Port       0
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
```

```
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name   Role         State        Cost     Prio   Type
----   ----         -----        ----     ----   -----
Gi0/1  Designated   Forwarding   200000   128    SharedLan

iS5comm# show spanning-tree vlan 1 detail
Bridge is executing the rstp compatible PVRST Protocol
Bridge Identifier has priority 32769, Address 00:01:02:03:04:01
Configured Hello time 2 sec, Max Age 20 sec, Forward Delay 15 sec
We are the root of the spanning tree
Number of Topology Changes 1
Time since topology Change 0 seconds ago
Transmit Hold-Count 3
Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

Port 1 [Gi0/1] of VLAN 1 is Designated, Forwarding
Port PathCost 200000   , Port Priority 128      , Port Identifier  128.1
Designated Root has priority 32769, address 00:01:02:03:04:01
Designated Bridge has priority 32769, address 00:01:02:03:04:01
Designated Port Id is 128.1, Designated PathCost 0
Timers: Hello Time - 2, MaxAge - 20, Forward Delay - 15, Hold - 1
No of Transitions to forwarding State :2
BPDUs : sent 188 , received 0
iS5comm# show spanning-tree vlan 1 interface gigabitethernet 0/1
Role         State        Cost     Prio
----         -----        ----     ----
Designated   Forwarding   200000   128

iS5comm# show spanning-tree vlan 1 summary
Spanning tree enabled protocol is PVRST
Spanning-tree pathcost method is long

PVRST Port Roles and States
Port-Index  Port-Role    Port-State   Port-Status
----------  ---------    ----------   -----------
1           Designated   Forwarding   Enabled
2           Designated   Forwarding   Enabled
3           Designated   Discarding   Enabled
4           Designated   Discarding   Enabled
5           Designated   Discarding   Enabled
```

```
6           Designated   Discarding   Enabled
7           Designated   Discarding   Enabled
8           Designated   Discarding   Enabled
9           Designated   Discarding   Enabled
10          Designated   Discarding   Enabled
11          Designated   Discarding   Enabled
12          Designated   Discarding   Enabled
13          Designated   Discarding   Enabled
14          Designated   Discarding   Enabled
15          Designated   Discarding   Enabled
16          Designated   Discarding   Enabled
17          Designated   Discarding   Enabled
18          Designated   Discarding   Enabled
19          Designated   Discarding   Enabled
20          Designated   Discarding   Enabled
21          Designated   Discarding   Enabled
22          Designated   Discarding   Enabled
23          Designated   Discarding   Enabled
24          Designated   Discarding   Enabled
```

Table 5: show Commands displaying Spanning Tree status

Command	Purpose
show spanning-tree active	Displays the detail of the bridge and active ports for all active instances. (Active ports are those ports that are participating in the spanning-tree)
show spanning-tree detail	Displays in detail about the port and bridge for all active instances. This includes designated bridge details, designated port details, timer values, root bridge, etc.
show spanning-tree vlan 1 active	Displays the detail of the bridge and active port for the instance corresponding to requested vlan.
show spanning-tree vlan 1 detail	Displays in detail about the port and bridge. This includes designated bridge details, designated port details, timer values, root bridge, etc.
show spanning-tree vlan 1 interface interface-id	Displays spanning tree information for the specified interface.
show spanning-tree vlan 1 summary	Displays a summary of port states or displays the total lines of the STP state section.

Configuring Transmit Hold Count

CONTEXT:

Transmit hold count value is a counter used to limit the maximum transmission rate of the switch.

The number of BPDUs transmitted during every Hello Time period ranges from a minimum of one to a maximum of not more than TxHoldCount values.

1. Execute the following commands in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Configure the Transmit Hold Count.

   NOTE: The transmit hold count ranges from 1-10. The default value is 6.

   ```
   iS5comm(config)# spanning-tree vlan 1 hold-count 7
   Hold Count for the given instance is set
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config)# exit
   ```

2. View the spanning tree information by executing the following show command.

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree vlan 1 detail
   Bridge is executing the rstp compatible PVRST Protocol
   Bridge Identifier has priority 32769, Address 00:01:02:03:04:01
   Configured Hello time 2 sec, Max Age 19 sec, Forward Delay 11 sec
   We are the root of the spanning tree
   Number of Topology Changes 1
   Time since topology Change 0 seconds ago
   Transmit Hold-Count 7
   Max Age 20 Sec, Forward Delay 15 Sec, Hello Time 2 Sec

   Port 1 [Gi0/1] of VLAN 1 is Designated, Forwarding
   Port PathCost 200000, Port Priority 128, Port Identifier  128.1
   Designated Root has priority 32769, address 00:01:02:03:04:01
   Designated Bridge has priority 32769, address 00:01:02:03:04:01
   Designated Port Id is 128.1, Designated PathCost 0
   Timers: Hello Time - 2, MaxAge - 19, Forward Delay - 11, Hold - 1
   No of Transitions to forwarding State :2
   BPDUs : sent 804 , received 0
   ```

   NOTE: Execute the no spanning-tree vlan 1 hold-count Global Configuration mode command to configure the transmit hold-count to its default value.

   ```
   iS5comm(config)# no spanning-tree vlan 1 hold-count
   ```

Configuring Encapsulation

CONTEXT:

For VLAN information to be passed between switches, trunking must be configured between the switches. VLAN trunking allows a port to pass traffic from multiple VLANs between the two switches. Frames traveling over a trunk are tagged to identify to which VLAN the frames belong. When implementing trunking between switches, the ports at either end of the connection are set up for trunk mode, and the trunk encapsulation mode must match.

Trunk encapsulation dictates the manner in which frames are identified (tagged) on a trunk and defines the VLAN services available. To set the Encapsulation type as ISL on the Interface, first set up the Port as trunk.Transmit hold count value is a counter used to limit the maximum transmission rate of the switch.

By default, the Dot1q Encapsulation is set.

1. Execute the following commands to set the Encapsulation type as ISL in the switch.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the Interface Configuration mode.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   – Configure the Port as Trunk Port.

   ```
   iS5comm(config-if)# switchport mode trunk
   ```

   – Set the Encapsulation type as ISL.

   ```
   iS5comm(config-if)# spanning-tree encap ISL
   Pvrst Encapsulation ISL is set.
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#end
   ```

2. View the following output - verify if the encapsulation type is set as ISL on Port 1).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree interface gigabitethernet 0/1
   encapsulationtype
   Encapsulation Type is ISL
   ```

   NOTE: Execute the no spanning-tree encap Interface Configuration Mode command to set the Encapsulation type as dot1q on the interface.

   ```
   iS5comm(config-if)# no spanning-tree encap
   Pvrst Encapsulation Dot1q is set.
   ```

Configuring BPDU Guard

CONTEXT:

BPDU Guard can be enabled/disabled on per port basis— it disables the port upon BPDU reception on the port. The disablement effectively denies devices behind such ports from participation in STP. After this, the port can only be manually enabled

By default, the BPDU Guard is disabled.

1. Execute the following commands to set the BPDU Guard on the Interface.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the Interface Configuration mode.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   – Enable the BPDU Guard on the Port.

   ```
   iS5comm(config-if)# spanning-tree bpduguard enable

   Bpdu Guard is Enabled
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#end
   ```

2. View the following output (if on Port 1 BPDU guard is set).

   FOR EXAMPLE: Type the following:

   ```
   iS5comm# show spanning-tree interface gigabitethernet 0/1 bpduguard
   ```

   Bpdu Guard is Enabled

   NOTE: Execute the no spanning-tree bpduguard Interface Configuration Mode command to disable Bpdu guard on the interface.

   ```
   iS5comm(config-if)# no spanning-tree bpduguard
   ```

Configuring Root Guard

CONTEXT:

Root Guard can be enabled or disabled on per port basis. If enabled on port, the switch ignores superior BPDUs received on that port and blocks that port. The port will revert back to forwarding automatically once it stops receiving superior BPDUs. To enable the Root Guard on the Interface, first configure the Port as trunk.

By default, the Root Guard is disabled.

1. Execute the following commands to set the Root Guard on the Interface.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Enter the Interface Configuration mode.

```
iS5comm(config)# interface gigabitethernet 0/1
```

– Configure the Port as Trunk Port.

```
iS5comm(config-if)# switchport mode trunk
```

– Enable the Root Guard on the Port.

```
iS5comm(config-if)# spanning-tree guard root
```

– Return to the Privileged EXEC Mode.

```
iS5comm(config-if)#end
```

2. Execute the no spanning-tree guard command in Interface Configuration Mode to disable Root Guard on the interface.

   FOR EXAMPLE: Type the following:

```
iS5comm(config-if)# no spanning-tree guard
Pvrst RootGuard is disabled
```

Configuring Loop Guard

CONTEXT:

Loop Guard can be enabled or disabled on a port. This feature changes the port to an inconsistent state if no BPDUs are received, thus, isolating the failure and letting spanning tree converge to a stable topology until the port starts receiving BPDUs again.

This feature prevents alternative or root ports from becoming designated ports due to failure in a unidirectional link. This feature is useful when the neighbor bridge is faulty, that is, the bridge cannot send BPDUs but continues to send data traffic.

This parameter can be configured only for point-to-point links.

Loop Guard feature is not supported for shared links

Loop Guard feature can be enabled on all port types—access, trunk & hybrid, but the behavior of a loop-guard enabled hybrid port in an interoperation scenario is not defined in the implementation.

By default, the Loop Guard is disabled.

1. Execute the following commands to set the Loop Guard on the Interface.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

   – Enter the Interface Configuration mode.

```
iS5comm(config)# interface gigabitethernet 0/1
```

   – Configure the link type as point-to-point.

```
iS5comm(config-if)# spanning-tree link-type point-to-point
```

   – Enable the Loop Guard on the particular port.

```
iS5comm(config-if)# spanning-tree guard loop
```

– Return to the Privileged EXEC Mode.

```
iS5comm(config-if)#end
```

2. Execute the following show commands to view the output.

FOR EXAMPLE: Type the following:

```
iS5comm# show spanning vlan 1 interface gigabitethernet 0/1 detail
Loopguard is enabled on the port
```

NOTE: Execute the no spanning-tree guard command in Interface Configuration Mode to disable Loop Guard on the interface.

```
iS5comm(config-if)# no spanning-tree guard
```

Configuring BPDU Filter

CONTEXT:

BPDU Filter can be enabled or disabled on per port basis. If enabled on port, the switch ignores BPDUs received on the port and blocks it. The port will revert back to forwarding automatically once it stops receiving BPDUs or error recovery disable timer expires.

By default, the BPDU Filter is disabled.

1. Execute the following commands to set the Loop Guard on the Interface.

FOR EXAMPLE: Type the following:

– Enter the Global Configuration Mode.

```
iS5comm# configure terminal
```

– Enter the Interface Configuration mode.

```
iS5comm(config)# interface gigabitethernet 0/1
```

– Enable the BPDU Filter on the Port.

```
iS5comm(config-if)# spanning-tree bpdufilter enable
```

– Return to the Privileged EXEC Mode.

```
iS5comm(config-if)#end
```

2. Execute the following show commands to view the output.

FOR EXAMPLE: Type the following:

```
iS5comm# show spanning vlan 1 interface gigabitethernet 0/1 detail
BPDU filter is Enabled
```

NOTE: Execute the no spanning-tree bpdufilter command in Interface Configuration Mode to disable BPDU Filter on the interface.

```
iS5comm(config-if)# no spanning-tree bpdufilter
```

3.2. Configuring PVRST+ VLAN Module

The following sections describe the configuration of a PVRST+ VLAN Module. The following has to be performed:

- Disable GVRP module.
- Configure Trunk, Access, and Hybrid Ports

Pre-Requisites for Running PVRST+

CONTEXT:

To set up a PVRST+ module as completely operational, some initial configurations are required. The following is to be done:

- GVRP module must be disabled.

Disabling GVRP

1. Execute the following commands in the IS5Com ISS

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Disable GVRP Module.

   ```
   iS5comm (config)# set gvrp disable
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config)#exit
   ```

Configuring Trunk, Access, and Hybrid Ports

CONTEXT:

Once PVRST+ is enabled, user has to explicitly issue commands to configure ports as Trunk or Access and as member ports of a VLAN.

In PVRST+, ports are configured as either Trunk or Access or Hybrid for making Port membership to a particular VLAN. The default port type is Hybrid.

1. Once port is created successfully, it becomes a member port of default VLAN. To configure a port as Trunk, execute the following commands.

   FOR EXAMPLE: Type the following:

   – Enter the Global Configuration Mode.

   ```
   iS5comm# configure terminal
   ```

   – Enter the Interface Configuration mode.

   ```
   iS5comm(config)# interface gigabitethernet 0/1
   ```

   – Configure a port as Trunk.

   ```
   iS5comm(config-if)# switchport mode trunk
   ```

   – Return to the Privileged EXEC Mode.

   ```
   iS5comm(config-if)#exit
   ```

NOTE: Once a port is configured as trunk port, it becomes member port of all active VLANs in the system.

2. To configure a port as Access, execute the following commands.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config) # set port gvrp gigabitethernet 0/1 disable
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# switchport acceptable-frame-type
untaggedAndPrioritytagged
iS5comm(config-if) # switchport mode access
iS5comm(config-if)#exit
```

   NOTE: An Access port becomes a Member port of a VLAN as per the PVID (Port VLAN ID) for that port. .

3. To configure a PVID for a particular port, execute the following commands.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config) # set port gvrp gigabitethernet 0/1 disable
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if) # switchport pvid 1
iS5comm(config-if)#exit
```

3.3. Example of PVRST+ Configuration

1. Execute the following commands.

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)# set gvrp disable
iS5comm(config)# spanning-tree mode pvrst
Spanning Tree enabled protocol is RSTP, now RSTP is being shutdown
iS5comm(config)# interface gigabitethernet 0/1
iS5comm(config-if)# switchport mode trunk
iS5comm(config-if)# no shutdown
iS5comm(config-if)# exit
iS5comm(config)# vlan 1
iS5comm(config-vlan)# vlan active
iS5comm(config-vlan)# exit
iS5comm(config)# vlan 2
iS5comm(config-vlan)# vlan active
iS5comm(config-vlan)# end
```

```
iS5comm# show spanning-tree
-----------------------------------------------------
Spanning-tree for VLAN 1
We are the root of the Spanning Tree
Root Id         Priority   32769
Address    00:01:02:03:04:01
Cost       0
Port       0
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32769
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ------
Gi0/1  Designated  Forwarding   200000   128    SharedLan

Spanning-tree for VLAN 2
We are the root of the Spanning TreeRoot Id         Priority   32770
Address    00:01:02:03:04:01
Cost       0
Port       0
Hello Time 2 Sec, Max Age 20 Sec, Forward Delay 15 Sec

Spanning Tree Enabled Protocol PVRST
Bridge Id       Priority 32770
Address 00:01:02:03:04:01
Hello Time 2 sec, Max Age 20 sec, Forward Delay 15 sec
Name   Role        State        Cost     Prio   Type
----   ----        -----        ----     ----   ------
Gi0/1  Designated  Forwarding   200000   128    SharedLan
Summary Steps
```

2. Below listed commands are executed in a specified sequence to configure PVRST+ and start functioning

   FOR EXAMPLE: Type the following:

```
iS5comm# configure terminal
iS5comm(config)#set gvrp disable
iS5comm(config)#spanning-tree mode pvrst
```

```
iS5comm(config)# interface interface-type <interface-id>
iS5comm(config-if )#switchport mode trunk
iS5comm(config-if )#no shutdown
iS5comm(config-if )#end
```

NOTE: A port which is untagged member of a VLAN cannot be configured as Trunk Port. A port becomes member of VLAN's only by configuring it as a Trunk / Access / Hybrid tagged port.Access port becomes member of VLAN that as per its PVID.A port becomes member of VLAN's only by configuring it as a Trunk / Access / Hybrid tagged port